

Health Disparity: Asthma in African American Communities

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Introduction

Commonly thought of as a childhood disease, asthma does not necessarily disappear in adulthood. In fact, it may develop or manifest in middle age. Asthma is a disease of the airways that is inflammatory and chronic in nature. It is caused by the blocking or narrowing of lung airways. Breathing is compromised in people with asthma. The most common symptoms are wheezing; shortness of breath; pain or tightness of the chest; or a cough that may be experienced at night or early in the morning. Unremitting inflammation in the airways creates a state of hypersensitivity responsiveness to cold air, exercise, dust mites, various pollutants in the air, stress, and anxiety.

The United States (U.S.) and other industrialized nations are experiencing an increase in asthma cases. Although many medical and scientific advances have been made in the treatment of asthma in the past few decades, racial and ethnic disparities persevere in the rates of prevalence, morbidity, and mortality in the U.S. (Joseph, Williams, Ownby, Saltzgaber, & Johnson, 2006). While the disparity is particularly high between White Americans and Hispanics of Puerto Rican descent, disparities between Black and White Americans are significant and enduring.

Can progress be made in improving or eliminating the disparities? How do ancestry, socioeconomic status, and physical environment contribute? And what are promising areas of research to reduce these disparities? This chapter explores these questions.

Asthma in the U.S.: Prevalence and Effects

Asthma as a chronic condition continues to affect a significant portion of the U.S. population, according to statistics from the National Center for Environmental Health (2011). In 2009, one in 12 people (about 25 million, or 8% of the population) had asthma, compared with one in 14 people (about 20 million, or 7%) in 2001. Work related, or occupational, asthma was reported at 1.9 million cases among working adults, which accounted for about 15.7% of adult asthma cases. The afflicted age group for work-related asthma varies widely, but tends to be more concentrated in 45- to 64-year-olds (20.7%). There was a 6% increase in costs in the U.S. associated with asthma, including medical expenses, missed school and work days, and early deaths, from \$53 billion in 2002 to about \$56 billion in 2007. In 2008, 33% of adults with asthma missed on average five work days because of it.

Children

Over 7 million children in the U.S. suffer from asthma and related symptoms (Centers for Disease Control and Prevention, 2011). Asthma as a chronic disease has a significant effect on the child population and on the health care system. From a public health perspective, pediatric asthma is recognized as a serious chronic health condition due to its high prevalence, significant morbidity, effect on children and their families, and the high cost of medical care, including cost for medications (Centers for Disease Control and Prevention, 2011).

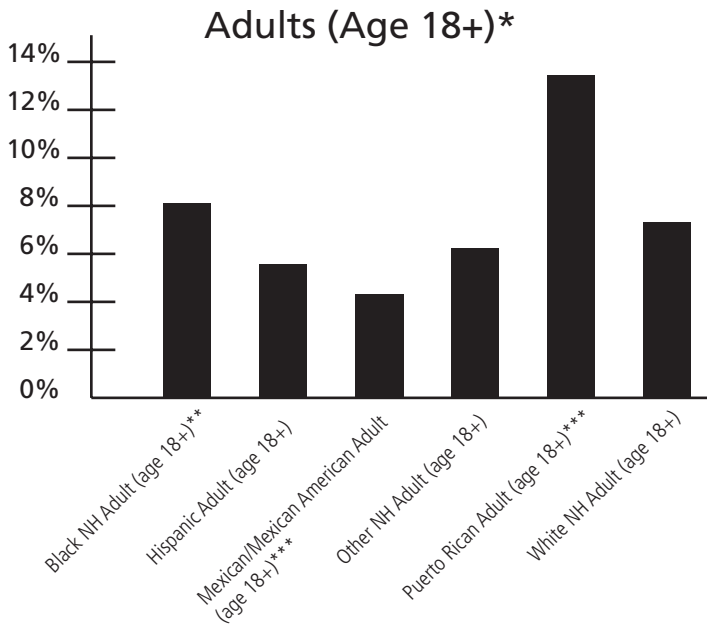
Additional statistics on asthma from the National Center for Environmental Health (2011) provide more information on asthma's effects. Greater than half (53%) of the population suffering from asthma had an asthma attack in 2008. A higher percentage of children than adults with asthma suffered an attack (57% compared with 51%). In 2007, 185 children and 3,262 adults died from asthma. In 2009, one in 10 children had asthma compared with one in 12 adults. In 2010, three out of five children suffering from asthma had one or more asthma episodes in the previous

year. In 2008, more than 59% of children with asthma missed on average four days of school because of it.

Disparities Between Black and White Americans

In 2014, the most recent year with available data, 7.6% of White American adults had asthma, compared with 8.7% of African American adults (see Figure 1). The prevalence of asthma attacks for Black Americans was higher (4.6 to 5.8%) compared with White Americans (3.7% to 4.3%) in most years between 2001 and 2010 (Centers for Disease Control and Prevention, 2012). According to the same report, for each year from 2001 to 2009, the death rate for Black Americans was 1.6 to 2 times higher than that for White Americans.

