Trends in asthma prevalence, hospitalization risk, and inhaled corticosteroid use among Alaska Native and nonnative Medicaid recipients younger than 20 years

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Background: Few trend data on asthma prevalence exist for US indigenous populations, and none exist for Alaska Natives.

Objective: To document the epidemiologic features of asthma in Alaska Natives and nonnatives stratified by urban (Anchorage) and rural (non-Anchorage) residence.

Methods: We conducted a retrospective review of Alaskans younger than 20 years enrolled in Medicaid during 1999 to 2002. Asthma was defined as a claim for *International Classification of Diseases, Ninth Revision,* codes 493.0x to 493.9x plus asthma-associated medication during the same calendar year.

Results: Among 117,080 Medicaid enrollees, the 4-year asthma prevalence was 3.1% and was 40% to 90% greater for urban residents regardless of race. Yearly prevalence increased from 1.0% to 2.2% ($P < .001$), with increases in all subgroups. Of 4 predominantly Alaska Native census areas, the area with resident pediatricians and previous participation in asthma research had a 4-year asthma prevalence 5- to 11-fold higher than the other areas. Among persons with asthma, yearly hospitalization risk decreased (from 9.3% to 6.8%; $P = .02$) concurrent with an increase in the yearly use of inhaled corticosteroids (from 50% to 64%; $P < .001$). Urban Alaska Natives had the greatest decrease in hospitalization risk and the greatest increase in inhaled corticosteroid use.

Conclusions: Relatively dramatic demographic differences and temporal trends in asthma prevalence occurred in the absence of known differences or changes in risk factor prevalences. This suggests a role for differences in the use of asthma as a diagnosis for respiratory illness. Failure to diagnose and thus treat asthma may affect outcomes because decreases in hospitalization risk were temporally associated with increases in inhaled corticosteroid use.

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INTRODUCTION

Reported adult and childhood US asthma prevalences have increased or remained steady.[1,2] The reasons for this are unknown but may be related to increased exposure to environmental toxins such as air pollution,[3,4] decreased exposure to some antigens during infancy and early childhood,[5,6] or changes in diagnostic practices.[2,7] Similarly, through 2002, morbidity and mortality rates of US pediatric asthma have remained stable or increased,[1,2] despite an increased focus on patient education through programs such as Wee Wheezers,[8] Asthma Care Training for Kids,[9] and Power Breathing and changes in therapeutic strategies, including an increased emphasis on inhaled corticosteroids and other long-term control medications.[10] It is possible that these relatively recent interventions will have an effect in the future.

Since publication of an earlier study of asthma prevalence in Alaska,[11] provider and patient education classes have accelerated, primarily in Anchorage, which contains half of the state's population, and the state has added a third pediatric allergist, all based in Anchorage. We evaluated trends in asthma prevalence and medication use among Alaska Natives and nonnatives enrolled in Medicaid during 1999 to 2002. The study goals were to document trends in asthma prevalence, to determine whether a temporal association between hospitalization and inhaled corticosteroid use existed, and to evaluate the contribution of race and rural vs urban residence on a variety of asthma outcomes.

METHODS

Health Care in Alaska

During the study, health care services in Alaska were delivered through a variety of private, public, nonprofit, Native Corporation, and Indian Health Service entities. Alaska Natives constituted the state's largest racial minority and were predominantly rural residents who usually received services through Native Corporation and Indian Health Service facilities. Care in most small villages was provided at clinics staffed by village health aides, with support provided by physicians based at regional centers. For Medicaid-enrolled

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persons, all in-state facilities billed Medicaid regardless of where a specific individual obtained care. Based on 2001 census data, the proportion of all Alaska Natives younger than 20 years enrolled in Medicaid increased from 49% to 59% during the study compared with an increase from 20% to 25% for nonnatives. Little difference in Medicaid enrollment percentages existed by Anchorage and non-Anchorage residence.

