

Prevalence of Asthma and Chronic Respiratory Symptoms Among Alaska Native Children*

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Study objectives: To quantify the prevalence and impact of chronic respiratory symptoms among predominantly Alaska Native (AN)/American Indian (AI) middle school students.

Design: School-based prevalence assessment using the International Study of Asthma and Allergy in Children survey, with supplemental video material and added questions about productive cough, exposure to tobacco smoke, and the functional impact of symptoms.

Setting: The Yukon-Kuskokwim delta region of western Alaska.

Participants: A total of 466 children in the sixth to ninth grades, 81% of whom are AN/AI (377 children).

Interventions: No study intervention.

Results: Among the 377 AN/AI children, 40% reported one of the following three categories of chronic respiratory disease: physician-diagnosed asthma, 7.4%; asthma-like symptoms (ALS) without an asthma diagnosis, 11.4%; and chronic productive cough (CPC) without asthma diagnosis or symptoms, 21.5%. Symptom prevalence differed substantially between the largest town in the region and rural villages. After an adjustment for demographic factors, exposure to environmental tobacco smoke, active tobacco smoking, and self-report of atopy, village residents were 63% less likely to have ALS ($p = 0.009$), and had a twofold greater risk of CPC ($p < 0.001$) compared to children living in the town. Children with respiratory symptoms experienced sleep disturbances and accessed clinic visits for respiratory problems more often than did asymptomatic children.

Conclusions: Chronic respiratory symptoms are very common among AN children. CPC is an important nonasthmatic respiratory condition in this population. The differing patterns of respiratory illness within this region may help to elucidate the specific risk factors for asthma and chronic bronchitis in children.
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Key words: adolescence; asthma epidemiology; child; Eskimos; North American Indian

Abbreviations: AI = American Indian; ALS = asthma-like symptoms; AN = Alaska Native; CI = confidence interval; CPC = chronic productive cough; ETS = environmental tobacco smoke; ISAAC = International Study of Asthma and Allergies in Children; OR = odds ratio; RR = relative risk; YK = Yukon-Kuskokwim

Asthma is the most common chronic disease of childhood, affecting at least 5 million children in the United States and causing significant morbidity among children of all ages.^{1–3} Worldwide, the prevalence of asthma among children has increased steadily during the last 2 decades.⁴ Considerable evidence^{5–8} indicates that regional variation exists in the prevalence of asthma and in the relative importance of risk factors. Understanding these variations is important both for local health-care endeavors and also for gaining insight into the epidemiology of asthma.

The prevalence and severity of asthma among Alaska Native (AN) and American Indian (AI) chil-

dren has been incompletely described. In the United States, urban ANs and AIs have been identified as high-risk populations due to significantly lower general health indexes than whites.^{9,10} Some studies¹¹ have suggested comparable rates of asthma in AN/AI children and the general US population. In contrast, asthma mortality among AI adults has been reported to be negligible.¹² Even so, asthma may be an emerging problem as the increase in hospitalization rates for asthma among AN/AI children has paralleled the increase described for white children.^{10,13,14}

Information regarding the prevalence of asthma and its functional impact among AN children is both timely and important. Clarifying the disease burden

among the AN/AI population is a priority of the National Institutes of Health.¹⁵ Many culturally specific asthma interventions targeting African-American and Hispanic children have been initiated.^{16–19} Yet, it is unclear whether similar culturally specific interventions focused on AI/AN children are warranted.

Children from the Yukon-Kuskokwim (YK) delta region of southwestern Alaska are predominantly Yup'ik Eskimo. Culturally,²⁰ linguistically,²⁰ and by relatedness of genetic markers,²¹ AN residents of the YK delta are more similar to other coastal Eskimo (also called Inuit) populations in northeastern Siberia and northern Canada than to inland ANs/AIs. The YK delta is 258,000 square kilometers of subarctic tundra that contain one large town, Bethel, which serves as the hub of local commerce and health care. The population is approximately 25,000, with 5,600 people living in Bethel and the remaining 75% of the population living in rural villages.²²

Several factors that are highly prevalent in the region may predispose Yup'ik children to acquire asthma, including crowded housing conditions, low income levels, and frequent exposure to environmental tobacco and wood-burning stove emissions.^{10,22–24} Children from the YK delta also experience extremely high rates of acute lower respiratory tract infections, which may contribute to the development of chronic airway disease, particularly in AN/AI children.^{24–34} Yup'ik children also have high rates of postinfectious bronchiectasis.^{35,36}

The YK delta also has characteristics that may protect children from acquiring asthma. Exposure to

concentrated industrial or motor vehicle emissions is rare. Exposure to allergens is thought to be uncommon, given the subarctic climate.²⁹ Unlike many urban poor populations, AN children have access to an integrated health-care system, which initially was established by the Indian Health Service and is maintained by a native corporation.

