



Disparities in complementary alternative medicine use and asthma exacerbation in the United States

Eun Ji Kim, Joseph Simonson, Sonia Jacome, Joseph Conigliaro, Amresh D. Hanchate & Negin Hajizadeh

To cite this article: Eun Ji Kim, Joseph Simonson, Sonia Jacome, Joseph Conigliaro, Amresh D. Hanchate & Negin Hajizadeh (2019): Disparities in complementary alternative medicine use and asthma exacerbation in the United States, Journal of Asthma, DOI: [10.1080/02770903.2019.1614615](https://doi.org/10.1080/02770903.2019.1614615)

To link to this article: <https://doi.org/10.1080/02770903.2019.1614615>



Accepted author version posted online: 02 May 2019.



Submit your article to this journal [↗](#)



Article views: 16



View Crossmark data [↗](#)

Disparities in complementary alternative medicine use and asthma exacerbation in the United States

Eun Ji Kim MD, MS, MS^{1,2}, Joseph Simonson MD³, Sonia Jacome MSCH², Joseph Conigliaro MD, MPH^{1,2}, Amresh D. Hanchate PhD⁴, Negin Hajizadeh MD MPH^{2,3}

¹Division of General Internal Medicine, Donald and Barbara Zucker School of Medicine at Hofstra/Northwell, Lake Success, NY 11042

²Division of Health Services Research, Department of Medicine, Center for Health Innovations and Outcomes Research, Manhasset, NY 11030

³Department of Internal Medicine, Donald and Barbara Zucker School of Medicine at Hofstra/Northwell, Manhasset, NY 11030

⁴Section of General Internal Medicine, Boston University School of Medicine, Boston, MA 02118

Corresponding Author: Eun Ji Kim MD, MS, MS, Division of General Internal Medicine, Donald and Barbara Zucker School of Medicine at Hofstra/Northwell, 2001 Marcus Avenue Suite S160, Lake Success, NY 11042, E-mail: ekim7@northwell.edu. Telephone: 516-519-5600. Fax: 516-519-5601

Abstract

Complementary and alternative medicines (CAM) are associated with poor asthma medication adherence, a major risk factor for asthma exacerbation. However, previous studies showed inconsistent relationships between CAM use and asthma control due to small sample sizes, demographic differences across populations studied, and poor differentiation of CAM types. We examined associations between CAM use and asthma exacerbation using a cross-sectional analysis of the 2012 National Health Interview Survey. We included adults ≥ 18 years with current asthma ($n=2,736$) to analyze racial/ethnic differences in CAM use as well as the association between CAM use and both asthma exacerbation and emergency department (ED) visit for asthma exacerbation across racial/ethnic groups. We ran descriptive statistics and multivariable logistic regressions. Blacks (OR=0.63 [0.49-0.81]) and Hispanics (OR=0.66 [0.48-0.92]) had decreased odds of using CAM compared to Whites. Overall, there was no association between CAM use and asthma exacerbation (OR=0.99 [0.79-1.25]) but the subgroup of ‘other complementary approaches’ was associated with increased odds of asthma exacerbation among all survey respondents (1.90 [1.21-2.97]), Whites (OR=1.90 [1.21-2.97]), and Hispanics (OR=1.43 [0.98-2.09]). CAM use was associated with decreased odds of an ED visit for asthma exacerbation (OR=0.65 [0.45-0.93]). These associations were different among racial/ethnic groups with decreased odds of ED visit among Whites (OR=0.50 [0.32-0.78]) but no association among Blacks and Hispanics. In summary, we found that both CAM use and the association between CAM use and asthma exacerbation varied by racial/ethnic group. The different relationship may arise from how CAM is used to complement or to substitute for conventional asthma management.

Key Words: asthma; complementary and alternative medicine (CAM); health disparity; herbal; National Health Interview Survey (NHIS); minorities

Introduction

Asthma is a common medical condition that affects one in thirteen people in the United States (1). Disadvantaged racial and ethnic minority groups, particularly Blacks and Puerto Rican Americans, are disproportionately affected and suffer greater rates of emergency department (ED) utilization, hospitalization, and mortality from the disease (2-7). According to the CDC, the mortality from asthma is about three times higher in Blacks compared to non-Hispanic Whites (1). Many factors associated with disparities in asthma outcomes have been identified, and include environmental factors and issues surrounding medication adherence that arise from social determinants of health. For example, racial and ethnic minorities residing in low socioeconomic areas are at an increased risk of asthma exacerbation due to air pollution, poor quality housing, stress, and occupational exposures (8-10). Adherence with prescribed asthma medications is poorer in Blacks and Hispanics compared to White patients (11-14). Alongside other factors such as access to care, physician-patient communication, language barriers, beliefs about prescribed medications, and affordability, preference for complementary and alternative medicine has been cited as an important barrier to adherence with prescribed medications and improving asthma control in disadvantaged racial and ethnic communities (15, 16).

Complementary and alternative medicine (CAM) refers to medical practices that may complement or replace conventional medical treatments (17). CAM can be categorized into two broad groups (1) “natural products” such as herbs, vitamins, and minerals and (2) “mind and body practices” such as yoga, tai chi, qi gong, massage, meditation, breathing exercises, acupuncture, and chiropractic and osteopathic manipulation (17). The mainstay of treatment for asthma is the use of inhaled corticosteroids and beta agonists; but CAM is widely used by patients in the treatment of asthma (18-21). In the US, CAM use for asthma management is very common, ranging from 66% to 86% (22-24). The effect of CAM use on adherence with conventional asthma medications and asthma control remains unclear, as does its impact on asthma morbidity and mortality (25-29). For example, some studies have shown poor asthma medication adherence with CAM use or a significant association between asthma exacerbation and CAM use (25-27). However, in other instances, CAM use, specifically yoga, has been associated with improved asthma control and symptoms (30, 31). This may be due to prior studies having small sample sizes, examining demographically different populations, and combining different types of CAM into one group.

