

# Chapter 2

## Race and Ethnicity

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### Overview

Respiratory health disparities are major sources of morbidity and mortality among disadvantaged populations in the United States (US). As US demographics shift away from a white majority, existing disparities related to race and ethnicity (see Chaps. 1 and 15) will become more apparent and widespread. Across most respiratory diseases, African Americans suffer greater morbidity and mortality than non-Hispanic whites [1–5]. Although Latino populations are classified as a single ethnic group, there is considerable variability in the prevalence of and mortality from respiratory diseases across subgroups. In the USA, Puerto Ricans have one of the highest burdens from asthma, while Mexican Americans have relatively low prevalence of and morbidity from asthma [3, 6, 7]. Reducing disparities related to race and ethnicity is one of the goals for the *Healthy People 2020* initiative [8]. Approaching the differences in respiratory health related to race and ethnicity requires a transparent understanding of the scope of the problem that will be described further in this chapter. The etiology and perpetuation of these disparities will be discussed with a life course perspective [9], which harnesses tools from sociology, epidemiology, population genetics, and molecular biology. An integrated

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approach will provide structure to the study of respiratory health disparities related to race and ethnicity and may unveil new directives to address, and with time, possibly eliminate these disparities.

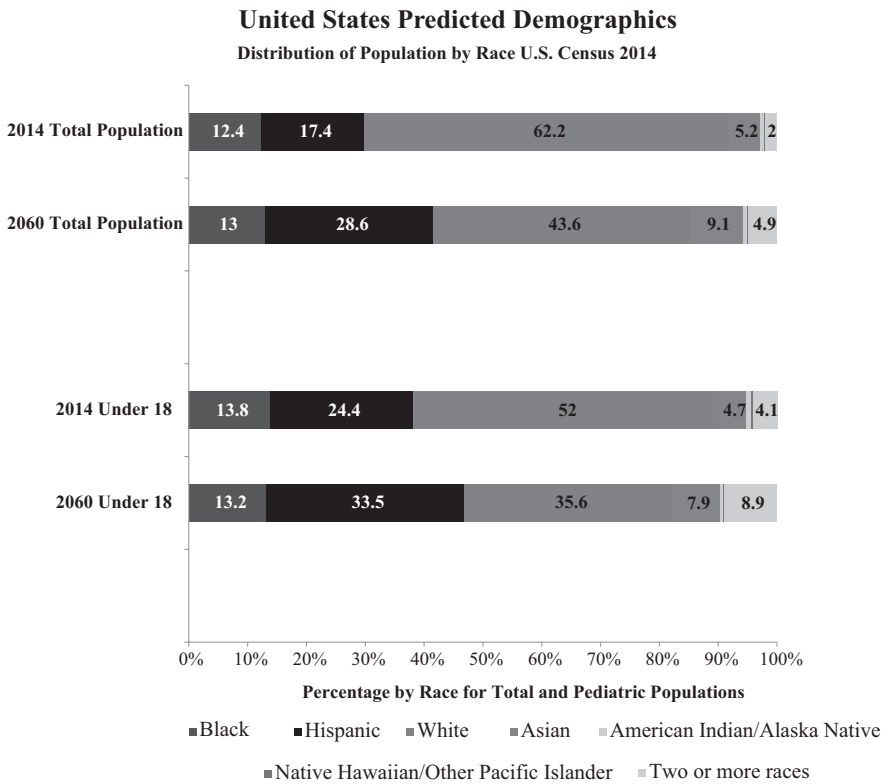
## **Shifting Demographics in the United States**

Racial and ethnic minorities—who currently make up nearly 40 % of the US population—are projected to become the majority by 2043, with a more pronounced shift in the pediatric population (Fig. 2.1) [10]. This phenomenon has been ignited by the influx of more than 40 million immigrants of predominantly Latino and Asian descent over the last five decades [11, 12].

