

HEALTH ECONOMICS

A Population-Based Study of Health Service Deficits for US Adults with Asthma

MAY NAWAL LUTFIYYA, PH.D.,^{1,*} JOEL EMERY MCCULLOUGH, M.D., M.PH., M.S.,² AND MARTIN STEPHEN LIPSKY, M.D., M.S.³

¹*Research Division, Essentia Institute of Rural Health, Duluth, MN, USA.*

²*Public Health Department, Spokane Regional Health District, Spokane, WA, USA.*

³*Department of Community and Family Medicine, University of Illinois-Chicago College of Medicine at Rockford, Rockford, IL, USA.*

Objective. Asthma prevalence in the United States is higher than it is in many other countries and its impact in terms of healthcare expenditures and morbidity and mortality is staggering. In the United States, many groups bear a disproportionate burden of asthma. Understanding the epidemiology of adult asthma and deficits in health care can identify opportunities for improving care and effectively managing resources. **Methods.** The computed dependent variable, health service deficits, entails a lack of health insurance, not having a healthcare provider, deferring medical care because of cost, and having had no routine medical exam. Bivariate and multivariate analyses were performed on 2005 Behavioral Risk Factor Surveillance Survey data to examine the relationship between health service deficits experienced by adults with asthma and socioeconomic status (SES), race and ethnicity, and geographic locale. The variable was also calculated for each US state. **Results.** Hispanic (OR = 1.594, 95% CI = 1.588–1.599) and Other/Multiracial (OR = 1.447, 95% CI = 1.441–1.452) adults with current asthma had greater odds of having a health service deficit. Rural adults with current asthma had greater odds of having a health service deficit (OR = 1.086, 95% CI = 1.083–1.089) when compared with non-rural adult residents. Low-SES (OR = 1.976, 95% CI = 1.971–1.982) and middle-SES (OR = 1.596, 95% CI = 1.592–1.600) adults with current asthma had greater odds of having a health service deficit. The percentage of current asthma adults experiencing at least one health service deficit by state ranged from a low of 28.5% (Delaware) to a high of 58.8% (Wyoming). **Conclusion.** There are clear patterns of disparity associated with health services and asthma that can help target interventions.

Keywords adult asthma, health disparities, health service deficits

INTRODUCTION

Asthma is a chronic respiratory condition that affects about 300 million people worldwide (1,2). In the United States, asthma prevalence exceeds that in many other countries (3) and has been increasing since 1980 (4–9). In 2009, the current asthma prevalence was 8.2% in the United States. The substantial increase in the reported prevalence of asthma and its impact on health highlight the importance of research that enhances the understanding of the epidemiology of asthma (10).

Symptoms of asthma are caused by airway inflammation and episodic, reversible narrowing of airways. This inflammation and airway narrowing occur in response to exposure to triggers such as allergens, cigarette smoke, and cold air (11). While the etiology of asthma remains uncertain (1, 11), effective means exist for both controlling and preventing the symptoms of asthma. Despite the availability of effective treatment, the morbidity and mortality associated with asthma continue to pose a significant burden on the health of people in the United States (1, 4, 11, 12).

In addition to the impact of asthma on health, developed countries can expect to spend 1–2% of their

healthcare budget on asthma. In the United States, the costs of asthma in terms of both direct healthcare expenditures and indirect costs such as losses in work productivity make it one of the most financially costly chronic diseases (9). In 1994 the financial burden from asthma exceeded 12 billion dollars (2), with more than \$5 billion in direct costs (1, 3). In 2005–2009 there were 1.11 million ED visits for asthma as well as 299,000 asthma hospitalizations for US adults (11). ED visits and hospitalizations accounted for a significant proportion of the direct costs for asthma (9). Undertreatment or inappropriate care for asthma can result in potentially avoidable hospitalizations or ED visits.

Understanding the epidemiology of asthma and identifying population groups at risk for deficits in health services can help target interventions that might improve care and reduce costs. For example, in the United States asthma disproportionately affects some populations (4–9, 13) with non-Caucasians and economically disadvantaged individuals at greater risk for current asthma. Clement et al. (13) described several other possible demographic and health service-related contributory factors that might account for differences in the prevalence and health outcomes related to asthma. Among these factors is geographic locale or place of residence, an attribute often overlooked as a determinant of health. Earlier research has suggested urban residency as an independent risk factor for asthma in children (14) and that in general,

*Corresponding author: May Nawal Lutfiyya, Ph.D., Research Division, Essentia Institute of Rural Health, Duluth, MN 55805, USA; Tel: 218-786-8118; E-mail: mlutfiyya@eirh.org

health disparities among rural minority populations were more severe than among urban minorities (15). However, research comparing non-rural with rural populations has yielded mixed findings (1, 16) suggesting the need for further study.

By analyzing national population-based data, this study sought to fill in some of the recognized gaps in the current understanding of the epidemiology of asthma in US adult populations and to specifically explore who is at risk for health service deficits. A health service deficit is a new analytic concept that we are proposing for use in health service-related research addressing chronic disease. This concept facilitates the examination of how a group makes use of services relevant to their chronic condition(s). Factors that influence health services include prevalence of the disease, availability of services, the ability to access available services, cultural influences, and other barriers to appropriate care. We believe an enhanced understanding of the epidemiology of adult asthma and deficits in care can identify opportunities for improving care and aid in effectively utilizing resources.

METHODS

In this article, 2005 Behavioral Risk Factor Surveillance Survey (BRFSS) data were analyzed to examine issues relevant to asthma epidemiology and disparities associated with asthma care. The BRFSS is comprised of both core questions and optional modules. We chose this year of data to analyze because the optional BRFSS adult asthma module was used by 23 states and/or territories. In the subsequent years of available data many fewer states chose this option. We analyzed data collected via questions from both the core survey and the optional adult asthma module.

BRFSS data are collected using a random-digit-dial telephone survey targeting adults 18–99 years of age. These data are collected under the guidance of the Centers for Disease Control and Prevention (CDC) in collaboration with all US states and most US territories. Once collected, BRFSS data are weighted by state or territory to represent the US adult population. BRFSS data are cross-sectional and are focused on health risk factors and behaviors as well as chronic disease. A detailed description of the survey design and sampling measures can be found elsewhere (17).