The purpose of this study is to use nationally representative survey data to determine the demographic factors predictive of CAM use in asthma patients and to determine the association between CAM use and asthma exacerbation among different racial and ethnic groups. We hypothesize that 1) there are disparities in CAM use among different racial/ethnic groups and 2) CAM use is associated with increased risk of asthma exacerbation. We analyzed data from the 2012 National Health Interview Survey, which contained information on both asthma and CAM use. We further examined the data by racial and ethnic groups and by different types of CAM adjusting for sociodemographic and healthcare utilization characteristics.

Methods

Study design, setting, and participants

This is a cross-sectional analysis of the 2012 National Health Interview Survey (NHIS), an annual, nationally representative survey that contains self-reported information on sociodemographic background and health status (32). The survey is conducted in person at participants' residence and includes 34,525 adults 17 years or older in the United States. Our study cohort consisted of all survey respondents 18 years or older who had asthma (answered yes to "Still have asthma?"), valid responses to covariates, and responded to questions about CAM use (n=2,736). We identified a participant to use CAM based on his/her answer to the question, "used [CAM type], past 12 months?"

Complementary and alternative medicine (CAM)

Based on previous CAM categorizations (17, 33), we categorized CAM into three groups: natural products, mind and body exercises, and other complementary approaches. Natural products included herbals, vitamins (vitamins A, B, C, D, E, H, or K), and minerals (calcium, magnesium, iron, chromium, zinc, selenium, or potassium). Mind and body exercises included yoga, tai chi, and qi gong. Other complementary approaches included massage, acupuncture, energy healing therapy, naturopathy, hypnosis, biofeedback, Ayurveda, chelation therapy, and craniosacral therapy. Within the other complementary approaches category, because prevalence of energy healing therapy, naturopathy, hypnosis, biofeedback, Ayurveda, chelation therapy, or craniosacral therapy use were low (prevalence of use less than 0.5%), we combined these modalities and labeled them as "other".

Asthma exacerbation and ED visit for asthma exacerbation

Asthma exacerbation was based on self-report responding to the question, "Had an asthma episode/attack past 12 months?" Emergency department visit for asthma exacerbation was also based on self-report responding to the question, "Had visit to ER due to asthma past 12 months?"

Covariates

We used self-reported race/ethnicity and categorized the race and ethnicity indicators into five groups: non-Hispanic White, non-Hispanic Black, Hispanic, Asian, and Other. Next, we identified key sociodemographic and healthcare utilization characteristics associated with differential risk of asthma exacerbation and CAM use (34-38). For sociodemographic variables, we included age, gender, educational level, low income status, employment, and insurance. To adjust for differences in the prevalence of asthma among different age groups, we categorized age into four groups: 18-34, 35-49, 50-64, and 65+. Educational achievement was reported as education of adult with the highest education in the family. We categorized participants' education into four groups: less than high school diploma, high school diploma or equivalent, greater than high school education (but no college degree), and completed college or higher. Low-income status was defined as family income equal or less than 100% of the Federal Poverty Level. We also included BMI as a covariate due to higher prevalence of asthma exacerbation among patients with obesity (39). BMI was categorized into four groups: underweight (<18.5

kg/m²), normal weight (18.5-24.9 kg/m²), overweight (25.0-29.9 kg/m²), and obese (≥ 30.0 kg/m²) (40). For healthcare utilization characteristics, we examined whether participants had a healthcare provider and whether they reported any healthcare visit in the past year. Respondents were identified to have limited English proficiency if they used non-English for the survey interview.

Statistical analysis

In our statistical analyses, we incorporated multistage stratification sampling design and sampling weights (41). For all analyses, we compared all racial/ethnic groups but did not present the “Other” racial/ethnic group results due to small sample size. To characterize the sample population by race/ethnicity we compared the unadjusted prevalence of sociodemographic indicators, CAM use, asthma exacerbation, and ED visit for asthma exacerbations. We performed chi-square test of similarity to examine racial/ethnic differences in covariates. To account for multiple comparisons, the Holm-Bonferroni sequential method was applied (42). We conducted multivariable logistic regression models to examine the relationship between CAM use and demographic covariates. We also ran multivariable logistic regression with CAM use as outcome adjusting for asthma exacerbation or ED visit for asthma exacerbation, separately. We then examined an association between combined CAM use and our primary outcome variables of asthma exacerbation and ED visit for asthma exacerbation using multivariable logistic regression. We also examined the relationships between specific types of CAM and the asthma exacerbations outcomes. Additionally, we ran multivariable logistic regression analysis individually for Whites, Blacks, and Hispanics to assess the relationship between racial/ethnic differences in CAM use and the primary outcome variables of asthma exacerbation and ED visit for asthma exacerbation.

All statistical analyses were conducted using SAS 9.4 (SAS Institute Inc., Cary, NC, USA).

Results

Participants

The 2012 NHIS included 34,525 survey participants, 2,736 (8.0%) of which reported current asthma and were included in our study. Prevalence of current asthma among different racial ethnic groups was 8.1% in Whites, 10.1% in Blacks, 6.1% in Hispanics, and 4.6% in Asians.

Table 1 shows characteristics of survey participants with asthma (n=2,736). The majority of the study participants were female (62.7%), 18-54 years old (66.5%), and overweight/obese (68.7%). Within the past year, 48.7% reported having an asthma exacerbation and 11.9% reported going to ED for an asthma exacerbation. There were racial/ethnic differences in ED visit for asthma exacerbation: 9.4% of Whites, 22.1% of Blacks, 16.1% of Hispanics, and 4.5% of Asians reported going to the ED for asthma exacerbation ($p < 0.01$). Three-quarters (74.1%) had a health care provider, but only 8.3% saw a healthcare provider within the past year. Here too, there were racial/ethnic differences.

