Chapter 16
Asthma in Minority Populations

Alexander N. Ortega, Daphne Koinis-Mitchell, and Peter J. Gergen

Introduction

This chapter presents information on asthma in the minority population in the United States. The asthma literature is vast with over 4,000 new studies being added each year. Despite this impressive number of publications, the asthma literature on ethnic and racial minorities is sufficient enough only to discuss the black and Latino experiences. Furthermore, most asthma studies include children, since asthma is the most common childhood chronic disease. Thus, we focus most of our review on asthma in children. The observations for minority children and adults are similar. In brief, Latino and black children and adults have higher prevalence rates of asthma, have a higher likelihood of being hospitalized for asthma, have asthma symptoms that are poorly controlled and managed, and have higher asthma-related mortality rates than their white counterparts (Canino et al. 2006; Hunninghake et al. 2006; Mannnino et al. 1998; Ortega and Calderon 2000; Rhodes et al. 2003; Shapiro and Stout 2002).

While the asthma literature on minority populations is quite voluminous, and thus difficult to capture fully in one chapter, this chapter will focus on a handful of key risk factors for minority populations including environmental factors, psychosocial factors, psychiatric disorders, obesity, genetics, and cultural factors. We then discuss issues in asthma management and control for minority populations, and we review the importance of considering cultural factors and the application of broad-based intervention approaches.

A.N. Ortega (✉)
School of Public Health and Institute for Social Research, University of California Los Angeles, 2134 Rolfe Hall, Los Angeles, CA, 90095-1484, USA
e-mail: aortega@ucla.edu

Epidemiology of Asthma in Minority Populations

Minority children and adults suffer a disproportionate burden of asthma morbidity and mortality. For example, Lara et al. (2006) recently analyzed the National Health Interview Survey (NHIS) and reported that 13% of youth ages 2–17 years had a parent-reported lifetime asthma diagnosis. Approximately 12.7% of white youth, 15.8% of black youth, and 12.4% of Latino youth had a lifetime diagnosis of asthma (Lara et al. 2006). When the Latino group was disaggregated, 25.8% of Puerto Rican youth, 10.1% of Mexican youth, 14.9% of Cuban youth, and 14.9% of Dominican youth had a lifetime diagnosis. It should be noted that while Mexican-American children have a lower proportion of parent-reported asthma diagnosis in the population, the public health impact is very significant. Mexican-Americans represent the highest *frequency* of Latino children with asthma, given that they are the largest ethnic subgroup in the population.

For minority populations, asthma is associated with high levels of impairment, many missed days from school and work, hospitalizations, and increased odds for mortality when compared with whites (Akinbami et al. 2005; Cohen et al. 2006; Mannino et al. 2002). Minorities are also less likely to be on appropriate asthma management plans, and, thus, they are more

A. Harver and H. Kotses (eds.), *Asthma, Health and Society: A Public Health Perspective*,
DOI 10.1007/978-0-387-78285-0_16,

likely to have their asthma poorly controlled (Lieu et al. 2002; Ortega et al. 2002a). For Latinos, high rates of asthma and its consequences appear specific to Puerto Ricans both on the U.S. mainland and on the island. Puerto Ricans have been shown, in multiple probability studies, to have the highest prevalence of self- or parent-reported asthma than any other racial or ethnic group (Carter-Pokras and Gergen 1993; Rhodes et al. 2003; Lara et al. 2006; Ortega et al. 2002b; Perez-Perdomo et al. 2003; Rose et al. 2006), and Puerto Ricans have demonstrated to have more morbidity, as measured by missed days of school, clinic visits and emotional impact (Cohen et al. 2006; Lieu et al. 2002).

Understanding the Asthma Differences

Given the differences reported in morbidity and mortality of asthma among the various racial/ethnic groups, it is logical to ask if these differences simply reflect the economic disparities which exist in the U.S., or are they just the indication of underlying biologic differences in asthma among different groups. For instance, Smith et al. (2005) used the National Health Interview Survey to examine the prevalence of childhood asthma by race and ethnicity and income, and they reported that income modified the association between race and asthma, where black children were at higher odds of asthma than white children but only among the very poor. Race, ethnicity, and poverty are important determinants of asthma morbidity and mortality. In the US, the various racial, ethnic, and poverty groups tend to be geographically segregated. Large concentrations of poverty and minority populations are disproportionately present in inner-cities. It is difficult to explore the role of race and ethnicity in the pathogenesis of asthma, since there are many confounding factors (i.e., income levels, educational status, insurance status, zone of residence). We can, however, indirectly approach the study of the phenomenon by examining what is known about asthma clinical course, risk factors, genetics, and treatment response in order to understand if there are consistent differences found.

Atopy

Atopy is a consistent risk factor for the development and severity of asthma. Allergen skin tests and total and/or specific IgE are commonly used measurements of atopy. Population surveys of allergen skin test reactivity report higher rates of skin test reactivity among minorities (Arbes et al. 2005). Looking specifically at allergens associated with asthma (cockroach, dust mite, Alternaria), black and Mexican-American children are found to have higher levels of reactivity to these specific allergens than whites (Stevenson et al. 2001). Higher levels of total IgE have also been found in black and Latina women (Lester et al. 2001; Litonjua et al. 2005). The development of atopy is a complex interaction of genetic predisposition and environmental exposures. Environmental exposures can vary greatly on a number of different factors such as urban versus rural and socioeconomic gradient. Different environmental exposure could explain these differences or they could reflect yet unknown genetic differences.

Pulmonary Function

Asthma is a lung disease. Certain lung characteristics such as lung size or airway size may predispose a group to more readily develop asthma. Racial and ethnic differences do exist for pulmonary function and bronchoreactivity. Spirometric reference standards created from healthy population samples find that even after adjusting for height, an important determinant of pulmonary function, blacks have lower FEV_1, a measure of air flow in the lung, than Latinos or whites (Hankinson et al. 1999). Further, bronchoreactivity, a measure of how easily airways will constrict and impede airflow, is increased in blacks as compared with whites (Joseph et al. 2000; Sherman et al. 1993). The reason for this increase in bronchoreactivity is unclear. Adjusting for known risk factors of bronchoreactivity, such as IgE, has explained this increase in some (Sherman et al. 1993) but not all studies (Joseph et al. 2000). The lower flow rates and increased bronchoreactivity could clinically manifest in certain groups reacting to lower levels of asthmogenic agents such as allergens or pollution. This lowered sensitivity would manifest as more asthma activity and severity.

Asthma Attacks

Lara et al. (2006) reported on 12-month parent-reported asthma attacks in the NHIS, and they found that

approximately 6% of all youth had an asthma attack in the past year. About 5.7% of white youth, 7.5% of black youth, and 5.1% of Latino youth had a 12-month asthma attack. For the Latino youth, 11.8% of Puerto Ricans, 4% of Mexicans, 5.9% of Cubans, and 5.3% of Dominicans had a 12-month asthma attack. With reported morbidity and mortality consistently elevated in minorities, particularly for blacks and Puerto Ricans, it raises the question: Are asthma attacks more severe in these populations? A number of studies looking at children and adults with asthma attacks presenting to emergency rooms provide information on this question. In a large study of children presenting to the emergency room with an acute asthma attack, asthma severity at presentation, emergency room management, and post-discharge outcomes were similar for black, Latino, and white children (Boudreaux et al. 2003a). Similar findings for adults were reported by this same group (Boudreaux et al. 2003b). Another study of adults presenting with acute asthma to an emergency room found that blacks presented with lower pulmonary flow rates than whites during an acute attack (El-Ekiaby et al. 2006). For the most part, an asthma attack appears to have the same range of intensity among the various racial/ethnic groups.

