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# Asthma Prevalence in Hispanic and Asian American Ethnic Subgroups: Results From the California Healthy Kids Survey

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## ABSTRACT

**OBJECTIVES.** Asthma prevalence for different ethnic groups in the United States, beyond white, black and Hispanic, is seldom reported. We compared the prevalence of asthma diagnosis among various Hispanic and Asian American ethnic subgroups using data collected from the school-based California Healthy Kids Survey.

**METHODS.** The California Healthy Kids Survey was administered to 462 147 public school students in the seventh, ninth, and 11th grades throughout California during the 2001–2002 and 2002–2003 school years. Prevalence of lifetime asthma diagnosis was calculated for 11 Asian American Pacific Islander subgroups and 8 Hispanic subgroups.

**RESULTS.** Asthma prevalence among Hispanic subgroups ranged from 13.2% for Mexican American students to 22.8% for Puerto Rican students and 23.0% among Cuban American students. Lifetime asthma diagnosis among the 11 Asian American Pacific Islander subgroups ranged from 10.9% among Korean American students to 23.8% among Filipino American students.

**CONCLUSIONS.** The survey revealed substantial variation in asthma prevalence between the different Hispanic and Asian American Pacific Islander subgroups and that Pacific Islanders, Filipinos, Cubans, and Puerto Ricans are at elevated risk for asthma. Differences in the distributions of characteristics related to country of birth, residential history, generational status, and/or degree of acculturation might account for much of the observed differences in asthma prevalence between ethnic subgroups. Previous asthma prevalence estimates for Asians or Hispanics are in part a function of the particular ethnic composition of the population under investigation. We suggest that asthma studies that include a substantial number of Asian Pacific Islander and Hispanic persons use a more detailed categorization of race/ethnicity.

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### Key Words

asthma, prevalence, Hispanic, Latino, Asian, Pacific Islander, ethnicity, race

### Abbreviations

CHKS—California Healthy Kids Survey  
CDE—California Department of Education  
API—Asian or Pacific Islander  
CI—confidence interval  
OR—odds ratio

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**A**STHMA PREVALENCE VARIES considerably between countries, as well as between different populations within countries.<sup>1-3</sup> Interactions among genetic, environmental, and social factors have been postulated to explain the observed differences in asthma prevalence. In the United States, the prevalence of asthma diagnosis is generally higher in blacks than in whites or Hispanics (with the exception of Puerto Ricans).<sup>2</sup> These major socially constructed racial and ethnic categories are usually treated as homogeneous populations because of convention or sample-size considerations. Although some reports indicate that asthma prevalence among Puerto Ricans in the United States is 2 to 3 times higher than among Mexican Americans, little is known about asthma prevalence in other Hispanic populations.<sup>4</sup> Asthma prevalence for Asian Americans as a whole, much less specific Asian American ethnic subpopulations, is seldom reported. Persons of Hispanic or Asian ancestry constitute ~16% of the population of the United States and 41% of the population of California, and these percentages are expected to increase rapidly over the next 25 years.<sup>5</sup>

The California Healthy Kids Survey (CHKS), administered by the California Department of Education since 1998, has been adapted as a tool for statewide asthma surveillance. A series of questions related to asthma was added in 2001. Given the very large sample size (462 147) of the CHKS and the ethnic diversity in California, we were able to investigate small ethnic subpopulations normally encompassed under the general categories of "Hispanic" and "Asian." In this article we compare the prevalence of asthma diagnosis among various Hispanic and Asian American ethnic subgroups by using data collected from the CHKS during 2001–2003 and explore potential reasons for these differences.

## METHODS

The CHKS is an anonymous, self-administered survey taken at school. All of the public schools in California are eligible to participate in CHKS for a nominal fee. School districts receiving state funding to support smoking and substance abuse education are required to evaluate their programs using representative cross-sectional surveys, such as the CHKS. Much of the content of the CHKS is similar to that in the National Youth Risk Behavior Survey of the Centers for Disease Control and Prevention. The CHKS is administered biennially to seventh-, ninth-, and 11th-grade students in participating public schools and to those in the same grades in nontraditional school settings (ie, continuation, magnet, and alternative schools) and measures a number of health and social indicators. Results from the CHKS are used to help identify leading health concerns in the school-age population, to evaluate school-based programs, and to help guide state and local policies.