CAM Use

We examined CAM use among those with current asthma by race/ethnicity (Table 2). 58.5% of participants with current asthma used CAM within the past year. Higher percentages of Whites and Asians used CAM compared to Blacks and Hispanics (% of CAM use: 62.8% Whites, 46.9% Blacks, 45.4% Hispanics, 62.3% Asians; $p < 0.01$). Most of the CAM used was in the 'natural products' category (21.4% used herbals, 40.3% used vitamins, and 33.6% used minerals). Yoga practice in the 'mind and body exercises' category was also common among asthma patients (17.6% of White and 22.9% of Asian patients but only 9.3% of both Black and Hispanic patients). There were also racial/ethnic differences in use of herbals, vitamins, minerals, and yoga (p -values < 0.05).

To identify characteristics associated with different types of CAM use among asthma patients, we performed multivariable logistic regressions analysis (Table 3). Blacks and Hispanics had decreased odds ratio of using CAM compared to Whites (Blacks: OR=0.63 [0.49-0.81] and Hispanics: OR=0.66 [0.48-0.92]). Among Blacks, the differences arose from use of natural products (OR=0.62 [0.48-0.79]) and mind and body exercises (OR=0.53 [0.35-0.79]). Males, compared to females, had decreased odds of using CAM (OR=0.57 [0.45-0.71]), including natural products (OR=0.59 [0.47-0.74]) and mind and body exercises (OR=0.45 [0.33-0.63]). Variables associated with increased CAM use included older age group, higher education level, lower income, and having a healthcare provider.

To examine whether having an asthma exacerbation or ED visit for exacerbation in the past year was associated with CAM use, we ran additional analyses with these covariates in the CAM use models (Table 4). We found that having an asthma exacerbation within the past year was associated with 87% increased odds of using a CAM type category in the 'other complementary approaches' (OR=1.87 [1.20-2.91]). Having an ED visit for asthma exacerbation was associated with decreased odds of CAM use (OR=0.65 [0.46-0.93]), specifically natural products (OR=0.69 [0.48-0.98]).

Asthma exacerbation and ED visit for asthma exacerbation

In looking at whether CAM use was associated with the outcomes of asthma exacerbation (Table 5), we did not find any association among the overall population (OR=0.99 [0.79-1.25]), among Whites (OR=0.99 [0.76-1.30]), or among Blacks (OR=0.87 [0.63-1.21]). However, among Hispanics, use of CAM was associated with increased odds (OR=1.43 [0.98-2.09]) of asthma exacerbation, although this had borderline statistical significance ($p=0.06$).

In looking at whether CAM use was associated with ED visit for asthma exacerbation, we found that CAM use associated with decreased odds (OR=0.65 [0.45-0.93]). This decrease was seen among Whites (OR=0.50 [0.32-0.78]); however, there was no association among Blacks (OR=0.72 [0.43-1.20]) and Hispanics (OR=1.48 [0.81-2.71]). The CAM category of 'natural products' was associated with decreased odds (OR=0.68 [0.48-0.97]) of ED visit for asthma exacerbation but the category of 'other complementary approaches' was associated with increased odds (OR=1.90 [1.21-2.97]) of ED visit for asthma exacerbation.

Discussion

Consistent with previous studies (43-45), we found that CAM use was common among asthma patients and the type of CAM use varied among different racial/ethnic groups. We also identified characteristics associated with CAM use, including being elderly, having a person in a family with high education level, low income, and having a healthcare provider. Compared to Whites, Blacks and Hispanics were less likely to use CAM but there was no difference in CAM use in between Whites and Asians. There was no association between CAM use and asthma exacerbation, but CAM use was associated with decreased odds of ED visit asthma exacerbation. In subgroup analysis, use of the CAM category of 'other complementary approaches' was associated with increased odds of asthma exacerbation. However, use of CAM from the category of 'natural products' was associated with decreased odds of ED visit for asthma exacerbation.

The relationship between CAM use and asthma exacerbation differed among racial/ethnic groups. Among Whites, CAM use was associated with decreased likelihood of ED visits for asthma exacerbation compared to Blacks or Hispanics who had no association or increased association with ED visits. There are several possible explanations for this finding. Whites, compared to Blacks and Hispanics, tend to have favorable sociodemographic characteristics including having a family member with a higher educational level, high income, employment, and insurance. Therefore, CAMs may be concomitantly used with prescribed asthma medications rather than being used as a substitute (46, 47). Another possibility is that among different CAM being used, they may be using CAM with more evidence of benefit (e.g. yoga) (31, 48).

Among Black participants, we found no relationship between CAM use and asthma exacerbations or ED visit for asthma exacerbation. Based on our study findings, it is likely that disparities in asthma control between Blacks and Whites are not arising from CAM use but rather from other adherence-related or environmental factors driven by socioeconomic characteristics. This is contrary to another study which has suggested that CAM use among Blacks is high (49).

One noticeable finding is that CAM use among Hispanic participants is associated with an increased asthma exacerbations but not ED visits for asthma exacerbation. The increased odds of asthma exacerbation without an association with ED visit may be arising from Hispanics avoiding ED visits when they are experiencing an asthma exacerbation. Another interesting finding is that use of 'natural products' or 'other complementary approaches' as an independent variable showed that these specific types of CAM were contributing to the disparity in asthma exacerbation. Studies have identified high percentages of Hispanics using unconventional CAM, including "zumos" and "mal ojos", which are frequently used as a substitute for Western medicine and thus could result in poor asthma management (15, 50). Another explanation for the increased odds of asthma exacerbation among Hispanics is limited English proficiency. In this study, we found one-fifth of the Hispanic participants to have limited English proficiency, which is commonly associated with poor medication adherence, negative perception of conventional asthma medication, and patient-physician communication barriers (51, 52).