Response to Therapy

Another aspect of an acute attack which could contribute to racial/ethnic group differences is the response to therapy. Do the various asthma drugs work similarly among all groups? Burchard et al. (2004) found in a study of Mexican and Puerto Rican participants with asthma from San Francisco, New York City, Puerto Rico, and Mexico City that Puerto Ricans had worse lung function and had decreased bronchodilator responsiveness to albuterol compared to Mexicans. The authors speculated that these differences could contribute to the increase in asthma morbidity and mortality reported in Puerto Ricans. Another intriguing piece of evidence is that the treatment responses to various drugs may differ among racial/ethnic groups, comes from a study which looked at T-lymphocyte response to glucocorticoids among whites and blacks with and without asthma. The T-lymphocytes from black asthmatics had significantly lower responsiveness to glucocorticoids as compared to white asthmatics (Federico et al. 2005). In contrast, a study on adults presenting with acute asthma to an emergency room found that albuterol was an equally effective bronchodilator for both blacks and whites. (El-Ekiaby et al. 2006). Two large treatment studies of inner-city children and adolescents reported that excellent control could be achieved in populations by applying guidelines-based asthma therapy with access to medications and reinforcement for adherence (Jones et al. 2007; Szefler et al. 2008).

Genetics

Our understanding of the genetics of asthma has been increasing rapidly. It is worthwhile to examine the genetic differences reported to see if asthma varies genetically among groups. One such target of intense study is the β_2-adrenergic receptor gene. Polymorphisms of this gene are associated with the diagnosis, severity, and response to treatment in non-minority populations (Raby and Weiss 2001). Ethnic variations in this particular gene have been implicated as the underlying cause of the differential bronchodilation that is seen in Puerto Ricans when compared to Mexicans (Choudry et al. 2005b) and to the diagnosis of asthma among Mexican adults (Santillan et al. 2003). Other gene-environment interactions which have been identified in whites are also found in Latinos, such as the interaction of CD14 genotypes and environmental tobacco smoke (Choudhry et al. 2005). Not all implicated asthma genes have been found to be important in minority populations. For example ADAM33, a gene suspected of playing an important role in asthma and airway remodeling, was found not to be associated with asthma in Latinos (Lind et al. 2003). Another approach taken in genetics is to characterize the ancestral background of individuals using ancestry informative markers. Surprisingly, in Mexican Americans, a higher degree of European ancestry was associated with more severe asthma, while in Puerto Ricans no association was found (Salari et al. 2005).

Asthma appears to be governed by many different genes whose expressions are modified by environmental exposure. To date, the various genes implicated in the pathogenesis of asthma do not track well with the various racial and ethnic groups. However, our understanding of the role of genetics is hindered by the lack

of reproducibility and contradictory findings of many of the reports.

Asthma Diagnosis

Increased asthma prevalence has long been reported among the various racial/ethnic groups. Prevalence levels can vary greatly among minorities living in a similar environment (Ledogar et al. 2000). Do these differences reflect true differences in disease or simply the differential acquisition of a diagnosis? One approach to this problem is to look at the symptoms of asthma such as wheeze and see how individuals receive the diagnosis of asthma. Akinbami et al. (2005) found evidence that minority children might be over-diagnosed after accounting for wheeze. Differences in active wheeze were found among the various groups, but not to the same extent as the differences in asthma diagnosis. Another study of Philadelphia school children found diagnosed asthma almost twice as high in black children than white children, while the levels of chronic wheeze were equal (Cunningham et al. 1996). When the analyses were restricted to just those reporting chronic wheeze, black children continued to have higher levels of diagnosed asthma. Receiving an asthma diagnosis is related to access to health care. For example, presence of health insurance is associated with increased levels of asthma diagnoses (Freeman et al. 2003). There is no gold standard for the diagnosis of asthma, and in fact one study found that pediatricians often do not know or use national guidelines, and use a variety of clinical factors to make an asthma diagnosis (Werk et al. 2000).

Access to Care

Limited access to quality health care is problematic in poor and minority communities. Many believe that limited access to and use of quality health care contributes, in large part, to the differences in asthma morbidity and mortality among subgroups in the population. The U.S. military offers an opportunity to look at racial and ethnic differences in asthma morbidity and mortality in an environment, where access to care issues are virtually absent or at least well controlled. In the civilian section, blacks have over twice the death rate from asthma than whites. In contrary, the experience in the military finds similar mortality rates in blacks and whites (Ward 1992). Interestingly, when looking at asthma hospitalizations the rate among blacks remained elevated (Gunderson et al. 2005). The lack of difference in mortality may simply reflect the military's not allowing severe asthmatics to enlist or that residual effects of income or education are limited, since the recruits are employed and the income levels of military personnel are not drastically different enough to have effects. The differential in hospitalization may not simply reflect disease differences but behavioral differences in utilization of health care.

Studies have also demonstrated that minority children and children on Medicaid are more likely to use emergency rooms and less likely to use primary care for their ongoing asthma care, even after adjusting for symptom severity, insurance status, and having a usual source of care (Berg et al. 2004; Cohen et al. 2006; Ortega et al. 2001). These findings suggest that medication use patterns and more frequent emergency room use among this population may be related to other factors such as lack of knowledge about the preventative treatment for asthma, potential mistrust of health care providers, and/or medications, perceived convenience and accessibility of services, or specific concerns regarding daily asthma medications.

Is Asthma a Different Disease Among Minorities?

While differences are found in data from pulmonary function tests and certain risk factors such as allergen skin testing, when appropriate treatment is given to inner city asthmatics their disease responds as would be expected in non-minority populations. At this time, there is no clear evidence that asthma is biologically a different disease among the poor and minorities. Thus the differences in prevalence are due in a large part to the differential acquisition of the diagnosis rather than in differences in the disease itself (Gergen 1996). Many of the differences in the morbidity and mortality reflect the inequities within our society, namely less access to quality health care, poor environmental quality and air, and poverty. This conclusion should not dishearten but challenge us with the realization that the differential burden of asthma can be overcome.

Environmental Risk Factors

For the past couple of decades, asthma researchers have tried to understand, which risk factors contribute to higher asthma burden in minorities than whites, in order to develop interventions to reduce the disease and its impact. Epidemiological studies of asthma have largely focused on the role of the environment. Several environmental factors have been implicated in the disease, and they include ozone levels and fine particles, indoor and outdoor allergens (i.e., mold, pet dander, and grass), air contaminants, dust mites, and cockroaches among others (Bakirtas and Turktas 2006; Belanger et al. 2003; Eggleston et al. 1998; Gent et al. 2003; Leaderer et al. 2002).

Studies have also suggested that the environment may explain differences in asthma risk between ethnic and racial minorities and whites (Corburn et al. 2006). A significant proportion of blacks and Latinos, particularly those who live in inner-cities, live in communities that are poor and come from households with low-incomes. Low-income neighborhoods tend to have higher levels of poor indoor and outdoor air quality, and people from such neighborhoods are more likely to be exposed to tobacco smoke (Eggleston et al. 2005; Kattan et al. 2005; Warman et al. 2006) than people from middle or high-income neighborhoods. Housing in low-income neighborhoods are more likely to have poor ventilation and water leaks that foster high concentrations of indoor allergens and infestations of cockroaches, mites and mice (Canino et al. 2006; Rosenstreich et al. 1997).

While many researchers argue that genetic predisposition and the environment play a significant role in the epidemiology of asthma and may contribute to some of the differences in observed risk between minority and non-minority children, other factors deserve attention. In fact, it has been recommended that new community interventions consider additional individual and socio-contextual factors (Canino et al. 2006; Warman et al. 2006). For instance, there has been a growing attention to the roles of psychosocial factors (i.e., stress and violence), mental illness, and physical health co-morbidities in the epidemiology of the disease (Canino et al. 2006; Freeman et al. 2003; Hunninghake et al. 2006; Kwon et al. 2006; Ortega et al. 2004a, 2004b; Wright and Steinbach 2001; Wright et al. 2004).

Psychosocial Factors

Psychosocial factors such as parental stress and community violence have been found to be associated with asthma, in inner-city children. Wright and Steinbach (2001, 2002, 2004) have examined perceived parental stress and violence in inner-city children, and have found modest effects. Clinical studies have demonstrated that parental stress is elevated among youth with asthma and that level of parental stress is related to severity of childhood asthma and use of health services for asthma. It is unclear whether parental stress transmits stress to youth thereby increasing asthma severity, or whether more severe illness in youth leads to increased stress in parents. Wright et al. (2002) have offered the explanation that stress might change parental behaviors such as smoking or breast feeding or may impact child development through pathological processes such as reducing immune response or increasing susceptibility to lower respiratory infection (Wright et al. 2002). Wright (2006) also reviews the literature on community stress such as exposure to crime, violence, poverty, and substandard housing; she posits that violence exposure increases psychological risk which contributes to asthma morbidity.