The CHKS consists of a core module, required of all participating schools, and several optional modules. In 2001, an asthma question was added to the core module pertaining to lifetime asthma diagnosis: "Has a doctor ever told you or your parent/guardian that you have asthma?" Four asthma symptom questions were added to an optional survey module that also includes other questions pertaining to physical activity and nutrition. During the time period analyzed in this report, fall 2001 to spring 2003, the California Department of Education (CDE) required written parental consent in order for a student to take the CHKS. The general survey methodology is described in greater detail elsewhere.<sup>6</sup>

Lifetime asthma prevalence is defined as the total of "yes" responses to the above question on the core module divided by the total number of responses to the question (including "yes," "no," or "don't know"). Surveys with no response to this question and those that did not meet the eligibility criteria established by the CDE were not included in this analysis. CDE eligibility criteria excluded respondents who had satisfied  $\geq 2$  of the following conditions: responded inconsistently to questions, reported exaggerated drug use, marked that they used a fake drug in the list of real drugs, and marked that they did not respond honestly in the reliability question at the end of the survey.<sup>6</sup>

The racial and ethnic group(s) of the respondents was determined from 3 separate questions on the core module. On the first question, respondents were asked, "How would you describe yourself?" and instructed to mark all applicable responses among the following: white or white (non-Hispanic), Hispanic or Latino/Latina, black or African American (non-Hispanic), Asian or Asian American, American Indian or Alaska Native, Native Hawaiian or Pacific Islander, and other. In 2 separate additional questions, respondents were asked to further describe their ethnic/racial affiliation. For those who described themselves as Asian or Pacific Islander (API), options included Asian Indian, Cambodian, Chinese, Filipino, Japanese, Korean, Laotian, Vietnamese, Hawaiian, Guamanian, Samoan or other Pacific Islander, and other Asian. For those who described themselves as Hispanic or Latino/Latina, options included Central American, South American, Cuban, Mexican, Puerto Rican, or other Hispanic. Those selecting multiple groups were classified as "mixed Hispanic" or "mixed Asian" in the analysis. We created mutually exclusive race/ethnicity categories based on the responses to these questions. Respondents who identified with only Hispanic or Latino/Latina in the first question and an ethnic subgroup in the additional Hispanic question were categorized into mutually exclusive Hispanic/Latino/Latina ethnic subgroups. Similarly, respondents who identified with either Native Hawaiian/Pacific Islander or Asian in the first question and selected an ethnic subgroup in the

additional API question were categorized into mutually exclusive API ethnic subgroups.

The sampling scheme varied from district to district and was based on the number of enrolled students and the number of schools in the district.<sup>6</sup> For example, large school districts were required to select a representative sample of  $\geq 1000$  students. To most appropriately account for the sampling scheme, we constructed 95% confidence intervals (CIs) using PROC SURVEYMEANS in SAS 9.0 (SAS Institute, Cary, NC) and identified the school as a cluster variable. To determine the statistical significance of the difference in asthma prevalence between 2 populations, we calculated multivariate odds ratios (ORs) adjusting for grade and gender and associated 95% confidence intervals using PROC LOGISTIC in SAS 9.0. We tested for statistical significance by calculating Wald  $\chi^2$  and associated *P* values. The level of significance was set at  $\alpha = .05$ .

## RESULTS

In total, 462 147 seventh-, ninth-, and 11th-grade students and those from nontraditional settings took the CHKS survey during the 2001–2002 and 2002–2003 school years,  $\sim 17\%$  of all California students in these grades during those years. Of these surveys, 53 317 students had missing data for the asthma question on the core module and an additional 4486 surveys did not meet the eligibility criteria established by the CDE. In addition, 132 surveys were excluded because they were found to be from private schools. The final sample consisted of 404 212 surveys from 2448 schools, representing 666 of California's 1050 school districts in 56 of California's 58 counties.

