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# Changes to the North Carolina Child Health Assessment and Monitoring Program Survey Methodology and Data Collection in 2011

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## Overview

The North Carolina Child Health Assessment and Monitoring Program (N.C. CHAMP) is a cross-sectional annual telephone survey that collects information about the health characteristics of children and adolescents from birth to age 17 in the state of North Carolina. N.C. CHAMP is designed to produce state-level prevalence estimates of various health indicators used to monitor child health status and identify child health priority areas. The 2011 N.C. CHAMP survey is conducted by the State Center for Health Statistics (SCHS) within the Chronic Disease and Injury Section of the North Carolina Division of Public Health. Funding for N.C. CHAMP is provided by the federal Maternal and Child Health Block Grant.

The purpose of this report is to document the recent changes to N.C. CHAMP methods for data collection, analysis and dissemination. Though the changes to the 2011 N.C. CHAMP sampling design and the weighting methodology are significant, they are limited in scope. Many parts of the N.C. CHAMP survey process in place in 2010, such as the questionnaire design process, interviewer training and evaluation and the call-back protocols for obtaining accurate measures of child height and weight, have been maintained in 2011 N.C. CHAMP.[1]

## Introduction

The mission of N.C. CHAMP is to fulfill a core public health surveillance need by supplying valid and reliable state-level statistical estimates on the health of North Carolina children. It is the only survey in North Carolina used to assess the health characteristics of approximately 2.2 million children in North Carolina from birth to age 17. The N.C. CHAMP survey has been conducted in both English and Spanish each year since 2005.

To carry out this surveillance role, N.C. CHAMP has established the following goals: 1) to monitor the status of child health (ages 0–17) and identify child health problems in North Carolina; 2) to measure parents' perspectives on child health issues; 3) to provide accurate and valid data to inform evidence-based decisions, strategies and policies to improve child health and 4) to assess relationships between parent health and child health, and inform family-centered approaches to improve child health.

The N.C. CHAMP survey is a callback survey to the North Carolina Behavioral Risk Factor Surveillance System (N.C. BRFSS) land-line telephone survey of adults. The national BRFSS is a state-based system of

health surveys conducted by the Centers for Disease Control and Prevention (CDC) that collects data about health practices associated with the leading causes of morbidity, mortality and disability in all 50 states, the District of Columbia and several U.S. Territories.[2] North Carolina has been participating in the national BRFSS since 1990.

During the N.C. BRFSS interview, households with children under 18 years of age are identified and recruited to participate in N.C. CHAMP. One child is selected at random from each household, and the adult most knowledgeable about the health of the selected child is interviewed during the follow-up N.C. CHAMP survey. Questions on the N.C. CHAMP survey address a wide variety of topics related to the child's health, including health care access, oral health, nutrition, physical activity, family involvement and parent opinion on topics such as childhood obesity. A total of 1,395 N.C. CHAMP interviews were completed based on the 2011 survey. Each year state-level prevalence estimates are disseminated through the SCHS website and a de-identified public-use data file is made available for research.

## Changes to Sampling Design

Until 2011, the N.C. BRFSS and N.C. CHAMP results were based on data obtained only from households with landline telephones. In response to the rapid rise in the percentage of U.S. households that use only cell phones, the national BRFSS included cell phone households in the sample for the first time in 2011. This fundamental change to the sampling frame was implemented to maintain the validity and coverage of the survey. As a result, new methods of developing the analytic survey weights were adopted as well. These changes to the N.C. BRFSS resulted in parallel changes to the N.C. CHAMP sample design and weighting methodology.

The 2011 N.C. CHAMP survey is the first time that a sufficient number of responses from households with cell phones have been collected to include when computing estimates of child health status. Previous studies have found differences in the health behaviors and demographic characteristics of cell phone households compared to landline populations and incorporating cell phone households into the sample frame is expected to improve the accuracy of the N.C. CHAMP estimates.[3,4] Additionally, there has been a rapid increase in the proportion of N.C. children living in cell phone households. The rate of children living in cell phone households doubled from 16 percent in 2007 to 34 percent in 2010.[3] Therefore, the inclusion of cell phone respondents into the N.C. CHAMP sample was necessary in order to maintain the validity of the survey results. In 2011, 41 percent of N.C. BRFSS cell phone respondents had one or more children under 18 living in the household compared to 25 percent of N.C. BRFSS landline respondents.

Three versions of the 2011 N.C. BRFSS questionnaire were used in North Carolina. Cell phone-only sample members received a version of the questionnaire different from the two versions given to landline sample members. Each version contained the CDC core items and differed by their optional modules and state-added questions. One of the landline versions of the questionnaire included an Asthma Follow-up module from the CDC which recruited adults with asthma to participate in a follow-up telephone survey. Contacted households were asked to participate in only one follow-up survey, therefore households that included an asthmatic adult were not recruited for N.C. CHAMP; resulting in a potential source of bias for N.C. CHAMP estimates. In 2011, 165 households with children were recruited for the Asthma Follow-up survey and were ineligible for N.C. CHAMP.

## Call Disposition and Outcome Rates

Changes to the 2011 N.C. CHAMP sampling design have an impact on the annual response, cooperation, refusal and contact rates. The response rate is the proportion of completed or partial interviews among all eligible respondents; the cooperation rate is the number of completed interviews among contacted respondents; the contact rate is the proportion of eligible respondents who were contacted and the refusal rate is the proportion of eligible respondents who refused to give an interview.

When some N.C. CHAMP-eligible households do not complete the N.C. CHAMP survey, there is a potential for the resulting child health estimates to be biased due to the non-response. While outcome rates alone are not sufficient to assess the accuracy of the data, the N.C.

