Original Article

Prevalence of Asthma in School Children on the Arizona-Sonora Border

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What is already known about this topic? Population-based studies have previously shown that Mexican-born children living in the United States have a lower prevalence of asthma than children not born in Mexico. However, the causality of this remains unclear.

What does this article add to our knowledge? Using the International Study of Asthma and Allergy in Children questionnaire, we found a significantly higher prevalence of asthma in school children of Mexican descent in Arizona, compared with those in Sonora, Mexico, despite proximity and common ancestry.

How does this study impact current management guidelines? This difference in asthma prevalence may be attributable in part to environmental influences. Understanding these differences may identify modifiable risk factors for asthma.

BACKGROUND: Mexican-born children living in the United States have a lower prevalence of asthma than other US children. Although children of Mexican descent near the Arizona (AZ)-Sonora border are genetically similar, differences in environmental exposures might result in differences in asthma prevalence across this region.

OBJECTIVE: The objective of this study was to determine if the prevalence of asthma and wheeze in these children varies across the AZ-Sonora border.

METHODS: The International Study of Asthma and Allergy in Children written and video questionnaires were administered to 1753 adolescents from 5 middle schools: Tucson (school A), Nogales, AZ (schools B, C), and Nogales, Sonora, Mexico (schools D, E). The prevalence of asthma and symptoms was compared, with analyses in the AZ schools limited to self-identified Mexican American students.

RESULTS: Compared with the Sonoran reference school E, the adjusted odds ratio (OR) for asthma was significantly higher in US schools A (OR 4.89, 95% confidence interval [CI] 2.72-8.80), B (OR 3.47, 95% CI 1.88-6.42), and C (OR 4.12, 95% CI 1.78-9.60). The adjusted OR for wheeze in the past year was significantly higher in schools A (OR 2.19, 95% CI 1.20-4.01) and B (OR 2.67, 95% CI 1.42-5.01) on the written questionnaire and significantly higher in A (OR 2.13, 95% CI 1.22-3.75), B (OR 1.95, 95% CI 1.07-3.53), and Sonoran school D (OR 2.34, 95% CI 1.28-4.30) on the video questionnaire compared with school E.

CONCLUSIONS: Asthma and wheeze prevalence differed significantly between schools and was higher in the United States. Environmental factors that may account for these differences could provide insight into mechanisms of protection from asthma. © 2016 American Academy of Allergy, Asthma & Immunology (J Allergy Clin Immunol Pract 2016;■:■-■)

Key words: *Asthma; Bacterial Load; Environment; Mexican Americans; Socioeconomic Factors; Wheezing*

Asthma is a chronic disease for which an individual's early life exposures may be critically important as preventive or modulating factors.[1] Although the prevalence of asthma in Hispanic children across the United States is similar to the prevalence of

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Conflicts of interest: T. F. Carr has received consultancy fees from Aimmune National Advisory Board; has provided expert testimony for the law offices of Joel L. Herz; and has received lecture fees and payment for manuscript preparation from the North American Rhinology and Allergy Conference. P. I. Beamer has received research support from the National Institutes of Health (NIH), Sonoran Environmental Research Institute and Enviromental Protection Agency. L. B. Gerald has received research support from HRSA/MCHB. Y. O. Van Horne has received research support from the NIH T32 (# ES007091). D. Vercelli has received research support from Johnson & Johnson (UA009253-0001). F. D. Martinez has received consultancy fees from Copeval; and has received research support from the NIH/National Heart Lung and Blood Institute (HL098112, HL09501, HL064307, HL30045, and HL0981889, HL056177), NIH/National Institute of Environmental Health Sciences (ES006694), and Johnson & Johnson (UA009253-0001). A. L. Wright has received research support from the NIH and has received fees for participation in review activities from NIH. The rest of the authors declare that they have no relevant conflicts of interest.

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Abbreviation used
ISAAC- International Study of Asthma and Allergy in Children

asthma in non-Hispanics, there is variability among Hispanics, with the risk of asthma in children of Mexican descent being very low compared with other subgroups.[2-5] Evidence supports an effect of nativity on this risk.[6] Children who were born in and emigrated from Mexico have been shown to have a lower prevalence of asthma than Mexican American children born in the United States.[6-11] Degree of acculturation, age of immigration to the United States, immigrant generation, and duration of time lived in the United States have all been associated in a dose-dependent manner with the prevalence of asthma.[9,12-15] Much of this prevalence data, however, is acquired through national surveys. In contrast, cross-sectional analyses of socioeconomically distinct but geographically and ethnically similar regions can provide unique insight into the impact of social and economic factors on disease prevalence.[16]

