# National Health and Nutrition Examination Survey: Impact of Declining Response Rates on Nonresponse Bias, 2013 – 2016, Executive Summary

## Purpose

This executive summary provides a general overview of a comprehensive analysis to evaluate the impact of unit nonresponse on the resulting survey estimates for the 2013–2014 and the 2015–2016 cycles of the National Health and Nutrition Examination Surveys (NHANES). A detailed report will be published in 2019.

## Background

Several national face-to-face surveys have experienced a recent decline in response rates. Survey response rate is a valuable data quality measure and the most widely used indicator of survey quality. A high response rate increases the likelihood that the survey accurately represents the target population. However, a lower response rate is not always associated with higher levels of bias in the estimates due to nonresponse, and the levels of nonresponse bias can differ for different estimates in the same survey. Nonresponse bias can be substantial when two conditions hold: (1) the response rate is relatively low, and (2) the difference between the characteristics of respondents and nonrespondents is relatively large.

Since 2011, the National Health and Nutrition Examination Surveys (NHANES) has observed continuous decreases in its overall response rate. A review of each of the survey stages (i.e. the screener, the in-home interview, and the MEC exam) has shown this decrease is largely occurring at the sampled person (SP) in-home interview.

In the NHANES 2013–2014 survey cycle, the screener response rate was 98.2%, where the screener response rate is calculated as the number of households that completed the screener divided by the number of occupied households. From the responding households, 14,332 persons were selected from

30 different study locations. Of those selected, 10,175 (71.0%) completed the interview questionnaire and 9,813 (68.5%) were examined. For the NHANES 2015–2016 survey cycle, the screener response rate was 94.3%. From the responding households, 15,327 persons were selected from 30 different study locations. Of those selected, 9,971 (65.1%) completed the interview questionnaire and 9,544 (62.3%) were examined. Both two-year survey cycles resulted in overall response rates that were lower than experienced in previous years of NHANES. Response rates by age and gender are available on the NHANES website and can be found at https://wwwn.cdc.gov/nchs/nhanes/ResponseRates.aspx.

To better understand the effects of nonresponse on NHANES, a detailed nonresponse bias analysis was conducted for the two most recent releases of the survey, namely, the 2013–2014 and the 2015–2016 cycles of NHANES. The final and comprehensive report will published in 2019. A brief description of the methods used and some of the conclusions are presented below.

## Methods and Findings in Brief

All analyses were performed for the overall population as well as for three analysis domains of interest: children ages 0 to 19, adults ages 20 to 59, and adults ages 60 and older. Nonresponse bias is variable dependent and the NHANES survey is designed to produce a wide variety of health estimates. For the purpose of this nonresponse bias analysis, we focused on potential nonresponse bias in five key survey outcomes for the majority of analyses:

1. Obesity among children and adults
    - Definition of obesity: BMI was calculated as weight in kilograms divided by height in meters squared, rounded to one decimal place. Obesity in adults aged 20 years and over was defined as a BMI of greater than or equal to 30. Obesity in youth aged 2-19 years was defined as a BMI of greater than or equal to the age- and sex-specific 95th percentile of the 2000 Centers for Disease Control and Prevention growth charts.

2. Hypertension among adults
    - Definition of hypertension: Hypertension among adults aged 20 years and over was defined as a mean systolic blood pressure of ≥140 mmHg, a mean diastolic blood pressure of ≥90 mmHg, or current use of medication to lower blood pressure.

3. High total cholesterol among adults
    - Definition of high total cholesterol: Serum total cholesterol greater than or equal to 240 mg/dL among adults aged 20 years and over.

4. Prevalence of diagnosed diabetes
    - Definition of diagnosed diabetes: Participants were classified as having diagnosed diabetes if they answered “yes” to the question: “Other than during pregnancy, have you ever been told by a doctor or health professional that you have diabetes or sugar diabetes?”

5. Mean of total birth weight
    - Definition of total birth weight: Birth weight is determined by a question about the weight of participants 15 years of age and younger at birth. If the answer is given in pounds and ounces, or kilograms or grams, then it is converted to ounces.

