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Effect of Asthma Call-back Survey methodology changes on work-related asthma estimates, 19 states, 2007–2012

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Abstract

Objective: Asthma Call-back Survey methodology has been changed recently, as a new sampling design, weights calculation (2011–2012), and revised work-related asthma (WRA) section (2012) were implemented. To assess the effect of these changes on the WRA and possible WRA estimates among ever-employed adults with current asthma, we analyzed 2007–2012 data for 37 505 ever-employed adults (≥ 18 years) collected from 19 US states (representing an estimated 10 million adults each year). **Methods:** Using data from landline telephone (LLP) households, we calculated estimates applying poststratification weights (2007–2010) and “raking” weights (2011–2012). Also, using data from LLP/cellular telephone (CP) households combined, we calculated estimates applying “raking” weights (2012). **Results:** Based on LLP household data, the WRA estimates ranged from 7.8% to 9.7% during 2007–2010, was 9.1% in 2011 and 15.4% in 2012. Possible WRA estimates ranged from 35.1% to 38.1% during 2007–2010, was 38.1% in 2011 and 39.8% in 2012. Using the 2012 LLP/CP household data, the WRA and possible WRA estimates were 15.4% and 38.9%, respectively. **Conclusions:** Implementation of “raking” weights did not substantially change the WRA or possible WRA estimates among ever-employed adults with current asthma. The WRA and possible WRA estimates based on LLP and LLP/CP samples in 2012 were comparable, as CP users are younger and less likely to have WRA. The substantial upward shift in the 2012 WRA estimates likely was associated with the revision to the WRA section.

Keywords

Asthma Call-back Survey, Behavioral Risk Factor Surveillance System, cellular telephone, occupational health, poststratification, raking, work-related asthma

History

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Introduction

Asthma is a chronic disease of the airways affecting 8.2% of adults (18.7 million) in the US in 2010 [1]. Work-related asthma (WRA) is asthma that is caused or made worse by exposures at work, such as chemicals, smoke, dust, fumes or mold [2]. WRA is associated with a change or loss of employment, loss of wages, increased unscheduled healthcare visits, more frequent symptoms and poor health-related quality of life [3–5]. The American Thoracic Society estimated that 15% of adult asthma (range 4–58%) is attributable to workplace exposures [6] and an estimated 22% of adult asthma is pre-existing asthma worsened by conditions at work [7].

The Behavioral Risk Factor Surveillance System (BRFSS) is an ongoing telephone survey among the non-institutiona-

lized US civilian population aged ≥ 18 years designed to collect state- and US territory-specific information on preventive health practices and risk behaviors [8]. The survey includes a standardized core questionnaire asked by all states and territories, and optional modules with a set of questions that address specific topic. In addition, individual states develop and add questions to address topics important for the state programs. The Asthma Call-back Survey (ACBS) is an optional module, conducted 2 weeks after the BRFSS interview, designed to collect additional data on asthma and WRA from BRFSS participants who indicate they have ever been told by a health professional they have asthma [9].

The proportion of adults in cellular telephone (CP)-only households has been increasing in the US, and in 2012 was 36.2% [10]. Specific subpopulations, such as renters, males, those at or near the federal poverty level and young adults (18–34 years), are more likely to live in CP-only households and may not be interviewed when a solely landline telephone (LLP) household sample is used [11–13]. Estimates produced from telephone surveys that exclude CP-only households may be biased because CP-only households often are representative of populations with greater risk factors [13,14]. In

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addition, BRFSS response rates have been decreasing over time [13]. To address concerns over the increasing proportion of CP-only households and decreasing response rates, the BRFSS and ACBS methodologies have been adjusted, including a new methodology of weighting data and the addition of CP households in their samples [13].

Before 2011, to calculate population estimates, weights for survey responses were developed using a method called “poststratification”, which is a process of standardization that simultaneously adjusts data to known population proportions of geographic region, race, gender and age based on Census data. In 2011, poststratification was replaced by a new method called iterative proportional fitting or “raking”, which adjusts in an iterative process to known population proportions based on census data using more demographic variables than poststratification [13,15]. Raking reduces non-response bias and provides estimates that are more representative of the population [13,15].

In 2011, CP households were incorporated by all states into the BRFSS sample and by six states into the ACBS sample [13]. In 2012, CP households were incorporated by 22 states into the ACBS sample and the data are available for analyses. Approximately 20% of completed BRFSS interviews in 2012 were conducted with CP respondents [8,13].

In addition to the new weighting process and the inclusion of CP households in the sample, some questions in the ACBS WRA section were reordered and revised in 2012 to facilitate better understanding of the questions among respondents (Table 1) [9]. The phrase “outside the home” was removed from the question addressing respondents’ employment. The WRA diagnosis question, “Were you ever told by a doctor or other health professional that your asthma was related to any job you ever had?”, was reworded to “Have you ever been told by a doctor or other health professional that your asthma was caused by, or your symptoms made worse by, any job you ever had?”. The four questions addressing asthma caused or made worse by exposures at respondents’ current or previous job were reworded and re-ordered. In particular, the phrase related to occupational exposures, “chemicals, smoke, fumes

or dust” was replaced with “chemicals, smoke, dust or mold”.