For this analysis the population of interest was US adults self-reporting currently having asthma diagnosed by a healthcare professional. All analyses were performed on weighted data as is recommended by the CDC. The weighting calculated by the CDC used the most recently available census data to provide a stratified representation of the nation's non-institutionalized population.

In the analyses presented here a number of variables were either re-coded or computed. A summary of the re-coded variables used in the analysis of this study is presented in Table 1. The following three variables were

computed: health service deficits, socioeconomic status (SES), and asthma control.

Health service deficits, the primary dependent variable in this analysis, were computed from the response categories of a number of different variables (health insurance status, personal healthcare provider, deferment of medical care because of cost, and routine medical exam). These response categories were as follows: did not have health insurance in the past 12 months, did not have a healthcare provider in the past 12 months, deferred medical care because of cost in the past 12 months, and did not have a routine medical exam in the past 12 months. Having one of these constituted having a health service deficit.

SES was one of the primary independent variables. According to WHO SES is one of the strongest determinants of health (18). While SES is a commonly used term in analyses across disciplines (e.g., sociology, social epidemiology, social psychology) many have noted that no general consensus exists about how to either define or measure the construct (18–21). Typically SES refers to a combination of household income and other social measures such as attained educational level indexed into a single variable (18). The most important purpose of SES is to provide some means of comparing relative position with regard to others. Almost always SES is computed as a three-level variable (i.e., low, middle, and high) (21). Others have noted that various measures of SES are not interchangeable and that each one assesses a different aspect of SES and reflects the intent and approach of the investigator (21). In our analysis SES is a composite or computed variable comprised of two categorical variables: education and income. In keeping with convention, data categories from each of these individual variables were coded as one of low, mid-range, or high and numbered as 1, 2, or 3, respectively. The numbering was necessary in order to create a composite variable (in this instance one variable from two separate ones). The variables with numbered factors or categories were then added together to create the composite variable of SES. For education, low was less than high school and was coded as 1, mid-range was high school graduate and was coded as 2, and high was at least some college and was coded as 3. For income, low referred to the category <\$25,000 and was coded as 1, mid-range referred to \$25,000–<\$50,000 and was coded as 2, and high equaled >\$50,000 and was coded as 3. When the individual variables were added together the possible computed range was 2–6 points. These points were then indexed in the following manner: low = 2–3 points, mid-range = 4–5 points, and high = 6 points. These cut points were purposive. For the lowest range of the index, 2 points was the floor (smallest possible point assignment); for the mid-range of the index, 4 points was the floor; and likewise for the high range of the index, 6 points was the floor. Any points below the floor for the mid-range were assigned to the lowest index category just as any points below the floor for the highest index category were assigned to the mid-range index category.

TABLE 1.—Original survey question and response categories with re-coded response categories.

2005 BRFSS data			
Analysis variable	Survey question	Original response categories	Re-coded response categories
Sex	Indicate the sex of respondent	Male Female	Male Female
Race and ethnicity	Which one of these groups would you say best represents your race?	Race responses were combined with Hispanic variable to create the second column categories White Black or African American Asian Native Hawaiian or Other Pacific Islander American Indian, Alaska Native Other Multiracial but preferred race not asked Don't know/not sure, refused Yes No Don't know/not sure, refused — age in years	White, non-Hispanic Black non-Hispanic Asian non-Hispanic Native Hawaiian or Other Pacific Islander non-Hispanic American Indian, Alaska Native non-Hispanic Other non-Hispanic Multiracial non-Hispanic Don't know/not sure, refused Hispanic Non-Hispanic Don't know/not sure, refused
Age range	Are you Hispanic or Latino?		Missing Hispanic
	What is your age?		Missing 18–34 years 35–64 years ≥ 65 years <High school Completed high school Educated beyond high school
Education	What is the highest grade or year of school you completed?	Never attended school or only kindergarten Grades 1 to 8 (elementary) Grades 9 to 11 (some high school) Grade 12 or GED (high school graduate) College 1–3 years (some college or technical school) College 4 years or more (college graduate) Refused, not asked, or missing	Missing Married or living with partner Unmarried and not living with a partner Less than \$25,000 Missing
Marital status	Are you: (marital status)	Married A member of an unmarried couple Divorced Widowed Separated Never married Refused, not asked, or missing Less than \$10,000 Less than \$15,000 (\$10,000 to less than \$15,000) Less than \$20,000 (\$15,000 to less than \$20,000) Less than \$25,000 (\$20,000 to less than \$25,000)	Missing Married or living with partner Unmarried and not living with a partner Less than \$25,000 Missing
Household income	Is your annual household income from all sources?		

(Continued)

TABLE 1.—(Continued)

Analysis variable	Survey question	Original response categories	Re-coded response categories
Have health insurance	Do you have any kind of healthcare coverage, including health insurance, prepaid plans such as HMOs, or government plans such as Medicare?	Less than \$35,000 (\$25,000 to less than \$35,000)	\$25,000 to less than \$50,000
		Less than \$50,000 (\$35,000 to less than \$50,000)	≥\$50,000
		Less than \$75,000 (\$50,000 to less than \$75,000)	Missing
Have a personal physician	Do you have one person you think of as your personal doctor or healthcare provider? (If “No” ask “Is there more than one or is there no person whom you think of as your personal doctor or healthcare provider?”)	\$75,000 or more	Yes
		Don’t know/not sure, refused, not asked, or missing	No
		Yes	Missing
Timing of last routine medical checkup	About how long has it been since you last visited a doctor for a routine checkup? (A routine checkup is a general physical exam, not an exam for a specific injury, illness, or condition.)	Don’t know/not sure, refused	Missing
		Yes, only one	Yes
		More than one	No
Deferment of medical care because of cost	Was there a time in the past 12 months when you needed to see a doctor but could not because of cost	No	Missing
		Don’t know/not sure, refused	Yes
		Yes	No
Timing of last routine medical checkup	Within past year (anytime less than 12 months ago)	Within past 2 years (1 year but less than 2 years ago)	Within the past 12 months
		Within past 5 years (2 years but less than 5 years ago)	More than 12 months ago
		5 or more years ago	Missing
Deferment of medical care because of cost	Was there a time in the past 12 months when you needed to see a doctor but could not because of cost	Never	Yes
		Don’t know/not sure or refused	No
		Yes	Missing