This study seeks to define the prevalence of diagnosed asthma and chronic respiratory symptoms associated with asthma and chronic bronchitis among middle school students in the YK delta region of Alaska. It examines the significance of these conditions by describing the severity and functional impact of the symptoms and explores potential risk factors for chronic respiratory symptoms among AN/AI students.

MATERIALS AND METHODS

Design and Study Population

Students in grades 6 to 9 in three communities in the YK delta region of Alaska completed the International Study of Asthma and Allergies in Children (ISAAC) written survey with accompanying video³⁷ in school in the fall of 1997. The three communities represent two distinct life styles: a town that is the regional center, and two rural coastal villages. The three communities comprise > 25% of the population of the region.

Families were notified of the study by mail, and parents provided passive consent prior to participation in the study. Testing was confidential but not anonymous so that students with positive responses could be referred for medical evaluation and care. Approval was obtained from the University of Washington Human Subjects Review Board, the Yukon-Kuskokwim Delta Regional Health Corporation, the Lower Yukon School District, and the tribal councils of the villages.

The survey employed was developed by the ISAAC Steering Committee.³⁷ In conjunction with the written survey, the ISAAC video was shown, depicting five scenarios of asthma symptoms.^{38,39} The videotaped scenarios of asthmatic symptoms helped to avoid confusion about culturally specific words and allowed cross-cultural comparisons of prevalence.⁴⁰ Positive responses have been shown to correlate with bronchial hyperreactivity, as measured by the response to methacholine or hypertonic saline solution inhalation.^{38,40,41}

In order to identify students with nonasthmatic chronic respiratory symptoms, a question was added asking “do you spit up mucus”? Response options were as follows: “no”; “occasionally”; and “yes.” Productive cough in the absence of wheeze or shortness of breath was considered to be uncharacteristic of asthma and a possible indicator of chronic airway irritation or infection (*eg*, bronchitis). This is the first time that this question has been used for symptom surveillance. Although the question has not been previously validated, it draws on language that is commonly used in clinical practice in the region to describe chronic productive cough (CPC). The purpose of this question was to identify symptomatic children who would not otherwise be captured by the standard ISAAC questions. Acknowledging the extensive validation data for the ISAAC questions, in our scoring scheme the ISAAC questions were given precedence over the question about productive cough. Therefore, children reporting

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both asthma (or asthma-like symptoms [ALS]) and productive cough were considered to have asthma, although the overlap is reported below.

Students were asked to “estimate the amount of time that you are around tobacco smoke” to assess exposure to environmental tobacco smoke (ETS), and about their own smoking behavior. Previous studies^{42,43} have shown that parental reporting of ETS exposure in the home correlates well with measured cotinine levels in the urine and hair of children. Exposure to ETS, as measured by these questions, has been shown to be significantly associated with both current wheezing and physician diagnosis of asthma in elementary school students.⁴⁴ Validated questions about the influence of respiratory symptoms on daily function and health-care resource use also were added.⁴⁵ Surveys were administered to classrooms of children who watched the ISAAC video together and completed the written survey individually.

Analysis

Definitions: Students provided up to three responses describing their ethnicity. Students reporting any AN or AI heritage were categorized as AN/AI, while students who did not include AN/AI in any of their answers were categorized as “non-native.” Most analyses were limited to those children reporting AN/AI heritage. Exposure to ETS was analyzed as a dichotomous variable, with *high exposure* defined as “several hours per day” and *low exposure* defined as “little or none.” *Active smoking* was defined as having smoked at least one cigarette within the last 30 days.