Data Source

We used a retrospective method similar to that reported previously.[11] Multiple data files were obtained from the Alaska Division of Medical Assistance. The master file consisted of all persons younger than 20 years enrolled in Medicaid between January 1, 1999, and December 31, 2003. The master file contained a unique identifier for each person and the person's city of residence, race, sex, and date of birth. Not all children were enrolled in Medicaid for the entire study period because they either lost their eligibility or enrolled after the beginning of the study. Among all children, 34% were continuously enrolled during the entire study period compared with 55% of children with asthma. Among children not continuously enrolled, the average length of enrollment was 14 months for all children and 20 months for children with asthma.

Three data files were obtained that contained all provider-, inpatient facility–, and outpatient clinic–approved billing claims for *International Classification of Diseases, Ninth Revision,* codes 493.0x to 493.9x, the standard codes for asthma. A fourth subsidiary data file was obtained for pharmacy claims paid by Medicaid. This file was limited to approved claims for all marketed medications in the following categories: inhaled β-agonists, inhaled corticosteroids, and leukotriene modifiers. Additional medications included cromolyn, nedocromil, and ipratropium bromide. Oral corticosteroids were not included because of their frequent indication for diseases other than asthma, whereas methylxanthines were not included because a previous work indicated that they were rarely prescribed; in addition, we assumed that any child receiving one of these medications would also receive other asthma medications. Note that the pharmacy file has information on filled prescriptions, which reflects a combination of provider prescribing practices and patient prescription filling practices.

Case Definitions and Analysis

The primary definition of asthma was an approved claim for asthma-related medication use and care during the same calendar year. This conservative definition was chosen because of concern about the potentially common use of *International Classification of Diseases, Ninth Revision,* code 493.xx for any asthma evaluation regardless of the final diagnosis. Secondary analyses included persons with approved claims for asthma-related medication use or care.

The 1 pharmacy and 4 services data files were linked to the eligibility file by matching on the unique identifier number. Because asthma prevalence was the primary outcome of interest, most analyses were performed with the individual as the unit of analysis. Consequently, multiple visits or medications for a single person during a particular year or for all 4 years, depending on the analysis, were ignored. For all calculations, the denominator was calculated as the number of persons enrolled in Medicaid during the period in question (ie, the individual year or all 4 years together) regardless of total days enrolled.

Age was calculated as the person's age on December 31 of the first year during the 4-year study in which the subject was identified in the database. Residence was categorized as Anchorage or non-Anchorage; Anchorage was the only substantial urban center and contained approximately half of the state's population and 3 of its 4 largest hospitals. For risk factor analysis, during which all 4 years of data were summed, Anchorage residence was counted as positive if the individual had resided in Anchorage at any time during the 4-year period. Of Alaska Natives, 4.1% resided in and outside of Anchorage at different times during the study compared with 2.4% of nonnatives. Deleting these persons from the analysis did not substantially alter the results and had no effect on the conclusions.

During univariate analysis, risk ratios and their 95% confidence intervals (CIs) were calculated. Multiple logistic regression models were created to evaluate the independent association between outcome variables and Alaska Native status, age, sex, and Anchorage residence. For all models, all independent variables were entered simultaneously. In addition, all models were adjusted for the total days of enrollment during the study by entering this into each model as a continuous variable. All analyses were performed using a statistical software program (SPSS version 11.0; SPSS Inc, Chicago, IL).

RESULTS

Enrollment Characteristics

During the 4-year study, 117,080 in-state residents younger than 20 years were enrolled in Medicaid at some point, with 34% enrolled during all 4 years. The number of children enrolled increased from 66,462 during 1999 to 75,291 during 2000, 80,562 during 2001, and 84,265 during 2002. During the 4-year study, Anchorage and non-Anchorage Alaska Natives were enrolled for a mean of 743 and 796 days, respectively, and Anchorage and non-Anchorage nonnatives were enrolled for 675 and 707 days, respectively.