Our study found that CAM use may be associated with asthma exacerbation and this depends on the type of CAM use examined. Use of 'natural products', such as vitamins, herbals, or minerals

was associated with decreased ED visits for asthma exacerbation but use of ‘other complementary approaches’ was associated with increased ED visits. Based on sociodemographic characteristics associated with the CAM use, it is possible that those who are more health-conscious may be taking more ‘natural products’ or practicing mind and body exercises (46, 47). If this is the case, then use of ‘natural products’ may be an indirect marker for self-caring behavior that is preventing asthma exacerbation. We also noted that the use of ‘other complementary approaches’, such as hypnosis and Ayurveda, were very low among survey participants. Future study is needed to explore how cultural backgrounds and distrust towards conventional medications factor into specific types of CAM use for disease management.

This study has several limitations. Because this is an analysis of cross-sectional data, we cannot establish causal relationships. We hypothesized that CAM use would be associated with increased asthma exacerbations and ED visits because CAM use is associated with poor adherence to asthma medications (28, 29). This assumes the effect directionality from CAM use to asthma control. However, our study finding does not preclude the reverse causality in which poor asthma control has triggered participants to rely more on CAM for asthma management. We also do not know if the CAM survey participants are using CAM for asthma treatment or for other medical conditions. Further information regarding whether CAM is being used either to complement or replace prescribed asthma medications or for other medical conditions would indicate how CAM is affecting adherence. This will need to be explored in longitudinal studies measuring whether CAM use was negatively affecting adherence and subsequent exacerbations. Another limitation of the data is lack of clinical information such as current prescribed asthma medications, medication adherence, asthma severity, or results of pulmonary function tests. However, it is likely that those who visited the ED had similar asthma severity (53). The survey asks questions about various types of CAM use, but may be still missing less commonly used CAM, including folk remedies. Lastly, this study is limited by self-reported information and shared method variance.

Conclusion

We found wide variations in CAM use, types of CAM used, and associations with asthma outcomes among asthma patients from different racial and ethnic groups. Future studies are needed to understand why there are different associations between CAM use and asthma exacerbation among different racial/ethnic groups. It will be important to investigate what cultural factors contribute to decisions to use CAM for asthma treatment and whether it is being used as a complement or substitute for prescribed asthma medications. This is particularly important among Hispanics because CAM use appears to be associated with an increased risk of asthma exacerbation.

None of the authors have a conflict of interest.

The views expressed in this article are those of the authors and do not necessarily represent the views of the Donald and Barbara Zucker School of Medicine at Hofstra/Northwell and Boston University.

References

1. CDC-Asthma <https://www.cdc.gov/asthma/default.htm>: CDC.gov; 2018 [April 1, 2018]. Available from: <https://www.cdc.gov/asthma/default.htm>.
2. Carr W, Zeitel L, Weiss K. Variations in asthma hospitalizations and deaths in New York City. *Am J Public Health*. 1992;82(1):59-65. Epub 1992/01/01. PubMed PMID: 1536336; PMCID: PMC1694413.
3. Homa DM, Mannino DM, Lara M. Asthma mortality in U.S. Hispanics of Mexican, Puerto Rican, and Cuban heritage, 1990-1995. *Am J Respir Crit Care Med*. 2000;161(2 Pt 1):504-9. Epub 2000/02/15. doi: 10.1164/ajrccm.161.2.9906025. PubMed PMID: 10673193.
4. Akinbami LJ, Schoendorf KC. Trends in childhood asthma: prevalence, health care utilization, and mortality. *Pediatrics*. 2002;110(2 Pt 1):315-22. Epub 2002/08/08. PubMed PMID: 12165584.
5. Hunninghake GM, Weiss ST, Celedon JC. Asthma in Hispanics. *Am J Respir Crit Care Med*. 2006;173(2):143-63. Epub 2005/10/08. doi: 10.1164/rccm.200508-1232SO. PubMed PMID: 16210666; PMCID: PMC2662985.
6. Gupta RS, Carrion-Carire V, Weiss KB. The widening black/white gap in asthma hospitalizations and mortality. *J Allergy Clin Immunol*. 2006;117(2):351-8. Epub 2006/02/08. doi: 10.1016/j.jaci.2005.11.047. PubMed PMID: 16461136.
7. Eisner MD, Katz PP, Yelin EH, Shiboski SC, Blanc PD. Risk factors for hospitalization among adults with asthma: the influence of sociodemographic factors and asthma severity. *Respir Res*. 2001;2(1):53-60. Epub 2001/11/01. doi: 10.1186/rr37. PubMed PMID: 11686864; PMCID: PMC56211.
8. Canino G, McQuaid EL, Rand CS. Addressing asthma health disparities: a multilevel challenge. *J Allergy Clin Immunol*. 2009;123(6):1209-17; quiz 18-9. Epub 2009/05/19. doi: 10.1016/j.jaci.2009.02.043. PubMed PMID: 19447484; PMCID: PMC2693441.
9. Williams DR, Sternthal M, Wright RJ. Social determinants: taking the social context of asthma seriously. *Pediatrics*. 2009;123 Suppl 3:S174-84. Epub 2009/04/16. doi: 10.1542/peds.2008-2233H. PubMed PMID: 19221161; PMCID: PMC3489274.
10. Robinson JC. Exposure to occupational hazards among Hispanics, blacks and non-Hispanic whites in California. *Am J Public Health*. 1989;79(5):629-30. Epub 1989/05/01. PubMed PMID: 2631689; PMCID: PMC1349507.
11. Apter AJ, Reisine ST, Affleck G, Barrows E, ZuWallack RL. Adherence with twice-daily dosing of inhaled steroids. Socioeconomic and health-belief differences. *Am J Respir Crit Care Med*. 1998;157(6 Pt 1):1810-7. Epub 1998/06/25. doi: 10.1164/ajrccm.157.6.9712007. PubMed PMID: 9620910.

