

Clinical Communications

Recent trends in current asthma prevalence among US adults, 2009-2018

Yun Zhou, PhD^{a,b}, and Yuewei Liu, MD, PhD^c

Clinical Implications

- The prevalence of current asthma in US adults aged 20 years or older significantly increased between 2009 and 2014 and flattened out between 2015 and 2018. These findings highlight the need for sustained attention to adult asthma prevention and control.

As a major public health concern, asthma affected 339.4 million people worldwide in 2016.¹ Previous studies have estimated asthma prevalence among US adults using data from the National Health and Nutrition Examination Survey (NHANES),² the National Health Interview Survey,³ and the Behavioral Risk Factor Surveillance System⁴; however, the changes in adult asthma prevalence after 2010 remain less clear. We analyzed the continuous NHANES data to obtain a comprehensive understanding of the trends in current asthma prevalence among US adults between 2009 and 2018.

The continuous NHANES included a series of nationally representative interviews and health examinations through cycles of 2-year intervals since 1999. In each cycle, a sample representative of the civilian noninstitutionalized resident population of the United States was selected using a complex, stratified, multi-stage probability cluster sampling design. To estimate the trends in prevalence of current asthma between 2009 and 2018, we included the recent 5 cycles of NHANES data (ie, cycles 2009-2010, 2011-2012, 2013-2014, 2015-2016, and 2017-2018) in this analysis. Participants 20 years or older were asked “Has a doctor or other health professional ever told you that you have asthma?” A participant with a positive answer was then asked “Do you still have asthma?” to identify whether the participant currently had asthma. We excluded those with missing responses to either question in the final analysis. The NHANES was approved by the National Center for Health Statistics Research Ethics Review Board, and all the adult participants enrolled had written consent.

To obtain comparable prevalence of the 5 cycles, we applied the 2000 US Census population as the standard age distribution and estimated age-adjusted asthma prevalence in each survey cycle overall and by demographic and clinical covariates including sex, race, education, family income-to-poverty ratio (FIPR), and family history of asthma with appropriate sample weights to compensate for unequal probabilities of selection and participant nonresponse. Participants with missing responses