Potential atopy was defined as a self-report of “a problem with sneezing, or runny, or blocked, or stuffed nose in the absence of a cold or the flu,” occurring within the last 12 months, accompanied by itchy-watery eyes. In order to avoid any misclassification that might arise if children had difficulty distinguishing rhinitis symptoms with and without infection, we chose a more stringent definition of atopy that required both rhinitis and conjunctival symptoms.

Students were categorized into four mutually exclusive diagnostic groups based on clinical symptoms and a doctor diagnosis of asthma. Students were classified as having asthma if they had ever received a diagnosis by a physician. Students were categorized as having ALS if they had reported wheezing in the last 12 months or had experienced at least three of the five video scenarios in the last 12 months but had never received a diagnosis of asthma.³⁸ Students who did not satisfy the criteria for asthma or ALS but reported mucus expectoration occurring more than occasionally were categorized as having CPC. Students without these symptoms were categorized as “asymptomatic.”

Statistical Analysis: The χ^2 test and Fisher exact test were used for assessing unadjusted associations among categorical variables. Analysis of variance was used to test for differences between group means of continuous variables. Multinomial (polytomous) logistic regression was used to test the significance of the association between independent potential risk factors and each clinical symptom category, with the asymptomatic group as the common reference group.⁴⁶ In general, cases with missing covariate data were excluded from the latter analysis.⁴⁷ However, because a large number of children (AN/AI, 78 children; non-native, 45 children) skipped the question on active smoking, and, because responders differed demographically from nonresponders, active smoking was modeled as the indicator variables smoker/nonsmoker/no response.

Odds ratios (ORs) overestimate relative risk (RR) when an outcome is not rare, therefore, ORs and their confidence intervals (CIs) were converted to corrected prevalence ratios, which better estimate RR, using the method described by Zhang and Yu.⁴⁸ This correction was applied when the prevalence of the

outcome was $> 10\%$ and the OR from the multivariable logistic models was > 2.5 or < 0.5 . Corrected estimates are indicated in the text as RRs. The Pearson correlation coefficient was used to assess covariate collinearity. Analyses were performed using statistical software packages (SPSS, version 10.0; SPSS, Inc; Chicago, IL; and Stata, release 6.0; StataCorp; College Station, TX).

RESULTS

Of 605 eligible students, 466 students (77%) completed the questionnaire and are included in the analysis. Reasons for nonparticipation included the following: class not available to conduct the survey (99 students); parental or student request (25 students); or absence from school (15 students). The proportion of children from each community reflected the relative size of these communities, as follows: 279 students (60%) were from the town; 119 students (25%) were from village A; and 68 students (15%) were from village B. Sixty students (13%) identified two ethnic backgrounds. Nine students did not report ethnicity and were excluded from those analyses dependent on ethnicity information. Eighty-one percent of students (377 of 466 students) identified themselves as AN/AI, which is similar to the rate of 85% reported for the region in the 1990 US census enumeration.⁴⁹ Of those students living in the town, 72% were AN/AI, whereas 98% of those living in the villages reported AN/AI heritage. Of the students who identified a tribal affiliation (136 students), 90% reported that they were Yup'ik. Eighty students reported an ethnicity that was not AN/AI, of which 75% identified themselves as white, 15% as “other,” 4% as African American, 4% as Asian-Pacific Islander, and 1% as Hispanic.

The AN/AI cohort had equal proportions of girls and boys, and was evenly divided among grade levels. The mean ($\pm$ SD) age was 13.3 ± 1.4 years (age range, 10 to 18 years). Students in the town had a different distribution of gender and active smoking than those living in the villages (Table 1), but were not different in the proportion of children with potential atopy or of those exposed to ETS. While there was some overlap between children reporting high exposure to ETS and active smoking, this was limited enough ($r = 0.30$) to allow for the continued analysis of both variables.