Since the key survey outcomes are unknown for the nonrespondents, many of the analyses relied on auxiliary variables that are known for the full sample. These auxiliary variables include area-level information from census data, information collected in the NHANES screener, and from external sources that were matched to each sampled unit.

Overall, eight analyses were conducted to examine nonresponse bias on NHANES. A brief description of each analysis is provided in Table 1.

**Table 1. Description of Nonresponse Bias Analyses Conducted for the 2013-2014 and the 2015-2016 Cycles of NHANES**

| | Analysis type | Description |
|---|---|---|
| 1 | Bivariate analysis of the relationship between response status and auxiliary variables | Response rates for subgroups of auxiliary variables were computed. Chi-square tests were used to detect a significant relationship between response indicator and the auxiliary variables of interest. |
| 2 | Multivariate analysis of the relationship between response status and auxiliary variables | A classification tree algorithm was used to evaluate the relationship between response status and multiple auxiliary variables. It used Chi-square tests to divide the sample into subgroups that best explain differential response rates.. |
| 3 | Calculation of the R-indicator | The Representativeness Indicator (R-indicator) was calculated as another measure to assess data quality prior to any nonresponse adjustment weighting. It is a function of the variation in response propensities and takes a value from 0 to 1. A high value means low variation in propensity scores, signifying that the sample respondents are highly representative of the target population. The R-indicator was compared over cycles of NHANES. |
| 4 | Evaluation of the effect of weighting adjustments on nonresponse bias | The effect of weighting procedures on reducing nonresponse bias in both auxiliary variables and outcomes was evaluated by comparing estimates before and after the weighting adjustments. |
| 5 | Correlations of weighting variables and outcome variables | Nonresponse weighting adjustments can be effective in reducing nonresponse bias in the survey outcomes, to the extent that the weighting variables and outcome variables are correlated, so the correlations between weighting and outcome variables were computed to evaluate this relationship. |
| 6 | Comparison of weighted survey estimates to external totals from NHIS and the American Community Survey (ACS) | Estimates produced from the NHANES survey were compared with estimates from NHIS and ACS and with estimates from prior years of NHANES. Large differences between the estimates from the NHANES survey (using the fully adjusted weights) and the other sources could indicate the potential for nonresponse bias. |

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| 7 | Calculation of the range of bias | Nonresponse adjustment procedures are based on the assumption that the mean value for nonrespondents is the same as that for respondents within a weighting cell. For this analysis, the assumption was varied to assess the impact on the outcome estimates. Within each nonresponse adjustment cell, nonrespondents were assumed to be at the low range of values or at the high range. The resulting estimates give an indication of the potential range of nonresponse bias. |
| 8 | Level-of-effort analysis | Estimates of outcome variables were computed by level-of-effort, as measured through response propensity. To the extent that the low propensity respondents are similar to the nonrespondents, differences in outcome estimates between the high and low propensity respondents could indicate nonresponse bias. |

The nonresponse bias analysis for the NHANES 2013–2014 and NHANES 2015–2016 survey cycles did not provide any evidence of substantial bias in the final survey estimates. We evaluated nonresponse bias prior to weighting adjustments using both bivariate and multivariate analyses to examine the relationship of response status to the auxiliary variables, and by examining the R-indicator. Then we evaluated the effects of the weighting adjustments on nonresponse bias by comparing differences in estimates between stages of weighting, and by examining correlations of auxiliary variables with outcomes. Finally, we evaluated nonresponse bias on final outcome statistics after weighting adjustments were implemented by comparing NHANES estimates to external data sources (i.e. The National Health Interview Survey (NHIS) and the American Community Survey (ACS)) and prior years of NHANES. We calculated the potential range of bias through a sensitivity analysis, and evaluated differences in a pre-specified set of outcome estimates for respondents when considering level-of-effort to obtain response.