12. Apter AJ, Boston RC, George M, Norfleet AL, Tenhave T, Coyne JC, Birck K, Reisine ST, Cucchiara AJ, Feldman HI. Modifiable barriers to adherence to inhaled steroids among adults with asthma: it's not just black and white. *J Allergy Clin Immunol*. 2003;111(6):1219-26. Epub 2003/06/06. PubMed PMID: 12789220.
13. Williams LK, Joseph CL, Peterson EL, Wells K, Wang M, Chowdhry VK, Walsh M, Campbell J, Rand CS, Apter AJ, Lanfear DE, Tunceli K, Pladevall M. Patients with asthma who do not fill their inhaled corticosteroids: a study of primary nonadherence. *J Allergy Clin Immunol*. 2007;120(5):1153-9. Epub 2007/10/16. doi: 10.1016/j.jaci.2007.08.020. PubMed PMID: 17936894.
14. Wu AC, Butler MG, Li L, Fung V, Kharbanda EO, Larkin EK, Vollmer WM, Miroshnik I, Davis RL, Lieu TA, Soumerai SB. Primary adherence to controller medications for asthma is poor. *Ann Am Thorac Soc*. 2015;12(2):161-6. Epub 2015/01/09. doi: 10.1513/AnnalsATS.201410-459OC. PubMed PMID: 25569765; PMCID: PMC4342835.
15. Bearison DJ, Minian N, Granowetter L. Medical management of asthma and folk medicine in a Hispanic community. *J Pediatr Psychol*. 2002;27(4):385-92. Epub 2002/05/03. PubMed PMID: 11986361.
16. McQuaid EL. Barriers to medication adherence in asthma: The importance of culture and context. *Ann Allergy Asthma Immunol*. 2018;121(1):37-42. Epub 2018/03/28. doi: 10.1016/j.anai.2018.03.024. PubMed PMID: 29580846.
17. National Institute of Health Center for Complementary and Integrative Health- Complementary, Alternative, and Integrative Health: What's in a Name? <https://nccih.nih.gov/health/integrative-health> [August 1, 2018]. Available from: <https://nccih.nih.gov/health/integrative-health>
18. Slader CA, Reddel HK, Jenkins CR, Armour CL, Bosnic-Anticevich SZ. Complementary and alternative medicine use in asthma: who is using what? *Respirology*. 2006;11(4):373-87. Epub 2006/06/15. doi: 10.1111/j.1440-1843.2006.00861.x. PubMed PMID: 16771907.
19. Metcalfe A, Williams J, McChesney J, Patten SB, Jette N. Use of complementary and alternative medicine by those with a chronic disease and the general population--results of a national population based survey. *BMC Complement Altern Med*. 2010;10:58. Epub 2010/10/20. doi: 10.1186/1472-6882-10-58. PubMed PMID: 20955609; PMCID: PMC2967501.
20. Morgan W, Center H, Arms-Chavez C, LoBello SG. Complementary and alternative medicine use and asthma: relation to asthma severity and comorbid chronic disease. *J Asthma*. 2014;51(3):333-8. Epub 2013/12/07. doi: 10.3109/02770903.2013.871559. PubMed PMID: 24304047.
21. Chen W, Fitzgerald JM, Rousseau R, Lynd LD, Tan WC, Sadatsafavi M. Complementary and alternative asthma treatments and their association with asthma control: a population-based

study. *BMJ Open*. 2013;3(9):e003360. Epub 2013/09/06. doi: 10.1136/bmjopen-2013-003360. PubMed PMID: 24005131; PMCID: PMC3773646.

22. Blanc PD, Kuschner WG, Katz PP, Smith S, Yelin EH. Use of herbal products, coffee or black tea, and over-the-counter medications as self-treatments among adults with asthma. *J Allergy Clin Immunol*. 1997;100(6 Pt 1):789-91. Epub 1998/01/23. PubMed PMID: 9438488.

23. Blanc PD, Trupin L, Earnest G, Katz PP, Yelin EH, Eisner MD. Alternative therapies among adults with a reported diagnosis of asthma or rhinosinusitis : data from a population-based survey. *Chest*. 2001;120(5):1461-7. Epub 2001/11/20. PubMed PMID: 11713120.

24. Pachter LM, Cloutier MM, Bernstein BA. Ethnomedical (folk) remedies for childhood asthma in a mainland Puerto Rican community. *Arch Pediatr Adolesc Med*. 1995;149(9):982-8. Epub 1995/09/01. PubMed PMID: 7655603.

25. Roy A, Lurslurchachai L, Halm EA, Li XM, Leventhal H, Wisnivesky JP. Use of herbal remedies and adherence to inhaled corticosteroids among inner-city asthmatic patients. *Ann Allergy Asthma Immunol*. 2010;104(2):132-8. Epub 2010/03/24. doi: 10.1016/j.anai.2009.11.024. PubMed PMID: 20306816; PMCID: PMC2946361.

26. Shen J, Oraka E. Complementary and alternative medicine (CAM) use among children with current asthma. *Prev Med*. 2012;54(1):27-31. Epub 2011/10/22. doi: 10.1016/j.ypmed.2011.10.007. PubMed PMID: 22015560.

27. George M, Topaz M, Rand C, Sommers MLS, Glanz K, Pantalon MV, Mao JJ, Shea JA. Inhaled corticosteroid beliefs, complementary and alternative medicine, and uncontrolled asthma in urban minority adults. *J Allergy Clin Immunol*. 2014;134(6):1252-9. Epub 2014/09/15. doi: 10.1016/j.jaci.2014.07.044. PubMed PMID: 25218286; PMCID: PMC4261037.

28. McQuaid EL, Fedele DA, Adams SK, Koinis-Mitchell D, Mitchell J, Kopel SJ, Seifer R, Jandasek B, Fritz GK, Canino G. Complementary and alternative medicine use and adherence to asthma medications among Latino and non-Latino white families. *Acad Pediatr*. 2014;14(2):192-9. Epub 2014/03/08. doi: 10.1016/j.acap.2013.09.006. PubMed PMID: 24602583; PMCID: PMC3950892.

29. Philp JC, Maselli J, Pachter LM, Cabana MD. Complementary and alternative medicine use and adherence with pediatric asthma treatment. *Pediatrics*. 2012;129(5):e1148-54. Epub 2012/04/12. doi: 10.1542/peds.2011-2467. PubMed PMID: 22492763; PMCID: PMC4074611.