Seventh graders made up the largest percentage of the sample (38.4%) followed by ninth graders (31.2%)

and 11th graders (26.7%). Students from nontraditional school settings comprised only  $\sim 4.7\%$  of the sample. There were more females than males (53.2% vs 46.8%). Non-Hispanic white (white) students made up the largest percentage (34.1%) followed by Hispanic students (29.0%) and APIs (12.3%). Black students comprised 4.3% of the sample. Among the Hispanic or Latino/Latina respondents, Mexican Americans were by far the largest group, accounting for 73.3%. Among the API respondents, Filipinos represented the largest group, accounting for 20.7%.

Lifetime asthma prevalence was 18.4% (95% CI: 18.1–18.6) for the entire sample. Black students had higher asthma prevalence than the other 4 major race/ethnic groups and were 1.38 (95% CI: 1.33–1.43) times more likely than white students to have asthma. The lifetime asthma prevalences for API and Hispanic students were significantly lower than that for white students (Table 1).

Results indicated substantial variation in asthma prevalence between the different Hispanic subgroups and between the different API subgroups. Asthma prevalence among Hispanic subgroups ranged from 13.2% (95% CI: 12.9–13.5) for Mexican American students to 22.8% (95% CI: 20.8–24.9) for Puerto Rican students and 23.0% (95% CI: 19.7–26.4) among Cuban American students, nearly a twofold difference. Students who identified as having a Central American background displayed an asthma prevalence more closely related to that of Mexican American students, although significantly higher. South American students fell in the middle (Table 2). Lifetime asthma diagnosis among the 11 API subgroups ranged from 10.9% (95% CI: 10.0–11.8) among Korean American students to 23.8% (95% CI: 22.7–24.9) among Filipino American students (Table 3).

**TABLE 1** Lifetime Asthma Prevalence Rates According to Demographics

Variable	N <sup>a</sup>	Lifetime Asthma Rate, %	95% CI	OR <sup>b</sup>	95% CI	<i>P</i>
Total	404 212	18.4	18.1–18.6			
Grade						
7th	155 216	16.5	16.2–16.8	Ref		
9th	126 170	19.0	18.6–19.4	1.18	1.16–1.21	<.0001
11th	103 772	19.7	19.3–20.1	1.23	1.21–1.26	<.0001
Nontraditional	19 054	22.0	21.1–22.8	1.44	1.38–1.49	<.0001
Gender						
Female	213 234	17.8	17.5–18.1	Ref		
Male	187 830	18.9	18.7–19.2	1.07	1.06–1.09	<.0001
Race/ethnicity						
White, non-Hispanic	136 493	20.2	19.9–20.5	Ref		
Hispanic	116 137	14.1	13.8–14.4	0.65	0.64–0.67	<.0001
API	49 189	16.7	16.2–17.2	0.80	0.77–0.82	<.0001
Native American	6 180	19.4	18.3–20.5	0.96	0.90–1.03	.1004
Black	17 238	25.8	25.1–26.5	1.38	1.33–1.43	<.0001
Other race/ethnicity	35 197	17.8	17.3–18.3	0.90	0.87–0.92	<.0001
Mixed race/ethnicity	40 065	23.6	23.1–24.1	1.25	1.21–1.28	<.0001

Ref indicates reference group.

<sup>a</sup> *N* is the total number of individuals.

<sup>b</sup> Adjusted for race/ethnicity, grade, and gender.

**TABLE 2** Lifetime Asthma Prevalence Rates According to Hispanic or Latino/Latina ethnic subgroups

Hispanic Subgroups	N <sup>a</sup>	Lifetime Asthma Rate, %	95% CI	OR <sup>b</sup>	95% CI	P
Mexican	89 340	13.2	12.9–13.5	Ref		
Central American	7325	14.4	13.6–15.3	1.11	1.04–1.19	.0028
South American	3826	17.7	16.4–18.9	1.41	1.30–1.54	<.0001
Puerto Rican	1633	22.8	20.8–24.9	1.92	1.71–2.16	<.0001
Cuban	717	23.0	19.7–26.4	1.95	1.63–2.32	<.0001
Other Hispanic	5960	16.4	15.4–17.5	1.30	1.21–1.39	<.0001
Mixed Hispanic	4805	19.6	18.3–20.9	1.61	1.50–1.73	<.0001

Ref indicates reference group

<sup>a</sup> N is the total number of individuals.

