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A M E R I C A N C O L L E G E O F
 **C H E S T**
P H Y S I C I A N S



Asthma Hospitalizations Among American Indian and Alaska Native People and for the General US Population*

Rosalyn J. Singleton, MD; Robert C. Holman, MS; Nathaniel Cobb, MD; Aaron T. Curns, MPH; and Edna L. Paisano, MSW

Study objectives: Asthma is one of the most common chronic diseases in the United States. High rates of asthma hospitalization have been reported for some ethnic minorities; however, asthma hospitalization rates for American Indian/Alaska Native (AI/AN) populations of all ages have not been studied. In this study, we examined and compared hospitalization rates for AI/AN populations and the general population in the United States.

Design: Hospital discharge records with a first-listed diagnosis of asthma were evaluated for AI/AN populations and the US general population of all ages from 1988 to 2002.

Results: The asthma hospitalization rate for AI/AN populations decreased from 17.8/10,000 per year in 1988 to 1990 to 12.9/10,000 per year in 2000 to 2002. The overall age-adjusted rate for 2000 to 2002 was slightly lower than that for the general US population (12.9/10,000 and 16.4/10,000, respectively). However, AI/AN populations living in the Southwest region (17.6/10,000) had the highest asthma hospitalization rate among the Indian Health Service regions and the rate from 2000 to 2002 was similar to that for the general US population. The 2000 to 2002 asthma hospitalization rate for AI/AN populations < 1 year of age (infants) was higher than that in US infants, and the rates for AI/AN age groups ≥ 1 year were similar to or lower than those for the general US population.

Conclusions: While asthma was rarely reported among AI/AN populations before 1975, the average annual age-adjusted asthma hospitalization rate was only slightly lower for AI/AN populations than that for the US general population from 2000 to 2002. Furthermore, the asthma hospitalization rates for AI/AN populations living in the Southwest and East regions were similar to the rate for the general US population. Efforts to further increase asthma awareness and symptom recognition among AI/AN populations should be implemented to help to reduce asthma hospitalizations. (CHEST 2006; 130:1554–1562)

Key words: Alaskan Native; American Indian; asthma; children; epidemiology (pulmonary); hospitalization; pulmonary

Abbreviations: AI/AN = American Indian/Alaska Native; CI = confidence interval; ICD-9-CM = International Classification of Diseases, Ninth Revision, Clinical Modification; IHS = Indian Health Service; LRTI = lower respiratory tract infection; NHDS = National Hospital Discharge Survey; RR = risk ratio

Asthma is one of the most common chronic diseases among all ages in the United States.^{1–3} Although asthma prevalence, morbidity, and mortality increased in the 1980s,^{3,4} the hospitalization rate for asthma in the United States peaked in the mid-1980s and gradually declined through 1999.^{3,4} Relative to whites, men, and adults, higher rates of asthma hospitalization were reported among blacks, women, and children.^{2,3}

There are few reports on asthma prevalence among American Indian/Alaska Native (AI/AN) populations, and these reports suggest that asthma was rare before 1975. Herxheimer⁵ reviewed records in the Indian Health Service (IHS) facilities in Arizona and New Mexico in 1964 and concluded that “bronchial asthma was indeed almost unknown in American Indians before 1931.” In 1974, Slocum et al⁶ found only one patient with asthma in 9,000 AI/AN

visits to a Montana IHS clinic between 1974 and 1975. However, by 1987, Stout et al and others⁷⁻⁹ reported that the prevalence of parent-reported asthma was similar among AI/AN and US children.

A previous study¹⁰ found that the asthma hospitalization rate in registered Indians in Saskatchewan increased between 1979 and 1989, and that there was increased hospitalization risk for Indians 0 to 4 years and 35 to 64 years of age compared with other Saskatchewan populations. In the United States, Hisnanick et al¹¹ reported an average increase of 2.6% per year in the asthma hospitalization rate for IHS facilities between 1979 and 1989. Asthma hospitalization rates among AI/AN populations during this period closely approximated rates for white US children.¹¹ Studies¹²⁻¹⁴ in Washington and Alaska reported comparable rates of asthma prevalence and hospitalization between AI/AN and non-AI/AN children > 1 year of age. The Alaska Medicaid database study found lower asthma prevalence but a higher asthma hospitalization rate in nonurban Alaska Native people than in urban Alaska Native people.¹⁴

In this study, we describe and compare asthma hospitalization rates for AI/AN populations with those for the general population in the United States. Information regarding AI/AN asthma hospitalization across age groups is timely since reducing disparities in asthma and hospitalizations for asthma is a key goal of the Healthy People 2010 objectives.¹⁵ Although recent trends show a plateauing in the hospitalization rate for asthma for the United States,³ it is unclear whether similar trends are occurring among AI/AN populations and if culturally specific interventions, similar to those targeting African-American and Hispanic children, are warranted.