Prevalence of Self-Reported Respiratory Symptoms Among AN/AI Students

Among the 377 students who identified themselves as AN/AI, 40% reported chronic respiratory symptoms. Twenty-eight students (7.4%) reported they had received the diagnosis of asthma from a physician. Thirteen of the 28 children with a physician diagnosis of asthma reported that they had

Table 1—Characteristics of AN/AI Survey Respondents by Location of Residence in a Town or Village*

Characteristics	Town (n = 199)	Villages (n = 178)	Overall (n = 377)	p Value
Female gender	46	63	54	< 0.05
Age, yr				NS
≤ 11	16	21	19	
12	26	25	25	
13	28	18	23	
≥ 14	30	36	33	
ETS exposure†				NS
Never or very little	55	53	54	
Occasionally	31	30	30	
Several hours per day	14	17	16	
Active smoking†	27	41	34	< 0.05
Potential atopy	12	16	13	NS

*Values given as %, unless otherwise indicated. NS = not significant at the $p = 0.05$ level.

†Percentages are calculated based on valid responses, as follows: 23 students did not report ETS exposure; 123 students did not report smoking status (96 from the town, 27 from the villages).

wheezed in the last 12 months. An additional 43 children (11.4%) had reported ALS in the last year but had not received a physician diagnosis of asthma.

Expectorating mucus was common in this AN/AI population, with 114 students (30%) reporting this symptom as occurring more than occasionally. Of those reporting frequent mucus expectoration, 9 students (8%) had received a diagnosis of asthma and 24 students (21%) had ALS. Eighty-one students (71% of those with expectoration; 21.5% of the AN/AI survey population) did not fall into the previous two categories and were considered to be a separate symptom group (*ie*, CPC). A total of 225 students (60%) were asymptomatic.

Among the subgroup of non-native students in our survey (89 students), the prevalence of diagnosed

asthma and of ALSs without a doctor diagnosis was similar to that of AN/AI students (11% and 17%, respectively). However, the prevalence of CPC was significantly lower ($p < 0.001$), as it was reported by only six of the non-native children (7%). The remaining 58 children (65%) were asymptomatic.

Of the AN/AI students, 95 students (25%) reported having a problem with sneezing, or having a runny, blocked, or stuffed nose in the absence of a cold or flu within the last 12 months. Fifty-one of these children (14%) reported this difficulty in association with itchy-watery eyes and were considered to be potentially atopic. Frequencies among non-native students were similar (29% and 10%, respectively).

Risk Factors Associated With Clinical Symptoms Among AN/AI Students

Among AN/AI students, clinical symptom category was significantly associated with age and location of residence, but not with gender (Table 2). Students with ALS were slightly older than students in other clinical groups. There was a dramatic difference in prevalence rates by location of residence. Residents in the villages were less likely to have asthma or ALS, and were more likely to have productive cough. In the villages, the prevalence of asthma was 4%, of ALSs was 7%, and of CPC was 34%. In contrast, for residents of the town, the prevalence of asthma was 10%, of ALS was 16%, and of productive cough was 11%.

High ETS exposure ($p = 0.005$) and active smoking behavior ($p < 0.001$) were both significantly associated with clinical symptom status. Those children with asthma and ALS reported the highest rates of ETS exposure for several hours per day. Students with ALS and productive cough were disproportion-

Table 2—Unadjusted Association of Student Characteristics With Clinical Symptom Categories Among AN/AI Respondents (n = 377)*

Characteristics	Clinical Categories			
	Active Asthma (n = 28)	ALSs (n = 43)	CPC (n = 81)	No Symptoms (n = 225)
Female gender	54	59	58	51
Age, yr	13.3 (1.4)	13.8 (1.7)†	13.4 (1.7)	13.3 (1.4)
Residence in village	29	28	74‡	44
High exposure to ETS§	28%†	33%‡	15	11
Active smoker				
Yes (n = 113)	14	47‡	38†	20
Unknown (n = 123)	18	30‡	12	22
Potential atopy	11	33‡	16	9

*Values given as % or mean (SD).

† $p \leq 0.05$.

‡ $p \leq 0.01$ compared to asymptomatic.

§Twenty-three students did not report ETS exposure.

ately more likely to report active smoking (Table 2). Those not answering the active smoking question did not differ from question responders in the prevalence of any symptom category (data not shown), but children with ALS were more likely than children in the asymptomatic group not to respond (Table 2).

Atopy was associated with clinical symptom status as well ($p = 0.001$). The highest proportion of potential atopy was seen among students with ALS (33%). Comparatively few students with diagnosed asthma (11%) reported atopy.