Figure 1. Asthma Prevalence by Race and Ethnicity, American Adults



* Includes persons who answered “yes” to the questions: “Have you ever been told by a doctor or other health professional that you had asthma?” and “Do you still have asthma?”

** NH = Non-Hispanic

***As a subset of Hispanic

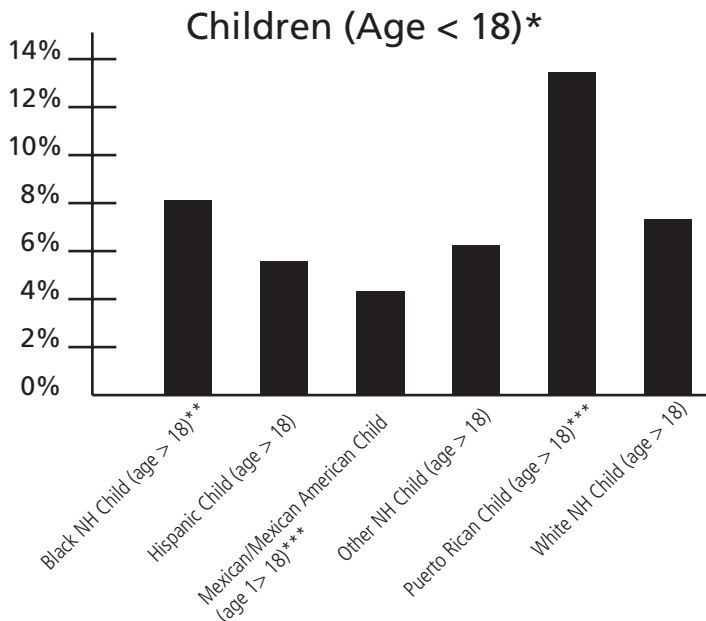
Source: 2014 National Health Interview Survey (NHIS) Data, Table 4-1, accessed from <http://www.cdc.gov/asthma/nhis/2014/table4-1.htm>.

These disparities do not appear to be decreasing. Bhan, Kawachi, Glymour, and Subramanian (2015) studied whether racial and ethnic disparities in the U.S. increased over time. After analyzing data from 3,868,956 adults across the U.S. from the Behavioral Risk Factor Surveillance System from 1999 to 2011, they concluded that disparities in asthma prevalence by race and ethnic group did not improve. Their findings confirmed earlier reports of patterns of racial disparities coupled with higher risks of asthma prevalence among non-Hispanic blacks.

Children

The disparities in asthma prevalence, morbidity, and mortality between Black and White American children are particularly troubling. In 2014, the most recent year for which data are available, 13.4% of Black American children had asthma, compared with just 7.6% of White American children (see Figure 2).

Figure 2.
Asthma Prevalence by Race and Ethnicity, American Children



*Includes persons who answered “yes” to the questions: “Have you ever been told by a doctor or other health professional that you had asthma?” and “Do you still have asthma?”

** NH = Non-Hispanic

***As a subset of Hispanic

Source: 2014 National Health Interview Survey (NHIS) Data, Table 4-1, accessed from <http://www.cdc.gov/asthma/nhis/2014/table4-1.htm>.

This disparity appears to have increased over time. Akinbami, Simon, and Rossen (2016) found that inequalities in asthma prevalence between Black and White children climbed continuously from 2001 to 2010. From 2001 to 2010, the authors found that among Black children, asthma prevalence trended upward by an average of 3.8% (range, 11.4% to 16.8%). The ratio of Black children to White having asthma by the end of the reporting period was two to one.

How Black and White children encounter care for asthma varies. Akinbami et al. also found White children tended to have more outpatient visits or encounters than Black children. During these encounters, symptoms tended to be milder than what Black children experienced. Children in minority ethnic and lower socioeconomic groups were more likely to display greater disease severity during outpatient encounters, and these exacerbations were more likely to require more emergency care.

The asthma trending analysis conducted by Akinbami, Moorman, Simon, and Schoendorf (2014) reports that between 2001 and 2010, asthma prevalence for African American youth (ages 0–17) increased from 1.4 to 2.0 times the asthma prevalence for White youth. African American youth experienced a greater number of exacerbations than white youth, and as a result had more school absences connected with emergency room visits/hospitalizations and a higher risk for mortality (Gupta, Carrion-Carrie, & Weiss, 2006).

Possible Causes of Disparities

A Complex Problem

Castillo, Jordan, Tan, and Williams (2010) sought to discover the underlying causes for African Americans having higher rates of asthma and less than optimum health outcomes. The researchers' findings point to various contributing social factors, including lack of access to health care, problems with communication, the social structure of neighborhoods, and the overall ecological properties of living in less than ideal conditions. Although not necessarily intentional, research has uncovered that care in poor minority communities tended to be of lesser quality, resulting in inferior treatment. African Americans living in poor neighborhoods had a higher rate of hospitalizations for asthma, which may be related to under-treatment in the primary care area,

they noted. Access to a specialist was more restricted due to cost in low-income neighborhoods, leaving primary care providers as the main source for specialized treatment, the researchers found.