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MATERIALS AND METHODS

Hospital discharge data from the IHS Direct and Contract Health Service Inpatient Data set for AI/AN populations and the National Hospital Discharge Survey (NHDS) for the general US population were analyzed for calendar years 1988 to 2002.¹⁶⁻¹⁸ The IHS inpatient data set includes all AI/AN patient discharge records obtained from IHS-operated and tribally operated hospitals and from hospitals that have contracted with IHS or tribes to provide health-care services to federally recognized AI/AN populations within the United States.¹⁹ This study represents only AI/AN people who received direct or contract health-care through IHS-operated or tribally operated facilities across the United States. The IHS California and Portland administrative areas were excluded because neither had IHS- or tribally operated hospitals. In addition, California does not report contract health services inpatient data by diagnosis, and Portland has limited contract health service funds for inpatient care.^{20,21}

The NHDS is a representative sample of discharge records from short-stay, nonfederal, general and children's hospitals in the United States. The NHDS records were weighted by using procedures from the National Center for Health Statistics to obtain nationally representative hospitalization estimates for the US population.^{18,22}

Hospital discharge records with an International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) code for asthma (ICD-9-CM code 493) listed as the first diagnosis on the IHS inpatient data set and on the NHDS record were selected.²³ Inpatient first-listed asthma hospitalizations were defined as asthma hospitalizations for this study and are presented unless otherwise indicated. Hospital stays for newborns were excluded. A hospitalization is the unit of analysis in this study.

Hospital discharge records were examined by age group, sex, month of discharge, length of stay, geographic region, and time period (from 1988 to 1990 and from 2000 to 2002). In addition, the overall hospitalization rates for all ages excluding patients < 1 year of age (infants) were reported because asthma hospitalizations among infants reflect a diverse diagnostic category and may include hospitalizations with transient wheezing associated with respiratory infection.^{2,13,24} IHS administrative areas were classified into the following regions (Fig 1): East (Nashville), Northern Plains (Aberdeen, Bemidji, and Billings), Alaska, Oklahoma, and Southwest (Albuquerque, Navajo, Phoenix, and Tucson).²⁰ Standard US Census regions (Northeast, Midwest, South, and West) were used for the NHDS data.²⁵ Monthly estimates of US discharges were made using only NHDS records sampled from hospitals fully responding for all 12 months of that year. Race was not analyzed for the general US population because race was not reported for approximately 19% of the hospitalizations.

Asthma hospitalization rates and their associated 95% confidence intervals (CIs) were expressed as the number of hospitalizations per 10,000 population. Annual in-hospital fatality rates were calculated as the number of asthma deaths per 100 asthma hospitalizations. AI/AN population denominators for hospitalization rates were determined for each year of the study using the IHS fiscal-year 2002 user population estimates¹⁹ (released 2004) and adjusted retrospectively for annual changes in the IHS service population (released 2004).^{19,26} The user population includes all registered AI/AN patients (excluding California and Portland areas) who received IHS-funded health-care service at least once within the preceding 3 years.¹⁹ The service population is an estimate of the number of AI/AN people eligible for IHS-funded health care.²⁶ For the general US population, hospitalization rates were calculated by using NHDS data with annual US natality data for infants and annual US resident population estimates for other age groups from 1988 to 2002.^{27,28}



FIGURE 1. Map of United States outlining IHS regions.

Annual and overall SEs of NHDS estimates for determining 95% CIs were calculated by using software to account for the stratified sampling techniques (SUDAAN; Research Triangle Institute; Research Triangle Park, NC). Denominators were considered free from sampling error.²⁹ Comparisons of age group, sex, and region among AI/AN populations during 2000 to 2002 were made by using risk ratios (RRs) and 95% CIs.³⁰ Age-adjusted rates, calculated by using the direct method with the 2000 US resident population as the standard population,²⁷ were compared between the AI/AN and the general US populations.