Adjusted estimates of risk for respiratory symptoms were obtained by entering all of the surveyed risk factors into a multivariate polytomous regression model (Table 3). In the multivariate analysis, only high ETS exposure was identified as a statistically significant predictor of physician-diagnosed asthma (RR, 3.9; 95% CI, 1.4 to 11.0), although the wide CIs suggest an unstable estimate due to small numbers. In contrast, several independent risk factors for ALS were identified. Compared to the reference group of children with no symptoms, strong positive associations were seen with potential atopy (RR, 3.9; 95% CI, 1.8 to 5.3), high ETS exposure (RR, 2.8; 95% CI, 1.4 to 4.7), and active smoking (RR, 3.2; 95% CI, 1.5 to 5.4). In addition, the risk for ALS was > 2.5 times higher for residents of the town than for residents of the villages (RR, 2.7; 95% CI, 1.3 to 5.9). In contrast, the risk of CPC was elevated twofold in residents of the villages compared to residents of the town (RR, 2.2; 95% CI, 1.5 to 2.9). After adjustment for the other factors in the model, age, gender, AN/AI ethnicity, ETS exposure, active smoking, and atopy were not independent risk factors for productive cough.

To investigate the stability of the risk factor associations, several other models also were examined (not shown). Expanding the analysis to all 466 students who answered the survey and including ethnicity as a covariate in the model did not substan-

tively alter any of the associations identified for ALS or productive cough. However, in this model high ETS was no longer significantly associated with asthma. Restricting the model to the students who answered the active smoking question or removing active smoking/unknown smoking status from the model did not appreciably change risk estimates or CIs for the associations described above. Modeling self-report of allergic rhinitis (*ie*, sneezing, runny, blocked, or stuffy nose in the absence of a cold or flu occurring in the last 12 months) instead of atopy did not alter the associations in the original model, although allergic rhinitis also became significantly associated with diagnosed asthma.

Impact of Respiratory Symptoms

Questions designed to measure the impact of the reported respiratory symptoms in the 12 months prior to the survey are listed in Table 4. Sixty-one students (16%) reported sleep disturbances due to wheezing or cough, and 11 of them reported that this occurred at least once per week. Students in each of the three symptom categories were more likely than asymptomatic students to report any respiratory-related sleep difficulties (children with asthma: RR, 5.9; 95% CI, 2.4 to 14.7; children with ALS: RR, 4.2; 95% CI, 2.6 to 5.9; and children with productive cough: OR, 2.4; 95% CI, 1.2 to 5.0). Thirty-two children (9%) experienced activity limitation due to wheezing, coughing, or breathing difficulties. Seventeen students (5%) had wheezed severely enough to limit speech to one or two words between breaths. Speech limitation was associated with ALS ($p = 0.043$), and showed a trend toward a relationship with asthma ($p = 0.056$) and productive cough ($p = 0.080$). Respiratory symptoms resulted in missed school one or more times per month for 16 students (5%). Twenty-two children (6%) stated that they had made two or more visits to a doctor in the

Table 3—Comparison of AN/AI Students With Asymptomatic Children for Each Clinical Category From Multivariate Polytomous Regression Analysis*

Variables	Clinical Category		
	Asthma	ALS	CPC
Female gender	1.15 (0.48–2.73)	1.70 (0.80–3.63)	1.08 (0.61–1.88)
Age (years)	0.94 (0.67–1.32)	1.10 (0.86–1.41)	0.98 (0.81–1.18)
Residence in a village	0.43 (0.16–1.12)	0.37 (0.17–0.79)‡	2.19 (1.52–2.89)‡
High ETS exposure	3.90 (1.38–11.00)†	2.76 (1.37–4.70)‡	1.17 (0.53–2.56)
Active smoking	0.60 (0.17–2.16)	3.17 (1.50–5.39)‡	1.61 (0.82–3.17)
Unknown smoking status	0.67 (0.21–2.15)	2.87 (1.36–4.99)‡	0.68 (0.30–1.58)
Potential atopy	1.37 (0.36–5.17)	3.86 (1.78–5.32)‡	1.36 (0.61–3.03)

*Values given as RR (95% CI).

† $p < 0.05$.

‡ $p < 0.01$.