<sup>b</sup> Adjusted for grade and gender.

**TABLE 3** Lifetime Asthma Prevalence Rates According to API Ethnic Subgroups

API Subgroups	N <sup>a</sup>	Lifetime Asthma Rate, %	95% CI	OR <sup>b</sup>	95% CI	P
Filipino	9943	23.8	22.7–24.9	Ref		
Korean	5061	10.9	10.0–11.8	0.39	0.36–0.44	<.0001
Laotian	661	11.6	9.1–14.2	0.42	0.33–0.53	<.0001
Cambodian	1300	12.2	10.5–13.8	0.43	0.36–0.51	<.0001
Vietnamese	4702	13.6	12.6–14.6	0.51	0.46–0.56	<.0001
Chinese	11 511	14.4	13.6–15.1	0.54	0.51–0.58	<.0001
Asian Indian	2739	16.3	14.9–17.7	0.63	0.56–0.70	<.0001
Japanese	2619	18.9	17.4–20.3	0.74	0.67–0.83	<.0001
Pacific Islander	2261	21.0	19.2–22.8	0.85	0.76–0.95	.0034
Other API	3565	11.5	10.2–12.8	0.42	0.37–0.47	<.0001
Mixed API	3749	19.8	18.5–21.2	0.81	0.74–0.89	<.0001

Ref indicates reference group

<sup>a</sup> N is the total number of individuals.

<sup>b</sup> Adjusted for grade and gender.

## DISCUSSION

Among California middle and high school students, the lifetime asthma prevalence for APIs and Hispanics is significantly lower than that for whites, Native Americans, or blacks. However, the ethnic subgroups that comprise the Hispanic and Asian American populations display more than a twofold difference in asthma prevalence. Children who identified as Filipino, Pacific Islander, Puerto Rican, and Cuban have asthma prevalence significantly higher than that of the non-Hispanic white population. CHKS is the first survey from which to draw statistically reliable conclusions about asthma prevalence in several Hispanic and Asian subpopulations in the United States.

We cannot directly compare the asthma prevalence estimates from CHKS with other studies because of the different populations sampled and different methodologies used. However, our finding that persons of Puerto Rican heritage have a very high asthma prevalence and that those of Mexican heritage have a relatively low prevalence is consistent with other studies.<sup>2–4,7,8</sup> This general pattern holds when the outcome is asthma mortality rather than asthma diagnosis.<sup>9</sup> Few studies have examined asthma prevalence in any of the other Hispanic subgroups investigated in CHKS. The relative asthma prevalence among Hispanics as a group, as com-

pared with other major racial or ethnic groups, can be explained partly as a function of the specific background of the Hispanic population under investigation. In areas where the Hispanic population is largely Puerto Rican and Cuban, asthma prevalence among Hispanics has been found to be very high compared with the general population.<sup>10</sup> In California, where the Hispanic population is largely of Mexican descent, Hispanics as a group are significantly less likely to have been diagnosed with asthma than the general population.<sup>11</sup>

Few estimates of asthma prevalence exist either for the API population as a group or for API ethnic subgroups. One statewide random-digit-dial health survey in California permitted respondents to select their ethnicity as “Pacific Islander” as distinct from “Asian.” Like CHKS, that survey found unusually high asthma prevalence among Pacific Islanders at 21%.<sup>11</sup>