The study also indicates a problem with communication between patients and providers in African American communities. Physicians tended to control the conversation when interacting with African American patients, and low literacy levels are likely in minority groups and may affect comprehension of health directives from the health care providers, the researchers found.

Lack of Medication Adherence

Rohan et al. (2010) studied paths of adherence to daily inhaled corticosteroid (ICS) medication for one year in economically disadvantaged African American youth with asthma. They investigated whether a relationship exists between treatment adherence to symptom control, use of quick relief medication, and health care utilization. The researchers' primary findings indicate notable decrement in the path of treatment adherence to ICS medication over the year period. The children and adolescents who were observed typically used less than half of their prescribed medication dosages from the start, and the rate further declined to 20% after one year of participating in the study. The observations also show an association between the overall low rates of treatment adherence (less than 50%) with an increase in emergency room visits, clinic visits, and hospitalization. The findings do not indicate a relationship between adherence to a pediatric asthma treatment plan with frequency of symptoms and frequency of use of quick relief medications. The implications are that economically disadvantaged African American children and adolescents with low adherence to their prescribed asthma medication regimen are more likely to utilize health care services for asthma treatment.

Barnes and Ulrich (2015) conducted a systematic review of the literature to examine whether better adherence to ICS can improve asthma outcomes and if adherence to ICS can be improved. Asthma maintenance therapy is predominately controlled by the use of ICS. Although ICS are the most prescribed asthma medications, adherence levels remain low. The researchers reviewed 19 studies that met the inclusion criteria and concluded that a mean level of ICS adherence ranging from 22 to 63% was associated with improvement up to and after an ex-

acerbation. Low adherence levels were attributed to youth, being African American, having mild asthma, having less than 12 years of formal education, and ineffective communication with health care providers.

Barnes and Ulrich found adherence levels were connected to being prescribed a fixed combination therapy consisting of ICS and long-acting 2 agonists. Decent adherence was linked with higher forced expiratory volume in 1 second (FEV1), a lower percentage of eosinophils in the sputum, a reduction in hospitalizations, less use of corticosteroids, and a lower mortality rate. Poor adherence was credited with 24% of exacerbations and 60% of asthma-related hospitalizations. The majority of the studies noted an upsurge in adherence specifically after intensive interventions, trailed by quality of life improvement and improvement in symptoms, FEV1, and oral corticosteroid use. Most studies reported that even after interventions designed to increase adherence, varying results were noted with no significant increase in better outcomes. The researchers concluded that adherence to ICS remains an elusive goal and further exploration of the barriers needs to be undertaken.

Financial Burden of Health Care

There are major differences in health and health care for Americans that lead to health disparities primarily among people of color. The U.S. Department of Health and Human Services (HHS) Action Plan to Reduce Racial and Ethnic Disparities defines health disparities as inequities in health outcomes that are tightly interconnected with social, economic, and environmental disadvantage. These factors are regularly driven by the social conditions in which persons live, learn, work, and play (U.S. Department of Health and Human Services, 2011).

The Joint Center for Political and Economic Studies report *The Economic Burden of Health Inequalities in the United States* (LaVeist, Gaskin, & Richard, 2009) documents significant disparities in the cost of health inequalities in the U.S. The study found that from 2003 to 2006, 30.6% of direct medical care expenditures for African Americans, Asians, and Hispanics were due to health inequalities. For the same time period, if health disparities were eliminated, direct medical care expenses could have been reduced by \$229.4 billion. Additionally, by eliminating health inequalities for minorities, indirect cost of care for illness

and premature death could have been reduced by one trillion dollars. Furthermore, the combined costs for health inequalities and premature death in the U.S. for 2003 to 2006 amounted to \$1.24 trillion. Lastly, to place the \$1.24 trillion into perspective, it was calculated to be greater than the gross domestic product (GDP) of India, the world's twelfth largest economy in 2008 (LaVeist, Gaskin & Richard, 2009).

The milestone 2002 report, *Unequal Treatment: Confronting Racial and Ethnic Disparities in Health Care*, recognizes the lack of insurance as a substantial driver of health care disparities (Institute of Medicine, 2002). Minority populations are more adversely affected by lack of insurance than by any other demographic or economic barrier. Because racial and ethnic minorities constitute about one-third of the U.S. population, about 50 million people are less likely to be insured (Smedley, 2008; HHS, 2011). One of the main purposes of health insurance is to provide financial protection from the costs of unforeseen illness. It is also an instrument used for funding and pre-paying for an assortment of health benefits, which may be neither sporadic nor unexpected. The Institute of Medicine (2011) reports that underinsurance, no insurance, and gaps in insurance coverage are accountable for adverse health outcomes. In the U.S., the private market is comprised of mostly large-subscriber groups providing insurance coverage for about 86% of the cost of services. However, this type of insurance is only available to 19% of insured Americans (Agency for Healthcare Research and Quality, 2014).