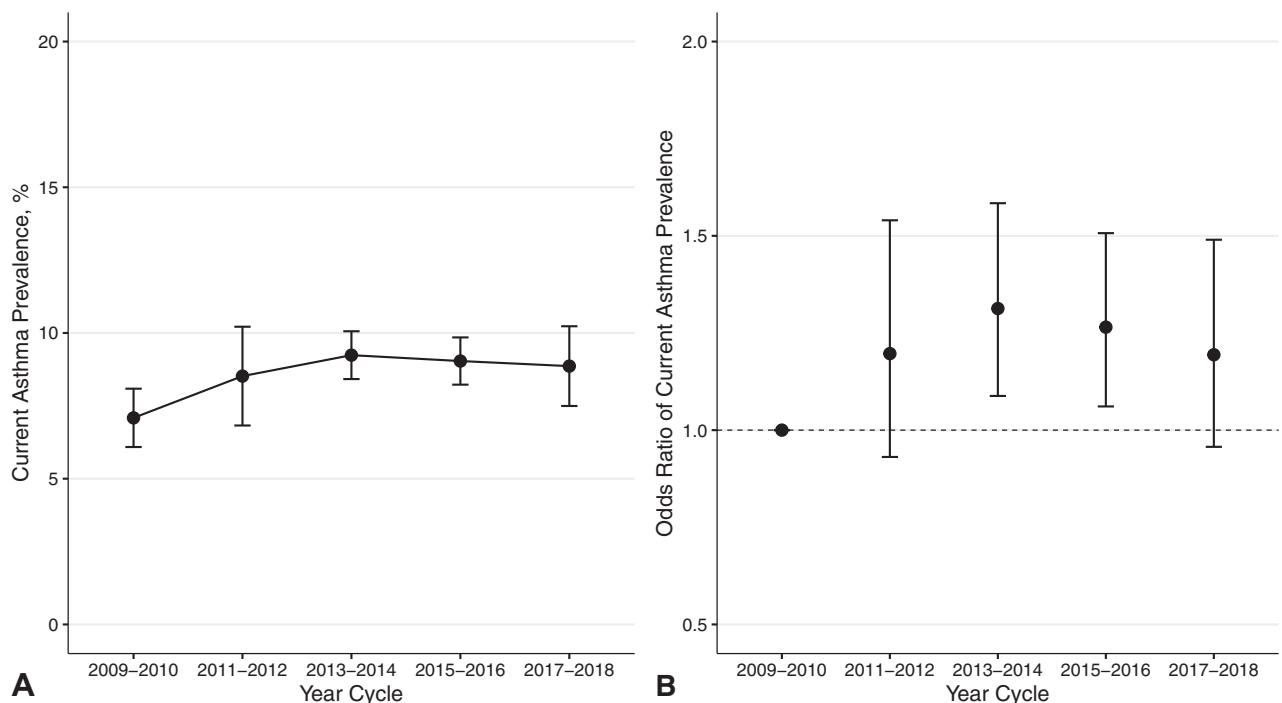


FIGURE 1. (A) Prevalence of current asthma and **(B)** weighted associations of survey cycle and prevalence of current asthma among participants 20 years or older in the United States (2001-2018). Error bars indicate 95% CIs. Asthma prevalence was adjusted for age on the basis of 2000 US Census population. Odds ratios of asthma prevalence were analyzed using weighted logistic regression models, adjusting for age, sex, race/ethnicity, education level, poverty income ratio, and family history of asthma.

TABLE I. Trends in current asthma prevalence among participants 20 y or older in the United States by demographic and clinical covariates (2009-2018)

Covariate	Prevalence, % (95% CI)*					FDR for linear trend†	P value for nonlinear trend
	2009-2010	2011-2012	2013-2014	2015-2016	2017-2018		
Current asthma/ participants,‡ n	476/6191	464/5542	525/5751	488/5703	515/5546		
Sex							
Male	5.0 (3.9-6.1)	7.0 (5.3-8.8)	6.4 (5.2-7.6)	6.1 (4.9-7.3)	5.5 (4.6-6.4)	0.66	.03
Female	9.0 (7.7-10.3)	9.9 (7.9-12.0)	11.9 (10.5-13.2)	11.8 (9.9-13.7)	12.0 (9.6-14.4)	0.34	.19
Race/ethnicity							
Mexican-American	3.3 (2.1-4.5)	4.6 (2.6-6.6)	6.5 (5.5-7.5)	4.8 (3.5-6.1)	6.9 (4.5-9.4)	0.18	.46
Other Hispanic	7.2 (5.3-9.1)	7.9 (5.9-9.9)	7.8 (5.5-10.0)	7.3 (5.4-9.3)	8.8 (7.0-10.7)	0.87	.86
Non-Hispanic white	7.1 (6.0-8.3)	9.3 (7.1-11.6)	9.8 (8.7-10.8)	10.0 (8.9-11.2)	8.6 (6.5-10.7)	0.67	.009
Non-Hispanic black	10.4 (7.7-13.2)	9.5 (8.0-11.0)	11.1 (8.9-13.4)	10.4 (8.4-12.4)	11.8 (9.3-14.3)	0.42	.63
Other	5.9 (3.6-8.3)	5.8 (4.0-7.6)	7.7 (5.6-9.7)	8.1 (5.0-11.3)	10.2 (5.2-15.2)	0.18	.62
Education level							
High school or below	8.2 (6.3-10.2)	8.2 (5.9-10.5)	8.4 (6.6-10.3)	9.4 (7.6-11.2)	10.1 (6.0-14.2)	0.31	.70
High school graduate	7.5 (5.6-9.4)	8.7 (5.2-12.2)	9.7 (7.1-12.3)	8.0 (6.2-9.8)	9.6 (7.1-12.1)	0.42	.59
College or above	6.6 (5.6-7.6)	8.6 (6.3-10.9)	9.2 (8.3-10.1)	9.3 (8.1-10.5)	8.3 (6.7-9.8)	0.39	.008
FIPR§							
<1	11.2 (7.7-14.7)	12.6 (10.1-15.1)	12.1 (9.7-14.5)	13.0 (10.4-15.5)	13.8 (9.8-17.9)	0.58	.80
≥1	6.6 (5.7-7.5)	7.6 (5.7-9.6)	8.9 (8.0-9.9)	8.5 (7.6-9.4)	8.4 (7.0-9.7)	0.39	.03
Family history of asthma							
Yes	16.0 (12.6-19.4)	19.6 (15.9-23.3)	18.6 (16.4-20.7)	20.7 (18.3-23.2)	19.2 (15.4-23.0)	0.16	.24
No	4.8 (4.1-5.5)	5.5 (4.2-6.9)	6.8 (5.9-7.6)	5.5 (4.7-6.4)	5.4 (4.3-6.6)	0.34	.03