Self-defined health status	Would you say that in general your health is	Excellent Very good Good Fair Poor Don't know/not sure, refused, not asked, or missing	Good to excellent Fair to poor Missing
Residency by geographic locale	Metropolitan status code	In the center city of an MSA Outside the center city of an MSA but inside the county containing the center city Inside a suburban county of the MSA In an MSA that has no center city Not in an MSA	Non-rural
Asthma ever	Have you ever been told by a doctor, nurse, or other health professionals that you had asthma?	Yes No Don't know/not sure, refused, not asked, or missing	Rural Yes No Missing
Current asthma	Do you still have asthma	Yes No Don't know/not sure, refused, or missing	Yes No Missing
Age at asthma diagnosis	How old were you when you were first told by a doctor, nurse, or other health professionals that you had asthma	Don't know/not sure, refused, or missing Age 11 or older Age 10 or younger Don't know/not sure, refused or missing	Age 11 or older Age 10 or younger Missing
Emergency asthma care during the past 12 months	During the past 12 months, how many times did you visit an emergency room or urgent care center because of your asthma	___ Number of visits None Don't know/not sure, refused, or missing	At least one ED visit No ED visits Missing
Urgent asthma treatment during the past 12 months	During the past 12 months, how many times did you see a doctor, nurse, or other health professionals for urgent treatment of worsening asthma symptoms	___ Number of visits None Don't know/not sure, refused, or missing	At least one urgent visit No urgent visits Missing

(Continued)

TABLE 1.—(Continued)

Analysis variable	Survey question	Original response categories	Re-coded response categories
Routine asthma care during the past 12 months	During the past 12 months, how many times did you see a doctor, nurse, or other health professionals for a routine checkup for your asthma	___ Number of visits None Don't know/not sure, refused, or missing	At least one routine visit No routine visits Missing
Asthma attack during the past 12 months	During the past 12 months, have you had an episode of asthma or an asthma attack	Yes No Don't know/not sure, Refused or missing	Yes No Missing
Activities limited because of asthma during the past 12 months	During the past 12 months, how many days were you unable to work or carry out your usual activities because of your asthma	___ Number of days None Don't know/not sure, refused, or missing	At least one day No days Missing
Asthma symptoms during the past 30 days	Symptoms of asthma include cough, wheezing, shortness of breath, chest tightness, and phlegm production when you don't have a cold or respiratory infection. During the past 30 days, how often did you have any symptoms of asthma?	Not at any time Less than once a week Once or twice a week More than two times a week, but not everyday Everyday, but not all the time Everyday, all the time Don't know/not sure, refused, or missing	Two or fewer More than two per week Missing
Sleep difficulty because of asthma during the past 30 days	During the past 30 days, how many days did symptoms of asthma make it difficult for you to stay asleep? Would you say—	None One or two Three to four Five 6 to 10 More than 10 Don't know/not sure, refused	None At least once Missing
Days used prescribed preventative asthma medication in the past 30 days	During the past 30 days, how many days did you take a prescription asthma medication to prevent an asthma attack from occurring?	Never 1–14 days 15–24 days 25–30 days Don't know/not sure, refused	None At least once
Times used asthma inhaler during an attack in the past 30 days	During the past 30 days, how often did you use a prescription asthma inhaler <i>during an asthma attack</i> to stop it?	Never (include no attack in the past 30 days) 1–4 times (in the past 30 days) 5–14 times (in the past 30 days) 15–29 times (in the past 30 days) 30–59 times (in the past 30 days) 60–99 times (in the past 30 days) 100 or more times (in the past 30 days) Don't know/not sure, refused	None At least once Missing

Note: BRFSS, Behavioral Risk Factor Surveillance Survey; MSA, metropolitan statistical area.

TABLE 2.—Asthma control.^a

Characteristics/variable	Controlled asthma (all of the following)	Partially controlled asthma (any measure present in any week)	Uncontrolled asthma
Asthma symptoms (daytime symptoms)	None (twice per week)	More than twice per week	Three or more features of partially controlled asthma present in any week
Activities limited (limitations)	None	Any	
Sleep difficulties (nocturnal symptoms)	None	Any	
Times used asthma inhaler (need for relief/rescue treatment)	None (twice per week)	More than twice per week	
Asthma attack (exacerbations)	None	One or more/year	One in any week

Note: ^a Adapted from the asthma control definition from Pedersen et al. (22) guidelines.

Asthma control was computed using the definition of control adopted by the Global Initiative for Asthma (22). Three levels of control were computed: controlled, partially controlled, and uncontrolled. The following response categories of the variables were computed: asthma attack (in the past 12 months), activities limited (because of asthma in the past 12 months), asthma symptoms (during the past 30 days), sleep difficulties (because of asthma in the past 30 days), and times used asthma inhaler (in the past 30 days). Table 2 describes the construction of this variable.

The metropolitan statistical area (MSA) variable included in BRFSS was used to define the place of residence as either rural or non-rural. Rural residents were defined as persons living either within an MSA that had no city center or outside an MSA. Non-rural residents included all respondents living in a city center of an MSA, outside the city center of an MSA but inside the county containing the city center, or inside a suburban county of the MSA.

Race and ethnicity were calculated from participant responses to two separate survey questions—one regarding race and the other regarding Latino/Hispanic ethnicity. Combining the responses to these two questions allowed for the derivation of the race and ethnicity variable used. All race/ethnicity categories were computed as *mutually exclusive* entities. For example, all respondents coded as Caucasian chose White as their racial classification, likewise Black for African American, and so on. If a respondent identified himself/herself as Hispanic or Latino he/she was classified by that ethnic category, regardless of any additional racial classification. The category of Other/Multiracial was also calculated and used in some of the analyses; however, it was not included in the bivariate analysis. In no instance was a Hispanic or Latino self-identified person also classified as Caucasian or African American or Other/Multiracial.