Whereas there have been multiple hypotheses advanced for the observed disparities in asthma prevalence between different population groups, the explanations are usually posited in terms of socioeconomic factors that would tend to lead to poor asthma management and health outcomes but are not necessarily associated with the development of asthma in the first place. Several researchers have suggested that genetic variation may contribute to differences in asthma prevalence be-

tween racial or ethnic groups. As with other complex disease, various candidate genes or gene complexes have been postulated to confer susceptibility for developing asthma, and the frequency of these candidate genes sometimes varies among racial or ethnic groups.<sup>12</sup> For example, one study suggested that Puerto Ricans are more likely to have an abnormal variant of  $\alpha$ -1-antitrypsin, a protein related to inflammatory response.<sup>13</sup> Puerto Ricans with asthma living in the United States have been found to have lower lung function relative to Mexican Americans with asthma.<sup>14</sup> Furthermore, one recent study found that CD14 gene polymorphisms are associated with asthma severity, lung function, and immunoglobulin E levels among Hispanics with asthma who are exposed to tobacco smoke and that these alleles are found at different frequencies in Hispanic ethnic subgroups.<sup>15</sup> Nonetheless, although there is a strong hereditary component to asthma, no definitive genetic marker has yet been identified that links the probability of developing asthma with race or ethnicity.

In California, Hispanics born in the United States have nearly 3 times the probability of having an asthma diagnosis than foreign-born Hispanics who have not become naturalized, and Hispanics who have become naturalized, a proxy measure of acculturation, as well as years of residence, fall between these two extremes.<sup>16</sup> Furthermore, using 2 sources of national data, Holguin et al<sup>17</sup> reported that Mexican Americans born in the United States had between 2.1 and 2.7 times the probability of having an asthma diagnosis as those born in Mexico, even after adjusting for age, gender, BMI, smoking status, access to health care, and language. A survey of Chinese American children in Boston, MA, found that children born in the United States had an asthma prevalence nearly 4 times that of foreign-born children.<sup>18</sup> Studies of migrants moving from less to more developed countries have shown a strong positive correlation between years of residence in the host country and report of asthma symptoms.<sup>19–23</sup> Genetic factors alone cannot explain the pattern of increasing risk among migrant populations moving from less to more developed countries. It is reasonable to assume that the differences in asthma diagnosis between some ethnic groups are related in part to a variation in exposure to environmental or cultural factors (eg, dietary) associated with living in the United States.

Asthma prevalence in the United States, Australia, New Zealand, the United Kingdom, and several other nations in Western Europe is markedly higher than countries in the non-Western world.<sup>1</sup> A large percentage of the API and Hispanic populations in California are in fact foreign born or children of the foreign born; therefore, residential history and degree of acculturation may be of special importance when investigating asthma in these groups. API and Hispanic immigrants to the United

States most often come from countries with relatively low asthma prevalence.

Many characteristics of economic development and a Western lifestyle have been hypothesized to explain the worldwide increase in asthma, although the epidemiologic evidence is inconsistent. Both atopic and nonatopic factors comprise what has been labeled as the “westernization package.”<sup>24</sup> Asthma symptoms can be precipitated or exacerbated by exposure to various allergens, some of which are more common in the developed world. For example, modern, energy-efficient homes are thought to favor the growth of dust mites and mold, which could contribute to greater asthma severity.<sup>25</sup> However,  $\geq 1$  study that showed an association between moving to a developed country and developing asthma found the new cases of asthma to be consistent with noneosinophilic mechanisms, whereas a study of an Asian population determined that sensitization to allergens accounted for only a minority of the new cases of asthma in immigrants.<sup>19</sup> Lower exposures to potential early life protective factors in the developed world, such as endotoxins, as well as parasitic, bacterial, and viral infections, may result in reduced activity of T-regulatory cells and the development of a Th2 inflammatory response profile characteristic of allergic disease. The “hygiene hypothesis” provides one explanation of the lower rates of asthma among children raised on farms, in less developed countries, and in large families.<sup>24</sup> There is increasing evidence that prenatal or perinatal exposure to tobacco smoke is associated with the development of asthma; however, tobacco smoke exposure is often lower in more developed countries.<sup>26,27</sup>