Summary Prevalence and Trends

The 4-year asthma prevalence was 3.1% (n = 3,631), and 0.46% of the total study population (n = 538) had an asthma-related hospitalization. Among those with asthma, 9.9% (n = 359) experienced at least 1 asthma-related hospitalization, 6.1% experienced at least 2, and 2.0% had at least 4. The yearly asthma prevalence increased steadily from 1.0% to 2.2% (χ^2 for trend, 374; $P < .001$) during the study, whereas among persons with asthma, the percentage who were hos-

Table 1. Prevalences of Asthma and at Least 1 Asthma-Related Hospitalization Among Medicaid-Enrolled In-State Residents Younger Than 20 Years (Alaska, 1999-2002)*

Risk group†	Asthma		Asthma-related hospitalization		Hospitalization among persons with asthma	
	Prevalence, %	Prevalence ratio (95% CI)	Prevalence, %	Prevalence ratio (95% CI)	Prevalence, %	Prevalence ratio (95% CI)
Alaska Native status × residence						
Native, Anchorage (n = 9,293)	4.8	1.2 (1.1-1.4)	0.82	2.0 (1.5-2.6)	12	1.7 (1.2-2.4)
Native, non-Anchorage (n = 32,388)	2.5	0.66 (0.60-0.72)	0.63	1.5 (1.2-1.9)	17	2.3 (1.7-3.0)
Nonnative, non-Anchorage (n = 36,112)	2.8	0.74 (0.68-0.81)	0.34	0.81 (0.63-1.0)	7.4	1.0 (0.75-1.4)
Nonnative, Anchorage (n = 27,531)	3.8	Referent	0.42	Referent	7.3	Referent
Female						
Yes (n = 58,333)	2.7	0.79 (0.75-0.85)	0.35	0.62 (0.52-0.74)	8.1	0.71 (0.58-0.87)
No (n = 58,745)	3.5	Referent	0.57	Referent	11	Referent
Age <5 y at enrollment						
Yes (n = 45,607)	3.1	1.0 (0.94-1.1)	0.89	4.8 (3.9-5.8)	18	3.8 (3.0-4.7)
No (n = 71,473)	3.1	Referent	0.19	Referent	4.8	Referent

Abbreviation: CI, confidence interval.

* Asthma is defined as the receipt of asthma-related medication and care during the same calendar year.

† Denominators are not the same for all risk group categories because not all relevant information was available for all persons.

pitalized decreased from 9.3% to 6.8% (χ^2 for trend, 9.8; $P < .02$). Inhaled corticosteroid use increased from 0.70% to 2.0% among all Medicaid recipients (χ^2 for trend, 576) and from 50% to 64% among persons with asthma (χ^2 for trend, 72) ($P < .001$ for both). To provide an upper limit on the potential asthma prevalence, data were also evaluated defining asthma as the receipt of any asthma-related medication or care. Using this definition, the 4-year asthma prevalence was 9.3% (n = 10,922), whereas the yearly prevalence increased from 4.1% to 5.9%.

Subgroup Prevalences and Trends

Four-year asthma prevalences were significantly lower among persons who lived outside Anchorage regardless of race (Table 1). By contrast, the risk of hospitalization for asthma was substantially greater among Alaska Natives regardless of residence. Only small and mostly nonsignificant differences existed between groups in the prevalence of ever filling a prescription for inhaled corticosteroids (data not shown).

During the 4-year study, the asthma prevalence (Fig 1) and the proportion of persons with asthma who filled a prescription for inhaled corticosteroids (Fig 2) increased among all groups. Alaska Natives residing in Anchorage had the greatest rise in the latter outcome and the greatest drop in hospitalization (Fig 3). The mean number of asthma-related hospitalizations—per 1,000 persons with asthma—decreased between 1999 and 2002 for nonnative Anchorage (from 162 to 120) and non-Anchorage (from 257 to 103) residents, and it remained static for Alaska Native Anchorage (from 205 to 195) and non-Anchorage (from 288 to 279) residents. Among persons with asthma who had at least 1 inhaled corticosteroid prescription filled, the mean number of inhaled corticosteroid prescriptions filled per year of enrollment increased for all groups, including Alaska Native Anchorage (from 1.4 to 2.5) and non-Anchorage (from 2.1 to 2.9) residents and nonnative Anchorage (from 2.8 to 3.0) and non-Anchorage (from 2.5 to 3.0) residents; for context, a standard 120-dose corticosteroid inhaler used twice a day would last a maximum of 60 days.