The Agency for Healthcare Research and Quality (2014) reports that large group employer-sponsored full insurance coverage is trending downward, and employees living with chronic illnesses, such as asthma, may find themselves underinsured. Public insurance programs, such as Medicaid and other state-sponsored programs, are experiencing benefit reductions as well, due to rising costs to the states for supporting qualified individuals. The Deficit Reduction Act of 2005 has provisions built in allowing states to require Medicaid recipients to contribute minimal co-pays and premiums amounts (Agency for Healthcare Research and Quality, 2014). As co-pays and premiums rise, the Medicaid-covered person has to make choices, including how often to visit a primary care provider, how often to use prescriptions, and how often to refill these prescriptions.

Chang, et al. (2014) note variances in the utilization of health care insurance while examining the effect of managed care services on health care utilization. They also studied the impact of managed care services on access to care, quality of pharmaceutical care, and health care outcomes in both Medicaid and privately insured pediatric populations with asthma. This large study consisted of 11,027 children with asthma from 2005 to 2007. The cohort subsequently was divided into 6,435 children enrolled in Medicaid and 4,592 children with private insurance.

The findings reveal many interesting aspects of Medicaid versus private health insurance. Medicaid-covered children in 2007 showed a hospitalization rate of 33.1% compared with 28.7% for privately-covered children. Children with a private insurance plan had a significantly higher medication possession ratio (MPR) value of 40.11 compared with 45.74 for Medicaid-covered children (MPR is one of many standard measures of medication adherence). Medicaid-covered children were more likely to have had an ED visit in 2007: 58.4% compared with privately insured children at 32.6%. Private insurance covered children were also more likely to have seen a pediatrician in 2007: 83.9% had had at least one pediatrician visit, compared with 77.0% for Medicaid-covered children. For Medicaid enrollees, the mean total expenses were \$11,075 compared with \$14,722 for private insurance enrollees. This represents a 25% variance in lower expenditures for Medicaid enrollees. African American children were 46% less likely to visit the outpatient clinic, had 37% lower frequency of office visits, had 82% higher likelihood of being hospitalized, and were 15% more likely to visit an emergency department than white children.

African American women with asthma are considered to be members of a group. This subgroup provides opportunities to understand the relationships between health insurance coverage, financial burden perception, and asthma health outcomes. African American women are disproportionately afflicted by asthma in relation to high urgent care use, self-management prospects, and less than optimum health outcomes (Centers for Disease Control and Prevention, 2011).

Patel, Caldwell, Song, and Wheeler (2014) aimed to describe what factors made African American women with asthma, both those who had private insurance and those with public insurance, perceive a financial burden in managing their asthma. The

researchers also looked for associations between the type of insurance coverage, the women's perception of their financial burden, and their health outcomes related to asthma. Both groups of women expressed greater associations between out-of-pocket expenses and a greater perception of financial burden. The women who perceived asthma as a financial burden had poorly controlled asthma and "more urgent healthcare visits, lower household income, and report lower quality of life," the researchers found.

The study was conducted before the Affordable Care Act (ACA) took effect. The authors noted that the ACA would help millions of Americans become publicly or privately insured. They also noted, however, that patients were likely to continue to perceive a financial burden because the ACA's assistance with out-of-pocket expenses is for subscribers within lower income thresholds. Additional policy reforms are needed to reduce out-of-pocket costs patients incur in managing chronic conditions over the long term, the researchers added.

The publicly insured in this study consumed more urgent care. This deviation in consumption may be explained by the lack of available quality care for the publicly insured. Public insurance programs, such as Medicaid, must work around reduced access to care barriers continuously. This may lead to lack of stability of care from episodic coverage, which tends to be a common occurrence. As each individual with asthma is unique, the tailored asthma plan required to manage the condition may not be attainable or sustainable due to inadequate financial protection from health insurance coverage. There are other expenses that are not normally covered by health insurance such as cost to travel to and from the provider of services, loss of work hours, or lifestyle changes, which add to the perception of financial burden (Patel et al., 2014).

An earlier study by Patel, Brown, and Clark (2013) indicates that patient perceptions tend to impact self-management behaviors. As suggested by the findings of the study, health care providers have opportunities to collaborate with care team members to discover and design plans to help reduce the cost of asthma regimens and provide low cost options and assistance programs. Government sponsored insured individuals must face the fact that they carry a higher disease burden and are very susceptible to fluctuations in coverage eligibility (Patel et al., 2014).

Medication Cost

One of the barriers to asthma management and a cause of lack of medication adherence could be the cost of prescription drugs, which may disproportionately affect African Americans due to generally lower levels of income and higher poverty rates. Due to the chronic nature of asthma, multiple medications may be prescribed to control symptoms (Patel et al., 2009). In several instances, a physician may need to add a new medication for better control, but may be unaware of the cost pressures on families. The authors surveyed pediatricians and family physicians to inquire about their practice of asking patients or family members about cost or financial barriers that may prevent them from obtaining their prescribed medications. The researchers noted that some asthma medications are only available as the brand-name medication. Brand-name medications, if covered by health plans, have a higher co-pay attached compared with generic medications.

The researchers found that of the 343 pediatricians and family physicians they surveyed, only one-third reported taking the burden of the cost of the prescription upon the family as a possible barrier. Half of providers surveyed did not address drug cost burden with the patients or their caregivers at all.