In New Mexico and California, Latinos are already the ethnic majority [13, 14], while in Hawaii, Asian/Pacific Islanders are the current ethnic majority [15]. These states offer insights on approaches to reduce racial and ethnic disparities in respiratory health. Childhood asthma disproportionately affects African American and Latino communities in Central and Northern California [16]. In response to high rates of asthma-related hospitalizations, a comprehensive statewide program was created [17] to better improve surveillance of disease and develop integrated approaches to reduce the burden from asthma in low-resource communities. In Hawaii, Native Hawaiians have more than double the mortality rate from cardiovascular disease as Caucasian residents [18]. A possible cause of this disparity is the use of clopidogrel, a drug that is commonly used to treat and prevent myocardial infarction and stroke [18] but is significantly less effective in carriers of a genotype that is more frequent in East Asians (23–45 %) [19] and Pacific Islanders (40–77 %) [20, 21] than in Caucasians (10–20 %). In March 2014, the District Attorney of Hawaii filed a lawsuit against GlaxoSmithKline, the makers of clopidogrel, claiming false, unfair and deceptive marketing of a product known to be less effective in the majority of their residents [18]. Across the Nation, local and state governments have led efforts to ban tobacco smoke, which have led to improvements in respiratory disease [22–25]. Thus, efforts at the local and state level are necessary, and often occur more swiftly and effectively than those at the federal level.

## **Race and Ethnicity, Are the Categories Obsolete?**

In 1997, the Office of Management and Budget set the standards on how to collect and record data on race and ethnicity [26]. These set categories (Table 2.1) are used for categorizing data for federal statistics, including the U.S. Census Bureau, program administrative reporting, and civil rights compliance reporting. The National Institutes of Health also depends on these categories for study enrollment reporting, and in turn, many investigators have used these categories to shape research



**Fig. 2.1** Current and predicted distribution of US population by race/ethnic group and age group. Data from U.S. Census Bureau: 2014 National Projections. Population estimates for American Indian/Alaska Native: Total 0.7 (2014) 0.6 (2060); Under 18 0.9 (2014) 0.6 (2060). Population estimates for Native Hawaiian/Other Pacific Islander: Total 0.2 (2014) 0.2 (2060); Under 18 0.2 (2014) 0.2 (2060). *Reference:* Colby, Sandra L. and Jennifer M. Ortman, *Projections of the Size and Composition of the U.S. Population: 2014 to 2060*, Current Population Reports, P25-1143, U.S. Census Bureau, Washington, DC, 2014

conducted in different racial and ethnic groups. These defined categories of race and ethnicity have become poor proxies of multiple environmental and socioeconomic exposures, and have been inelegantly used as surrogates for determining genetic risk of disease. Detractors of the terms race and ethnicity argue that by describing disparities within the confines of these categories, efforts are shifted away from the real causes of disease [27]. However, while the current categories of race and ethnicity are limiting and not truly representative of the diversity or blending of cultures in the USA, most metrics, including health, financial, and educational, are collected using these set categories and, in turn, are used to influence policy decisions that may impact the overall respiratory health of Americans. Thus, it remains important to examine respiratory health disparities within these confines.

**Table 2.1** Minimum race and ethnicity categories in the USA by the Office Management and Budget

<i>Question 1. Ethnicity (asked before the race question)</i>
<ul style="list-style-type: none"><li>• Hispanic or Latino</li><li>• Not Hispanic or Latino</li></ul>
<i>Question 2. Race<sup>a</sup></i>
<ul style="list-style-type: none"><li>• White</li><li>• Black or African American</li><li>• American Indian or Alaska Native</li><li>• Asian</li><li>• Native Hawaiian or Other Pacific Islander</li></ul>

<sup>a</sup>More than one category may be selected

Why Race and Ethnicity Matter for Respiratory Health

Whereas race has been characterized by an individual’s primary continent of origin, ethnicity is defined by a shared social, linguistic, and cultural heritage (e.g., African American, Hispanic) [28, 29]. Hispanics and African Americans have varying degrees of African, European, and Native American genetic ancestry [30], and such ancestral variability has been shown to influence lung function and airway diseases in these ethnic groups [31–34]. Hispanic is an ethnicity and not a race: Hispanics should be classified into subgroups by country or region of origin, and such subgroups often differ with regard to risk factors and disease burden (see above). For example, smoking patterns differ across various Hispanic subgroups in the USA [35]. Thus, combining subgroups or ignoring racial ancestry can lead to biased results of respiratory research studies in Hispanics and other racially admixed populations.