Analyses were conducted to compare the US adult population with and without asthma, as well as to describe the US adult population with asthma in light of specific variables such as frequency of asthma exacerbations; number of routine, urgent, and ED visits; and overall healthcare utilization. Bivariate analysis was performed to examine the health service deficits by SES, race/ethnicity, and geographic locale. Multivariate logistic regression analysis was performed to examine the health service

deficits experienced by adults with asthma controlling for SES, race and ethnicity, and geographic locale. The dependent variable—health service deficit—was calculated for each US state in order to identify the states where the greatest health service deficits existed. ArcView version 10.0 (ESRI, Redlands, CA, USA) was used to map all US states according to the health service deficit variable.

For all statistical analyses, alpha was set at $p < .05$. Statistical Package for Social Sciences (SPSS, IBM, Chicago, IL, USA) version 19.0 was used to complete all statistical analyses performed in this study. Human subject approval was sought and received from Essentia Health's Institutional Review Board (IRB) as well as the University of Illinois, College of Medicine at Rockford's IRB.

RESULTS

The prevalence estimates for US adults with current asthma stratified by race/ethnicity were 8.06% for Caucasians, 8.70% for African Americans, 5.83% for Hispanic adults, and 8.69% for Other/Multiracial adults. In addition, there was a greater likelihood for rural adults to currently have asthma than non-rural adults (OR = 1.173, 95% CI = 1.171–1.175).

When examining the characteristics of US adults with current asthma, 52.3% reported adult onset condition (see Table 3). About 65.0% or more women reported current asthma than men as did adults aged 35–64 years (51.3%). Almost 14% (13.7%) of US adults with current asthma reported that they did not have health insurance and 46.3% of adults with asthma had uncontrolled asthma. A higher proportion of middle-SES adults (45.5%) had current asthma than either low-SES (25.0%) or high-SES (29.5%) adults.

Table 4 displays geographic locale and race and ethnicity by SES for US adults with current asthma. For rural as well as African American and Hispanic US adults with asthma at least 30% of each subpopulation was of low SES and at least 40% of middle SES. The range for high SES was 15.7–33.8%. Almost 34% of Caucasian US adults with asthma were high in SES while the same was true for only 15.7% of similar African Americans. Likewise, 32.7% of non-rural adults with asthma were high in SES while only 18.5% of rural adults were.

TABLE 3.—Characteristics of US adults ≥ 18 years of age with current asthma (2005 BRFSS data) ($n = 17,527,227^a$).

Variables	Factors	Percentage (%)
Sex	Male	34.5
	Female	65.5
Marital status	Married or living with a partner	57.0
	Not married or partnered	43.0
Race and ethnicity	Caucasian	70.7
	African American	10.5
	Hispanic	11.0
	Other/Multiracial	7.8
Age	18–34 years	32.8
	35–64 years	51.3
	≥ 65 years	15.5
SES	Low SES	25.0
	Middle SES	45.5
	High SES	29.5
Residency by geographic locale	Non-rural	79.8
	Rural	20.2
Health insurance	Do not have health insurance	13.7
	Have health insurance	86.3
Healthcare provider	Do not have healthcare provider	13.5
	Have healthcare provider	86.5
Asthma onset age	Preadolescent onset	36.1
	Adolescent onset	11.6
	Adult onset	52.3
Asthma control	Controlled asthma	12.5
	Partially controlled asthma	41.1
	Uncontrolled asthma	46.3
Asthma attacks in the past 12 months	At least one asthma attack	51.7
	No asthma attacks	48.3
ED asthma visits in the past 12 months	At least one asthma ED visit	16.2
	No ED asthma visits	83.8
Urgent asthma visits in the past 12 months	At least one urgent asthma visit	28.1
	No urgent asthma visits	71.9
Routine asthma care in the past 12 months	At least one routine asthma visit	45.3
	No routine asthma visits	54.7
Work days limited because of asthma in the past 12 months	At least one workday limited	30.2
	No workdays limited	69.8

Notes: SES, socioeconomic status; BRFSS, Behavioral Risk Factor Surveillance Survey.

^aWeighted n .

TABLE 4.—Geographic locale, race and ethnicity, and socioeconomic status (SES) of US adults with asthma (2005 BRFSS data).

Variable	Factors	SES		
		Low SES (%)	Middle SES (%)	High SES (%)
Geographic locale	Non-rural	22.4	44.9	32.7
	Rural	34.1	47.4	18.5
Race and ethnicity	Caucasian	20.8	45.5	33.8
	African American	37.2	47.1	15.7
	Hispanic	40.2	43.6	16.2
	Other/Multiracial	25.4	47.0	27.6

Note: BRFSS, Behavioral Risk Factor Surveillance Survey.

Bivariate analysis of US adults with current asthma examining health service-related variables by race/ethnicity, SES, and geographic locale is presented in Table 5. When compared with Caucasian adults with current asthma, similar African Americans were at greater risk of having: at least one ED visit for asthma (OR = 2.339, 95% CI = 2.329–2.350); at least one urgent care visit for asthma (OR = 1.290, 95% CI = 1.284–1.296); and at least one workday limited because of asthma in the

past 12 months (OR = 1.227, 95% CI = 1.221–1.232). African Americans were also at greater risk of not having health insurance (OR = 1.233, 95% CI = 1.231–1.233); not having a healthcare provider (OR = 1.260, 95% CI = 1.259–1.260); and for having deferred medical care because of cost (OR = 1.260, 95% CI = 1.259–1.260).

When compared with Caucasian adults with current asthma, similar Hispanic adults were at greater risk

TABLE 5.—Bivariate analysis of US adults ≥ 18 years of age with current asthma examining health services-related variables stratified by race/ethnicity, socioeconomic status (SES), and geographic locale (2005 BRFSS data).