30. Nagarathna R, Nagendra HR. Yoga for bronchial asthma: a controlled study. *Br Med J (Clin Res Ed)*. 1985;291(6502):1077-9. Epub 1985/10/19. PubMed PMID: 3931802; PMCID: PMC1417003.

31. Sodhi C, Singh S, Dandona PK. A study of the effect of yoga training on pulmonary functions in patients with bronchial asthma. *Indian J Physiol Pharmacol*. 2009;53(2):169-74. Epub 2010/02/02. PubMed PMID: 20112821.

32. National Health Interview Survey <https://www.cdc.gov/nchs/nhis/index.htm>: Center for Disease Control and Prevention; 2012 [April 26, 2018].
33. Koithan M. Introducing Complementary and Alternative Therapies. *J Nurse Pract.* 2009;5(1):18-20. Epub 2010/01/05. doi: 10.1016/j.nurpra.2008.10.012. PubMed PMID: 20046927; PMCID: PMC2754854.
34. Dubay LC, Lebrun LA. Health, behavior, and health care disparities: disentangling the effects of income and race in the United States. *Int J Health Serv.* 2012;42(4):607-25. Epub 2013/02/02. doi: 10.2190/HS.42.4.c. PubMed PMID: 23367796.
35. Ginde AA, Espinola JA, Camargo CA, Jr. Improved overall trends but persistent racial disparities in emergency department visits for acute asthma, 1993-2005. *J Allergy Clin Immunol.* 2008;122(2):313-8. Epub 2008/06/10. doi: 10.1016/j.jaci.2008.04.024. PubMed PMID: 18538382; PMCID: PMC3538825.
36. Litonjua AA, Carey VJ, Weiss ST, Gold DR. Race, socioeconomic factors, and area of residence are associated with asthma prevalence. *Pediatr Pulmonol.* 1999;28(6):394-401. Epub 1999/12/10. PubMed PMID: 10587412.
37. Halm EA, Wisnivesky JP, Leventhal H. Quality and access to care among a cohort of inner-city adults with asthma: who gets guideline concordant care? *Chest.* 2005;128(4):1943-50. Epub 2005/10/21. doi: 10.1378/chest.128.4.1943. PubMed PMID: 16236839.
38. Cabana MD, Lara M, Shannon J. Racial and ethnic disparities in the quality of asthma care. *Chest.* 2007;132(5 Suppl):810S-7S. Epub 2007/12/06. doi: 10.1378/chest.07-1910. PubMed PMID: 17998345.
39. Kapadia SG, Wei C, Bartlett SJ, Lang J, Wise RA, Dixon AE, American Lung Association Asthma Clinical Research C. Obesity and symptoms of depression contribute independently to the poor asthma control of obesity. *Respir Med.* 2014;108(8):1100-7. Epub 2014/06/21. doi: 10.1016/j.rmed.2014.05.012. PubMed PMID: 24947900; PMCID: PMC4130899.
40. Executive summary of the clinical guidelines on the identification, evaluation, and treatment of overweight and obesity in adults. *Arch Intern Med.* 1998;158(17):1855-67. Epub 1998/10/06. PubMed PMID: 9759681.
41. Variance Estimation Guidance, NHIS 2006-2015 (Adapted from the 2006-2015 NHIS Survey Description Documents) <https://www.cdc.gov/nchs/data/nhis/2006var.pdf>: CDC; 2016 [August 9, 2018]. Available from: <https://www.cdc.gov/nchs/data/nhis/2006var.pdf>.
42. Holm S. A Simple Sequentially Rejective Multiple Test Procedure. *Scandinavian Journal of Statistics.* 1979;6(2):65-70.

43. Eisenberg DM, Davis RB, Ettner SL, Appel S, Wilkey S, Van Rompay M, Kessler RC. Trends in alternative medicine use in the United States, 1990-1997: results of a follow-up national survey. *JAMA*. 1998;280(18):1569-75. Epub 1998/11/20. PubMed PMID: 9820257.
44. Kessler RC, Davis RB, Foster DF, Van Rompay MI, Walters EE, Wilkey SA, Kaptchuk TJ, Eisenberg DM. Long-term trends in the use of complementary and alternative medical therapies in the United States. *Ann Intern Med*. 2001;135(4):262-8. Epub 2001/08/21. PubMed PMID: 11511141.
45. Rhee SM, Garg VK, Hershey CO. Use of complementary and alternative medicines by ambulatory patients. *Arch Intern Med*. 2004;164(9):1004-9. Epub 2004/05/12. doi: 10.1001/archinte.164.9.1004. PubMed PMID: 15136310.
46. Davis MA, West AN, Weeks WB, Sirovich BE. Health behaviors and utilization among users of complementary and alternative medicine for treatment versus health promotion. *Health Serv Res*. 2011;46(5):1402-16. Epub 2011/05/11. doi: 10.1111/j.1475-6773.2011.01270.x. PubMed PMID: 21554272; PMCID: PMC3207184.
47. Rhee TG, Marottoli RA, Van Ness PH, Tinetti ME. Patterns and Perceived Benefits of Utilizing Seven Major Complementary Health Approaches in U.S. Older Adults. *J Gerontol A Biol Sci Med Sci*. 2018;73(8):1119-24. Epub 2018/05/03. doi: 10.1093/gerona/gly099. PubMed PMID: 29718133; PMCID: PMC6037109.
48. Yang ZY, Zhong HB, Mao C, Yuan JQ, Huang YF, Wu XY, Gao YM, Tang JL. Yoga for asthma. *Cochrane Database Syst Rev*. 2016;4:CD010346. Epub 2016/04/27. doi: 10.1002/14651858.CD010346.pub2. PubMed PMID: 27115477.
49. Sidora-Arcoleo K, Yoos HL, McMullen A, Kitzman H. Complementary and alternative medicine use in children with asthma: prevalence and sociodemographic profile of users. *J Asthma*. 2007;44(3):169-75. Epub 2007/04/25. doi: 10.1080/02770900701209640. PubMed PMID: 17454333.
50. Risser AL, Mazur LJ. Use of folk remedies in a Hispanic population. *Arch Pediatr Adolesc Med*. 1995;149(9):978-81. Epub 1995/09/01. PubMed PMID: 7655602.
51. Federman AD, Wolf M, Sofianou A, Wilson EA, Martynenko M, Halm EA, Leventhal H, Wisnivesky JP. The association of health literacy with illness and medication beliefs among older adults with asthma. *Patient Educ Couns*. 2013;92(2):273-8. Epub 2013/03/26. doi: 10.1016/j.pec.2013.02.013. PubMed PMID: 23523196; PMCID: PMC3720706.
52. Wisnivesky JP, Krauskopf K, Wolf MS, Wilson EA, Sofianou A, Martynenko M, Halm EA, Leventhal H, Federman AD. The association between language proficiency and outcomes of elderly patients with asthma. *Ann Allergy Asthma Immunol*. 2012;109(3):179-84. doi: 10.1016/j.anai.2012.06.016. PubMed PMID: 22920072.