Other psychosocial factors such as parental worry, which may be related to stress, have been associated with the over use of emergency departments for asthma care and with help seeking for asthma (Carswell et al. 1990; Wakefield et al. 1997), and this is important since minorities, particularly those without insurance or who are under-insured, tend to be high emergency room utilizers. Furthermore, family stress may affect families' knowledge about asthma treatment and perceived severity of the disease (Carswell et al. 1990).

Mental Health and Psychiatric Factors

Consistent with the research on family and community stress and asthma, there have been studies on the associations of psychiatric disorders and asthma and asthma management in minority populations (Ortega et al. 2002b). Parental stress is associated with risk for mental illness and both stress and mental illness are associated with asthma outcomes (Ortega et al. 2002b, 2003, 2004a; Richardson et al. 2006; Wright et al. 2002).

The National Cooperative Inner-City Asthma Study (NCIAS) investigated factors that contribute to asthma morbidity in inner-city children. The study found that children whose caretakers had clinically significant levels of mental health problems were hospitalized for asthma almost twice the rate as children whose caretakers did not have significant mental health problems (Weil et al. 1999). Poor parental mental health is also thought to be associated with less effective parenting styles, inappropriate use of health services, and poor adherence to medications (Bartlett et al. 2004; Weil et al. 1999). Furthermore, Bender et al. (2000) reported that family psychological adaptation is related to parental perception of control of asthma. Less functional families may have difficulty following through with treatment guidelines, which, in turn, may increase children's risk of having severe asthma. For example, Shalowitz et al. (2000) found maternal life stressors and symptoms of depression were associated with high levels of childhood asthma morbidity among children in subspecialty practices.

Asthma is not only associated with mental health problems in parents but also in youth. Associations between parental reports of asthma diagnoses and anxiety and depression were found in island Puerto Rican youth (Ortega et al. 2003). The associations persisted despite adjusting for maternal mental health problems. Island Puerto Rican youth with asthma were 40% more likely to have any psychiatric disorder, 60% more likely to have more than one psychiatric disorder, 40% more likely to have an anxiety disorder, 160% more likely to have an affective disorder, and 210% more likely to have co-morbid anxiety and depression than children without asthma (Ortega et al. 2003). Goodwin et al. (2004, 2005) have also found that asthma is related to depression and anxiety in inner-city community samples, and that psychiatric problems are associated with increased help-seeking for asthma. Most studies have found that asthma is specifically associated with internalizing disorders; this is an important observation, since at least Puerto Ricans have been shown to have higher rates of anxiety and depression than other Latino subgroups (Ortega et al. 2006).

While researchers have observed relationships between asthma and mental health concerns in a variety of settings and populations, little is known about the mechanisms underlying this relationship, even despite recent efforts to explore the prospective relationships between asthma and mental illness (Hasler et al. 2005; Feldman et al. 2006). Several suppositions have been offered. First, psychiatric symptoms (i.e., anxiety attacks) are thought to be part of the development of asthma for some individuals and may lead to exacerbations through hyperventilation (Carr 1998; Carr et al. 1994, 1996). Second, enduring the chronic stress of having asthma may lead to depression (Bender et al. 2000; Mrazek 1997). Third, asthma and mental illness share similar risk factors such as stress (Schmaling et al. 2002; Wright et al. 2002) or genetic predisposition (Slattery et al. 2002; Wamboldt et al. 2002). Fourth, maternal psychopathology may confound the relation between a child's mental health and asthma because parental perception of the child's symptoms may be distorted (Frankel and Wamboldt 1998; Richters 1992; Shalowitz 2001; Wamboldt et al. 1998; Wright et al. 2002). Fifth, some have suggested that confusion over symptoms of anxiety, such as symptoms of panic attacks and separation anxiety, and it could account for elevated rates of co-morbidity between psychiatric disorders and asthma (Davies et al. 2001; Klein 2001; Ortega et al. 2004b). And sixth, studies have found that psychiatric impairment is related to the reduced ability to manage one's (or one's child's) asthma (Bartlett et al. 2004; Bender et al. 2000; Cluley and Cochrane 2001; Weil et al. 1999). Poor asthma management may increase the odds for both morbidity and mortality (Donahue et al. 1997; Suissa et al. 2000). More research is needed to explore directional pathways underlying these associations, and how these relationships may operate in specific ethnic and sub-ethnic groups that may contribute to asthma disparities.

Obesity

Obesity is a nationwide problem, and its increasing prevalence in both adults and children make it a U.S. epidemic (Blanck et al. 2006; Ogden and Tabak 2005). Latinos and blacks are more likely to be obese or overweight than whites (Blanck et al. 2006; Ogden and Tabak 2005). Obesity and overweight are associated with asthma (Gold and Wright 2005). Obesity could impact asthma through a number of different pathways: (1) increasing systemic inflammation through adipose tissue-induced inflammation (Visser et al. 1999) or through a pro-inflammatory diet (i.e., vitamin D intake

or high n-6/n-3 polyunsaturated fatty acid ratio) (Mickleborough and Rundell 2005; Troisi et al. 1995); (2) increasing the risk for co-morbid health conditions such as gastro-oesophageal reflux disease (GERD) or sleep-disordered breathing, which are associated with asthma risk (Shore 2006; Gunnbjornsdottir et al. 2004; Sulit et al. 2005); and (3) decreasing lung volume (Shore 2006). The question still remains whether the elevated risk for obesity and poor nutrition among minorities contribute to their asthma risk and helps explaining disparities in asthma.

Culture and Belief Systems

Few studies have examined the association between cultural-related factors and asthma management practices. The impact of culture on asthma morbidity is an area that necessitates further exploration, due to disparate treatment and health outcomes between individuals from racial and ethnic minority and non-Latino white backgrounds. The majority of studies including ethnic minority samples tend to focus on the association of ethnic minority status or racial background and asthma morbidity. Many of these studies conceptualize ethnic or racial background as a "cultural factor," which can be misleading given that these constructs do not represent the specific cultural values or experiences of ethnic minority individuals. In addition, much heterogeneity exists within ethnic groups and subgroups. The interaction between ethnic minority status or racial background and socioeconomic status is often difficult to disentangle, as indicated by findings from research in this area. Some studies have revealed an independent relationship between ethnic minority status and asthma morbidity, even after controlling for socioeconomic status (Lieu et al. 2002). Others indicate that socioeconomic status accounts for a large portion of the disparities in morbidity outcomes between Latino and black individuals and their white counterparts (Miller 2000). One study examined associations among multiple risk factors related to urban poverty and ethnic minority background and asthma morbidity in children, such as acculturative stress and discrimination (Koinis-Mitchell et al. 2007). Results show that multiple risks including those associated with asthma, culture and context account for more morbidity in children than one single risk factor, such as poverty or asthma severity. Since ethnic and racial minority individuals tend to be clustered in urban environments, more work is needed to examine interactions of various experiences related to context and culture that may have a bearing on morbidity for children and adults from specific ethnic groups.

Another line of research including Latino and black children and adults indicates that adherence to controller medication use has been found to be quite low, as studies have reported that, on average, daily controller medications are taken approximately 30% of the time (e.g., Ortega et al. 2002a; Rand et al. 2000; Riekert et al. 2003). Much attention has revolved around identifying the barriers to consistent asthma medication use among this population. Results from some studies widen our understanding of how culture may intersect with medication adherence and two themes appear to emerge. First, beliefs related to the nature of asthma and asthma medications seem to influence medication management practices. Second, studies have found a high use of alternative medications in this population.