Independent variables and factors	Unadjusted odds ratio (95% CI)			
	Race/ethnicity		SES	
	Caucasian/African American	Caucasian/Hispanic	African American/Hispanic	Low SES/high SES
Emergency department asthma visits in the past 12 months—at least one asthma ED visit	Risk greater for African Americans OR = 2.339 (2.329–2.350)	Risk greater for Hispanics OR = 1.827 (1.817–1.836)	Risk greater for African Americans OR = 1.152 (1.148–1.156)	Risk greater for low SES OR = 1.738 (1.735–1.742)
Urgent asthma visits in the past 12 months—at least one urgent asthma visit	Risk greater for African Americans OR = 1.290 (1.284–1.296)	Risk greater for Hispanics OR = 1.276 (1.270–1.282)	Risk greater for African Americans OR = 1.008 (1.004–1.011)	Risk greater for low SES OR = 1.317 (1.314–1.320)
Routine asthma visits in the past 12 months—no routine asthma visit	Risk greater for Caucasians OR = 1.015 (1.014–1.015)	Risk greater for Hispanics OR = 1.110 (1.105–1.115)	Risk greater for Hispanics OR = 1.138 (1.134–1.142)	Risk greater for low SES OR = 1.003 (1.001–1.004)
Asthma attack in the past 12 months—at least one asthma attack	Risk greater for Caucasians OR = 1.025 (1.024–1.025)	Risk greater for Hispanics OR = 1.232 (1.226–1.238)	Risk greater for Hispanics OR = 1.265 (1.261–1.270)	Risk greater for high SES OR = 1.032 (1.031–1.034)
In the past 12 months workdays limited because of asthma—at least one workday limited	Risk greater for African Americans OR = 1.227 (1.221–1.232)	Risk greater for Hispanics OR = 2.270 (2.260–2.280)	Risk greater for Hispanics OR = 1.424 (1.419–1.429)	Risk greater for low SES OR = 1.374 (1.370–1.377)
Health insurance status—do not have health insurance	Risk greater for African Americans OR = 1.232 (1.231–1.233)	Risk greater for Hispanics OR = 1.358 (1.357–1.358)	Risk greater for Hispanics OR = 1.041 (1.041–1.041)	Risk greater for low SES OR = 6.452 (6.439–6.466)
Have primary care provider—do not have a primary care provider	Risk greater for African Americans OR = 1.260 (1.259–1.260)	Risk greater for Hispanics OR = 1.408 (1.408–1.409)	Risk greater for Hispanics OR = 1.061 (1.061–1.061)	Risk greater for low SES OR = 1.457 (1.453–1.460)
In the past 12 months medical deferred because of cost	Risk greater for African Americans OR = 1.260 (1.259–1.260)	Risk greater for Hispanics OR = 1.093 (1.093–1.094)	Risk greater for African Americans OR = 1.177 (1.173–1.181)	Risk greater for low SES OR = 7.434 (7.420–7.448)
				Greater rural risk OR = 1.285 (1.282–1.288)

Note: BRFSS, Behavioral Risk Factor Surveillance Survey.

for all of the examined health service-related variables. Likewise when compared with African American adults with current asthma similar Hispanic adults were at risk for all but three of the health service-related variables examined. These three variables were as follows: ED visits, urgent asthma care visits, and deferring medical care because of cost. For workday limitations (at least one workday limited because of asthma in the past 12 months) Hispanics were at greater risk than Caucasians (OR = 2.270, 95% CI = 2.269–2.280) as well as African Americans (OR = 1.424 95% CI = 1.419–1.429).

When comparing rural and non-rural adults with current asthma on the health-service-related variables, rural adults were at greater risk for four and non-rural adults were at greater risk for five of the nine health service-related variables. Of note, rural adults with asthma had a greater risk of not having health insurance (OR = 1.319, 95% CI = 1.315–1.322) and of deferring medical care because of cost (OR = 1.285, 95% CI = 1.282–1.288). Finally, when comparing low- and high-SES adults with current asthma, low-SES adults were at greater risk for all but one of the examined health service-related variables (at least one asthma attack in the past 12 months). Of note, low-SES US adults with asthma had much greater odds of not having health insurance when compared with similar high-SES adults (OR = 6.452, 95% CI = 6.439–6.466) and of deferring medical care because of cost (OR = 7.434, 95% CI = 7.420–7.448).

Multivariate logistic regression was performed using health service deficits as the dependent variable and SES, race and ethnicity, and geographic locale as the independent covariates (Table 6). These findings yielded that using high SES as the reference category, low-SES (OR = 1.976, 95% CI = 1.971–1.982) and middle-SES (OR = 1.596, 95% CI = 1.592–1.600) adults with current asthma had greater odds of having a health service deficit. Using Caucasian adults with current asthma as the reference category, Hispanic (OR = 1.594, 95% CI = 1.588–1.599) and Other/Multiracial (OR = 1.447, 95% CI = 1.441–1.452) adults with current asthma had greater odds of having a health service deficit.

TABLE 6.—Logistic regression in US adults with asthma with at least one health service deficit by race/ethnicity, socioeconomic status (SES), and geographic locale (2005 BRFSS data).

Independent variable and factors		Adjusted odds ratio (95.0% CI)
SES	Low SES	1.976 (1.971, 1.982)
	Middle SES	1.596 (1.592, 1.600)
	High SES	— ^a
Race and ethnicity	African American	0.942 (0.939, 0.945)
	Hispanic	1.594 (1.588, 1.599)
	Other/Multiracial	1.447 (1.441, 1.452)
	Caucasian	— ^a
Geographic locale	Rural	1.086 (1.083, 1.089)
	Non-rural	— ^a

Notes: BRFSS, Behavioral Risk Factor Surveillance Survey.

^aReference category.

Furthermore, using non-rural adults with current asthma as the reference category, rural adults with current asthma had greater odds of having a health service deficit (OR = 1.086, 95% CI = 1.083–1.089).

Table 7 displays the percentage of US adults with current asthma experiencing at least one health service deficit by state of residence. Data are displayed for all, rural, Hispanic, and low-SES adults with current asthma. The rates for all US adults have a 31 point range from a low of 28.5% (Delaware) to a high of 58.8% (Wyoming) and are mapped by state in Figure 1. The data have been divided into tertiles and as indicated in the legend color-coded to indicate the lowest, middle, and highest tertiles. Nine states constituted the lowest tertile (28.50–38.93%) of percentage of US adults with asthma as having at least one health service deficit. Twenty-four states constituted the middle tertile (38.94–49.37%) while 17 states constituted the highest tertile (49.38–59.80%).

DISCUSSION

The first step in addressing healthcare disparities is an appreciation of who may be at risk (23) and who may not be accessing the services. This notion is grounded in the understanding that societies shape patterns of disease and that these patterns change over time in response to multiple factors (24, 25). In the case of asthma, the relative contributions of environmental, societal, and genetic influences for effectively managing asthma remain unclear.