53. Boudreaux ED, Emond SD, Clark S, Camargo CA, Jr., Multicenter Airway Research Collaboration I. Race/ethnicity and asthma among children presenting to the emergency department: differences in disease severity and management. *Pediatrics*. 2003;111(5 Pt 1):e615-21. Epub 2003/05/03. PubMed PMID: 12728120.

Table 1. Characteristics of asthma survey participants by race/ethnicity (weighted %)

	All (n=2,736)	White (n=1,670)	Black (n=513)	Hispanic (n=364)	Asian (n=91)	P-value
Sociodemographic characteristics						
Male	37.3	37.4	35.1	35.6	57.0	0.09
Age groups (years old)						
18-39	40.7	36.2	48.4	53.0	42.6	<0.01
40-54	25.8	26.9	25.6	19.7	26.4	
55-64	17.9	19.7	15.1	14.2	10.5	
65+	15.5	17.2	10.5	13.1	20.5	
Education						
Completed college or greater	33.9	36.7	23.5	20.9	58.0	<0.01
Higher than high school	38.6	38.5	39.7	41.3	28.2	
High school or equivalent	19.2	19.2	23.1	20.4	7.2	
Less than high school	8.2	5.6	13.7	17.4	6.6	
BMI group						
Underweight	2.2	2.1	0.6	3.7	1.0	<0.01
Normal	29.2	29.9	27.7	21.2	45.4	
Overweight	28.4	27.6	29.8	30.8	33.3	
Obese	40.3	40.3	41.9	44.3	20.2	
Currently employed	51.5	53.5	48.5	44.9	51.5	0.14
Low income	20.6	15.9	34.2	34.6	13.4	<0.01
No insurance	6.3	6.1	8.1	7.2	1.6	0.12
Limited English proficiency	2.9	0.3	0.0	21.3	11.5	-
Asthma characteristics						
Asthma attack (past 1yr)	48.7	48.5	48.3	53.9	41.8	0.37
ED visit for asthma (past 1yr)	11.9	9.4	22.1	16.1	4.5	<0.01
Medical care						
Have a healthcare provider	74.1	76.8	65.8	68.3	71.0	<0.01

Had a healthcare visit	8.3	7.2	9.0	11.4	11.5	0.10
------------------------	-----	-----	-----	------	------	------

Table 2. Descriptive analysis of complementary and alternative medicine use (within the past 12 months) among asthma participants by race/ethnicity (weighed %)

	All (n=2,736)	White (n=1,670)	Black (n=513)	Hispanic (n=364)	Asian (n=91)	P-value
CAM use	58.5	62.8	46.9	45.4	62.3	<0.01
Natural products						
Herbal	21.4	24.3	12.0	12.6	22.3	<0.01
Vitamin	40.3	44.4	31.0	26.7	40.9	<0.01
Mineral	33.6	36.5	23.5	29.1	28.5	<0.01
Mind and body exercises						
Yoga	15.8	17.6	9.3	9.3	22.9	<0.01
Taichi	4.5	4.9	2.5	3.8	6.2	0.33
Qigong	1.2	1.1	0.3	1.9	1.0	0.18
Other complementary approaches						
Massage	3.3	3.2	4.5	2.8	2.3	0.70
Acupuncture	0.2	0.2	0.0	0.0	1.0	-
Other	1.0	1.2	0.6	0.1	0.0	-

* Other includes energy healing therapy, naturopathy, hypnosis, biofeedback, Ayurveda, chelation therapy, or craniosacral therapy

Table 3. Characteristics associated with CAM use among asthma participants, using multivariable logistic regression analysis, adjusting for race/ethnicity, gender, age groups, educational level, BMI, employment, income, insurance, limited English proficiency, and having a healthcare provider. Results reported as odds ratios [95% confidence interval].

	Types of CAM			
	All	Natural products	Mind and body exercises	Other complementary approaches
Race/ethnicity (reference: non-Hispanic White)				
Black	0.63 [0.49-0.81]*	0.62 [0.48-0.79]*	0.53 [0.35-0.79]*	1.43 [0.76-2.85]
Hispanic	0.66 [0.48-0.92]*	0.72 [0.52-1.01]	0.72 [0.44-1.20]	0.63 [0.21-1.92]
Asian	1.06 [0.56-2.03]	1.01 [0.55-1.86]	1.10 [0.60-2.01]	0.74 [0.26-2.15]
Male	0.57 [0.45-0.71]*	0.59 [0.47-0.74]*	0.45 [0.33-0.63]*	0.61 [0.37-1.03]
Age group (reference: 18-39 years old)				
40-54	1.51 [1.12-2.03]*	1.77 [1.33-2.35]*	0.85 [0.60-1.19]	1.71 [0.98-3.00]
55-64	1.76 [1.31-2.35]*	2.17 [1.62-2.90]*	0.63 [0.44-0.92]*	1.42 [0.70-2.92]
65+	1.68 [1.21-2.33]*	2.23 [1.60-3.12]*	0.40 [0.25-0.66]*	2.17 [1.05-4.46]*
Education (reference: less than high school)				