An individual's health beliefs should be considered when attempting to understand potential variations in asthma management behaviors among the ethnic minority groups (Flores 2004). Studies that have examined the health beliefs and practices of black and Latino caregivers have shown that the relationships among parents' concerns about their children's medications (e.g., the dangers of dependence or long term effects), the under-use of daily, preventative asthma medications (Butz et al. 2000; Horne and Weinman 1999; Riekert et al. 2003) and lifetime history of asthma hospitalizations (Chen et al. 2003; Conn et al. 2005). These findings are consistent with those of qualitative studies including black adult patients with asthma (George and Apter 2004; George et al. 2003). In this research, the health beliefs and attitudes of adults have been proposed as partial explanations for low adherence to medical therapy and the consequent high burden of morbidity. Health beliefs that influenced adherence included patients' reliance on their assessment of asthma control over that of the health provider and concern about the adverse effects of inhaled corticosteroid therapy. In addition, many participants reported mistrust of the medical establishment. More research is needed to identify specific values and concerns by ethnic group and sub-group

that may be associated with non-adherence to prescribed daily medications.

A focus on alternative medication use in ethnic minority populations with asthma has also been highlighted. The question of whether alternative medicines interfere with effective management practices has also been raised. Results indicated a high use of alternative practices (e.g., prayers, rubs and massage) in inner city, black and Latino families with children who have asthma (Braganza et al. 2003). In one study, Dominican families chose remedies derived from folk beliefs about illness and health (Bearison et al. 2002). Results from this study found that Dominican parents frequently use folk remedies instead of their child's prescription medicines (Bearison et al. 2002). Other studies comparing the use of home remedies in Latino ethnic subgroups showed that Puerto Ricans use home remedies less frequently (Ledogar et al. 2000) than other Latino subgroups, while other findings show that Mexican Americans use home remedies frequently but not in place of traditional asthma medications (Wood et al. 1993). Taken together, these results suggest that although some families believe in the biomedical model (e.g., triggers can cause symptoms), they combine this knowledge and practice with locally salient traditional beliefs and practices (e.g., the use of folk remedies). Families' cultural values and beliefs that guide effective treatment behaviors both across and within ethnic groups need to be examined in further depth to inform ethno-medical approaches to asthma care.

Some results have also suggested that aspects of acculturation may be important to consider when identifying potential cultural-related factors, that may contribute to asthma disparities. Language barriers have often been used as an index of acculturation and are associated with lower rates of medication adherence(Apter et al. 1998). In one study, Latino children and adolescents from Spanish-speaking homes had lower rates of peak flow monitoring and poorer asthma knowledge than Latino children and adolescents from English-speaking homes (Chan et al. 2005). The results suggested that language barriers appeared to contribute to poorer asthma management practices and knowledge. Future research should examine other experiences related to acculturation beyond language preference and proficiency that may impact asthma morbidity. It may be that clashes between the value systems of patients and health care providers may have a bearing on management behaviors and subsequently the connection that is developed with providers and the health care center.

Interventions

Logically, narrowly focused interventions focusing on one or two elements of asthma treatment would have less probability of success for families from minority demographic profiles (e.g., versus encouraging consistent medication use, symptom monitoring and trigger control in the context of other stresses families face). For example, a nebulizer-education intervention among children with persistent asthma had no impact on asthma severity or health care use (Butz et al. 2006). Many of the "non-traditional" risk factors do not directly have an impact on the disease but distract the patient and family from paying attention to the disease, such as problems with housing or transportation. Therefore, interventions need to be broad-based. The National Cooperative Inner City Asthma Study (NCICAS) asthma intervention used an asthma counselor (AC) trained in asthma management. The AC usually had a background in social work. The AC worked with the families to better manage their asthma and to deal with other ongoing stresses, which reduced their abilities to focus on their asthma care. This intervention resulted in a reduced number of symptoms, days, and unscheduled health care use, which continued after the intervention ended (Evans et al. 1999). Another successful approach attempted to reduce the allergen burden within inner-city homes. This comprehensive environmental intervention clearly showed that the lower allergen levels were possible in the inner-city and this decrease significantly impacted disease activity (Morgan et al. 2004). These interventions were found to be cost effective (Sullivan et al. 2002; Kattan et al. 2005). An emergency room-based intervention where children and families received a single follow-up clinic visit and self-monitoring, environmental management, and trigger control reduced subsequent unscheduled health care use. (Teach et al. 2006). Interventions can be successful among poor and minority populations. The characteristics of successful interventions are their broad based nature and the involvement of the community.

Resilience in Minority Families: Processes Associated with Optimal Asthma Outcomes

A preponderance of evidence shows how ethnic and racial minority individuals with asthma experience more asthma burden relative to their white counterparts. There is a need for research to identify characteristics of individuals from this demographic profile who are functioning well, despite having asthma and facing other stresses related to the environment and ethnic minority background (Koinis-Mitchell et al. 2004). Many ethnic minority families do cope well in spite of their potential exposure to urban poverty, family stresses, and stresses associated with the complexity of asthma management. However, there is a dearth of research that examines which factors help to guard against adverse asthma outcomes. It should be noted that within the resilience literature, there is an important distinction between simply labeling a process as "protective" and actually demonstrating its moderating effect on an outcome in the face of specific stresses through statistical analyzes. In this regard, the pediatric asthma research has lagged far behind the wider child developmental research, which has employed rigorous methodologies when attempting to identify risk and protective factors associated with resilient developmental outcomes in ethnic and racial minority children (e.g., Koinis-Mitchell et al. 2005; Luthar et al. 2000).

Although this research is sparse, there are some pediatric asthma studies that have focused on identifying protective factors with ethnic minority, inner-city children. The studies have identified characteristics of black and Latino children, their families, and their wider social environment that may buffer their exposure to stresses related to urban living or asthma status, to optimize asthma outcomes (Koinis-Mitchell et al. 2005; Koinis-Mitchell and Murdock 2005; Koinis Mitchell 2004). For example, Koinis-Mitchell et al. (2004) findings showed that higher levels of adaptability (e.g., a more flexible temperament) and perceived control at baseline were related to more optimal asthma management strategies in a sample of urban children one year later, despite the presence of neighborhood disadvantage and asthma symptoms. Ongoing studies by these researchers employ both quantitative and ethnographic approaches to characterize resilient asthma outcomes, and to identify protective family values, beliefs, and practices associated with specific asthma management behaviors in non-Latino black, Dominican, and Puerto Rican families. Other research has shown that aspects of the health care system may be important to consider when attempting to identify potential moderating processes associated with more effective asthma control (Ortega et al. 2002a). It may be that the relationship between the physician and patient is paramount to enhance consistency with asthma-related visits and preventative care. More work demonstrating such protective effects is needed.

An interesting area that also warrants further exploration involves potential protective processes associated with differences in how Latino ethnic subgroups fare in terms of asthma outcomes in the US. Evidence has shown that among Latino ethnic subgroups, Mexican American's have the lowest prevalence of asthma and asthma morbidity in the United States, while Puerto Rican children bear a disproportionate amount of asthma burden (Homa et al. 2000; Lara et al. 2006). Yet, it is unclear what the mechanisms are that account for differences in Latino subgroup outcomes, as they cannot be explained solely by socio-demographic factors. As this review and others (e.g., Canino et al. 2006) indicate, evidence points to a complex interaction between various factors associated with one's genetic makeup, the environment, the health care system, one's psychological functioning and perceptions, and experiences of stress, social experiences (i.e., migration, discrimination, acculturation), and cultural belief systems and practices, that may all contribute to variations in asthma outcomes among Latino ethnic subgroups and blacks.

One recent study examined the relationship between country of birth and acculturation with asthma among a large group of Mexican American youth (using data from the National Health and Nutrition Examination Survey 1999–2002) (Eldeirawi and Persky 2006.). This study found that Mexican American adolescents born in the US and those with high acculturation levels reported significantly higher prevalence rates of asthma and wheezing than their peers with low acculturation levels born in Mexico. Both acculturation and country of birth were linked with the risk of asthma, with acculturation having stronger effects than country of birth. More research is needed to examine how asthma prevalence and morbidity rates among Latino ethnic subgroups may be impacted by migration patterns, acculturation levels, stresses related to acculturation, and the amount of time

spent in the US. In addition, moderating processes that may buffer the exposure to stressors related to acculturation and risk for asthma morbidity need to be identified for specific ethnic groups.