Race, while used to define groups of individuals from geographically distinct areas and who share physical attributes and lineage (e.g., white, black), has no genetic basis: 85 % of genetic variation occurs within individuals of the same race, while less than 15 % of variation occurs between races [36, 37]. All humans have the same set of genes and these genes may alter over time under unique evolutionary pressure. This leads to the expression of certain traits over others, and results in allelic frequencies that differ across ancestral populations [38]. Traits commonly used to distinguish between races, such as skin color and facial construction, are not genetically tied to specific race groups but instead result from environmental and behavioral forces that lead to change over time. For example, skin color is the result of the amount of sun exposure over generations—with darker skin being more common amongst those with ancestors who lived in regions near the equator. Despite similarly dark skin, the genetic variants underlying skin pigmentation differ between South Indians and Cape Verdeans [39–41]. In fact, South Asians and Western Europeans share a gene for light skin pigmentation [40] that is more reflective of colonization and migration patterns than of true racial differences. In fact, categories of race and ethnicity are more reflective of the shared experience of certain

groups in the USA. This includes their shared exposure to risk factors for respiratory disease, including air pollution and tobacco smoke, poverty, and inadequate access to medical services (see Chaps. 1 and 15).

In the USA, race has been used to segregate and deny freedoms or services to minority groups, thus allowing members of the majority to keep their leaders in control. Over centuries, these practices became institutionalized within the US political, educational, and health systems [42–45]. These practices have led communities of color to often live in urban deprived areas that lack adequate infrastructure, as evidenced by overcrowded homes and dilapidated housing units, and reduced access to reliable transportation, public education, and safe open spaces. For example, Latino and African American children often live in neighborhoods with high levels of air pollution and incur high levels of exposure to pesticides and toxic industrial chemicals [46, 47]. These same communities are not afforded optimal educational opportunities due to historical segregation of schools, a concentration of lower-performing schools in poor urban areas, and lack of financial resources to pursue higher education [48–50]. This has contributed to a concentration of racial/ethnic minorities in low wage jobs.

These forms of discrimination also impact healthcare delivery, financing, and research. The link of employment to health insurance has led to individuals with low wage jobs to have no insurance or be underinsured [51]. While the introduction of the Affordable Care Act [52] has reduced this inequity, racial and ethnic minorities are still underinsured compared with their white counterparts and more like to seek care in low performing hospitals and clinics [53–55]. The inherent bias in the educational system has led to a lack of diversity in the medical professions and a shortage of healthcare providers in minority communities, as individuals who identify as an underrepresented minority are more likely to serve their own communities (see Chap. 15) [56, 57].

The exclusion of racial and ethnic minorities also extends to biomedical research [58, 59]. For example, many studies have examined potentially detrimental exposures in white farm workers, while very few have assessed the effects of particulate matter and pesticide exposure on the respiratory health of migrant farm workers, many of who are undocumented, marginalized, and highly exposed to occupational hazards and pesticides [60, 61]. Healthcare providers and scientists are informed from and base their current practices on research extrapolated from a largely homogenous population, whom are usually white and male. Current practice is to apply findings from one group to another, which may lead to dangerous outcomes, given differences in genetic variation, socioeconomic factors, and environmental exposures across groups.

Race and ethnicity are powerful social constructs that influence day-to-day interactions, afford certain groups privileges over others, and impact how external threats or stress are distributed, perceived, and internalized. Moreover, self-identified race or ethnicity influences an individual's behavior and place of residence. Thus, race and ethnicity must be considered in the evaluation of respiratory health disparities.