RESULTS

Overall Rates and Trends

From 1988 to 2002, there were 23,970 asthma hospitalizations in IHS and tribal facilities among AI/AN populations included in this study. For the general US population, there were an estimated 7,075,818 (SE, 344,500) asthma hospitalizations. The rate of asthma hospitalizations for the AI/AN population decreased from 17.8/10,000 per year from 1988 to 1990, to 12.9/10,000 per year from 2000 to 2002 (RR, 1.4; 95% CI, 1.3 to 1.4; Table 1). The general US population average annual asthma hospitalization rate was 19.3/10,000 per year (95% CI, 16.8 to 21.8/10,000 per year) from 1988 to 1990, and 16.4/10,000 per year (95% CI, 14.7 to 18.1/10,000 per year) from 2000 to 2002 (Table 2) and did not significantly differ for the two periods. For 2000 to 2002, the average annual asthma hospitalization rate for the AI/AN population was slightly lower than that for the general US population (12.9/10,000 vs 16.4/10,000 per year). Excluding infant hospitalizations, the 2000 to 2002 asthma hospitalization rate for the

AI/AN population (11.5/10,000 per year; 95% CI, 11.2 to 11.8/10,000 per year) was lower than the rate for the general US population (15.7/10,000 per year; 95% CI, 14.2 to 17.3/10,000 per year; Tables 1, 2). Comparison of age-adjusted hospitalization rates for the two populations showed the same differences (all ages, 12.8/10,000 vs 16.4/10,000 per year, respectively; excluding infants, 11.5/10,000 vs 15.8/10,000 per year, respectively).

Age, Gender, and Region

From 2000 to 2002, the asthma hospitalization rates varied significantly by age group (Tables 1, 2). For both the AI/AN and the general US populations, age-specific rates were highest in infancy and early childhood, lower in later childhood and early adulthood, but increased again in older adulthood. In both the AI/AN and the general US populations, the lowest hospitalization rate occurred in the 20- to 44-year age group. AI/AN infants had a higher asthma hospitalization rate from 2000 to 2002 than US infants, while AI/AN children 1 to 19 years of age and adults 20 to 44 years of age had lower asthma hospitalization rates than similarly aged persons in the United States, and AI/AN and US adults 45 to 64 years and ≥ 65 years of age had similar rates (Tables 1, 2; Fig 2, 3). The average annual asthma hospitalization rate for the AI/AN population was lower for 2000 to 2002 than that for 1988 to 1990 in all age groups, except for 5- to 19-year-old subjects, who did not show a significant rate change (Table 1). In the US population, the asthma hospitalization rate decreased significantly in the 45- to 64-year and ≥ 65 -

Table 1—Asthma Hospitalizations and Hospitalization Rates for AI/AN Populations per 10,000, 1988–1990 and 2000–2002

Characteristics	1988–1990		2000–2002*		Rate change, 1988–1990 vs 2000–2002, %
	Subjects, No.	Rate (95% CI)	Subjects, No.	Rate (95% CI)	
Male gender	2,110	16.7 (16.0–17.4)	1,950	11.8 (11.3–12.3)	– 29.3†
Female gender	2,595	18.8 (18.1–19.5)	2,527	13.9 (13.4–14.5)	– 26.1†
Age, yr					
< 1	543	134.3 (123.4–146.1)	544	102.8 (94.5–111.9)	– 23.5†
1–4	1,000	45.7 (42.9–48.6)	1,184	41.3 (39.0–43.7)	– 9.6‡
5–19	657	7.9 (7.4–8.6)	867	8.0 (7.5–8.6)	1.3
20–44	1,081	11.1 (10.5–11.8)	752	5.9 (5.5–6.3)	– 46.8†
45–64	1,044	24.8 (23.3–26.3)	736	13.3 (12.4–14.3)	– 46.4†
≥ 65	380	23.1 (20.9–25.6)	394	18.3 (16.6–20.2)	– 20.8§
Region					
Alaska	309	11.6 (10.3–13.0)	415	11.9 (10.8–13.1)	2.6
East	82	12.7 (10.2–15.8)	148	13.5 (11.5–15.9)	6.3
Northern Plains	1,200	21.9 (20.7–23.2)	863	11.1 (10.4–11.9)	– 49.3†
Oklahoma	994	14.8 (13.9–15.6)	605	7.2 (6.6–7.8)	– 51.4†
Southwest	2,120	19.4 (18.6–20.2)	2,446	17.6 (16.9–18.3)	– 9.3§
Total	4,705	17.8 (17.3–18.3)	4,477	12.9 (12.5–13.3)	– 27.5†