Because Alaska Native non-Anchorage residents had a high risk of hospitalization but a low prevalence of asthma, we evaluated this group in more detail. We examined all 4 non-Anchorage census areas, which were predominantly Alaska Native, were each served by a regional Native Health Corporation Hospital, and had a total population of at least 5,000 (this latter criterion was included because of concern about small case numbers) (Fig 4). The 4 census area centers had populations of 3,100 to 5,700, whereas the associated 72 villages had populations smaller than 800. The Bethel census area had the highest asthma prevalence, including when asthma was defined as the receipt of medication or care (Table 2). Most census areas had too few cases to examine intracensus area differences using the standard asthma definition. Defining asthma as the receipt of any asthma-related medication or care, the prevalences within and outside the regional village centers were 19% and 11% in Bethel (prevalence ratio [PR], 1.7; 95% CI, 1.4–2.2), 5.6% and 3.1% in Nome (PR, 1.8; 95% CI, 0.89–3.6), 7.4% and 5.2% in the North Slope Borough (PR, 1.4; 95% CI, 0.53–3.8), and 9.5% and 6.3% in the Northwest Arctic Borough (PR, 1.5; 95% CI, 0.87–2.6).

Multivariate Risk Factor Analysis

Three regression models were created to evaluate the interaction of Anchorage residence and Alaska Native status when adjusted for age, sex, and days enrolled in Medicaid (Table 3). As with univariate analysis, Anchorage residence was a risk factor for asthma regardless of race, and Alaska Native

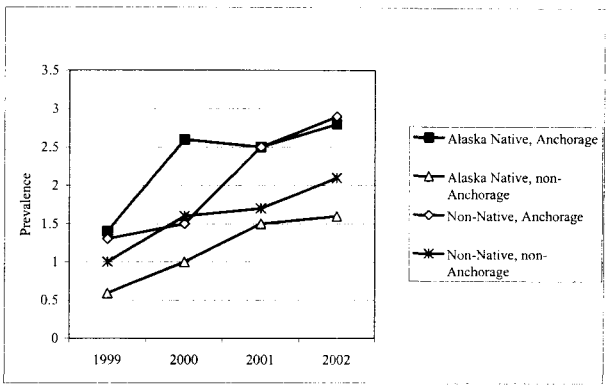

Figure 1. Persons with asthma among Medicaid recipients younger than 20 years by year of health care service, race, and residence (Alaska, 1999–2002).

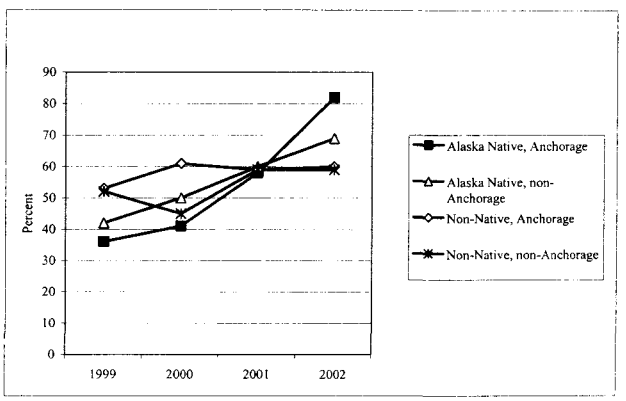

Figure 2. Persons with asthma who filled a prescription for an inhaled corticosteroid among Medicaid recipients younger than 20 years by year of health care service, race, and residence (Alaska, 1999–2002).

race was a risk factor for hospitalization regardless of Anchorage residence. These differences occurred independent of inhaled corticosteroid use.