## **What Is the Role of Genetic Ancestry in Examining Respiratory Health Disparities?**

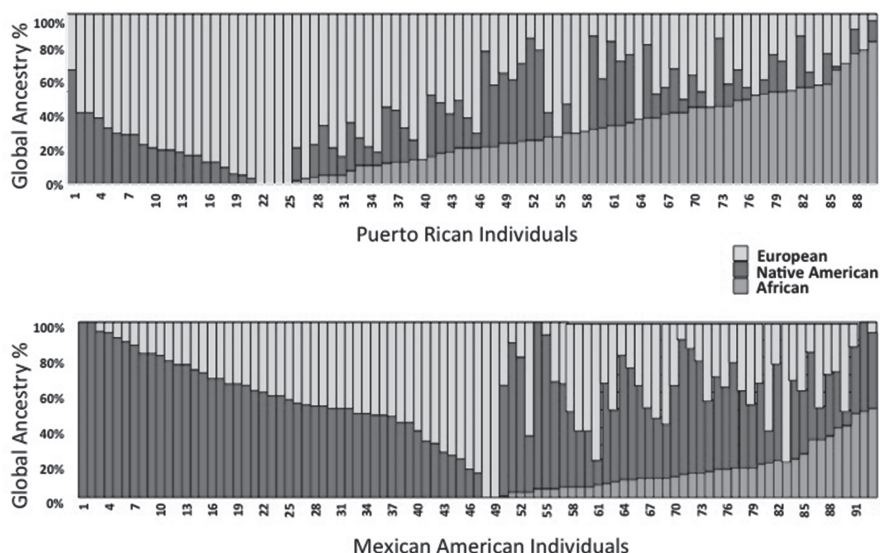
Racial differences in respiratory health cannot be solely explained by social and environmental inequalities [34, 62, 63]. Rather, the high burden of disease observed among minorities may result from the biological embodiment of specific socioeconomic, environmental, and discriminatory experiences that have occurred over generations [64–68]. However, not all individuals in minority groups develop adverse health outcomes in response to poverty and other stressors. To identify individuals or communities at risk, measures of susceptibility [69] and resilience, both behavioral and genetic [65, 70, 71], to environmental stressors may be used to predict who is most at risk from poor health outcomes based. Understanding the interaction between social and environmental upbringing with an individual's genetic and epigenetic profile [72] can broaden the understanding of disease pathology and expand potential therapeutic options for everyone.

As outlined in the previous section, race and ethnicity are sociopolitical constructs devoid of any true genetic basis. Conversely, genetic ancestry is a quantifiable variable that describes the geographical origin of different segments of an individual's genome [73]. Following the completion of the Human Genome Project in 2003 [74], genetic association studies have been applied, in increasing frequency, to identify variants that contribute to differences in disease prevalence and/or severity between human populations. Race and genetic ancestry are two related, but innately different, terms that are often used synonymously when discussing population differences and designators in biomedical research. Using race and genetic ancestry interchangeably is a dangerous practice that can lead to misconceptions and misunderstanding in the lay public, and misinterpretations for researchers [75, 76].

Genetic ancestry can be measured at the global level, which describes the total proportions of an individual's genome that derive from one or more source populations, or at the local level, where the genetic ancestry of chromosomal segments within an individual are assessed [73]. Genetic ancestry is unique to each individual, and varies both within and between racial ethnic groups. For example, individuals who self-identify as African American display a range of African, European, and Native American ancestral proportions depending on their US region of origin [28, 77, 78]. African American individuals from states that were slave-holding versus “free” show higher proportions of African ancestry than their counterparts from “free” states during the U.S. Civil War period [78].

There are also large differences in the proportions of African, European, and Native American ancestry within the Latino/Hispanic population in the USA [79, 80]. As in African Americans, ancestral proportions span the entire range of possibilities among individuals who self-identify as Latino/Hispanic, but ancestral proportions also show subgroup specific trends. For example, Mexican Americans and Puerto Ricans both display admixture from the same three aforementioned ancestral populations, but the average distribution of these ancestral estimates is quite different; Puerto Ricans have, on average, a larger proportion of African

### ***Global Ancestry Proportions of Self-Identified Mexican American and Puerto Rican Individuals***



**Fig. 2.2** Individual ancestry estimates for healthy Puerto Ricans and Mexican Americans, clustered by admixture levels. *Reference:* Gonzalez Burchard E, Borrell LN, Choudhry S, Naqvi M, Tsai HJ, Rodriguez-Santana JR, et al. Latino populations: a unique opportunity for the study of race, genetics, and social environment in epidemiological research. *American journal of public health.* 2005;95(12):2161–8. Epub 2005/11/01

Ancestry versus Native American ancestry, whereas Mexican Americans have higher proportions of both European and Native American ancestry versus African ancestry (see Fig. 2.2) [73, 81].