Environmental Health

Environmental pollution may be another cause for the disparities, particularly in children. According to an Environmental Protection Agency (EPA) fact sheet (Environmental Protection Agency, Accessed Nov. 14, 2016), environmental pollution may cause more harm in children than in adults. The cumulative effect is that more pollution is found children's bodies than adults. Higher levels of pollution exposure have been found in poor children and children of racial and ethnic minorities.

Geography: Inner-City Asthma Epidemic?

The authors (Keet, et al., 2015) sought to verify whether inner-city areas carry a high burden of childhood asthma, as has been presumed. Furthermore, they asked, how do urban residence, neighborhood-level poverty, race/ethnicity, and household poverty affect asthma prevalence? Whether certain aspects of life in poorer urban areas support the development of asthma had been an unknown. The presumption was that there exists

a high asthma prevalence and morbidity in the underprivileged areas of large metropolitan areas.

The researchers (Keet, et al., 2015) report the prevalence of asthma in inner city U.S. neighborhoods to be 12.9% compared with 10.6% in non-city areas. When adjustments were made for race/ethnicity, region, sex, and age, the difference was no longer significant and the odds ratio was at 1.01. Geographical areas within the U.S. showed a wide range of asthma prevalence in inner-city neighborhoods, from 7.9% in the West to 17.3% in the Northeast. It was also recorded that some non-inner city neighborhoods in distinctive regions experienced higher prevalence rates than some inner-city areas. From the researchers' analysis, it appears that racial or ethnic and socioeconomic aspects can explain the differences in asthma prevalence much more than urban or rural status.

The researchers note asthma prevalence in unadjusted models reveals a much higher rate in Blacks at 17.1% than Whites at 9.6%. Of significance is the asthma prevalence rate for Puerto Ricans at 19.8%. Furthermore, after adjustments for neighborhood-level poverty, urban/rural status, region, sex, age, and birth in the U.S., the analyses still show that being Black or Puerto Rican is a strong and independent predictor of asthma prevalence. In regards to asthma morbidity, being Black or Puerto Rican coupled with lower household income were solid independent predictors for asthma exacerbation and emergency room visits. These risk factors notwithstanding, the researchers cannot discard or measure the severity of environment exposures as well as urban exposures as possible confounding aspects.

Genetic Ancestry

Several research studies have looked at whether a genetic association exists that may predispose some racial and ethnic populations to higher rates of disease. A study by Yeager et al. (2008) investigated genetic admixture. The researchers remarked on the value of genetic association studies in classifying factors that may have an influence in disease disparities amongst various racial and ethnic populations. Can self-reporting predict degree of African ancestry, they asked? Predicting the degree of African ancestry and understanding the variances may reveal unique attributes and biological differences, such as risk for particular diseases and response to specific treatment. Their findings pro-

pose that self-reported race and ancestry may predict ancestral clusters, but is unable to reveal the extent of the admixture. Objectiveness and accuracy in the methodology of describing homogenous populations for the investigation of definite population-disease associations may be better obtained by genetic classifications of ancestry (Yeager et al., 2008).

These implications may be clinically significant, especially in studying chronic diseases, such as asthma, and in the development of pharmacogenetics. While research on a genetic association between African ancestry and asthma rates or response to treatment has found mixed results, it remains an active area of study. Assuming that the admixture level will continue to increase in coming years, then advancing this study to the larger African American community should be considered in the pursuit of the reduction of certain diseases, such as asthma. However, this area of research may be cost prohibitive given the current health care environment of the underserved African American population experiencing health disparities. The cost associated with continuing the current trend versus the cost of furthering research in this area should be examined and analyzed, since it is a fine balance where health care investments should be directed.

Genetics, Endotypes, and Asthma Therapy

Choosing appropriate asthma therapies for any patient can be very challenging. Health care providers are becoming more mindful in tailoring individualized treatment plans for their patients. Numerous studies indicate that treatment response may be affected by several barriers, such as socioeconomic status, the environment, and lack of adherence. Recent developments in phenotypic and endotypic methodologies reveal the possibility of better response to asthma therapy. However, pharmacogenomics, an emerging area of research on how an individual's genetic makeup influences his or her response to medications, may provide the definitive personalized conduit to treat asthma centered on an individual's genotype (Dunn & Weschler, 2016).

A phenotype can be defined as the outward expression of one's underlying genes. These expressions may change over time due to environmental pressures. The broad classifications of these phenotypes in asthma are valuable and are not limited to the categorization of symptomatic triggers, patterns of airflow

obstruction, and severity of disease (Corren, 2014). For example, explicit features such as age, race, body mass index (BMI), or sex are phenotypic predictors utilized in the personalization of the treatment process (Dunn, et al., 2015).