The US-Mexico border spans more than 3000 km, with the "border region" extending 100 km on each side of the border, as defined by the La Paz Agreement. Most of the region's population reside in 14 city pairs straddling the border, one of which comprises the sister cities of Nogales, Arizona, USA, and Nogales, Sonora, Mexico. Once a large shared city and environment where people easily traversed the US-Mexico border, this region has gradually separated into discrete cities following the adoption of stricter border controls. Nogales, Sonora, is the larger city, housing 90% of the region's population (approx. 241,129). Although the population of Nogales, Arizona, is 95% Hispanic, societal infrastructure is consistent with US standards and contrasts with that of Sonora in sanitation, access to clean drinking water, access to health care, and traffic density. The extent to which the border partition has impacted disparities between the environments, populations, and disease prevalence is not yet clear.[17] Tucson, Arizona, is located approximately 110 km north of Nogales, Arizona, along the Interstate 19 corridor. Although the general population of Tucson is reported to be 41.6% Hispanic,[18] some census tracts within Tucson are more than 90% Hispanic.

We hypothesized that as a result of environmental and/or social differences in these areas, the prevalence of asthma is lower in Sonora than in Arizona, and that these differences would be detected across this region, despite the proximity of the areas studied. We therefore sought to compare the prevalence of asthma and asthma symptoms among middle school aged children in 3 cities within this unique border location: Tucson, Arizona; Nogales, Arizona; and Nogales, Sonora, Mexico.

METHODS

We conducted a cross-sectional study of asthma and asthma symptoms among adolescents from 5 schools near the US-Mexico border: 1 school in Tucson, Arizona (school "A"), 2 in Nogales, Arizona (schools "B" and "C"); and 2 in Nogales, Sonora (schools "D" and "E") (Figure 1). The Arizona schools were chosen for the high proportion of Hispanic children. The schools in Sonora were chosen to represent children from higher (school D) and lower (school E) socioeconomic status. Characteristics of each school are shown in Table I. To capture students in the 13- to 14-year-old age range, seventh and eighth grades were invited to participate. Parental consent was obtained through forms or school-facilitated opt-out notifications, and a statement of assent read before questionnaires were distributed. Surveys were completed during a 4-week span in late spring 2015, during a single school day for each school, except for the Tucson school, which was surveyed over 2 days. Study documents were translated by a professional translator familiar with regional Spanish from English to Spanish, and then backtranslated by our bilingual study staff and investigators. The study was approved and monitored by the University of Arizona Human Subjects Protection Program.

Written questionnaire

Survey questions were taken directly from the International Study of Asthma and Allergy in Children (ISAAC), a questionnaire to assess asthma prevalence that has been validated in multiple populations around the world.[19-23] Children were asked to report if they "ever had asthma," "ever had wheezing or whistling in the chest," and "wheezing in the past 12 months." Subjects also recorded age, gender, and primary language spoken at home. In US schools, questionnaires were offered in both English and Spanish. In Mexican schools, questionnaires were offered in Spanish.

Video questionnaire

The ISAAC video questionnaire was administered to all participants. Students were instructed to watch 5 separate scenarios depicting asthma symptoms. After each scene, the students were instructed to answer the corresponding question of whether they have had these symptoms, and whether and how frequently the symptoms occurred in the past 12 months. Wheeze was defined based on responses to the first scenario, which depicts a person wheezing at his or her desk. Questions were asked in English in Arizona schools and Spanish in Sonora.

Dust collection

Dust sampling methods are reported in this article's Online Repository at www.jaci-inpractice.org.

Bacterial DNA extraction and quantitation

Bacterial DNA extraction and quantitation methods are reported in this article's Online Repository at www.jaci-inpractice.org.

Statistical methods

Demographic characteristics by school were compared by Fisher's exact test and one-way analysis of variance. Differences in asthma prevalence and reported wheeze were initially compared across schools by Fisher's exact test. We then calculated odds ratios for asthma and wheeze using mixed-effects logistic regression models to adjust for age and gender, and to control for within class-period correlation. The strength of agreement between written and video questionnaires was assessed by kappa coefficient, defined as follows[24]: poor (<0.20), fair (0.21-0.40), moderate (0.41-0.60), good (0.61-0.80), or very good (0.81-1.0). Statistical significance was defined as $P < .05$. All tests were performed using Stata version 10.0 (StataCorp, College Station, Tex).

RESULTS

A total of 1753 students participated in this survey. Participant characteristics are presented in Table II. A high proportion of students from Arizona schools self-identified as Hispanic of Mexican origin (Table II). All participants in Mexico were assumed to be Hispanic of Mexican origin. As our hypothesis focused on students of Mexican origin, all further analyses