Additional work identifying modifiable factors associated with optimal functioning in specific ethnic groups with asthma is needed. Many questions remain unanswered. It is not clear to what extent specific aspects of the health care system, family environment, or community may protect children from different ethnic groups from experiencing asthma morbidity. What is considered a resilient asthma-related outcome for each individual may differ depending upon the level of stresses faced, the duration of the exposure to specific stresses, and the individual's previous level of functioning. In addition, it may be the specific processes such as those associated with the family (e.g., praying, kinship networks) or community (e.g., social support networks, asthma education programs) serve more of a protective function for some families than others, but these processes have not yet been investigated. Future work exploring these questions and identifying the strengths of ethnic minority individuals with asthma would certainly offset the "deficit" emphasis that is commonly illustrated by results from research including this population. Further development of methodologies that capture the cultural uniqueness and hardiness of individuals from specific ethnic groups and subgroups is needed.

Conclusion

Our knowledge and understanding of asthma has increased greatly in the last two decades. This knowledge has changed the way we approach asthma. It was simply believed that asthma affects people due to episodic constrictions of airway smooth muscles. Thus, treatment was focused on episodic use of quick relievers to lessen this constriction. Asthma is now thought to result from a chronic inflammatory process in the lung. Treatments today focus on reducing this inflammation with controller medications such as inhaling steroids. In addition, much work is focused on changing the natural history of asthma by attempting to identify periods during a person's life when addition or removal of certain environmental factors can decrease the risk of developing asthma.

Despite this increase in knowledge, the disparity in asthma morbidity and mortality between whites and minorities remains, and the gap has not significantly decreased in the last decade. To close this continuing disparity among subgroups in the population will require studies specifically addressing these differences, as it appears simply increasing our overall knowledge of asthma will not close these gaps.

Future asthma research, especially in minority populations, must move beyond the traditional biomedical model of agent-disease-host. Research should also explore community, family, individual, psychosocial, and cultural factors and their impact on asthma and asthma management and control. Even if these factors do not change the basic pathophysiology of asthma, if not considered, they do make effective implementation of interventions difficult if not impossible. Identification of risk factors is not enough. Effective, *translatable*, self-sustaining interventions must be developed to change asthma burden in minority populations. Our review points out several interesting areas for further inquiry. More work is needed to determine if asthma is the same disease among ethnic groups in the area of genetics and differential responses to asthma medications. Research and policy on asthma in minority communities needs to focus not only on the reduction of environmental risk factors, but also implement innovative methods and policies to deliver high quality asthma health care, and create a better understanding of cultural values and beliefs around asthma and asthma care among blacks and Latino ethnic subgroups, particularly for Puerto Ricans. And finally, it must never be forgotten that asthma is a disease managed in large part by families at home. Programs must be developed and applied to empower asthmatics and their families to assume a leadership position in the management of the disease.

References

Akinbami LJ, Rhodes JC, Lara M (2005) Racial and ethnic differences in asthma diagnosis among children who wheeze. Pediatrics 115(5):1254–1260

Apter AJ, Reisine ST, Affleck G, Barrows E, ZuWallack RL (1998) Adherence with twice-daily dosing of inhaled steroids. Socioeconomic and health-belief differences. Am J Respir Crit Care Med 157(Pt 1):1810–1817

Arbes SJ, Gergen PJ, Elliott L, Zeldin DC (2005) Prevalences of positive skin test responses to 10 common allergens in the US population: results of the third National Health and

Nutrition Examination Survey. J Allergy Clin Immunol 116(2):377–383
Bakirtas A, Turktas I (2006) Determinants of airway responsiveness to adenosine 5′-monophosphate in school-age children with asthma. Pediatr Pulmonol 41(6):515–521
Bartlett SJ, Krishnan JA, Riekert KA, Butz AM, Malveaux FJ, Rand CS (2004) Maternal depressive symptoms and adherence to therapy in inner-city children with asthma. Pediatrics 113(2):229–237
Bearison DJ, Minian N, Granowetter L (2002) Medical management of asthma and folk medicine in a Hispanic community. J Pediatr Psychol 27(4):385–392
Belanger K, Beckett W, Triche E, Bracken MB, Holford T, Ren P, McSharry JE, Gold DR, Platts-Mills TA, Leaderer BP (2003) Symptoms of wheeze and persistent cough in the first year of life: associations with indoor allergens, air contaminants, and maternal history of asthma. Am J Epidemiol 158(3):195–202
Bender BG, Annett RD, Ikle D, DuHamel TR, Rand C, Strunk RC (2000) Relationship between disease and psychological adaptation in children in the Childhood Asthma Management Program and their Families. CAMP Research Group. Arch Pediatr Adolesc Med 154(7):706–713
Berg J, Wahlgren DR, Hofstetter R, Meltzer SB, Meltzer EO, Matt GE, Martinez-Donate A, Hovell MF (2004) Latino children with asthma: rates and risks for medical care utilization. J Asthma 41(2):147–157
Blanck HM, Dietz WH, Galuska DA, Gillespie C, Hamre R, Kettel Khan L, Serdula MK, Ford ES, Garvin WS, Mokdad AH, Densmore D (2006) State-specific prevalence of obesity among adults – United States, 2005. Morb Mortal Wkly Rep 55(36):985–988
Boudreaux ED, Emond SD, Clark S, Camargo CA Jr (2003a) Race/ethnicity and asthma among children presenting to the emergency department: differences in disease severity and management. Pediatrics 111(5 Pt 1):e615–e621
Boudreaux ED, Emond SD, Clark S, Camargo CA Jr (2003b) Acute asthma among adults presenting to the emergency department: the role of race/ethnicity and socioeconomic status. Chest 124(3):803–812
Braganza S, Ozuah PO, Sharif I (2003) The use of complementary therapies in inner-city asthmatic children. J Asthma 40(7):823–827
Burchard EG, Avila PC, Nazario S, Casal J, Torres A, Rodriguez-Santana JR, Toscano M, Sylvia JS, Alioto M, Salazar M, Gomez I, Fagan JK, Salas J, Lilly C, Matallana H, Ziv E, Castro R, Selman M, Chapela R, Sheppard D, Weiss ST, Ford JG, Boushey HA, Rodriguez-Cintron W, Drazen JM, Silverman EK (2004) Lower bronchodilator responsiveness in Puerto Rican than in Mexican subjects with asthma. Am J Respir Crit Care Med 169(3):386–392
Butz AM, Eggleston P, Huss K, Kolodner K, Rand C (2000) Nebulizer use in inner-city children with asthma: morbidity, medication use, and asthma management practices. Arch Pediatr Adolesc Med 154(10):984–990
Butz AM, Tsoukleris MG, Donithan M, Hsu VD, Zuckerman I, Mudd KE, Thompson RE, Rand C, Bollinger ME (2006) Effectiveness of nebulizer use-targeted asthma education on underserved children with asthma. Arch Pediatr Adolesc Med 160(6):622–628
Canino G, Koines-Mitchell D, Ortega AN, McQuaid EL, Fritz GK, Alegria M (2006) Asthma disparities in the prevalence, morbidity, and treatment of Latino children. Soc Sci Med 63(11):2926–2937
Carr RE (1998) Panic disorder and asthma: causes, effects and research implications. J Psychosom Res 44(1):43–52
Carr RE, Lehrer PM, Hochron SM, Jackson A (1996) Effect of psychological stress on airway impedance in individuals with asthma and panic disorder. J Abnorm Psychol 105(1):137–141
Carr RE, Lehrer PM, Rausch LL, Hochron SM (1994) Anxiety sensitivity and panic attacks in an asthmatic population. Behav Res Ther 32(4):411–418
Carswell F, Heck G, Robinson E, Hallows D, Peters T, Stanton T (1990) Family stress and childhood asthma. Nurs Pract 3(3):10–15
Carter-Pokras OD, Gergen PJ (1993) Reported asthma among Puerto Rican, Mexican-American, and Cuban children. Am J Public Health 83(4):580–582
Chan KS, Keeler E, Schonlau M, Rosen M, Mangione-Smith R (2005) How do ethnicity and primary language spoken at home affect management practices and outcome in children and adolescents with asthma? Arch Pediatr Adolesc Med 159(3):283–289
Chen E, Bloomberg GR, Fisher EGJ, Strunk RC (2003) Predictors of repeat hospitalizations in children with asthma: the role of psychosocial and socioenvironmental factors. Health Psychol 22(1):12–18
Choudhry S, Avila PC, Nazario S, Ung N, Kho J, Rodriguez-Santana JR, Casal J, Tsai HJ, Torres A, Ziv E, Toscano M, Sylvia JS, Alioto M, Salazar M, Gomez I, Fagan JK, Salas J, Lilly C, Matallana H, Castro RA, Selman M, Weiss ST, Ford JG, Drazen JM, Rodriguez-Cintron W, Chapela R, Silverman EK, Burchard EG (2005) CD14 tobacco gene-environment interaction modifies asthma severity and immunoglobulin E levels in Latinos with asthma. Am J Respir Crit Care Med 172(2):173–182
Choudhry S, Ung N, Avila PC et al. (2005) Pharmacogenetic differences in response to atbuterol between Puerto Ricans and Mexicans with asthma. Am J Respir Crit Care Med 171(6):563–570
Cluley S, Cochrane GM (2001) Psychological disorder in asthma is associated with poor control and poor adherence to inhaled steroids. Respir Med 95(1):37–39
Cohen RT, Celedon JC, Hinckson VJ, Ramsey CD, Wakefield DB, Weiss ST, Cloutier MM (2006) Health-care use among Puerto Rican and African-American children with asthma. Chest 130(2):463–471
Conn KM, Halterman JS, Fisher SG, Yoos HL, Chin NP, Szilagyi PG (2005) Parental beliefs about medications and medication adherence among urban children with asthma. Ambul Pediatr 5(5):306–310
Corburn J, Osleeb J, Porter M (2006) Urban asthma and the neighbourhood environment in New York City. Health Place 12(2):167–179
Cunningham J, Dockery DW, Speizer FE (1996) Race, asthma, and persistent wheeze in Philadelphia school children. Am J Public Health 86(10):1406–1409
Davies SJ, Jackson PR, Ramsay LE (2001) Dysfunctional breathing and asthma: panic disorder needs to be considered. Br Med J 323(7313):631