An endotype is a subtype of a condition characterized by pathophysiological processes (Corren, 2013). Lötval, Akdi, Bacharier, Bjermer, and Casale (2010) report that to describe potential endotypes, a group of experts selected the following seven factors: clinical characteristics, biomarkers, lung physiology, genetics, histopathology, epidemiology, and treatment response. Furthermore, the proposal is that each endotype be considered a discreet entity based on the seven. To illustrate, a type of blood biomarkers, eosinophils, are an endotypic approach applied for the forecasting of responsiveness to certain therapies such as ICS (Zissler, Bieren, Jakwerth, Chaker, & C.B.Schmidt-Weber, 2016).

Dunn et al. (2015), by looking at the role of genetic ancestry in personalized asthma therapy in Blacks, raise a significant question on the role of self-reported race or genetic ancestry in predicting responsiveness to asthma therapies. ICS are known as the go to therapies for asthma treatment. This particular study reports no significant difference to ICS responsiveness between Blacks and Whites. Although responsiveness to ICS seems to be equivalent in both, the Black population suffering from asthma continues to endure the largest share of morbidity and mortality (Dunn & Weschler, 2016). The researchers conclude that there must be other factors besides African genetic ethnicity playing a role in causing the differences; the root causes remain elusive. They also note that Blacks are understudied in clinical trials, which may account for the lack of understanding of the differences in clinical outcomes.

Untreated or undertreated asthma may lead to severe asthma. Severe asthma is a heterogeneous disease affecting a small segment of asthmatic individuals (5% to 10%), but accounting for a substantial percentage of health care resource consumption. Severe asthma is categorized by treatment requiring high doses of ICS and also comprises many clinical and physiological phenotypes. Similarly, the notion of endotype is gaining momentum in the various subtypes of the disease as they are classified in their respective unique functional or pathophysiological mechanism (Campo, et al., 2013). These new approaches to asth-

ma therapies show promise, and further research efforts should be encouraged.

Approaches to Reduce These Disparities

Joseph et al. (2006) note there are several approaches to reducing asthma disparities. The most common is the traditional disease prevention model. The disease prevention model consists of the following: primary prevention, which concentrates on reducing asthma incidences; secondary prevention, which encompasses disease detection, management, and control; and finally, tertiary prevention, which focuses on the reduction of the severity and the complications of the disease process. In regards to racial and ethnic disparities and higher prevalence of asthma, the translation of knowledge from the comprehension of the disease preventive process at all three stages should influence clinical practice and public health policy. Specific approaches to targeting these disparities at all three levels of prevention are described in the following sections.

Patient and Family Education

In their study cited earlier in this chapter, Rohan et al. (2010) state that the potential clinical implications from lack of medication adherence offer health care providers the opportunity to direct parental guidance, while offering limited independence or responsibility for asthma management for children. Educating parents and children on the best use of rescue asthma medicine to prevent or decrease the need to go to the ER would be helpful. Preventive measures involving both primary care providers and the children's primary care takers should focus on identifying patterns of nonadherence followed by targeted behavioral interventions.

Improving Care and Considering Costs

Evans-Agnew (2016) argues that the management of asthma in adolescents is influenced by school policies and school nursing. Evans-Agnew argues school nurses should more accurately follow national and federal recommended asthma management guidelines to monitor symptoms and medications, communicate with health care providers, and decrease environmental triggers.

The National Heart, Lung, and Blood Institute (NHLBI) Guidelines for the Diagnosis and Management of Asthma (EPR-3) (National Heart, Lung, and Blood Institute, 2007) establishes

guidelines for asthma management and diagnosis. The guidelines highly recommend that physicians ask patients or primary caretakers about the out-of-pocket expenses for the procurement of prescribed medications. It is apparent that patients' adherence to medication regimens may lead to non-compliance through an inability to procure the needed medications due to the financial burden.

The U.S. health insurance market is multifaceted. Shedding light on various pathways to describe the intricate relationship between patient characteristics, perception of health as related to financial burden, and health outcomes may enlighten health care providers in anticipating which vulnerable population is at higher risk for adverse outcomes and needs special attention to mitigate the cost in managing their chronic condition, particularly the most prevalent of out-of-pocket expenses, cost of medicines (Patel et al., 2014).

In their exploration of variances in the utilization of health care insurance, Chang, et al. (2014) highlight essential implications for health care providers and policy makers. From these findings, it appears that health care delivery among publicly and privately funded insurance may be connected to disparities in socioeconomic status. Eventually, the disparity in the delivery of health care will lead to lost productivity in the workforce and an increase in medical costs due to the undertreatment of the chronic condition. It may be beneficial to financially incentivize care providers in the public sector to provide quality of care.

While the ACA has increased the number of African Americans with health insurance, patient perception of the financial burden of health care costs remains an issue with insurance through the ACA. This is because the ACA bases premium and out-of-pocket cost subsidies on income level, with the lowest-income individuals receiving the largest subsidies. But these individuals and those with slightly higher income levels may still struggle with costs. More states agreeing to expand access to Medicaid, as offered through the ACA, would increase the numbers of African Americans with insurance, as would improving benefits available to the publicly insured.