Several additional characteristics of a Western lifestyle are thought to be risk factors for the development of asthma. Having a “Western diet” was associated with bronchial hyperreactivity in Asian schoolchildren in the United Kingdom.<sup>28</sup> It has been hypothesized that decreased consumption of antioxidants and omega-3 fatty acids and increased intake of omega-6 fatty acids have contributed to the increases in asthma and atopic disease.<sup>29</sup> Lack of physical activity and obesity, both characteristics of the modern “American” lifestyle, are independently associated with asthma and asthma severity.<sup>30</sup> Furthermore, women in wealthier countries are less likely to breastfeed. Breastfeeding has been demonstrated to have a protective effect against asthma and may reduce the incidence of respiratory syncytial virus, itself associated with the development of asthma.<sup>31</sup> Other factors associated with an increased risk of childhood asthma that are also associated with westernization include unusually small birth size and early life administration of antibiotics.<sup>24,32</sup>

Variation in asthma prevalence may be related in part to differences in diagnostic patterns. Using data from National Health and Nutrition Examination Survey III, Roberts<sup>33</sup> reported that physicians are more likely to diagnose asthma in some ethnic groups than others,

even with identical clinical presentations. Roberts<sup>33</sup> speculated that interpersonal dynamics within families and communication between families and health care providers are more likely than clinical differences to account for much of the disparity between cultural groups for both asthma symptom reporting and diagnosis. A separate study using different data supports the notion of differential diagnostic labeling between racial/ethnic groups with the same clinical presentation.<sup>34</sup> Many Hispanic and API migrants come from countries of which the medical systems are less likely to recognize asthma than the host country and of which the cultural beliefs about health are likely to continue to influence health-seeking behavior in subsequent generations. Linguistic differences need to be considered as well. Asthma prevalence is substantially higher in English-speaking countries than almost all other countries.<sup>1</sup> To the extent that language affects perception, it is possible that the English language somehow confers recognition of specific symptoms, both for patient and health care provider, as a distinct disease labeled asthma.

To explore whether the CHKS results are consistent with the hypothesis that asthma is related to lifestyle and culture, it is useful to compare Puerto Ricans and Mexicans, because these populations represent opposite ends of the prevalence spectrum among Hispanics. Limited evidence suggests that adolescents in Puerto Rico are diagnosed with asthma at much greater rates than Mexicans living in Mexico.<sup>1,35</sup> Lack of insurance has been cited as a reason for high asthma prevalence among Puerto Ricans in the United States.<sup>36</sup> However, Puerto Ricans had significantly greater access to health care than did Mexicans and other Latinos living in the same towns in the Northeast.<sup>7,8</sup> Some evidence, in fact, suggests that not having health insurance is protective against getting an asthma diagnosis within Hispanic populations.<sup>8</sup>

Reliable data on asthma in API countries of origin are limited. A standardized multinational survey revealed that adolescents in Fukuoka, Japan, and Manila, Philippines, have asthma prevalences ~7 times that of adolescents living in Seoul, Korea, and 3 times that of adolescents living in Beijing, China.<sup>1</sup> This general pattern seems to continue among the populations living in California. The difference in asthma prevalence between CHKS respondents of Japanese (18.9%) and Korean (10.9%) descent is striking. In California, Asians born in the United States have a 2.5 times greater probability of having an asthma diagnosis than foreign-born Asians who have not become naturalized. Foreign-born Asians who have become naturalized have asthma prevalence 50% higher than those who have not become naturalized. This pattern holds even when investigating Asian Americans only between the ages of 11 and 18 years.<sup>16</sup> It is noteworthy that, whereas 61% of Japanese Americans are born in the United States and 53% speak English at

home, only 22% of Koreans are born in the United States, and only 18% speak English at home.<sup>37</sup> Thus, asthma prevalence among API and Hispanic populations may be a function of both the prevalence in the country of origin, as well as residential history in the United States and degree of acculturation.