Additional Medications

Among persons with asthma, the 3 most commonly used nonsteroidal long-term control medications were cromolyn, montelukast, and salmeterol (as either a salmeterol or a salmeterol-fluticasone inhaler). The percentage of patients who filled a prescription for any nonsteroidal long-term control medication decreased each year, from 41% to 29% (χ^2 for trend, 38; $P < .001$), because of a decrease in the use of cromolyn from 16% to 2% (χ^2 for trend, 219; $P < .001$). By contrast, there was an increase in the use of montelukast (from 14% to 22%) (χ^2 for trend, 29; $P < .001$) and salmeterol (from 16% to 22%) (χ^2 for trend, 34; $P < .001$). Although the use of nonsteroidal long-term control medications rose during the study for all subgroups, Alaska Natives,

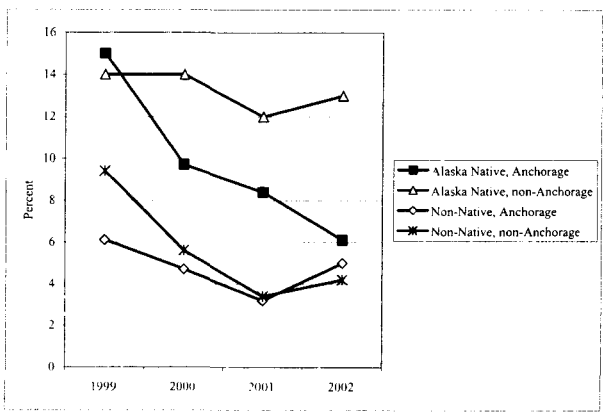

Figure 3. Persons with asthma requiring hospitalization among Medicaid recipients younger than 20 years by year of health care service, race, and residence (Alaska, 1999–2002).

particularly those living outside Anchorage, were less likely than nonnatives to use these medications. For brevity, only the results for salmeterol are presented (Fig 5), although the results were similar for montelukast. By 2002, cromolyn was used infrequently by all groups.

Of all filled prescriptions for salmeterol, the percentage filled in the absence of evidence of inhaled corticosteroid use during the same calendar year was 52%, 41%, 25%, and 14% for 1999, 2000, 2001, and 2002, respectively (χ^2, 129; $P < .001$). During 2002, 6% of Alaska Natives and nonnatives in Anchorage used salmeterol without evidence of inhaled corticosteroid use compared with 24% of Alaska Natives and 14% of nonnatives living outside Anchorage.

DISCUSSION

Asthma prevalence increased by 100% to 170% for all groups, regardless of race or residence. It is unlikely that increasing industrialization explains these findings: during the study, Alaska's population grew less than 1% per year, and major economic expansion did not occur (Alaska Department of Labor). Similarly, there is no known justification for implicating dramatic increases in risk factors such as exposure to dust mites,[12] cockroach feces,[13] or tobacco smoke or acute decreases in cultural practices that may provide protection, such as early exposure to animals.[5,6]

Within subgroups, Anchorage residents had an increased asthma prevalence regardless of Alaska Native status. Many rural Alaska residents live subsistence lifestyles, reside in crowded households, and may live in villages where hygiene is problematic, eg, because of lack of community septic systems. Furthermore, anecdotally, clinicians practicing in rural Alaska report seeing markedly fewer asthma cases than when they practiced in other areas of the United States. Thus, the decreased risk associated with non-Anchorage residence is consistent with recent research implicating delayed exposure to endotoxins or allergens[6,14] or increased exposure to