Recent studies have shown that both self-identified race or ethnicity and genetic ancestry are independently associated with differences in response to medication and disease prevalence and/or severity [5, 34, 69, 82–85]. For example, African ancestry is inversely correlated with lung function among African Americans [86]. Alternatively, Native American ancestry is positively associated with lung function but inversely associated with asthma risk in Latino/Hispanic children adolescents [34]. Mean global ancestry has been shown to correlate with self-identified race [87], but this correlation is not perfect and may leave a portion of the substructure within populations unidentified [88]. To avoid potential confounding leading to incorrect inference in genetic association studies, it is important to consider both self-identified race/ethnicity and genetic ancestry when constructing statistical models to assess the relationship between genotype and phenotype. The inclusion of race as a covariate in genetic association studies, or as stratification criterion, will address, in part, any inherent differences/similarities between participants due to environmental factors and other socio-cultural/political characteristics likely to be shared among individuals who self-identify within the same racial/ethnic group [34, 87].

Including genetic ancestry as a covariate in the analysis accounts for genetic differences between subjects due to shared patterns of allelic expression among members of an ancestral group, independent of phenotype status [87, 89].

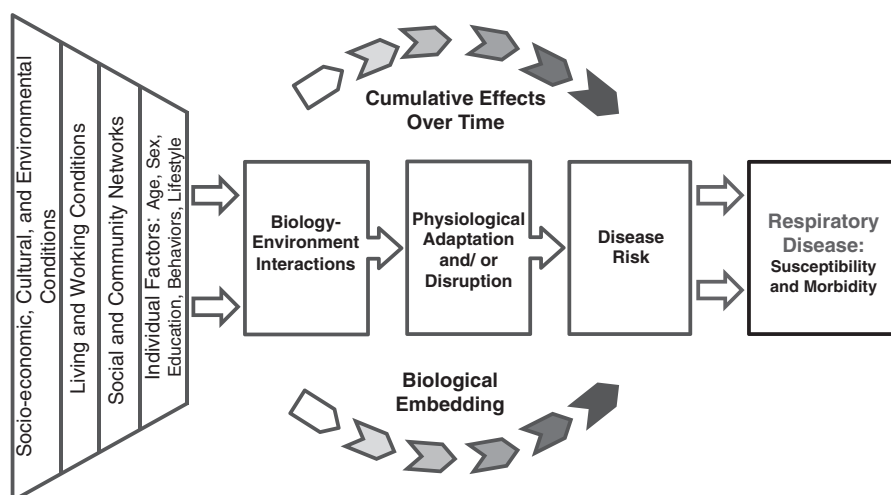
An additional use of genetic ancestry information in the context of health disparities research is admixture mapping. Given significant differences in disease prevalence and allelic frequencies among racial or ethnic groups, admixture mapping is comparatively more powerful than standard association tests to detect susceptibility loci for complex diseases in racially admixed populations [90, 91]. Incorporating genetic ancestry information into disease association analyses has the potential to inform care not only in admixed population but also in source “ancestral” populations. For example, learning why black patients with kidney failure have better survival than their counterpart whites may reveal insights helpful to whites [92]. Moreover, the influence of genetically determined ancestry on health can be leveraged to provide insights into pathogenic mechanisms and new treatment approaches [93].

## **Taking a Life Course Perspective for Examining Respiratory Health Disparities**

Understanding the complex interplay among biological, behavioral, social, and environmental determinants of respiratory disease in disadvantaged populations is crucial for improving the overall health of the population. A framework that incorporates concepts from multiple disciplines and examines determinants of health across the life span allows for a more holistic understanding of the root causes of disparities in respiratory health related to race and ethnicity (see also Chaps. 1 and 15). Racial and ethnic disparities in respiratory health are evident across all age groups: African American and Puerto Rican children [6] have higher prevalence of asthma compared with all other race/ethnic groups, and among adults, African Americans with lung cancer have a higher likelihood of death [1, 82]. The persistence of disparities across the life span suggests that the exposures and potential risks for respiratory disease should be examined as a cumulative experience that occurs over the course of one’s life. This includes considering exposures that may only occur during the in utero period, to those that may have an additive effect over time [9, 94]. This approach leaves room for the consideration of multilevel influences and allows for the examination of how individuals interact within their community and with their environment and how these said exposures, and the associated psychosocial stress, may affect biological processes and have an additive effect over time (Fig. 2.3).