To help identify strategies to improve asthma care, we have introduced the concept of health service deficits in the context of a chronic disease. Health service deficits examine how a group (e.g., rural adults) makes use of services relevant to their chronic condition (e.g., asthma). Factors that influence health services include prevalence of the disease, availability of services, the ability to access available services, cultural influences, and other barriers to appropriate care. By identifying health service deficits, policy makers can recognize areas of need and direct research to determine why a deficit might exist. Our results revealed that the prevalence of health service deficits was not shared equally across groups of adults with asthma and that some populations with asthma are at greater risk for a health service deficit than others. In summary, we found that Hispanic and Other/Multiracial adults with current asthma experienced greater health service deficits when compared with Caucasian adults with current asthma. In addition, Hispanic adults were at a greater risk for all of the examined health service-related variables compared with Caucasian adults. When compared with African American adults with current asthma, similar Hispanic adults were at greater risk for all but three of the health service-related variables examined. These three variables were as follows: ED visits, urgent asthma care visits, and deferring medical care because of cost. Unlike for African Americans, the increased risk for Hispanics existed across

TABLE 7.—Percentage of all, rural, Hispanic, and low-SES US adults with current asthma experiencing at least one health service deficit by state of residence 2005 BRFSS data^a.

State	All US adults with current asthma (%)	Rural adults with current asthma (%)	Hispanic adults with current asthma (%)	Low-SES adults with current asthma (%)
Alabama	49.4	54.7	76.6	36.6
Alaska	46.2	48.9	56.8	25.8
Arizona	43.2	51.0	58.7	27.4
Arkansas	50.7	54.2	84.6	38.9
California	47.3	46.3	63.5	20.6
Colorado	45.7	60.0	57.8	20.2
Connecticut	44.0	56.7	66.1	23.8
Delaware	28.5	23.2	15.9	27.5
Florida	36.4	43.8	49.0	42.8
Georgia	52.3	49.9	22.5	28.0
Hawaii	37.8	44.6	41.2	16.5
Idaho	59.8	55.3	85.9	24.6
Illinois	38.2	35.9	56.1	27.1
Indiana	47.5	41.8	74.7	38.2
Iowa	42.6	48.8	42.2	29.1
Kansas	36.9	42.9	68.5	31.6
Kentucky	51.5	53.5	71.8	46.8
Louisiana	53.0	55.1	91.1	40.4
Maine	46.7	50.6	64.0	28.0
Maryland	43.1	29.7	61.6	25.0
Massachusetts	34.1	22.5	52.0	25.4
Michigan	42.9	41.6	57.5	23.8
Minnesota	46.2	36.2	54.8	7.0
Mississippi	54.9	53.6	70.5	51.1
Missouri	48.7	55.5	84.0	29.9
Montana	54.1	55.5	100.0	37.3
Nebraska	44.3	48.9	56.2	21.3
Nevada	51.3	34.4	84.0	12.6
New Hampshire	35.5	38.7	30.9	24.0
New Jersey	39.6	N/A	56.4	26.3
New Mexico	51.0	49.9	46.9	22.4
New York	40.1	37.3	53.8	30.0
North Carolina	44.6	47.5	56.7	35.7
North Dakota	52.6	55.0	41.6	25.9
Ohio	45.1	55.6	71.4	33.5
Oklahoma	53.9	57.7	70.3	35.9
Oregon	51.5	52.2	54.2	24.9
Pennsylvania	44.2	46.2	27.9	30.8
Rhode Island	33.3	N/A	52.0	31.4
South Carolina	51.4	53.5	66.6	44.3
South Dakota	42.7	44.3	68.1	29.9
Tennessee	37.2	34.8	15.3	48.3
Texas	57.8	66.6	63.8	33.5
Utah	51.1	60.7	74.0	14.9
Vermont	46.6	44.4	54.3	20.2
Virginia	37.6	46.3	47.8	21.3
Washington	44.0	45.5	51.0	23.5
West Virginia	45.2	48.0	78.5	46.9
Wisconsin	43.8	49.5	62.0	17.9
Wyoming	59.7	61.3	84.2	18.2
USA	44.9	47.7	56.6	29.2

Notes: SES, socioeconomic status; BRFSS, Behavioral Risk Factor Surveillance Survey; N/A, not applicable.

^aHealth service deficit is defined as experiencing at least one of the following four conditions: does not have own physician, does not have health insurance, has deferred medical care in the past 12 months because of cost, and has not had a routine medical checkup in the past 12 months.

SEs and suggests that issues unique to Hispanics such as language or other cultural barriers play an important role in health service deficits for Hispanics with asthma. For example, the degree of acculturation might influence desire and/or the ability to seek services (26). Strategies

that further identify and address these barriers will likely be important for improving asthma management and outcomes for this group.

Not unsurprisingly, SES influenced health service deficits. When comparing low- and high-SES adults with

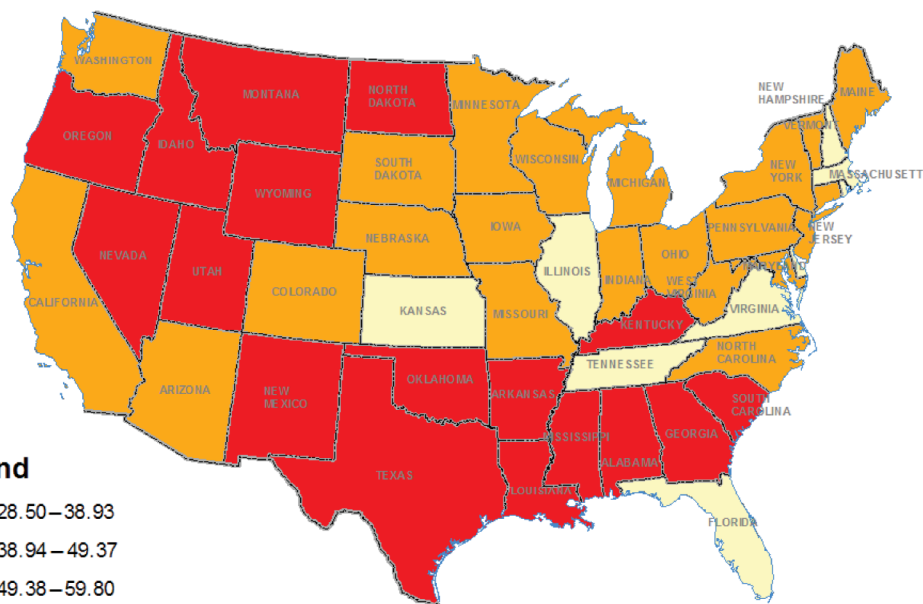
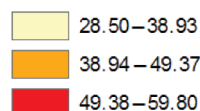
Alaska



Hawaii



Legend



2005 BRFSS data

FIGURE 1.—Percentage of US adults with current asthma experiencing at least one health service deficit by state of residence 2005 Behavioral Risk Factor Surveillance Survey (BRFSS) data.