*Asthma hospitalization rates per 10,000 per year among subjects > 1 year old were as follows: total (11.5; 95% CI, 11.2–11.8), male subjects (9.7; 95% CI, 9.2–10.2), female subjects (13.1; 95% CI, 12.6–13.7), Alaska (10.4; 95% CI, 9.4–11.6), East (12.4; 95% CI, 10.4–14.7), Northern Plains (9.8; 95% CI, 9.1–10.5), Oklahoma (6.7; 95% CI, 6.1–7.3), and Southwest (15.6; 95% CI, 15.0–16.3).

†p < 0.001, time period comparison.

‡p ≥ 0.01 to p ≤ 0.05, time period comparison.

§p ≥ 0.001 to p ≤ 0.01, time period comparison.

year age groups, while the rates for the other age groups did not significantly change (Table 2).

From 2000 to 2002, the asthma hospitalization rate was slightly higher in AI/AN female subjects than AI/AN male subjects (13.9/10,000 and 11.8/10,000

per year, respectively; RR, 1.2; 95% CI, 1.1 to 1.3; Table 1). When stratified by age group, the differences in asthma hospitalizations rates by gender were pronounced in both the AI/AN and the general US populations (Fig 2, 3). For both the AI/AN and

Table 2—Asthma Hospitalizations and Hospitalization Rates for General US Population per 10,000, 1988–1990 and 2000–2002

Characteristics	1988–1990		2000–2002*		Rate Change, 1988–1990 vs 2000–2002, %
	No. (SE)	Rate (95% CI)	No. (SE)	Rate (95% CI)	
Male gender	604,670 (55,700)	16.8 (13.7–19.8)	579,657 (46,600)	13.6 (11.6–16.0)	– 19.1
Female gender	826,135 (42,600)	21.8 (19.6–24.0)	823,104 (36,500)	18.9 (17.3–20.6)	– 13.3†
Age, yr					
< 1	59,230 (14,700)	49.0 (25.2–72.8)	76,073 (10,500)	62.8 (45.8–79.8)	28.2
1–4	243,577 (36,500)	56.1 (39.6–72.5)	274,459 (32,000)	59.6 (46.0–73.2)	6.3
5–19	253,327 (36,400)	16.0 (11.5–20.5)	259,299 (25,800)	14.1 (11.3–16.8)	– 11.9
20–44	300,911 (14,600)	10.1 (9.2–11.1)	285,237 (13,100)	9.1 (8.3–9.9)	– 10.0
45–64	266,980 (11,900)	19.4 (17.7–21.1)	284,498 (12,600)	14.7 (13.5–16.0)	– 24.2‡
> 65	306,590 (20,000)	33.3 (29.1–37.6)	223,195 (15,400)	21.1 (18.2–23.9)	– 36.6‡
Region					
Northeast	335,939 (16,200)	22.1 (20.0–24.2)	322,677 (22,500)	20.0 (17.2–22.7)	– 9.5
Midwest	409,335 (74,600)	22.9 (14.7–31.1)	320,176 (38,300)	16.5 (12.6–20.3)	– 27.9
South	431,921 (28,600)	17.0 (14.8–19.2)	509,415 (44,000)	16.7 (13.9–19.5)	– 1.8
West	253,610 (47,900)	16.3 (10.3–22.3)	250,493 (42,300)	13.0 (8.7–17.2)	– 20.2
Total	1,430,805 (94,800)	19.3 (16.8–21.8)	1,402,761 (75,500)	16.4 (14.7–18.1)	– 15.0

*Asthma hospitalization rates per 10,000 per year among patients > 1 year old were as follows: total (15.7; 95% CI, 14.2–17.3), male subjects (12.7; 95% CI, 10.9–14.6), female subjects (18.6; 95% CI, 17.0–20.2), Northeast (19.3; 95% CI, 16.7–21.8), Midwest (16.1; 95% CI, 12.5–19.7), South (16.0; 95% CI, 13.4–18.7), and West (12.0; 95% CI, 8.4–15.6).