*Current asthma prevalence was age-adjusted on the basis of 2000 US Census population.

†False-discovery rate (FDR) was used to adjust *P* values for linear trends by the linear step-up method of Benjamini and Hochberg, and analyzed by including the midpoint of each cycle as a continuous variable in weighted logistic regression models, adjusting for age (20-39/40-59/≥60 y), sex (male/female), race/ethnicity (Mexican-American/Other Hispanic/non-Hispanic white/non-Hispanic black/Other), education level (high school or below/high school graduate/college or above/unknown), poverty income ratio (<1/≥1/unknown), and asthma family history (yes/no/unknown).

‡Current asthma was defined according to positive answers to both “Has a doctor or other health professional ever told you that you have asthma?” and “Do you still have asthma?”

§Participants were categorized into 3 groups including below poverty (<1), at or above poverty (≥1), and those with missing responses (unknown) according to the FIPR.

were classified into an “unknown” group for each covariate in the analysis, including 43 (0.2%), 2985 (10.4%), and 620 (2.2%) missing responses for education level, FIPR, and asthma family history, respectively. Linear trends in asthma prevalence between 2009 and 2018 overall and by subgroup were analyzed by including the midpoint of each cycle as a continuous variable in weighted logistic regression model, with adjustment for age, sex, race/ethnicity, education, FIPR, and family history of asthma. Nonlinear trend was further tested by including orthogonal polynomial (quadratic and cubic) time variables in the models. Logistic regression model was also used to estimate odds ratios for each survey cycle, with the cycle 2009 to 2010 as the reference. Estimates for prevalence, trends, and the odds ratios were calculated by PROC SURVEYREG and PROC SURVEYLOGISTIC, accounting for differential weighting and the correlation among sample persons within a cluster. All analyses were performed using SAS version 9.4 (SAS Institute, Cary, NC).

Figure 1 shows the trends in prevalence of current asthma among participants 20 years or older in the United States between 2009 and 2018. Among 28,733 participants who completed the interview, 2468 were defined as having current asthma. The age-adjusted prevalence of current asthma in the cycles 2009 to 2010, 2011 to 2012, 2013 to 2014, 2015 to 2016, and 2017 to 2018 were 7.1% (95% CI, 6.1%-8.1%), 8.5% (95% CI, 6.8%-10.2%), 9.2% (95% CI, 8.4%-10.1%), 9.0% (95% CI, 8.2%-9.8%), and 8.9% (95% CI, 7.5%-10.2%), respectively (Figure 1).