Donahue JG, Weiss ST, Livingston JM, Goetsch MA, Greineder DK, Platt R (1997) Inhaled steroids and the risk of hospitalization for asthma. J Am Med Assoc 277(11):887–891

Eggleston PA, Butz A, Rand C, Curtin-Brosnan J, Kanchanaraksa S, Swartz L, Breysse P, Buckley T, Diette G, Merriman B, Krishnan JA (2005) Home environmental intervention in inner-city asthma: a randomized controlled clinical trial. Ann Allergy Asthma Immunol 95(6):518–524

Eggleston PA, Rosenstreich D, Lynn H, Gergen P, Baker D, Kattan M, Mortimer KM, Mitchell H, Ownby D, Slavin R, Malveaux F (1998) Relationship of indoor allergen exposure to skin test sensitivity in inner-city children with asthma. J Allergy Clin Immunol 102(4 Pt 1):563–570

El-Ekiaby A, Brianas L, Skowronski ME, Coreno AJ, Galan G, Kaeberlein FJ, Seitz RE, Villaba KD, Dickey-White D, McFadden ER Jr (2006) Impact of race on the severity of acute episodes of asthma and adrenergic responsiveness. Am J Respir Crit Care Med 174(5):508–513

Eldeirawi KM, Persky VW (2006) Associations of acculturation and country of birth with asthma and wheezing in Mexican American youths. J Asthma 43(4):279–286

Evans R 3rd, Gergen PJ, Mitchell H, Kattan M, Kerscmar C, Crain E, Anderson J, Eggleston P, Malveaux FJ, Wedner HJ (1999) A randomized clinical trial to reduce asthma morbidity among inner-city children: results of the National Cooperative Inner-City Asthma Study. J Pediatr 135(3):332–338

Federico MJ, Covar RA, Brown EE, Leung DYM, Spahn JD (2005) Racial differences in T-lymphocyte response to glucocorticoids. Chest 127(2):571–578

Feldman JM, Ortega AN, McQuaid EL, Canino G (2006) Comorbidity betweenasthma attacks and internalizing disorders among Puerto Rican children at one-year follow-up. Psychosomatics 47(4):333–339

Flores G (2004) Culture, ethnicity, and linguistic issues in pediatric care: urgent priorities and unanswered questions. Ambul Pediatr 4(4):276–282

Frankel K, Wamboldt MZ (1998) Chronic childhood illness and maternal mental health – why should we care? J Asthma 35(8):621–630

Freeman NC, Schneider D, McGarvey P (2003) The relationship of health insurance to the diagnosis and management of asthma and respiratory problems in children in a predominately Hispanic urban community. Am J Public Health 93:1316–1320

Gent JF, Triche EW, Holford TR, Belanger K, Bracken MB, Beckett WS, Leaderer BP (2003) Association of low-level ozone and fine particles with respiratory symptoms in children with asthma. J Am Med Assoc 290(14):1859–1867

George M, Apter AJ (2004) Gaining insight into patients' beliefs using qualitative research methodologies. Curr Opin Allergy Clin Immunol 4(3):185–189

George M, Freedman TG, Norfleet AL, Feldman HI, Apter AJ (2003) Qualitative research-enhanced understanding of patients' beliefs: results of focus groups with low-income, urban, African American adults with asthma. J Allergy Clin Immunol 111(5):967–973

Gergen P (1996) Social class and asthma – distinguishing between the disease and the diagnosis. Am J Public Health 86(10):1361–1362

Gold DR, Wright R (2005) Population disparities in asthma. Annu Rev Public Health 26:89–113

Goodwin RD, Fergusson DM, Horwood LJ (2004) Asthma and depressive and anxiety disorders among young persons in the community. Psychol Med 34(8):1465–1474

Goodwin RD, Messineo K, Bregante A, Hoven CW, Kairam R (2005) Prevalence of probable mental disorders among pediatric asthma patients in an inner-city clinic. J Asthma 42(8):643–647

Gunderson EKE, Garland CF, Gorham ED (2005) Health surveillance for asthma in the US Navy: experience of 9, 185, 484 person-years. Ann Epidemiol 15(4):310–315

Gunnbjornsdottir MI, Omenaas E, Gislason T, Norman E, Olin AC, Jogi R, Jensen EJ, Lindberg E, Bjornsson E, Franklin K, Janson C, Gulsvik A, Laerum B, Svanes C, Toren K, Tunsater A, Lillienberg L, Gislason D, Blondal T, Bjornsdottir US, Jorundsdottir KB, Talvik R, Forsberg B, Franklin K, Lundback B, Soderberg M, Ledin MC, Boman G, Norback D, Wieslander G, Spetz-Nystrom U, Cashelunge KS, Ryden E (2004) Obesity and nocturnal gastro-oesophageal reflux are related to onset of asthma and respiratory symptoms. Eur Respir J 24(1):116–121

Hankinson JL, Odencrantz JR, Fedan KB (1999) Spirometric reference values from a sample of the general U.S. population. Am J Respir Crit Care Med 159(1):179–187

Hasler G, Gergen PJ, Kleinbaum DG, Ajdacic V, Gamma A, Eich D, Rossler W, Angst J (2005) Asthma and panic in young adults: a 20-year prospective community study. Am J Respir Crit Care Med 171(11):1224–1230

Homa D, Mannino D, Lara M (2000) Asthma mortality in U.S. Hispanics of Mexican, Puerto Rican, and Cuban heritage, 1990–1995. Am J Respir Crit Care Med 161(2 Pt 1):504–509

Horne R, Weinman J (1999) Patients' beliefs about prescribed medicines and their role in adherence to treatment in chronic physical illness. J Psychosom Res 47(6):555–567

Hunninghake GM, Weiss ST, Celedon JC (2006) Asthma in Hispanics. Am J Respir Crit Care Med 173(2):143–163