†p ≥ 0.01 to p ≤ 0.05, time period comparison.

‡p < 0.001, time period comparison.

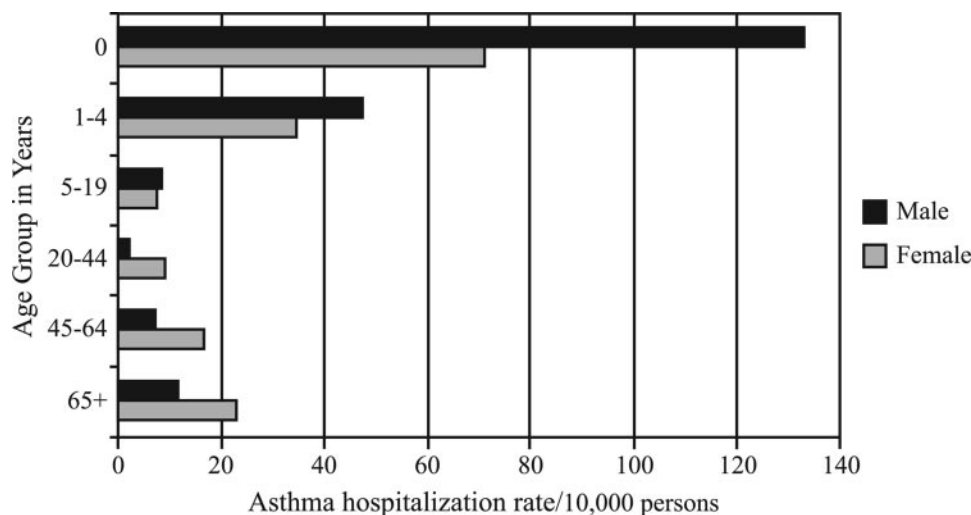


FIGURE 2. Age-specific asthma hospitalization rates for AI/AN populations by gender, 2000–2002.

the general US populations, male subjects < 5 years of age had significantly higher rates than female subjects, while female subjects had significantly higher rates in all adult age groups ≥ 20 years of age, and the rates for children 5 to 19 years of age were similar by gender.

The 2000 to 2002 asthma hospitalization rates varied significantly by region for AI/AN populations but not for the general US population (Tables 1, 2). The overall 2000 to 2002 average annual asthma hospitalization rates for AI/AN populations living in the Northern Plains, Oklahoma, and Southwest regions were significantly lower than the 1988 to 1990 average annual hospitalization rates, while there were no significant differences between the two periods in the average annual hospitalization rate for AI/AN populations in the Alaska and East regions.

The highest asthma hospitalization rate among the IHS regions from 2000 to 2002 occurred in the Southwest region (17.6/10,000 per year); the rate for the Southwest was similar to that for the United

States (age-adjusted rates of 17.3/10,000 and 16.4/10,000 per year, respectively; Tables 1, 2). The rate for the East region was also similar to the rate for the United States, while the other three IHS regions had lower rates than that for the United States (age-adjusted rates, 13.8/10,000, 12.2/10,000, 11.1/10,000, and 7.2/10,000 per year for the East, Alaska, Northern Plains, and Oklahoma regions, respectively). The lowest 2000 to 2002 rate occurred in the Oklahoma region. The higher rate in the Southwest region was influenced by the hospitalization rates for infants and for 1- to 4-year-old subjects (134.5/10,000 and 62.5/10,000 per year, respectively), which was higher than those for the other IHS regions, except for the East region (Table 3). After excluding infant hospitalizations, the overall rate for Southwest region remained higher than those for the other regions (Table 1). While the hospitalization rate for children < 5 years of age in other IHS regions decreased or remained the same for the two periods, the rate for Alaska infants and for 1- to 4-year-old subjects increased from 21.1/10,000 per year (95% CI, 11.1 to 39.0/10,000 per year) from 1988 to 1990, to 83.6/10,000 per year (95% CI, 63.9 to 108.9/10,000 per year) from 2000 to 2002, and 14.9/10,000 per year (95% CI, 10.5 to 20.9/10,000 per year) to 34.0/10,000 per year (95% CI, 28.0 to 41.4/10,000 per year), respectively; the only other significant increase for an age group was among the 5- to 19-year age group in the Southwest region (8.1/10,000 per year; 95% CI, 7.1 to 9.1/10,000 per year) and 11.7/10,000 per year (95% CI, 10.7 to 12.8/10,000 per year), respectively. The rates for infants and the ≥ 65 -year age group in the Southwest region were higher than those for the United States. In the US general population, the rate did not vary significantly by region.