Note: Health service deficit is defined as experiencing at least one of the following four conditions: does not have own physician, does not have health insurance, has deferred medical care in the past 12 months because of cost, and has not had a routine medical checkup in the past 12 months.

current asthma, low-SES adults were at greater risk for all but one of the examined health-service-related variables. Previous research supports the notion that inequalities in SES increase the risks of morbidity and mortality (27, 28). Our study found that compared with those from higher SES, lower SES adults had an increased likelihood of having at least one health service deficit. In addition to the fundamental challenge of income, SES is also a marker of health literacy, access issues (beyond health insurance), and perhaps cultural attitudes related to health that likely influence asthma care (29). Our findings reinforce the importance and challenge of identifying and overcoming the barriers faced by those with poorer SES who have asthma.

Another key finding was that after controlling for factors such as SES and ethnicity, rural adults with asthma were more likely to experience a health service deficit. Previous research shows that inner-city urban poor experience disproportionately high levels of morbidity and mortality related to asthma (29). A growing body of literature indicates the complex social and economic interactions of “neighborhoods” contribute to health disparities independent of individual-level risk factors (30). While disparities in health care among minorities and inner-city residents is a well-recognized problem, rural health disparities are becoming more recognized (31, 32) and suggest that rural culture may be a health determinant (33).

Social determinants of health or the social context in which people live their lives is a key contributor to health disparities or inequities and Hartley (33) has noted that researchers examining the health of rural

Americans need to explore questions such as: “Why does rural residence (culture, community and environment) reinforce negative health behaviors?” (34, p. 1676). We believe that examining *how* and *if* rural residence (culture, community, and environment) affects health behaviors is equally important and can help identify if rural residency is a *fundamental social cause* of health inequities defined as such by Link and Phelan (25). Accordingly, there are four essential features that characterize a fundamental social cause. These are as follows: (1) it influences multiple disease or health outcomes; (2) it affects these outcomes through multiple risk factors; (3) it entails access to resources that may be used to either avoid risks or minimize the consequence of disease; and (4) the association between the fundamental cause and the health is reproduced over time (24).

An enhanced understanding of health service deficits related to rural asthma care should prove useful for individuals hoping to lessen the degree of difference of disparity or inequity between rural and non-rural adults with asthma (34). Likewise those responsible for health-related planning at a statewide level can benefit from the knowledge of how their state ranks in comparison with other states. Our findings revealed that the percentage of population by state suffering from having an asthma-related health service deficit ranged from a low of 28.5% (Delaware) to a high of 58.8% (Wyoming). Understanding the reasons for this gap may shed light on how to optimize asthma care.

Several potential limitations to this study should be noted. First, the survey is based on telephone-derived data and may be skewed because those who could not

be reached by phone could not participate in the survey. For example, the widespread use of answering machines and caller ID allows people to filter their phone calls potentially leading to a passive refusal to participate in surveys such as the BRFSS. Of course, the use of answering machines and caller ID to filter out “unwanted” or “unfamiliar” callers is beyond the control of survey administrators. In addition, persons of lower SES may have been excluded because of poorer phone access. However, the fact that the vast majority of US residents live in households with telephones minimizes this bias. Furthermore, US cell phone numbers are now included in the pool of phone numbers contacted for the survey. In addition, study strength is the use of a large multi-state database that includes a robust sample of rural residents weighted to reflect the demographics of rural versus non-rural US populations.

A second limitation is that the survey used closed-ended questions, which limit a responder’s options to fully explain response choices. However, while a different question format may have yielded different results, the survey questions were worded so that the answer choices covered a wide range of response possibilities. A third and related limitation is that the answers are self-reported, which introduces the possibility of recall bias on the part of the survey participants.

Fourth, only those variables available from the survey questions could be used and these questions may not reflect a fully comprehensive measure of the concept of health service deficits. For instance, defining health service deficits might ideally also include information regarding care management. Since the values used to define health service deficits did not reflect elements of care management we might have underestimated the number of US adults with current asthma who had a health service deficit.

A fifth potential bias resulted from the languages of the survey—English and Spanish. Individuals who did not speak English or Spanish were excluded from this survey. Not all US residents speak the two languages of this survey, as a result those adults from other cultures who do not speak either English or Spanish and who have a health service deficit may have been excluded and as a result the aggregated data may not be representative of all adults who are residing in the United States.

CONCLUSIONS

Asthma is epidemiologically complicated. Despite the availability of effective treatment it remains one of the top five most expensive diseases in the US Healthcare System. This study identified clear patterns of disparity associated with health services and asthma. The recognition that subgroups such as Hispanics, those of low SES, and those living in rural communities are at greater risk for a health service deficit suggests the need to develop and test strategies to improve asthma care for these individuals. Moreover, the results of this study provide an invitation to undertake the work of

theory development around the conceptualization of rural residency as a possible fundamental social cause of health inequities (35, 36).

DECLARATION OF INTEREST

The authors report no conflicts of interest and declare that there were no competing interests involved with the completion of this research study. The authors alone are responsible for the content and writing of the paper.