Jones CA, Clement LT, Morphew T, Kwong KYC, Hanley-Lopez J, Lifson F, Opas L, Guterman JJ (2007) Achieving and maintaining asthma control in an urban pediatric disease management program: the Breathmobile Program. J Allergy Clin Immunol 119(6):1445–1453

Joseph CLM, Ownby DR, Peterson EL, Johnson CC (2000) Racial differences in physiologic parameters related to asthma among middle-class children. Chest 117(5):1336–1344

Kattan M, Stearns SC, Crain EF, Stout JW, Gergen PJ, Evans R 3rd, Visness CM, Gruchalla RS, Morgan WJ, O'Connor GT, Mastin JP, Mitchell HE (2005) Cost-effectiveness of a home-based environmental intervention for inner-city children with asthma. J Allergy Clin Immunol 116(5):1058–1063

Klein DF (2001) Asthma and psychiatric illness. J Am Med Assoc 285(7):881–882

Koinis-Mitchell D, Adams SK, Murdock KK (2005) Associations among risk factors, individual resources, and indices of school-related asthma morbidity in urban, school-aged children: a pilot study. J Sch Health 75(10):375–383

Koinis-Mitchell D, Murdock KK (2005) Identifying risk and resource factors in children with asthma from urban settings: the context-health-development model. J Asthma 42(6): 425–436

Koinis-Mitchell D, Murdock KK, McQuaid EL (2004) Risk and resilience in urban children with asthma. Child Health Care 33:275–298

Koinis-Mitchell D, McQuaid EL, Seifer R, Kopel SJ, Esteban C, Canino G, Garcia-Coll C, Klein R, Fritz GK (2007) Multiple urban and asthma-related risks and their association with asthma morbidity in children. J Pediatr Psychol 32(5): 582–595

Kwon HL, Ortiz B, Swaner R, Shoemaker K, Jean-Louis B, Northridge ME, Vaughan RD, Marx T, Goodman A, Borrell LN, Nicholas SW (2006) Childhood asthma and extreme values of body mass index: the Harlem children's zone asthma initiative. J Urban Health 83(3):421–433

Lara M, Akinbami L, Flores G, Morgenstern H (2006) Heterogeneity of childhood asthma among Hispanic children: Puerto Rican children bear a disproportionate burden. Pediatrics 117(1):43–53

Leaderer BP, Belanger K, Triche E, Holford T, Gold DR, Kim Y, Jankun T, Ren P, McSharry Je JE, Platts-Mills TA, Chapman MD, Bracken MB (2002) Dust mite, cockroach, cat, and dog allergen concentrations in homes of asthmatic children in the northeastern United States: impact of socioeconomic factors and population density. Environ Health Perspect 110(4):419–425

Ledogar R, Penchascadeh A, Iglesias Garden C, Acosta L (2000) Asthma and Latino cultures: different prevalence reported among groups sharing the same environment. Am J Public Health 90(6):929–935

Lester LA, Rick SS, Blumenthal MN, Togias A, Murphy S, Malveaux F, Miller ME, Dunston GM, Solway J, Wolf RL, Samet JM, Marsh DG, Meyers DA, Ober C, Bleecker ER (2001) Ethnic differences in asthma and associated phenotypes: collaborative study on the genetics of asthma. J Allergy Clin Immunol 108(3):357–362

Lieu TA, Lozano P, Finkelstein JA, Chi FW, Jensvold NG, Capra AM, Quesenberry CP, Selby JV, Farber HJ (2002) Racial/ethnic variation in asthma status and management practices among children in managed Medicaid. Pediatrics 109(5):857–865

Lind DL, Choudhry S, Ung N, Ziv E, Avila PC, Salari K, Ha C, Lovins EG, Coyle NE, Nazario S, Casal J, Torres A, Rodriguez-Santana JR, Matallana H, Lilly CM, Salas J, Selman M, Boushey HA, Weiss ST, Chapela R, Ford JG, Rodriguez-Cintron W, Silverman EK, Sheppard D, Kwok PY, Gonzalez Burchard E (2003) ADAM33 is not associated with asthma in Puerto Rican or Mexican populations. Am J Respir Crit Care Med 168(11):1312–1316

Litonjua AA, Celedon JC, Hausmann J, Nikolov M, Sredl D, Ryan L, Platts-Mills TA, Weiss ST, Gold DR (2005) Variation in total and specific IgE: effects of ethnicity and socioeconomic status. J Allergy Clin Immunol 115(4):751–757

Luthar SS, Cicchetti D, Becker B (2000) The construct of resilience: a critical evaluation and guidelines for future work. Child Dev 71(3):543–562

Mannino DM, Homa DM, Akinbami LJ, Moorman JE, Gwynn C, Redd SC (2002) Surveillance for asthma – United States, 1980–1999. Morb Mortal Wkly Rep 51(SS01):1–13

Mannnino DM, Homa DM, Pertowski CA, Ashizawa A, Nixon LL, Johnson CA, Ball LB, Jack E, Kang DS (1998) Surveillance for asthma – United States, 1960–1995. In *CDC Surveillance Summaries,* April 24, 1998. Morb Mortal Wkly Rep 47(No. SS-1):1–27

Mickleborough TD, Rundell KW (2005) Dietary polyunsaturated fatty acids in asthma-and exercise-induced bronchoconstriction. Eur J Clin Nutr 59(12):1335–1346

Miller JE (2000) The effects of race/ethnicity and income on early childhood asthma prevalence and health care use. Am J Public Health 90(3):428–430

Morgan WJ, Crain EF, Gruchalla RS, O'Connor GT, Kattan M, Evans R 3rd, Stout J, Malindzak G, Smartt E, Plaut M, Walter M, Vaughn B, Mitchell H (2004) Results of a home-based environmental intervention among urban children with asthma. N Eng J Med 351(11):1068–1080

Mrazek DA (1997) Psychological aspects in children and adolescents. In: Barnes PJ, Grunstein MM, Leff AR, Woolcock AJ (eds) Asthma. Lippincott-Raven, Philadelphia, pp 2177–2183

Ogden CL, Tabak CJ (2005) Children and teens told by doctors that they were overweight. Morb Mortal Wkly Rep 54(34):848–849

Ortega AN, Belanger KD, Paltiel AD, Horwitz SM, Bracken MB, Leaderer BP (2001) Use of health services by insurance status among children with asthma. Med Care 39(10): 1065–1074

Ortega AN, Calderon JG (2000) Pediatric asthma among minority populations. Curr Opin Pediatr 12(6):579–583

Ortega AN, Feldman JM, Canino G, Steinman K, Alegria M (2006) Co-occurrence of mental and physical illness in US Latinos. Soc Psychiatry Psychiatr Epidemiol 41(12):927–934

Ortega AN, Gergen PJ, Paltiel AD, Bauchner H, Belanger KD, Leaderer BP (2002a) Impact of site care, race, and Hispanic ethnicity on medication use for childhood asthma. Pediatrics 109(1):E1

Ortega AN, Goodwin RD, McQuaid EL, Canino G (2004a) Parental mental health, childhood psychiatric disorders, and asthma attacks in island Puerto Rican youth. Ambul Pediatr 4(4):308–315

Ortega AN, Huertas SE, Canino G, Ramirez R, Rubio-Stipec M (2002b) Childhood asthma, chronic illness, and psychiatric disorders. J Nerv Ment Dis 190(5):275–281

Ortega AN, McQuaid EL, Canino G, Goodwin RD, Fritz GK (2004b) Comorbidity of asthma and anxiety and depression in Puerto Rican children. Psychosomatics 45(2):93–99

Ortega AN, McQuaid EL, Canino G, Ramirez R, Fritz GK, Klein RB (2003) Association of psychiatric disorders and different indicators of asthma in island Puerto Rican children. Soc Psychiatry Psychiatr Epidemiol 38(4):220–226

Perez-Perdomo R, Perez-Cardona C, Disdier-Flores O, Cintron Y (2003) Prevalence and correlates of asthma in the Puerto Rican population: behavioral risk factor surveillance system, 2000. J Asthma 40(5):465–474

Raby BA, Weiss ST (2001) Beta2-adrenergic receptor genetics. Curr Opin Mol Ther 3(6):554–566