Compared with the cycle 2009 to 2010, the odds ratios for current asthma prevalence in cycles 2011 to 2012, 2013 to 2014, 2015 to 2016, and 2017 to 2018 were 1.20 (95% CI, 0.93-1.54), 1.31 (95% CI, 1.09-1.58), 1.27 (95% CI, 1.06-1.51), and 1.19 (95% CI, 0.96-1.49), respectively. We found significant nonlinear trend in current asthma prevalence between 2009 and 2018 (*P* for linear trend = .11; *P* for quadratic trend = .03, *P* for cubic trend = .78), with a peak in the cycle 2013 to 2014. The prevalence increased monotonically between 2009 and 2014 (*P* for linear trend = .006) and flattened out in the period 2015 to 2018 (*P* for linear trend = .53). Table I summarized both linear and nonlinear trends in the prevalence of current asthma among US adults by demographic and clinical covariates. Only nonlinear trend for current asthma between 2009 and 2018 was observed in male, non-Hispanic whites, participants with higher education or higher FIPR, and those without family history of asthma.

These findings update estimates on nationwide trends in current asthma prevalence among US adults between 2009 and 2018. We noted that the trend significantly increased between 2009 and 2014 and flattened out between 2015 and 2018, which might be due to the leveling off of prevalence among groups that previously had large increases in the prevalence of asthma, including male, non-Hispanic whites, participants with higher education or higher FIPR, or those without family history of asthma. The leveling off of prevalence may benefit from guideline implementation, increasing quality of care, and public

health action to control asthma-related risk factors including smoking, air pollution, and obesity. Nevertheless, it should be noted that the prevalence of current asthma reached 8.9% in the cycle 2017 to 2018, which doubled in the recent 25 years² and highlights the needs for sustained attention to adult asthma prevention and control. The main limitation in this study is that the definitions of current asthma were based on self-reported information rather than medical records. Bias inherent in ascertaining prevalence estimates likely results in estimates that may vary from true current asthma prevalence.

^aState Key Laboratory of Respiratory Disease, The First Affiliated Hospital of Guangzhou Medical University, Guangzhou, China

^bSchool of Public Health, Guangzhou Medical University, Guangzhou, China

^cDepartment of Epidemiology, School of Public Health, Sun Yat-sen University, Guangzhou, Guangdong, China

This work was supported by the National Natural Science Foundation of China (grant no.81803189).

Received for publication December 19, 2019; revised April 15, 2020; accepted for publication April 16, 2020.

Available online ■ ■

Corresponding author: Yuewei Liu, MD, PhD, Department of Epidemiology, School of Public Health, Sun Yat-sen University, 74 Zhongshan Second Rd, Guangzhou, Guangdong 510080, China. E-mail: liuyuewei@mail.sysu.edu.cn.

2213-2198

© 2020 American Academy of Allergy, Asthma & Immunology

<https://doi.org/10.1016/j.jaip.2020.04.041>

REFERENCES

1. GBD 2016 Disease and Injury Incidence and Prevalence Collaborators. Global, regional, and national incidence, prevalence, and years lived with disability for 328 diseases and injuries for 195 countries, 1990-2016: a systematic analysis for the Global Burden of Disease Study 2016. *Lancet* 2017; 390:1211-59.
2. Arif AA, Delclos GL, Lee ES, Tortolero SR, Whitehead LW. Prevalence and risk factors of asthma and wheezing among US adults: an analysis of the NHANES III data. *Eur Respir J* 2003;21:827-33.
3. Akinbami LJ, Moorman JE, Bailey C, Zahran HS, King M, Johnson CA, et al. Trends in asthma prevalence, health care use, and mortality in the United States, 2001-2010. *NCHS Data Brief*; 2012:1-8.
4. Bhan N, Kawachi I, Glymour MM, Subramanian SV. Time trends in racial and ethnic disparities in asthma prevalence in the United States from the Behavioral Risk Factor Surveillance System (BRFSS) study (1999-2011). *Am J Public Health* 2015;105:1269-75.