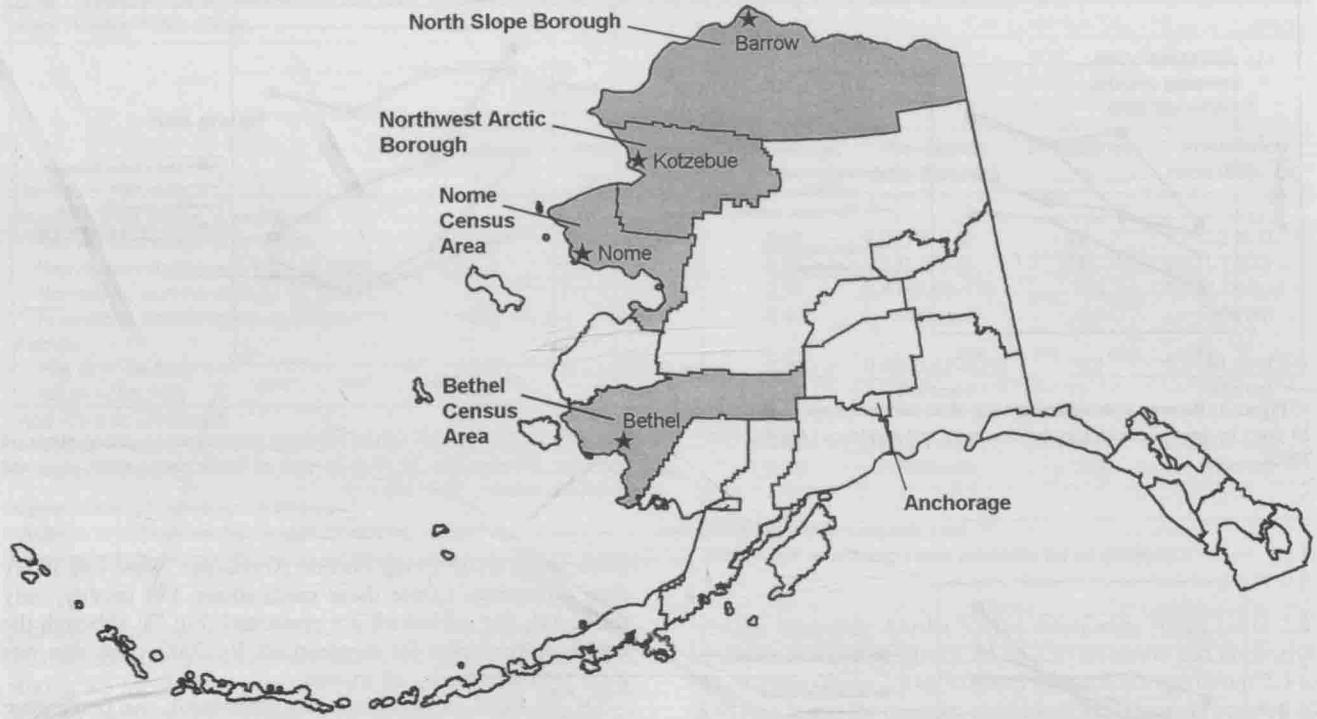

Figure 4. The 4 non-Anchorage census areas, which were predominantly Alaska Native, were each served by a regional Native Health Corporation Hospital, and had a total population of at least 5,000 (Alaska, 1999–2002).

Table 2. Asthma Prevalence Among 4 Predominantly Alaska Native Census Areas, Each Served by a Regional Hospital and With a Population of at Least 5,000 (Alaska, 1999-2002)

Census area	Asthma diagnosis and medication use		Asthma diagnosis or medication use	
	Prevalence, No. (%)	Prevalence ratio (95% CI)	Prevalence, No. (%)	Prevalence ratio (95% CI)
Nome (n = 1,110)	4 (0.36)	0.090 (0.03-0.24)	39 (3.5)	0.30 (0.21-0.41)
North Slope Borough (n = 251)	2 (0.80)	0.20 (0.05-0.80)	16 (6.4)	0.50 (0.31-0.82)
Northwest Arctic Borough (n = 818)	6 (0.73)	0.18 (0.08-0.42)	57 (7.0)	0.59 (0.45-0.77)
Bethel (n = 2,554)	102 (4.0)	Referent	304 (12.0)	Referent

Abbreviation: CI, confidence interval.

industrial pollution[3,15] as risk factors for asthma or asthma exacerbation.