In our evaluation of nonresponse bias prior to weighting adjustments, we reached the following conclusions:

- In the bivariate analysis, we showed that responding to the interview is significantly related to most or all of the variables considered for weighting and many additional auxiliary variables, both overall and for most items in the domain analyses by age group. Fewer auxiliary variables had a significant relationship to response at the exam level.

- In the multivariate analysis, the results are similar to those seen in the bivariate analyses. While these analyses provide evidence of nonresponse bias prior to weighting adjustments to the extent that the characteristics analyzed here are related to health, later analyses show that bias was reduced after weighting. Again, since there is very little nonresponse experienced between the interview and exam, the potential for bias at the exam stage is minimal.
- In the R-indicator analysis, there was no evidence that the nonresponse bias prior to any weighting adjustment for NHANES 2013–2014 and 2015–2016 is larger than that for NHANES 2011-2012, despite declining response rates. Overall and by domain, there are no significant differences of R-indicators over NHANES 2011–2012, 2013–2014, and 2015–2016 after considering the level of overlap between the 95 percent confidence intervals.

In our evaluation of the effects of the weighting adjustments on nonresponse bias, we reached the following conclusions:

- In our evaluation of differences in estimates across stages of weighting, the results indicate that few key estimates have large differences between stages for the interview and exam survey. However, in general, the full-sample estimates of the auxiliary variables were closer to the estimates after weighting adjustments than before weighting adjustments, which indicates bias in the auxiliary variables was reduced through the weighting process. The analysis also indicates a significant difference in diabetes and hypertension estimates before and after the weighting adjustments, which suggests that any bias in these two outcome variables was reduced through the weighting process to the extent that the outcomes are related to the auxiliary variables.
- In the analysis of correlations of auxiliary variables with outcomes, the overall and domain-based marginal correlations between input covariates and key survey outcome variables are generally not large, which means that the bivariate relationship between nonresponse adjustment variables and key survey outcome variables is generally not strong. When considering the weighting cells, correlations are stronger with key survey outcomes, hypertension in particular (followed by

obesity, diabetes, and mean birth weight), indicating that the combined set of auxiliary variables and interactions used in the weighting may be helping to reduce bias.

In our evaluation of nonresponse bias on final outcome statistics after weighting adjustments were implemented, we reached the following conclusions:

- When comparing NHANES to NHIS, in spite of declining response rates in both surveys and significant differences in some of the estimates, differences that were observed between estimates have not changed over time.
- When comparing NHANES to ACS, differences between the surveys for most of the characteristics are small. The differences that are observed, such as for the proportion of the population with a disability, can be explained by different modes of data collection, differences in survey questions, or differences in time periods. Furthermore, ACS is not a health survey; therefore, the reporting of health-related information may be underestimated.
- When comparing NHANES across cycles, changes in most of the estimates are minimal, and considerable changes over time appear to be real trends in the data.
- In the sensitivity analysis to evaluate the potential range of bias, for domains with high response rates, the potential for nonresponse bias in the key estimates is minimal, even if nonrespondents differ substantially from respondents. The possible range of bias is wider for domains with lower response rates, but the bounds are based on the extreme assumptions that the prevalence for all nonrespondents is either one half or 1.5 times that of respondents. Thus, the actual effect of nonresponse bias is expected to be much lower.
- In the level-of-effort analysis, birth weight increases as the response propensities decrease, but the weights somewhat adjusted for the trend. For high cholesterol, the percentages increase as the response propensities decrease. For the other outcome variables, this analysis does not show large changes in the estimates as response propensities decrease. To the extent that people with lower response propensities have similar health characteristics as nonrespondents, this analysis indicates estimates would not change much if nonrespondents were included.

## Conclusion

The nonresponse bias analysis for the NHANES 2013–2014 and NHANES 2015–2016 survey cycles did not provide any evidence of substantial bias in the final survey estimates. Although nonresponse bias cannot be completely ruled out, the analysis showed sample weighting effectively reduced the bias in auxiliary variables correlated with most outcome statistics.