The enhancements to the ACBS methodology may affect prevalence estimates. The CDC recommends that estimates produced after the methodology changes not be compared to those produced previously [13]. The objective of this study was to better understand the effect of these methodology changes on estimates of the proportion of WRA and possible WRA among ever-employed adults with current asthma.

Methods

We used ACBS data on adults aged ≥18 years from 19 states (California, Hawaii, Illinois, Indiana, Iowa, Michigan, Montana, Nebraska, Nevada, New Hampshire, New Mexico, New York, Ohio, Oklahoma, Oregon, Texas, Vermont, Washington and Wisconsin) that consistently collected LLP household data each year from 2007 to 2012 and also included CP households in 2012. The median response rates for these 19 states ranged from 44.9% in 2012 to 52.0% in 2010 for BRFSS and from 47.2% in 2012 to 57.1% in 2007 for ACBS. A surveillance exemption has been granted to BRFSS from the Institutional Review Board at the Centers for Disease Control and Prevention; states participating in BRFSS are subject to the Institutional Review Board requirements of their state.

Adults with current asthma were participants who responded “yes” to both “Has a doctor, nurse, or other health professional ever told you that you had asthma?” and “Do you still have asthma?” Ever-employed individuals were respondents who described their employment as “employed full-time”, “employed part-time” or as having ever been employed (outside the home) (Table 1). Respondents with WRA were those who were ever told by a doctor or other health professional that their asthma was related to any job they ever had. Respondents with possible WRA were those who did not have health-professional diagnosed WRA and indicated that their asthma was caused by or made worse by either “chemicals, smoke, fumes or dust” or “chemicals, smoke, dust or mold” in their current or previous job (Table 1).

Table 1. Revisions to the ACBS WRA section questions phrasing and order, 2007–2012.

Measure	2007–2011	2012
Ever-employed WRA	Have you ever been employed outside the home? Were you ever told by a doctor or other health professional that your asthma was related to any job you ever had?	Have you ever been employed? Have you ever been told by a doctor or other health professional that your asthma was caused by, or your symptoms made worse by, any job you ever had?
Possible WRA ^a	Was your asthma caused by chemicals, smoke, fumes or dust in your current job? Is your asthma made worse by chemicals, smoke, fumes or dust in your current job? Was your asthma caused by chemicals, smoke, fumes or dust in any previous job you ever had? Was your asthma made worse by chemicals, smoke, fumes or dust in any previous job you ever had?	Are your asthma symptoms made worse by chemicals, smoke, dust, or mold in your current job? Was your asthma first caused by things like chemicals, smoke, dust, or mold in your current job? Were your asthma symptoms made worse by things like chemicals, smoke, dust, or mold in any previous job you ever had? Was your asthma first caused by things like chemicals, smoke, dust, or mold in any previous job you ever had?

ACBS, Asthma Call-back Survey; WRA, work-related asthma.
^aQuestion order changed in 2012.

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Table 2. Proportion of WRA and possible WRA among ever-employed adults with current asthma by year, weight and sample type – 19 states^a, 2007–2012.

Year	Weight type	Sample	WRA		Possible WRA	
			%	95% CI	%	95% CI
2007	Poststratification	LLP	9.7	7.9, 11.5	38.1	34.9, 41.2
2008	Poststratification	LLP	7.8	6.7, 8.9	37.0	34.1, 39.8
2009	Poststratification	LLP	9.4	7.9, 10.9	35.1	32.4, 37.8
2010	Poststratification	LLP	8.5	6.9, 10.0	36.3	33.5, 39.0
2011	“Raking”	LLP	9.1	7.1, 11.2	38.1	34.9, 41.3
2012	“Raking”	LLP	15.4	12.8, 17.9	39.8	36.1, 43.6
2012	“Raking”	LLP and CP	15.4	13.2, 17.6	38.9	36.0, 41.8

CI, confidence interval; CP, cellular telephone; LLP, landline telephone; WRA, work-related asthma.
^aCalifornia, Hawaii, Illinois, Indiana, Iowa, Michigan, Montana, Nebraska, Nevada, New Hampshire, New Mexico, New York, Ohio, Oklahoma, Oregon, Texas, Vermont, Washington and Wisconsin.

Statistical analyses

Analyses were conducted using SAS® software version 9.3 (SAS Institute Inc., Cary, NC) survey procedures to address the complex sampling. Data were weighted to account for non-response differences in the sample and unequal probability of sample selection. Using data from LLP households, we calculated estimates first by applying weights produced by “poststratification” method to 2007–2010 data, then by applying weights produced by “raking” method to 2011 and 2012 data [13,15]. Next, we calculated estimates by applying weights produced by “raking” method to the 2012 combined LLP/CP household data. We estimated proportions (95% confidence intervals [CIs]). Estimates were considered not reliable if the relative standard error was >30% or if an estimate was based on a sample of <50 respondents [9]. Differences in estimates were considered statistically significant if 95% CIs did not overlap.