Following Standards and Considering Social Systems

The adolescent period is characterized as a developmental stage that is noticeably linked to the formation of self-identification

and independence (National Research Council, 2009). The significance of this developmental period for youth with asthma is that attitudes and practices established at this stage will continue into adulthood. African American youth's attitudes and practices are subject to individual management behaviors, health care practices, and community environments, as well as their understanding of their sociopolitical characteristics (Evans-Agnew, 2016). This stage also brings acute awareness to the adolescent about disparities in asthma management between themselves and others. The determinants in the health care system as seen in schools, the community, access to quality care, communication, cultural competencies, and biases are all very influential in the disparities in youth asthma management (Gupta, Springston, & Weiss, 2009; Krieger, 2008; Williams, Sternthal, & Wright, 2009).

Additional Solutions: Innovations

Health care is being revolutionized by health information technologies (HIT). New tools and applications (apps) are supporting patients in self-monitoring and decision making through the development and adoption of a personal care centered model that is digital and web-based. Additionally, online communities for asthma are developing into platforms of support and empowerment. Organizers of research advances that are patient-centered include Asthma Community Network and the Asthma and the Allergy Foundation of America. All of these efforts are aimed at patient empowerment and the facilitation of disease self-management. Researchers can benefit from HIT through electronic mechanisms that can help identify disease endotypes and personalized treatment plans grounded on patient-centric profiles. The data collected from the electronic records integrate symptom occurrences and medication usage along with environmental and genomic data (Himes & Weitzman, 2016).

HITs have sprung up across the electronic landscape and are spearheaded by several companies, including Apple. Apple's *ResearchKit* is a self-management tool, enrolling patients and providing a much needed data collection platform for researchers. Google has launched its own HIT product, *Verily*, to contribute to health improvement. Disease self-management programs can track patient symptoms, environmental exposures, and medication adherence. Management of chronic diseases, such as asthma, can benefit from increased dependence on clinical HIT,

as a result of the direct-to-consumer approach (Himes & Weitzman, 2016). These online communities provide free memberships and educational resources for asthma care improvements to individuals and advocacy groups.

Digital Technologies and Health Disparities

Can the concerns and barriers for those disproportionately affected by asthma be adequately addressed with the proliferation of digital tools? Will the tools narrow or widen the health disparity divide? There is an opportunity for program creators who develop online and smart phone apps to design and test their products in diverse groups and communities. However, several barriers must be addressed when pursuing the equalization of the health care divide: the cost of devices and internet access, cultural differences, and possibly lower literacy levels.

Technology is moving at a very fast pace. Most Americans depend on their smart phones, and these devices are becoming a necessity in daily life activities. Recently, Nielsen considered the demographics of U.S. smartphone users to include gender, race, and age. The report, *Millennials Are Top Smartphone Users* (2016), shows that multicultural consumers have the highest rate of smartphone ownership. Asian Americans lead at 95%, with African Americans as the second highest group at 93%, followed by Hispanics at 90%. The top three smartphone apps for adults 18 and over in the third quarter of 2016 were Facebook, Facebook Messenger, and YouTube. Additionally, the smartphone ownership rate by age group was as follows: millennials ages 18–24 at 98%; millennials ages 25–34 at 97%; Gen Xers ages 35–44 at 96%; ages 45–54 at 89%; ages 55–64 at 80%; and ages 65 plus at 68% (Nielsen, 2016).

Another Nielsen report, *Young, Connected and Black* (2016), highlights a surge in the use of technology and social media by African Americans, mostly millennials. Their voices are raising awareness and are evoking national discussion on civic and political issues. The report also notes that this age has great influence on mainstream America. Another Nielsen report, *Hacking Health: How Consumers Use Smartphones and Wearable Tech to Track Their Health* (2014), shows an upward swing in usage for fitness and health apps on smartphones. Consumers are accessing fitness and health apps at a considerable rate. About a third of U.S. smartphone users (46 million) accessed fitness and health

apps in January 2014, representing an 18% increase in users in the same category compared with the same month a year prior (Nielsen, 2014)

Social media can be a powerful tool in bridging the gap in health disparities. Technologically savvy multicultural millennials can exert considerable influence in civic and political arenas through advocacy groups by using the top three platforms: Facebook, Facebook Messenger, and YouTube to deliver information on such topics as the state of health and health care in local, regional, or national areas, proposed health care policies and their effect on specific demographic groups, and health care educational programs that are disease specific.

Digitally Guided Therapy

Digitally guided therapy for asthma sufferers offers unprecedented opportunities to support self-management and to gain valuable insights into respiratory chronic disease clinical symptoms management. One of the leading companies, highlighted here with information provided by the company, is Propeller Health, which is actively working on transforming treatment of respiratory diseases through digitally guided therapy.

As discussed earlier in this chapter, the burden of asthma remains exceptionally high. Asthma and other chronic pulmonary diseases adversely control the lives of about 50 million Americans. The price to patients and cost payers for managing these respiratory illnesses exceeds \$100 billion annually. A digitally guided therapy platform incorporates information from multiple sources. It connects the medication and machine intelligence to recommend the best therapy pathway for each patient. Most patients may only require adaptive self-management and technique training, which is delivered through the patient products information system. Other patients may require additional support, such as dose and schedule recommendation, changes to visit frequency, automated clinical outreach, and guidance for type and frequency of care manager outreach (Propeller, 2016).