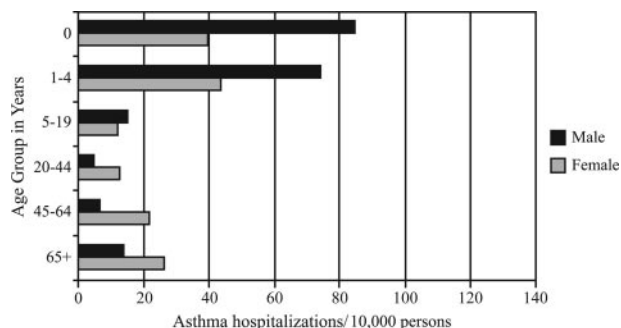


FIGURE 3. Age-specific asthma hospitalization rates for the general US population by gender, 2000–2002.

Table 3—Asthma Hospitalization Rates by Region for AI/AN Populations and for Overall General US Population by Age Group, 2000–2002

Age, yr	Hospitalization Rate per 10,000 per Year (95% CI)					
	Alaska	East	Northern Plains	Oklahoma	Southwest	United States
< 1	83.6 (63.9–108.9)	107.8 (61.4–184.9)	98.6 (82.0–118.5)	48.5 (36.3–64.6)	134.5 (120.1–150.5)	62.8 (45.8–79.8)
1–4	34.0 (28.0–41.4)	57.0 (42.5–76.2)	23.8 (20.3–27.9)	22.9 (19.4–26.9)	62.5 (58.0–67.2)	59.6 (46.0–73.2)
5–19	5.8 (4.5–7.4)	4.9 (2.9–8.1)	6.6 (5.6–7.7)	4.3 (3.5–5.2)	11.7 (10.7–12.8)	14.1 (11.3–16.8)
20–44	4.0 (3.0–5.4)	6.6 (4.5–9.8)	8.4 (7.4–9.6)	3.9 (3.2–4.7)	6.1 (5.4–6.8)	9.1 (8.3–9.9)
45–64	15.6 (12.6–19.3)	16.1 (11.1–23.1)	10.9 (9.2–12.9)	9.9 (8.4–11.7)	16.1 (14.5–18.0)	14.7 (13.5–16.0)
≥ 65	23.9 (18.0–31.7)	16.9 (9.2–30.4)	11.9 (9.0–15.8)	5.3 (3.7–7.6)	30.1 (26.6–34.2)	21.1 (18.2–23.9)

Hospital Length of Stay, Procedures, and Outcome

The median length of stay for asthma hospitalizations among the AI/AN population decreased from 3 days from 1988 to 1990 to 2 days from 2000 to 2002. From 2000 to 2002, the median length of stay for both male and female subjects was 2 days. Length of stay was highest for age groups ≥ 45 years of age (median, 3 days). Mechanical ventilation (ICD-9-CM codes 96.70–96.72) was listed as a procedure in $< 1\%$ of asthma hospitalizations among all age groups of AI/AN populations and in asthma hospitalizations for US subjects < 20 years of age; and 1.5% and 1.1%, respectively, of asthma hospitalizations for US subjects 20 to 44 years old and 45 to 64 years old. The in-hospital fatality rate was 0.1% for the AI/AN population and 0.4% for the general US population.

Seasonality

During 2000 to 2002, the peak months of asthma hospitalization for the AI/AN population were winter months (January through March), while the lowest number of asthma hospitalizations occurred during summer months (June through August; Fig 4). The

percentage of US asthma hospitalizations occurring during the summer months was also low but did not show a winter peak similar to the AI/AN population. The proportions of hospitalizations that occurred in the AI/AN and the general US populations during January through March were 34.9% and 29.5%, respectively. The monthly distribution of asthma hospitalizations did not markedly change when excluding infant hospitalizations.