Whatever the reasons for the observed differences, it is clear that aggregating ethnic subgroups together within the larger racial/ethnic categories of "Hispanic" or "Asian," while linguistically and demographically convenient, masks substantial heterogeneity not only in asthma prevalence, but also in the genetic, cultural, dietary, economic, geographic, and other factors that may affect the occurrence and diagnosis of this disease. We suggest that, when possible, asthma surveys that include a substantial number of API and Hispanic persons should use a more detailed categorization of race/ethnicity than the traditional categories of "Asian" and "Hispanic." Such distinctions are important when allocating scarce public health resources, particularly considering the amount of public health funding dedicated to reducing health disparities affecting minority populations.

The sheer size of the CHKS affords the statistical power to investigate small subpopulations without the need for oversampling, allowing investigators to determine parameters for specific populations with a high degree of precision. Despite its large size overall, however, the CHKS has several limitations. The statistical power is not as great for some of the ethnic subgroups with smaller sizes, such as Cubans and Laotians, leading to less precise prevalence estimates for these groups. The exclusive focus of the CHKS on the adolescent population limits the generalizability of our findings to younger children or to adults.

Because asthma diagnosis was self-reported, some misclassification is to be expected. The question regarding whether the respondent had ever been diagnosed with asthma is identical or nearly identical to that used in scores of other school-based surveys, including the International Study of Asthma and Allergies in Childhood, which is administered to 13- to 14-year-olds.<sup>38</sup> A few studies have investigated the accuracy of adolescent self-report of an asthma diagnosis, one of which collected data in a diverse school district in California.<sup>39,40</sup> The studies found good or very good concordance between child and parental reporting of asthma diagnoses, with kappa statistics ranging from 80% to 99%. Thus, whereas it cannot be known whether misclassification of disease varied by ethnic group, it is unlikely that misclassification could have altered the overall conclusions.

The CDE does not have a mechanism for tracking how well the CHKS represents the public school population of California. The response rate likely varied across schools, because, at the time these data were collected, CHKS required written parental consent.

However, it would not be possible to determine the extent to which the response rate varied across the subgroups investigated in this report without a labor-intensive analysis of the demographic characteristics of each participating school, nor would it be possible to determine whether the asthma status, symptomatology, or risk factor profile of students who took the survey differed from those who did not. However, it is unlikely that any response bias would have been strong enough to affect the overall conclusions.

CHKS does not collect information on place of birth, duration of residence in the United States, or generational status and, therefore, limits the further exploration of some of the hypotheses put forth in this article. Future cycles of CHKS could be improved by including such questions. In addition, although the CHKS collects relatively detailed information about the respondents' ethnicity compared with the vast majority of public health surveys, some of the choices for ethnic background, such as South or Central American, are still quite broad and could be improved with the addition of more options for reporting ethnicity.

## CONCLUSIONS

Our examination of different rates of asthma diagnosis using the CHKS reveals sharp differences within the traditional racial/ethnic classifications commonly used in descriptive and analytical epidemiologic studies in the United States. Among APIs living in the United States, Filipinos showed the highest asthma prevalence, followed by Pacific Islanders, Japanese, Indians, Chinese, Vietnamese, Cambodians, Laotians, and Koreans. Among Hispanics, persons of Puerto Rican and Cuban descent had the highest asthma prevalences, whereas persons of Mexican and Central American descent had the lowest, with South Americans in the middle. Among Hispanics and APIs, variability in the distributions of characteristics related to country of birth, residential history, and/or degree of acculturation to a "Western" lifestyle may account for much of the observed differences in asthma prevalence between ethnic subgroups, although it is not obvious which specific factors are responsible. Likewise, it is possible that as-yet-determined genetic factors that confer susceptibility to asthma and vary by ethnicity might play some role. Although there is some evidence that these patterns begin in the country of origin, cultural, social, and linguistic factors that persist in the United States, even across generations, may contribute to these differences. The study of disease patterns of immigrant populations moving from less to more developed countries has been instructive in understanding the relationships among genetic, environmental, and socio/behavioral risk factors for chronic diseases, such as stomach cancer, breast cancer, heart disease, and diabetes. We believe that continued research of asthma in ethnic subpopulations, and particularly immigrant populations,

can provide valuable insights into the etiology and natural history of asthma.

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