REFERENCES

1. Hartert TV, Peebles R. Epidemiology of asthma: the year in review. *Curr Opin Pulm Med* 2000; 6:4–9.
2. Braman SS. The global burden of asthma. *Chest* 2006; 130:4S–12S.
3. Gold DR, Wright R. Population disparities in asthma. *Annu Rev Public Health* 2005; 26:89–113.
4. Akinbami LJ, Moorman JE, Liu X. Asthma prevalence, health care use, and mortality: United States, 2005–2009. *National Health Statistics Report* 2011; Jan 12 (32):1–14.
5. Akinbami LJ, Moorman JE, Garbe PL, Sondik EJ. Status of childhood asthma in the United States, 1980–2007. *Pediatrics* 2009; 123:S131–S145.
6. Moorman JE, Zahran H, Truman BI, Molla MT. Current asthma prevalence—United States, 2006–2008. *MMWR* 2011; 60:84–86.
7. Wang LY, Zhong Y, Wheeler L. Direct and indirect costs of asthma in school-age children. *Prev Chronic Dis* 2005. Available at: http://www.cdc.gov/pcd/issues/2005/jan/04_0053.htm. Accessed March 17, 2011.
8. Corso P, Fertig A. The long-term economic costs of asthma. *Partnership for America’s success. Issue Paper #3*, 2009.
9. Bahadori K, Doyle-Waters MM, Marra C, Lynd L, Alasaly K, Swiston J, FitzGerald JM. Economic burden of asthma: a systematic review. *BMC Pulm Med* 2009; 9:24.
10. Subbarao P, Mandhane PJ, Sears MR. Asthma: epidemiology, etiology and risk factors. *CMAJ* 2009; 181:181–190.
11. Eder W, Ege MJ, vonMutius E. The asthma epidemic. *N Engl J Med* 2006; 355:2226–2235.
12. Carlton BG, Lucas DO, Ellis EF, Conboy-Ellis K, Shoheiber O, Stemple DA. The status of asthma control and asthma prescribing practices in the United States: results of a large prospective asthma control survey of primary care practices. *J Asthma* 2005; 42: 529–535.
13. Clement LT, Jones CA, Cole J. Health disparities in the United States: childhood asthma. *Am J Med Sci* 2008; 335:260–265.
14. Aligne CA, Auinger P, Byrd RS, Weitzman M. Risk factors for pediatric asthma: contributions of poverty, race, and urban residence. *Am J Respir Crit Care Med* 2000; 162:873–877.
15. Probst JC, Moore CG, Glover SH, Samuels ME. Person and place: the compounding effects of race/ethnicity and rurality on health. *Am J Public Health*. 2004; 10:1695–1703.
16. Valet RS, Perry T, Hartert T. Rural health disparities in asthma care and outcomes. *J Allergy Clin Immunol* 2009; 123:1220–1225.
17. Mokdad AH, Stroup DF, Giles WH. Public health surveillance for behavioral risk factors in a changing environment: recommendations from the Behavioral Risk Factor Surveillance Team. *MMWR* 2003; 52(RR09):1–12.
18. WHO. *Health Systems: Improving Performance*. France: WHO, 2000.
19. American Psychological Association, Task Force on Socioeconomic Status. *Report of the APA Task Force on Socioeconomic Status*. Washington, DC: American Psychological Association, 2007.
20. Department of Defense. *Population Representation in the Military Services: Fiscal Year 1999*. Washington, DC: Office of the Assistant Secretary of Defense, Force Management and Personnel, 2000.
21. Woolfolk A. *Educational Psychology*. 10th ed. Boston, MA: Allyn and Bacon, 2007.

22. Pedersen S. From asthma severity to control: a shift in clinical practice. *Prim Care Respir J* 2010; 19:3–9.
23. Smedley BD, Smith AY, Nelson AR. *Unequal Treatment Confronting Racial and Ethnic Disparities in Healthcare*. Washington, DC: The National Academy Press, 2003.
24. Phelan JC, Linkl BG, Tehranifar P. Social conditions as fundamental causes of health inequalities: theory, evidence, and policy implications. *J Health Soc Behav* 2010; 51:28–40.
25. Link BG, Phelan JC. Editorial: understanding sociodemographic differences in health—the role of fundamental social causes. *Am J Public Health* 1996; 86:471–472.
26. Martin MA, Shalowitz MU, Mijanovich T, Clark-Kauffman E, Perez E, Berry CA. The effects of acculturation on asthma burden in a community sample of Mexican American schoolchildren. *Am J Public Health* 2007; 97:1290–1296.
27. Marmot M. Social determinants of health inequalities. *Lancet* 2005; 365:1099–1104.
28. Goldman N. Social inequalities in health disentangling the underlying mechanisms. *Ann N Y Acad Sci* 2001; 954:118–139.
29. Weiss KB, Gergen PJ, Crain EF. Inner-city asthma. The epidemiology of an emerging US public health concern. *Chest* 1992; 101: 362S–367S.
30. Pearlman DN, Zierler S, Meersman S, Kim HK, Viner-Brown SI, Caron C. Race disparities in childhood asthma: does where you live matter? *J Natl Med Assoc* 2006; 98:239–247.
31. Lutfiyya MN, Patel Y, Steele J, Tetteh B, Chang L, Agüero C, Prakash O, Lipsky MS. Are there disparities in diabetes care? A comparison of care received by U.S. rural and urban adults with diabetes. *J Prim Care Res Dev* 2009; 9:320–331.
32. Lutfiyya MN, Lipsky MS, Wisdon-Behonek J, Inpanbutr-Martinkus M. Is rural residency a risk factor for overweight or obese U.S. children? Examination of national survey data. *Obesity* 2007; 15:2348–2356.
33. Hartley D. Rural health disparities, population health, and rural culture. *Am J Public Health* 2004; 94:1675–1678.
34. van Dis J. Where we live: health care in rural vs urban America. *JAMA* 2002; 287:108.
35. Stanford R, McLaughlin T, Okamoto LJ. The cost of asthma in the emergency department and hospital. *Am J Respir Crit Care Med* 1999; 160:211–215.
36. Flores G, Snowden-Bridon C, Torres S, Perez R, Walter T, Brotanek J, Lin H, Tomany-Korman S. Urban minority children with asthma: substantial morbidity, compromised quality and access to specialists, and the importance of poverty and specialty care. *J Asthma* 2009; 46:392–398.

Copyright of Journal of Asthma is the property of Taylor & Francis Ltd and its content may not be copied or emailed to multiple sites or posted to a listserv without the copyright holder's express written permission. However, users may print, download, or email articles for individual use.