DISCUSSION

Major Findings

The asthma hospitalization rate for the AI/AN population was lower for 2000 to 2002 than that for 1988 to 1990, while the general US population rate was similar for 1988 to 1990 and for 2000 to 2002. However, the rate for the Southwest AI/AN population was similar for the two periods, and the 2000 to 2002 rate was similar to that for the general US population. There were wide regional variations in asthma hospitalization rates in the AI/AN population but not in the general US population. The highest hospitalization rates among the AI/AN and the gen-

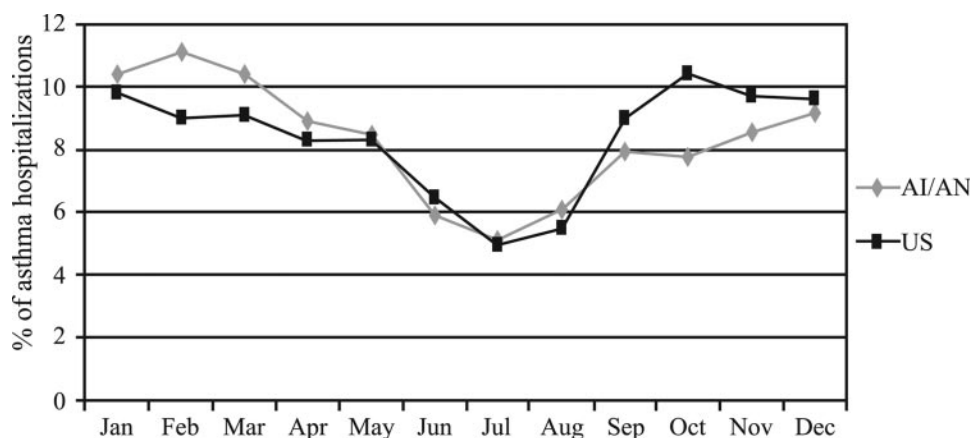


FIGURE 4. Percentage of asthma hospitalizations by discharge month among AI/AN populations and the general US population, 1988–2002.

eral US populations during from 2000 to 2002 were among infants and children 1 to 4 years of age. Asthma hospitalizations varied by season in both the AI/AN and the general US populations, with a noticeable peak occurring during the winter months for the AI/AN population.

While asthma was a rare diagnosis in many IHS areas before 1975,^{5,6} asthma prevalence and hospitalizations increased dramatically among AI/AN populations during the 1980s.^{7-9,11,19} In this study, asthma hospitalizations among AI/AN populations from 1988 to 2002 occurred at a rate similar to or slightly lower than the US rate. Although asthma prevalence is stable or increasing in the United States,³ asthma hospitalization rates appear stable in the general US population and are stable or decreasing among the AI/AN population.

Regional differences in AI/AN hospitalization rates may be affected by environmental risk factors, other comorbid medical risk factors, and differing thresholds for hospitalization. Low household income and educational level have been associated with increased asthma hospitalization rates in the general US population,^{2,31,32} and with higher rates of health problems among AI/AN populations as compared with other races.^{19,33} The median household income for AI/AN populations living in reservation states is approximately two thirds that of all races in the United States.²⁰ Cooking with a wood-burning stove is common in some IHS regions and has been shown to be associated with lower respiratory tract illness (LRTI) hospitalization among Southwest Navajo children.³⁴ Several factors may contribute to the lower rates of infectious disease³⁵⁻³⁹ and asthma hospitalizations seen in the Oklahoma region: the Oklahoma AI/AN population lives primarily in nonreservation settings and, compared with populations in other IHS regions, it has a higher percentage of college graduates and lower birth and infant mortality rates.²⁰

We reported separate asthma hospitalization rates for the AI/AN and US general populations ≥ 1 year of age because asthma hospitalizations among infants reflect a diverse diagnostic category and may include hospitalizations for infants with transient wheezing associated with LRTI.² Diagnostic substitution of asthma in place of bronchiolitis among AI/AN infants or recurring wheezing after bronchiolitis within the first year of life are likely to contribute to the high hospitalization rates observed in AI/AN infants.¹ In AI/AN infants, bronchiolitis^{13,37} and LRTIs,³⁸ and asthma hospitalization rates are twice as high as those for the US population. Alaska Native infants hospitalized with respiratory syncytial virus infection had high rates of wheezing visits during the early childhood.³⁹ These findings suggest that LRTIs are a major source of wheezing exacerbation in AI/AN

infants. The winter predominance of asthma hospitalizations appears accentuated in AI/AN populations, possibly reflecting the importance of LRTIs in asthma exacerbation for other ages among AI/AN populations as well.