Rand CS, Butz AM, Kolodner K, Huss K, Eggleston P, Malveaux F (2000) Emergency department visits by urban African American children with asthma. J Allergy Clin Immunol 105(1 Pt 1):83–90

Rhodes L, Moorman JE, Mannino DM (2003) Self-reported asthma prevalence and control among adults – United States, 2001. Morb Mortal Wkly Rep 52(17):381–384

Richardson LP, Lozano P, Russo J, McCauley E, Bush T, Katon W (2006) Asthma symptom burden: relationship to asthma severity and anxiety and depression symptoms. Pediatrics 118(3):1042–1051

Richters JE (1992) Depressed mothers as informants about their children: a critical review of the evidence of distortion. Psychol Bull 112(3):485–499

Riekert KA, Butz AM, Eggleston PA, Huss K, Winkelstein M, Rand CS (2003) Caregiver-physician medication concordance and undertreatment of asthma among inner-city children. Pediatrics 111(3):e214–e220

Rose D, Mannino DM, Leaderer BP (2006) Asthma prevalence among US adults, 1998–2000: role of Puerto Rican ethnicity and behavioral and geographic factors. Am J Public Health 96(5):880–888

Rosenstreich DL, Eggleston P, Kattan M, Baker D, Slavin RG, Gergen P, Mitchell H, McNiff-Mortimer K, Lynn H, Ownby D, Malveaux F (1997) The role of cockroach allergy and exposure to cockroach allergen in causing morbidity among inner-city children with asthma. N Eng J Med 336(19): 1356–1363

Salari K, Choudhry S, Tang H, Naqvi M, Lind D, Avila PC, Coyle NE, Ung N, Nazario S, Casal J, Torres-Palacios A, Clark S, Phong A, Gomez I, Matallana H, Perez-Stable EJ, Shriver MD, Kwok PY, Sheppard D, Rodriguez-Cintron W, Risch NJ, Burchard EG, Ziv E (2005) Genetic admixture and asthma-related phenotypes in Mexican American and Puerto Rican asthmatics. Genet Epidemiol 29(1):76–86

Santillan AA, Camargo CA Jr, Ramirez-Rivera A, Delgado-Enciso I, Rojas-Martinez A, Cantu-Diaz F, Barrera-Saldana HA (2003) Association between β_2-adrenoceptor polymorphisms and asthma diagnosis among Mexican adults. J Allergy Clin Immunol 112(6):1095–1100

Schmaling KB, McKnight PE, Afari N (2002) A prospective study of the relationship of mood and stress to pulmonary function among patients with asthma. J Asthma 39(6):501–510

Shalowitz MU, Berry CA, Quinn KA, Wolf RL (2001) The relationship of life stressors and maternal depression to pediatric asthma morbidity in a subspecialty practice. Ambul Pediatr 1(4):185–193

Shapiro GG, Stout JW (2002) Childhood asthma in the United States: urban issues. Pediatr Pulmonol 33(1):47–55

Sherman CB, Tollerud DJ, Heffner LJ, Speizer FE, Weiss ST (1993) Airway Responsiveness in young black and white women. Am Rev Respir Dis 148(1):98–102

Shore SA (2006) Obesity and asthma: cause for concern. Curr Opin Pharmacol 6(3):230–236

Slattery MJ, Klein DF, Mannuzza S, Moulton JL 3rd, Pine DS, Klein RG (2002) Relationship between separation anxiety disorder, parental panic disorder, and atopic disorders in children: a controlled high-risk study. J Am Acad Child Adolesc Psychiatry 41(8):947–954

Smith LA, Hatcher-Ross JL, Wertheimer R, Kahn RS (2005) Rethinking race/ethnicity, income, and childhood asthma: racial/ethnic disparities concentrated among the very poor. Public Health Rep 120(2):109–116

Stevenson LA, Gergen PJ, Hoover DR, Rosenstreich D, Mannino DM, Matte TD (2001) Sociodemographic correlates of indoor allergen sensitivity among United States children. J Allergy Clin Immunol 108(5):747–752

Suissa S, Ernst P, Benayoun S, Baltzan M, Cai B (2000) Low-dose inhaled corticosteroids and the prevention of death from asthma. N Eng J Med 343(5):332–336

Sullivan SD, Weiss KB, Lynn H, Mitchell H, Kattan M, Gergen PJ, Evans R (2002) The cost-effectiveness of an inner-city asthma intervention for children. J Allergy Clin Immunol 110(4):576–581

Sulit LG, Storfer-Isser A, Rosen CL, Kirchner HL, Redline S (2005) Associations of obesity, sleep-disordered breathing, and wheezing in children. Am J Respir Crit Care Med 171(6):659–664

Szefler SJ, Mitchell H, Sorkness CA, Gergen PJ, O'Connor GT, Morgan WJ, Kattan M, Pongracic JA, Teach SJ, Bloomberg GR, Eggleston PA, Gruchalla RS, Kercsmar CM, Liu AH, Wildfire JJ, Curry MD, Busse WW (2008) Management of asthma based on exhaled nitric oxid in addition to guideline-based treatment for inner-city adolescents and young adults: a randomized controlled trial. Lancet 372(9643):1065–1072

Teach SJ, Crain EF, Quint DM, Hylan ML, Joseph JG (2006) Improved asthma outcomes in a high-morbidity pediatric population. Arch Pediatr Adolesc Med 160(5):535–541

Troisi RJ, Willett WC, Weiss ST, Trichopoulos D, Rosner B, Speizer FE (1995) A prospective-study of diet and adult-onset asthma. Am J Respir Crit Care Med 151(5):1401–1408

Visser M, Bouter LM, McQuillan GM, Wener MH, Harris TB (1999) Elevated C-reactive protein levels in overweight and obese adults. J Am Med Assoc 282(22):2131–2135

Wakefield M, Staugas R, Ruffin R, Campbell D, Beilby J, McCaul K (1997) Risk factors for repeat attendance at hospital emergency departments among adults and children with asthma. Aust NZ J Med 27(3):277–284

Wamboldt FS, Price MR, Hume LA, Gavin LA, Wamboldt MZ, Klinnert MD (2002) Reliability and validity of a system for coding asthma outcomes from medical records. J Asthma 39(4):29–305

Wamboldt MZ, Fritz G, Mansell A, McQuaid EL, Klein RB (1998) Relationship of asthma severity and psychological problems in children. J Am Acad Child Adolesc Psychiatry 37:943–950

Ward DL (1992) An international comparison of asthma morbidity and mortality in US soldiers 1984 to 1988. Chest 101:613–620

Warman K, Silver EJ, Wood PR (2006) Asthma risk factor assessment: what are the needs of inner-city families? Ann Allergy Asthma Immunol 97(1 Suppl):S11–S15

Weil CM, Wade SL, Bauman LJ, Lynn H, Mitchell H, Lavigne J (1999) The relationship between psychosocial factors andasthma morbidity in inner-city children with asthma. Pediatrics 104(6):1274–1280

Werk LN, Steinbach S, Adams WG, Bauchner H (2000) Beliefs about diagnosing asthma in young children. Pediatrics 105(3 Pt 1):585–590

Wood PR, Hidalgo HA, Prihoda TJ, Kromer ME (1993) Hispanic children with asthma: morbidity. Pediatrics 91(1):62–69

Wright RJ (2006) Health effects of socially toxic neighborhoods: the violence and urban asthma paradigm. Clin Chest Med 27(3):413–421

Wright RJ, Cohen S, Carey V, Weiss ST, Gold DR (2002) Parental stress as a predictor of wheezing in infancy: a prospective birth-cohort study. Am J Respir Crit Care Med 165(3):358–365

Wright RJ, Mitchell H, Visness CM, Cohen S, Stout J, Evans R, Gold DR (2004) Community violence and asthma morbidity: the Inner-City Asthma Study. Am J Public Health 94(4):625–632

Wright RJ, Steinbach SF (2001) Violence: an unrecognizable environmental exposure that may contribute to greater asthma morbidity in high risk inner-city-populations. Environ Health Perspect 109:1085–1089