However, we also found a 5- to 11-fold higher identified asthma prevalence in the Bethel area compared with the neighboring census areas despite similar demographic and sociocultural characteristics. Unlike the other census areas, Bethel was served by pediatricians throughout the study; during 1997, Bethel and several surrounding villages participated in asthma research,[16] and shortly afterward the medical staff at the regional hospital in Bethel implemented pediatric asthma case management protocols. In addition, within census areas, residence in the regional village center—the site of the regional hospital and the only site with resident physicians—was associated with a higher identified asthma prevalence. A previous study[16] found that among pediatric residents of Bethel, 10% had a self-reported physician diagnosis of asthma compared with 4% of residents of surrounding villages, with relative differences approximately consistent with the present study.

The most coherent explanation for the observed findings is the existence of substantial geographic and temporal variations in provider use of asthma as a diagnosis. For example, it is likely that children from the more rural areas of Alaska with asthmalike respiratory symptoms are less likely to receive a diagnosis of asthma. A small study[16] in western Alaska found that many children with asthmalike symptoms

Table 3. Multiple Logistic Regression Analysis Results of Risk Factors for Asthma Outcomes Among Medicaid-Enrolled In-State Residents Younger Than 20 Years Adjusted for Days of Enrollment (Alaska, 1999-2002)*

Risk group	Odds ratio (95% CI)		
	Asthma	Hospitalization among persons with asthma	Inhaled corticosteroid use among persons with asthma
Alaska Native status × residence			
Native, Anchorage	1.2 (1.1-1.4)	1.5 (1.1-2.2)	0.94 (0.75-1.2)
Native, non-Anchorage	0.60 (0.52-0.63)	2.2 (1.6-3.0)	0.89 (0.74-1.1)
Nonnative, non-Anchorage	0.77 (0.71-0.84)	1.2 (0.85-1.7)	0.84 (0.70-1.0)
Nonnative, Anchorage	Referent	Referent	Referent
Female	0.81 (0.76-0.87)	0.83 (0.65-1.0)	0.90 (0.78-1.0)
Age <5 y	1.2 (1.1-1.2)	3.7 (2.9-4.8)	1.5 (1.3-1.7)

Abbreviation: CI, confidence interval.
* Asthma is defined as the receipt of asthma-related medication and care.

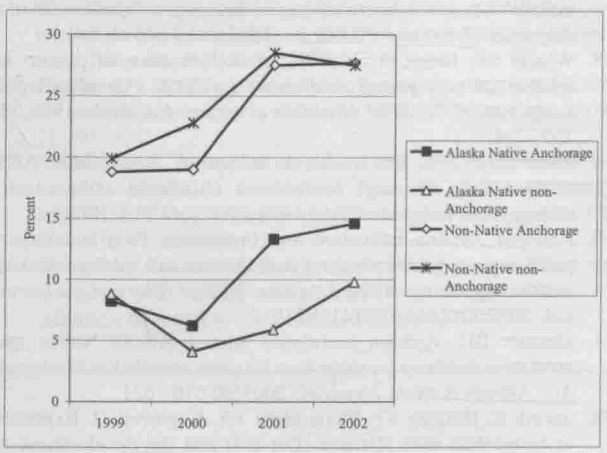

Figure 5. Persons with asthma who filled a prescription for salmeterol (either alone or in combination with fluticasone) among Medicaid recipients younger than 20 years by year of health care service, race, and residence (Alaska, 1999–2002).

did not receive an asthma diagnosis, particularly those from the smallest villages. A study[17] of Native Americans in Washington reported similar findings. Other studies[2,7] nationally have also hypothesized changes in diagnostic practices as 1 explanation for changes in asthma prevalence.

During the study, the prevalence of diagnosed asthma increased substantially. This suggests that if some children did not receive an asthma diagnosis when they actually had asthma, this problem as a whole is likely decreasing. Why this is so remains unknown, although it may be related to increased community asthma awareness after local and national education efforts. However, the data also indicate that the use of asthma as a diagnosis (and medication prescription) has been disproportionately concentrated in Anchorage. Consistent with this finding, most education efforts in Alaska have focused on Anchorage, many rural residents do not have road access to general pediatricians or other physicians, and all 3 pediatric allergy specialists in Alaska reside in Anchorage.