The decrease in asthma hospitalizations while asthma prevalence may be stable or increasing among AI/AN populations^{3,7,14} suggests that other factors, including increased use of asthma preventive treatment, may be affecting hospitalization rates. Gessner¹⁴ demonstrated that from 1999 to 2002, the yearly prevalence of asthma increased from 1.0 to 2.2% in Alaska Medicaid recipients < 20 years of age, while the percentage of hospitalizations among persons with asthma decreased. During this period, the largest decrease in hospitalization occurred among Anchorage Alaska Natives who also had the largest increase in inhaled corticosteroid use. Other studies^{24,39,40} have demonstrated an inverse correlation between delivery of inhaled corticosteroids and asthma hospitalization.

There is substantial variation in provider use of asthma as a diagnosis, and some data suggests that AI/AN populations are at risk for underdiagnosis of asthma.⁴¹ For example, while rural Alaska Native children and metropolitan Washington children had similar rates of self-reported asthma symptoms,^{12,42,43} a significantly higher percentage of metropolitan Washington children reported a physician diagnosis of asthma. Also, rural Alaska Native people had low asthma prevalence but high hospitalization rates compared with urban Alaska Native and non-Alaska Native people.^{14,44} Educational level, health-care access, income, ethnicity, and urban residence may be more associated with receiving a physician diagnosis of asthma than the prevalence of asthma symptoms.^{45,46} Failure to diagnose asthma in early stages is likely to lead to inadequate therapy and may predispose undiagnosed asthmatics to higher asthma hospitalization rates.

We found a gender difference in asthma hospitalization rates in relation to age similar to reports from other US and Canadian populations.^{3,47} The asthma hospitalization rate in AI/AN and US children is substantially higher for boys than girls 0 to 4 years of age; however, the difference in hospitalization rates by gender is reversed in adults ≥ 20 years old. Although the mechanisms for the interrelationship among sex, age, and asthma are unknown, airway size relative to lung size and gender-specific responses to environmental risk factors may explain some of these differences in asthma hospitalization rates.⁴⁷

It is not possible using the NHDS or IHS hospital discharge data to detect multiple hospitalizations for each patient. Therefore, the extent to which changes over time reflect the changes in frequency of hospital

readmissions is unknown. Asthma hospital trends cannot be used to "confirm" a change in prevalence trends because changes in the hospitalization rate may also reflect changes in medical practice, asthma therapy, and utilization of care. Differences in practice may also affect regional differences in asthma hospitalization rates.^{1,48} Diagnostic substitution may also affect asthma hospitalization rates.^{2,24} The AI/AN population denominator used may underestimate the actual number of AI/AN people because it is derived from the AI/AN population who receive medical care through the IHS/tribal system. AI/AN people eligible for IHS/tribal services could have received medical care outside the IHS/tribal system. However, AI/AN people are likely to seek IHS/tribal health care because prepaid IHS-funded health care is provided to eligible AI/AN people.⁴⁹ Hospital admission criteria, patterns for seeking health care, and diagnostic criteria may have varied within the IHS/tribal system and between the IHS/tribal and US populations.

CONCLUSION

The asthma hospitalization rate among AI/AN populations for 2000 to 2002 was lower than the rate for 1988 to 1990; the rate for the general US population did not differ for these periods. While asthma was rarely reported among AI/AN populations prior to 1975, the average annual asthma hospitalization rate from 2000 to 2002 was slightly lower for AI/AN populations than for the general US population. Furthermore, the rates for AI/AN populations living in the Southwest and the East regions were similar to that for the United States. The early diagnosis of asthma and subsequent use of preventive medications are a natural focus for reducing the risk of hospitalization for asthma.⁵⁰ Efforts to further increase asthma awareness and symptom recognition among AI/AN populations should help to reduce asthma hospitalization rates.

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