Table 4—Impact of Respiratory Symptoms in the Last 12 Months Among AN/AI Respondents (n = 377)

Impact Characteristics	No.	% of Total
Attacks of wheezing, No.		
1–3	38	27
4–12	7	5
> 12	5	4
Sleep has been disturbed by wheezing or cough		
< 1 night/wk	50	13
≥ 1 night/wk	11	3
Activities limited by wheezing, dry cough, or breathing difficulties		
< 1 d/wk	25	7
≥ 1 d/wk	7	2
Speech has been limited to one to two words between breaths	Yes	17
Missed school due to wheezing, cough, or breathing difficulties, d		
< 1 per mo	26	7
1–3 per mo	11	3
≥ 1 per wk	5	2
Visits to the doctor for wheezing, dry cough, breathing difficulties, No.		
1 visit/yr	67	18
≥ 2 visits/yr	22	6
Visits to an emergency department due to wheezing, dry cough, or breathing difficulties, No.		
1 visit/yr	17	5
≥ 2 visits/yr	11	3

last year, and 28 children (8%) reported at least one emergency department visit due to wheezing and/or breathing difficulties. Students in all three symptom groups were more likely than asymptomatic children to go to a doctor for breathing issues two or more times per year, but only the children with asthma and ALS were more likely to go to the emergency department for breathing issues.

DISCUSSION

Chronic respiratory conditions are common among Yup'ik adolescents living in the YK delta region of Alaska. This study is one of only a few descriptions of asthma prevalence among AN and AI children using standardized methodology, and is the first to describe the prevalence of CPC.^{11,12,14,50} Forty percent of the AN/AI children studied reported chronic respiratory symptoms. Nineteen percent of respondents reported either a physician diagnosis of asthma or symptoms consistent with asthma. An additional 21% of respondents reported productive cough occurring more than occasionally, distinct from asthma or ALS. The prevalence of respiratory conditions varied dramatically by location

within the YK delta, with lower prevalence of ALS and a higher prevalence of CPC in the villages compared to the town. Not surprisingly, tobacco exposure was identified as an important, potentially modifiable, risk factor for respiratory disease. High passive exposure to ETS was strongly associated with asthma and ALS, and active smoking was an additional risk factor for ALS and productive cough. These respiratory conditions were severe enough to cause school absence at least once a month for 5% of students and to trigger an emergency department visit for 8% of students within the last year.

It is helpful to interpret the YK prevalence figures in the context of reports of asthma prevalence among other populations. Recently, the ISAAC Steering Committee⁷ published data on the self-reported prevalence of asthma and asthma symptoms by children 13 to 14 years old from selected areas of 56 countries. The prevalence of “ever having asthma” ranged from < 2 to 28% between countries. Urban American and Canadian children both reported a 17% prevalence of “ever having asthma.” Similarly, the self-reported prevalence of wheeze in the last 12 months (including those with diagnosed asthma) ranged worldwide from 2 to 32%, with a prevalence in the United States of 22%. A more appropriate comparison may be to Inuit primary school children in northern Quebec, who have been reported to have a 6% prevalence of “wheeze in the last 12 months.”²⁹ In the YK delta, the prevalence of asthma and ALS among town residents is similar to those of urban US and Canadian populations, while village residents had a relatively low prevalence of asthma and ALS, which is more similar to other circumpolar Native populations.

The difference in the prevalence of asthma and ALS within the YK delta opens interesting questions about the source of this variation. The reduced prevalence of diagnosed asthma in the YK villages could be due to differential access to care or to different diagnoses of clinical symptoms by village health-care providers compared to physicians in Bethel. However, this would not explain the lower prevalence of self-reported ALS in the villages. It is possible that some aspect of village life, such as early viral respiratory infections or exposure to bacterial components such as endotoxin, is protective against the development of asthma and ALS. Alternatively, different environmental conditions, such as allergen exposure, in Bethel may predispose children to develop asthma. A more detailed understanding of these populations and their environments is needed to explain this difference in prevalence within the YK delta.