Failure to diagnosis asthma is likely to lead to inadequate therapy in addition to consequences such as failure to provide education about the disease and its triggers; lack of further diagnostic evaluation, such as allergy testing; and inappropriate follow-up. National guidelines produced by the National Asthma Education and Prevention Program and supported by the American Academy of Pediatrics recommend the use of inhaled corticosteroids as the basis for the management of all but the mildest forms of asthma.[3] We found that the doubling in asthma prevalence was temporally associated with a tripling in the proportion of persons using inhaled corticosteroids. Among persons with asthma, corticosteroid use also increased. It is encouraging that the large initial differences in the number of filled inhaled corticosteroid prescriptions between Alaska Natives and nonnatives had disappeared by the end of the study. Nevertheless, the mean number of filled prescriptions was less than 2 per year for all groups, an inadequate number for maintenance therapy given the standard 120 doses in an inhaler.

Inadequate inhaled corticosteroid therapy, including from failure to diagnosis asthma, poor compliance, or lack of education, has been associated with increased risk of hospitalization[18–24] and death.[25] Similarly, we found that hospitalization decreased by one third, concurrent with a 25% increase in inhaled corticosteroid use. The lack of an association between non-Anchorage Alaska Native status and corticosteroid use seems to contradict these results. However, Alaska Natives outside Anchorage tend to live in the least populated and least accessible villages, and, thus, patients and their families may have less access to the support and education necessary to improve compliance and ensure appropriate use once a prescription is filled. Other previously identified risk factors for hospitalization may also play a role, including allergen sensitization,[26–29] tobacco smoke exposure,[27] and viral infections.[29–33]

Alaska Native Anchorage residents had the most dramatic increases in asthma diagnosis and inhaled corticosteroid use

and by far the largest decrease in asthma hospitalization. During the study, the Alaska Native Medical Center in Anchorage, where most Alaska Native Anchorage residents received inpatient and outpatient care, implemented a system of advanced access whereby patients could call and receive an appointment with their primary care provider the same day.[34] Based on a transfer of ownership from the US government Indian Health Service to Alaska Native tribal organizations and a change to a client- and family-oriented service model, this system has resulted in an excess of 70% of outpatient visits being with a patient's primary provider and a decrease in emergency department visits by approximately 50%. These changes, in turn, may have created the conditions necessary for improved patient asthma education and treatment compliance. In addition, during the summer of 2000, pediatric asthma was the primary quality improvement measure implemented by the pediatric staff. Because no other Alaskan health care centers have implemented these 2 changes, it will be important to evaluate whether similar system changes elsewhere could lead to equally dramatic improvements.

National guidelines[3] suggest adding salmeterol therapy, a long-acting β_2-agonist, for persons with moderate-to-severe persistent asthma not controlled by inhaled corticosteroids alone.[10] We found that Alaska Natives were less likely to receive this medication, although it is unknown whether this decrease in prescription filling was medically appropriate. Many patients seemed to use salmeterol as a sole controller medication in the absence of inhaled corticosteroids despite this practice being contraindicated because of an increased risk of death and asthma exacerbation.[35,36] This practice decreased concurrent with the availability of a combined fluticasone-salmeterol inhaler after 2000. Nevertheless, it continues to occur, particularly among persons who do not reside in Anchorage.

We found that asthma prevalence is increasing, probably in large part because of increased diagnosis; it is unknown whether this reason explains part of the previously reported national increase in asthma prevalence.[1,2,37] At the same time, hospitalization risk has declined with more frequent inhaled corticosteroid use. Despite these positive findings, there is a need to increase education efforts and services to providers and patients in rural areas, particularly those with predominantly Alaska Native residents. Efforts should be made to increase nonphysician provider awareness of asthma as a diagnosis and patient and provider awareness of appropriate treatment. The temporal association between system changes in the clinical care of Alaska Native Anchorage residents and improved asthma indicators deserves more scrutiny to evaluate whether similar improvements could be achieved elsewhere. Ongoing surveillance efforts are needed to monitor whether interventions are successful.

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