For example, tobacco smoke is an important risk factor for almost all respiratory diseases. In utero tobacco exposure independently increases the incidence of wheeze and asthma among young children [95]. Postnatal exposure to tobacco smoke is associated with an increased risk of lower respiratory infections in infants [96], and continued secondhand smoke exposure during childhood is associated with asthma





**Fig. 2.3** Taking a life course perspective: a health model of respiratory disease. Adapted from Halfon et al. Life Course Health Development Model and from the biodevelopmental framework. *Reference:* Halfon N, Hochstein M. Life course health development: an integrated framework for developing health, policy, and research. *The Milbank quarterly*. 2002;80(3):433–479, iii. Center on the Developing Child. How early experiences get into the body: a biodevelopmental framework. 2014; [http://developingchild.harvard.edu/index.php/resources/multimedia/interactive\\_features/biodevelopmental-framework/](http://developingchild.harvard.edu/index.php/resources/multimedia/interactive_features/biodevelopmental-framework/). Accessed October 2, 2014, 2014

incidence [95] and worse asthma control [97]. In adults, it is well known that cumulative exposure to tobacco smoke increases the risk for chronic obstructive pulmonary disease (COPD) and lung cancer [98–100]; however, the effects of tobacco appears to be more profound in African Americans when compared with whites. Despite lighter smoking habits, African Americans with COPD experience greater pulmonary function decline compared with whites [69]; similar results have been observed in individuals without COPD [101]. A life course perspective allows for the consideration of the exposure over several key time points (points of susceptibility) and also allows for evaluation of the cumulative effect and how this effect may be different across racial/ethnic groups. This perspective also allows for examination of how the individual or group is exposed to the risk factor, in this case—tobacco, and how the multiple levels in which the individual is nested may interact to facilitate, or impede, the exposure to a known toxin or stress. For example, greater African ancestry [101], reduced tobacco metabolism [102], and increased breath holding with menthol cigarettes [103] have all been postulated as possible reasons for the decline in pulmonary function in the presence of tobacco smoke that is observed in African Americans when compared with whites. In addition to observing the direct effects of tobacco smoke, there is the need to examine which tobacco products are used and how these products are accessed or promoted to different racial/ethnic groups. Targeted advertisement of tobacco products to minority communities, including the peddling of menthol cigarettes, which use is significantly

higher among African Americans compared with all racial/ethnic groups [104, 105]. Menthol causes a sense of coolness and local anesthesia, promotes breath holding, and reduces the metabolism of nicotine [103, 106]. Data has suggested that smokers of menthol cigarettes have more difficulty in quitting despite smoking fewer cigarettes per day and this finding is most pronounced in African Americans [104, 105]. When examining the effects of tobacco exposure, it is important to note that racial and ethnic minorities have higher exposure to secondhand smoke compared with whites [107]. This exposure occurs both in and outside the home, where there is less control: multiunit and public housing often do not regulate tobacco use inside individual units despite the high risk of exposure in close living quarters [108]. Due to financial limitations, individuals or families living in such units lack the choice to move.

A life course framework allows us to consider multiple risk factors (genetic, biologic, behavioral, and environmental) and their interactions on disease pathogenesis at multiple levels. This holistic approach also leaves room for the idea that not all individuals respond the same to known risk factors for disease, and may open new avenues for the development of targeted interventions.

## Conclusions

Reducing disparities in respiratory health based on race and ethnicity requires awareness and understanding of (1) the disparities themselves, (2) the groups most vulnerable to disparities, and (3) the factors that contribute to disparities and which are the most amenable to intervention. Thus, research and innovation are crucial to understanding, treating, and controlling respiratory diseases, generally, and for addressing health disparities, specifically.

Coordination and integration of research efforts in basic sciences, computational sciences, clinical medicine, behavioral science, and public health will yield a better understanding of the root causes of disparities, which will ultimately facilitate the development of new approaches to eliminate respiratory health disparities.

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