All of this data is managed and delivered to the care providers via Propeller's proprietary care team tools. This particular platform for medication delivery is aimed at making current treatments more accessible and personalized. Patients and providers are empowered to measure, analyze, and adjust treatments as needed. Propeller over the last 12 months has forged

partnerships with over 45 programs, including major health care systems. The company reports results of improved disease control greater than 70% in the use of a rescue inhaler across diverse clinical settings and patient populations (Propeller, 2016). This proprietary system is currently offering a combination of a mobile application, sensors that attach to the recommended inhaler, and a sophisticated analytics system, all designed to help the patient keep track of medication use (Knutson, 2015).

Several other manufacturers of devices on the market offer smart inhalers to improve the management of respiratory illnesses and therapeutic compliance and effectiveness. Most of these new devices can accurately record the time of each delivered dose, store the data, not interfere with the dose delivery, and alert the user if a dose is skipped or forgotten. Most also provide real time access to data, collect geospatial data, and subsequently recognize environmental variables, such as air quality, pollen, ultraviolet sensitivity index levels, and housing codes. This can be downloaded to personal computers or mobile devices, and transmitted to care providers (Burgess, Wilson, Cooper & Davadason, 2006; Himes & Weitzman, 2016). Smart inhalers can become the next generation of respiratory care technology. By improving medication adherence, positive patient health outcome is increased and hospitalization admissions are decreased (Perez, 2015).

Conclusion

Asthma is a very complex disease with numerous causes. Both components of the disease, inflammation and airway constriction, must be treated to achieve ideal asthma control. Asthma takes a significant toll on those with the condition, affecting their ability to go school, work, and enjoy daily life. Managing the condition can be expensive for those with it and their families, and for the country as a whole.

Asthma rates are trending upward, and the condition disproportionately affects African Americans. The disparities in asthma prevalence, morbidity, and mortality between Black and White Americans are significant and do not show signs of reducing. While a significant amount of research has been performed, no single answer for these disparities has been found. Higher rates of poverty among African Americans, lower rates of health insurance and lower quality of care provided in African

American communities, lower rates of medication adherence, and environmental contaminants in African American communities all appear to be factors.

Although results have been mixed, whether African ancestry contributes to asthma susceptibility and challenges in controlling the condition remains an active area of research. Current studies in genetic science including and beyond African ancestry offer insights into the hereditary features of asthma and to the drivers that are activating the pathways of the disease.

The impact of associated direct and indirect costs of asthma are an incredible burden on the health care system infrastructure and on asthma patients and their families. Because African Americans are disproportionately likely to have a low household income and to be uninsured, these costs are disproportionately harder for Black Americans to bear. The high cost of medication and high cost-sharing for co-pays for prescribed bronchodilators and ICS therapies are associated with lack of medication adherence (Patel, Caldwell, Song, & Wheeler, 2014; Bårnes & Ulrik, 2015). Decrease in medication adherence leads to adverse asthma outcomes, which are costly emergency department visits and admissions.

The use of smart inhalers and mobile health technology is growing exponentially. These are new frontiers in health care treatment and delivery that show promise in reducing the asthma burden and the health disparities experienced by vulnerable populations with asthma. Smart inhalers can help address part of the complex asthma problem, including medication adherence and the management of resources. These devices can empower users to control and manage prescribed medications while taking charge of their health conditions. Other forms of technology may also be an aid in reducing these disparities. The cost of the devices and of Internet access, as well as whether such technology is effectively designed to consider barriers to its use for African Americans, will be factors in how effective such technology is in reducing these disparities.

For the future, conducting genetic studies across various populations as defined by race and ethnicity may be significant in clarifying population differences and risks for health disparities. Continuous interest in the identification of clinical markers, genetic markers, and biomarkers associated with asthma development in children should be considered for the purpose of

the prediction of asthma development in young children. However, such studies are expensive, and the benefit will need to be weighed with the cost in allocating health care resources.

Physicians prescribing asthma medications should consult with patients to better understand they and their families' ability to pay for these medications. Additional research should be conducted to better understand cost and other possible barriers to medication adherence for African Americans. Making health care more accessible and affordable would also help. The ACA has made significant strides in improving insurance rates for African Americans and other racial and ethnic minorities. However, results of the recent election have made the future of the act unclear, and it is uncertain what changes to or the repealing of the ACA could mean for vulnerable populations.

It is a reality that asthma disparities are extremely complex, challenging, and multilayered. These layers are represented, not exclusively, as disparities in environmental, health system, care providers, health care policies and regulations, health care insurance coverage (public versus private), and individual/family beliefs and attitudes toward asthma. Since this chronic disease and its causes are multifaceted, several approaches or strategies should be implemented to reduce said disparities. A multi-pronged humanistic, societal, and financial model should be undertaken to reduce the asthma burden in the African American community. The most promising plan may be universal health care. Unfortunately, the current uncertain political and civic climates are barriers that may make this plan unattainable.

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