Completed college or greater	2.50 [1.68-3.72]*	2.39 [1.64-3.47]*	6.69 [2.54-17.59]*	3.72 [1.07-12.95]*
Higher than high school	1.66 [1.15-2.41]*	1.69 [1.18-2.43]*	2.61 [0.97-7.06]	3.77 [1.15-12.34]*
High school or equivalent	1.26 [0.86-1.86]	1.42 [0.97-2.08]	1.42 [0.51-3.97]	2.54 [0.76-8.52]
BMI group (reference: normal BMI)				
Underweight	1.10 [0.49-2.48]	1.39 [0.61-3.16]	0.61 [0.25-1.51]	2.50 [0.74-8.52]
Overweight	1.01 [0.77-1.33]	1.11 [0.85-1.45]	0.49 [0.36-0.69]*	1.11 [0.62-1.97]
Obese	1.00 [0.78-1.30]	1.13 [0.88-1.45]	0.46 [0.34-0.62]*	0.75 [0.43-1.31]
Currently employed	0.92 [0.73-1.15]	0.95 [0.76-1.18]	0.85 [0.62-1.15]	2.16 [1.25-3.72]*
Low income	1.22 [1.02-1.45]*	1.15 [0.97-1.37]	1.10 [0.82-1.48]	0.76 [0.49-1.17]
No insurance	1.12 [0.78-1.60]	1.11 [0.77-1.60]	0.86 [0.53-1.42]	0.47 [0.19-1.13]
Limited English proficiency	0.66 [0.37-1.18]	0.64 [0.36-1.14]	0.44 [0.14-1.40]	2.97 [0.64-13.72]
Have a healthcare provider	1.46 [1.16-1.85]*	1.50 [1.17-1.93]*	1.13 [0.85-1.50]	1.84 [1.09-3.12]*

* P-value<0.05

Table 4. Characteristics associated with CAM use among asthma participants, using multivariable logistic regression analysis (Results reported as odds ratios [95% confidence interval].)**

	Outcome: CAM use			
	All	Natural products	Mind and body exercises	Other complementary approaches
Model 1 (including asthma exacerbation in the model)				
Race/ethnicity (reference: non-Hispanic White)				
Black	0.64 [0.49-0.82]*	0.62 [0.48-0.80]*	0.53 [0.35-0.79]*	1.52 [0.79-2.90]
Hispanic	0.67 [0.48-0.93]*	0.73 [0.53-1.02]	0.72 [0.44-1.20]	0.63 [0.21-1.90]
Asian	1.06 [0.56-2.02]	1.01 [0.55-1.86]	1.10 [0.60-2.01]	0.83 [0.30-2.31]
Asthma exacerbation	0.99 [0.79-1.24]	1.02 [0.82-1.26]	0.98 [0.75-1.29]	1.87 [1.20-2.91]*
Model 2 (including ED visit for asthma exacerbation in the model)				
Race/ethnicity (reference: non-Hispanic White)				
Black	0.66 [0.51-0.86]*	0.64 [0.50-0.83]*	0.54 [0.36-0.81]*	1.47 [0.77-2.83]
Hispanic	0.66 [0.48-	0.73 [0.52-1.01]	0.72 [0.44-1.20]	0.65 [0.21-1.98]

	0.92]**			
Asian	1.04 [0.54-1.99]	0.99 [0.53-1.83]	1.08 [0.59-1.99]	0.79 [0.28-2.23]
ED visit for asthma exacerbation	0.65 [0.46-0.93]*	0.69 [0.48-0.98]*	0.66 [0.38-1.12]	1.45 [0.78-2.67]

* P-value<0.05

** Adjusting for race/ethnicity, gender, age groups, educational level, BMI, employment, income, insurance, limited English proficiency, and having a healthcare provider. Model 1 also controls for asthma exacerbation and model 2 controls for ED visit for asthma exacerbation.

Table 5. Characteristics associated with asthma exacerbation determined by multivariable logistic regression, adjusting for gender, age, educational level, BMI, employment, income, insurance, limited English proficiency, and having a healthcare provider. Results reported as Odds ratio [95% confidence interval].

	Outcome: Asthma exacerbation			
	All	White	Black	Hispanic
Types of CAM				
All types of CAM	0.99 [0.79-1.25]	0.99 [0.76-1.30]	0.87 [0.63-1.21]	1.43 [0.98-2.09]**
Natural products	1.02 [0.83-1.26]	1.03 [0.80-1.33]	0.89 [0.63-1.24]	1.22 [0.83-1.80]
Mind and body exercises	0.99 [0.75-1.29]	0.92 [0.67-1.26]	1.70 [0.87-3.32]	0.90 [0.49-1.68]
Other complementary approaches	1.90 [1.21-2.97]*	2.06 [1.19-3.55]*	1.34 [0.49-3.90]	3.53 [0.72-17.29]
	Outcome: ED visit for asthma exacerbation			
	All	White	Black	Hispanic
All types of CAM	0.65 [0.45-0.93]*	0.50 [0.32-0.78]*	0.72 [0.43-1.20]	1.48 [0.81-2.71]
Natural products	0.68 [0.48-0.97]*	0.50 [0.32-0.78]*	0.90 [0.54-1.50]	1.46 [0.76-2.80]
Mind and body exercises	0.65 [0.39-1.09]**	0.55 [0.31-0.97]*	0.77 [0.23-2.55]	0.61 [0.14-2.62]
Other complementary approaches	1.49 [0.80-2.77]	1.26 [0.52-3.03]	1.24 [0.31-4.86]	2.55 [0.87-7.49]

* P-value<0.05

** P-value<0.10