A striking and unexpected finding of this survey was the large number of students with CPC and the

predominance of this symptom among village residents. It is not clear what medical diagnoses are represented in this group. Possible etiologies of chronic mucus production include chronic bronchitis, chronic sinusitis, and/or bronchiectasis. It is unlikely that children with cough-variant asthma were included in this category because only students who did not report asthma or ALS were eligible to be categorized as having CPC. We identified 33 children who both met the criteria for one of the asthma groups (*ie*, physician-diagnosed asthma or ALS) and reported productive cough occurring more than occasionally. When this overlap occurred, we elected to assign those students to the asthma category, based on the prior literature validating the ISAAC questions for this purpose. However, it is unknown whether the ISAAC questions are able to distinguish asthma from other chronic respiratory conditions when they are highly prevalent, such as the situation seen with CPC in the YK delta. This potential source of misclassification would cause our data to overestimate the prevalence of asthma and ALS, and to underestimate the prevalence of CPC.

The entity of CPC of childhood, which is distinct from asthma or other underlying medical disease, has been described previously in the setting of a Canadian pediatric pulmonary practice.⁵¹ Within this referral population, children with “pediatric chronic bronchitis” differed from asthmatic patients both in clinical features (*ie*, lack of diagnostic criteria for asthma, younger age at presentation, absence of hyperinflation on a chest radiograph, and presence of streaky or patchy densities on a chest radiograph) and in demographic characteristics (*ie*, female gender, native ethnicity, negative family history of asthma or eczema, history of hospitalization in infancy for pneumonia, and having a mother who smoked). Our data support the assertion of Sear and Wensley⁵¹ that pediatric chronic bronchitis exists as a distinct entity and that it may be a common problem among AN adolescents. Interestingly, 20% of the Inuit children in the study by Hemmelgarn and Ernst²⁹ in northern Quebec reported chronic cough. While these authors did not characterize this subgroup of children with chronic cough in depth, they do note an extremely high prevalence of active smoking (32%) in the general population of primary school children (age range, 6 to 13 years).²⁹ More study is needed to clarify the specific diagnoses represented in our group of children with chronic expectoration, but, in light of the high prevalence of otitis media, bacterial pneumonia, and bronchiectasis in this population, we think that these children clinically have nonatopic chronic bronchitis.

Although many health-care studies do not specify the tribal heritage of participants, it is important to

recognize that there is great heterogeneity within the ethnic category of AN/AI. The US government recognizes 562 different tribal groups that are geographically spread throughout Alaska and the lower 48 states, with almost 600 additional First Nation bands recognized by the Canadian government.²⁰ Some studies⁵² have shown heterogeneity of risk for diabetes within the AN/AI ethnic grouping, stressing the importance of the regional and/or tribal assessment of prevalence and risk factors for chronic disease. While we have incomplete information on the tribal affiliations of the students in this study, the demographics of the region, combined with the predominance of Yup'ik heritage among those students who did identify a tribal heritage, suggest that the variation in the prevalence of chronic respiratory conditions identified in this study is not explained by tribal heterogeneity within the YK delta.

The results of this survey should be interpreted in the context of the 77% participation rate. Although the rate of participation in this study is similar to a 72% rate observed in a large school-based study in California,⁵³ selection bias could have occurred if participation varied by specific symptom group. For example, if children were absent from school due to a chronic respiratory illness, these results would underestimate the prevalence of symptomatic children. It is possible that the villages selected for study were not representative of the other villages in the region. Yet, the fact that nearly a quarter of the sixth to ninth grade enrollees of the entire YK school district were surveyed (466 of 1,912 enrollees) enhances the ability to generalize to the regional population.

In summary, 40% of AN students in grades 6 to 9 reported chronic respiratory illness, with a large proportion reporting CPC. Productive cough is particularly common in the rural villages, where 34% of students reported this symptom. The burden of CPC includes interrupted sleep, which may potentially affect school performance and increase health-care utilization, and warrants individual medical evaluation and further population study. If a large proportion of those students with ALS have undiagnosed asthma, then the prevalence of asthma in the YK delta approaches levels that are more commonly seen in heavily urbanized environments. The group of children with ALS should be evaluated for the diagnosis of asthma to determine whether they would benefit from asthma care. Smoking prevention and cessation interventions targeting middle-school students may help to reduce the frequency of ALS. Further investigation of the differences in the distribution of symptoms within the YK region may offer insights into the relative role of environmental

and infectious exposures in the development of respiratory disease, and may suggest potential avenues for prevention.

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