Results

A total of 53 788 adults aged ≥18 years participated in the ACBS in 19 states during 2007–2012. Among these, 14 034 did not have current asthma, 910 were never employed and 1339 had missing information on employment or asthma and were excluded from the study. The remaining 37 505 participants (representing an estimated annual 10 million individuals) were ever-employed adults with current asthma.

Using LLP household data, among ever-employed adults with current asthma the WRA estimate ranged from 7.8% in 2008 to 9.7% in 2007; the estimate was 9.1% in 2011, and 15.4% in 2012. Using 2012 combined LLP/CP household data, among ever-employed adults with current asthma the WRA estimate was 15.4% (Table 2).

Using LLP household data, among ever-employed adults with current asthma the possible WRA estimate ranged from 35.1% in 2009 to 38.1% in 2007; the estimate was 38.1% in 2011, and 39.8% in 2012. Using 2012 combined LLP/CP household data, among ever-employed adults with current asthma the possible WRA estimate was 38.9% (Table 2).

With one exception, no significant changes were observed in the characteristics, such as sex, age, race, education level,

household income, insurance coverage, current employment status and smoking status, of ever-employed adults with WRA and possible WRA over time and between the 2012 LLP and combined LLP/CP households (Supplemental Tables S1 and S2). The notable exception was the estimated proportion of college graduates among those with possible WRA significantly decreased from 32.8% in 2010 to 23.0% in 2011.

The estimated proportion of ever-employed adults with current asthma that had WRA and possible WRA by state remained comparable from 2007 to 2011. There was an upward shift in the estimates in 2012, but no change occurred with the addition of CP households to the LLP sample (Supplemental Tables S3 and S4).

Discussion

This study showed that estimates of the proportion of WRA and possible WRA among ever-employed adults with current asthma remained unchanged for the period 2007–2010 and for 2011, but increased in 2012. The introduction of weights produced by the “raking” method in 2011 did not substantially affect the WRA or possible WRA estimates among ever-employed adults with current asthma. The WRA estimates substantially increased in 2012 compared with previous years, however. In 2012, CP households were included in the survey sample (the proportion of CP-only households among the 19 states included in this study ranged from 23.5% in New York to 44.5% in Texas) [9,10]. However, the WRA and possible WRA estimates among ever-employed adults with current asthma did not differ between the 2012 LLP and LLP/CP combined households, thus, the inclusion of CP households likely did not increase the proportion of adults with WRA and possible WRA in the sample. Individuals in CP households tend to be younger [13] and adults with WRA and possible WRA tend to be 45–64 years [4], which may explain why adding CP households did not affect estimates.

Other studies corroborate our findings that the use of “raking” weights and inclusion of CP households in the sample does not change asthma-related estimates [16,17]. Using 2008 BRFSS data from 18 states, Hu et al. determined that estimates of 9 out of 16 health indicators were biased when CP households were excluded; however, the prevalence

of ever having asthma among adults was not affected [17]. Using 2010 and 2011 BRFSS data from Kentucky, Kanotra and Siameh found that although inclusion of CP households and introduction of “raking” weighting methodology in 2011 affected estimates of several chronic diseases and health behaviors, the prevalence of current asthma among adults did not change significantly [16]. Although the use of “raking” did not affect the estimates of WRA and possible WRA, a significant change occurred in the proportion of college graduates among those with possible WRA in 2011, suggesting a correction for certain demographic factors, such as education, not previously included in poststratification weighting, with the use of raking weighting.

As the WRA estimates based on LLP and LLP/CP samples in 2012 were comparable, the overall upward shift in 2012 WRA estimates among ever-employed adults with current asthma was likely associated with the revisions to the ACBS WRA section. In 2012, the WRA question specifically asked if respondents had been told that their asthma was “caused by, or your symptoms made worse by” any job. Previously the question asked if their asthma was “related to” any job. The new wording of the WRA question may be a more sensitive method for identifying WRA cases.

This study has some limitations. Information on asthma was self-reported and was not validated by medical records or follow up with health care providers, thus, estimates may be subject to misclassification bias. No information was available to assess validity and reliability of the 2012 WRA questionnaire compared with previous years. In addition, no single year data were available to directly compare the effects of the two weighting methods. Moreover, the data used in this analysis are limited to adults living in 19 states; therefore, the results are not representative nationally or of non-participating states. Finally, due to small sample sizes, estimates among some subpopulations had wide CIs and others were not reliable, thus, not reported.

Conclusions

New methods improve the coverage and representativeness of the ACBS; however, studies are needed to assess the reliability and validity of the new estimates, in particular, estimates based on increasing proportions of CP households. The 2012 estimates cannot be compared with those produced from prior data and should be interpreted with caution. Due to the multiple methodology changes, the 2012 estimates of the proportion of WRA and possible WRA among ever-employed adults with current asthma should be considered as a baseline for future analyses. Furthermore, although the upward shift in the WRA estimates was most likely due to the revisions to the ACBS WRA section, an increased incidence or recognition of WRA by health care providers or individuals cannot be ruled out. Future studies where ACBS methodology and WRA questions remain unchanged will determine if WRA estimates are increasing.

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Declaration of interest

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Supplementary material available online

Supplemental Tables S1–S4