CHAMP response, cooperation, contact and refusal rates presented below provide measures of the potential for non-response bias. Formulas used are given in Appendix 1 and are based on standard definitions developed by the American Association of Public Opinion Research (AAPOR).[5]

The overall response rate for the 2011 N.C. CHAMP survey was 46 percent, the cooperation rate was 77 percent, the refusal rate was 14 percent and the contact rate was 61 percent. The final call dispositions for 2011 N.C. CHAMP, as well as the outcome rates, are presented separately for cell phone, landline and all respondents in Table 1. Differences are apparent between the outcome rates for the cell phone sample households and those for households with a landline telephone. Outcome rates presented in Table 1 show that eligible N.C. BRFSS landline respondents had higher contact rates than cell phone respondents and—once contacted—were more likely to complete the N.C. CHAMP interview than cell phone respondents.

The 2011 N.C. CHAMP response, cooperation and contact rates have all decreased when compared to the 2010 N.C. CHAMP outcome rates. The 2011 N.C. CHAMP refusal rate has increased to 14 percent from 11 percent in 2010. Trends of decreasing response rates and increased refusal rates have been seen for decades in social and behavioral surveys and N.C. CHAMP is no exception.[6] It should be noted that the N.C. BRFSS respondents who declined the invitation to participate in N.C. CHAMP are considered non-contacts—a determination that impacts all outcome rates except the refusal rate.

## Methodological Changes to Development of Analytic Weights

Each record in the N.C. CHAMP dataset has an associated analytic weight which is necessary for valid statistical analyses. The use of weighted data adjusts the results of the sample to better represent the entire population of North Carolina, allowing N.C. CHAMP data to be used to compute state-level prevalence estimates. The method used to construct the analytic weights for both the 2011 N.C. BRFSS and 2011 N.C. CHAMP was changed from a post-stratification approach utilized in 2010 to an iterative proportional fitting, or raking, approach employed in 2011. With both raking and post-stratification approaches, adjustments are made to account for the unequal probabilities of selection due to: 1) the sampling method, 2) households with different numbers of residential telephone numbers, 3) different numbers of children in the home, 4) non-response among different demographic groups and 5) non-coverage of households without working telephones. The

### Table 1. Frequency of N.C. CHAMP Call Disposition and Response Rates by Telephone Type

| | 2011 Cell | 2011 Landline | 2011 Total | 2010 Total (Landline Only) |
|---|---|---|---|---|
| BRFSS Respondents Eligible for CHAMP | 427 | 2,577 | 3,004 | 3,335 |
| Eligible BRFSS declining or otherwise not contacted for CHAMP | 195 | 762 | 957 | 643 |
| Eligible BRFSS called for CHAMP | 232 | 1,815 | 2,047 | 2,692 |
| CHAMP completed/partial interviews | 85 | 1,310 | 1,395 | 2,004 |
| CHAMP refusal/early termination | 8 | 47 | 55 | 24 |
| CHAMP refusal | 74 | 298 | 372 | 337 |
| CHAMP non-contact | 63 | 150 | 213 | 317 |
| CHAMP language barrier/other | 2 | 10 | 12 | 10 |
| CHAMP Response Rate | 20% | 51% | 46% | 60% |
| CHAMP Cooperation Rate | 50% | 79% | 76% | 84% |
| CHAMP Refusal Rate | 19% | 13% | 14% | 11% |
| CHAMP Contact Rate | 40% | 65% | 61% | 71% |

approaches differ by their adjustment for non-response and non-coverage.

The post-stratification approach used to calculate the analytic weights for earlier N.C. CHAMP surveys employed estimates of the age, race and sex of the N.C. child population that were developed by an external vendor and provided by the CDC. In 2011, the CDC ceased providing the N.C. child population estimates for post-stratification weighting of the data and—along with the N.C. BRFSS—N.C. CHAMP transitioned to rake weighting methodology as well.

Developing the weights using a raking methodology facilitates the inclusion of cell phone responses, allows more auxiliary information to be incorporated into the weights and improves the reliability of the N.C. CHAMP results.[4] However, as a result of the changes in the weighting methodology, data from 2011 forward cannot accurately be compared to earlier findings.

## Weighting Formula

For landline respondents, the following weighting formula is used to calculate the sampling weight assigned to each child (_CHAMPWT):

$$\text{_CHAMPWT} = \text{STRWT} * (1 / \text{_impNPH}) * \text{CHILDREN} * \text{RAKEWT} \quad \text{Eq. 1}$$

Where, STRWT is the stratum weight which represents the number of records in a stratum divided by the number of records selected; _impNPH is the imputed number of residential telephone numbers in the respondent's household; CHILDREN is the number of children (less than 18 years of age) living in the respondent's household. Values for STRWT, _impNPH and CHILDREN are found in the N.C. BRFSS end-of-year file supplied by the CDC for all landline respondents. In 2011, the number of household phone lines was not asked of cell phone respondents and as a result, no value is given for _impNPH. For cell phone respondents it is assumed that the number of cell phones in the household is equal to the number of adult household members with a maximum of five; this assumption is unlikely to be true for all households. The product of STRWT, (1 / _impNPH) and CHILDREN is called the Child Base Weight.

RAKEWT is the weight used to account for non-response and non-coverage and to adjust the sample demographic characteristics to those of the estimated state population. The weights are computed using a procedure called raking or iterative proportional fitting. In the 2011 N.C. BRFSS, a split questionnaire design was used that recruited some N.C. CHAMP-eligible respondents to the Asthma Follow-up survey and excluded them from participation in N.C. CHAMP. No corresponding weighting adjustment was calculated to account for this feature of the 2011 N.C. CHAMP sampling design.

## Imputation for Weighting

Item non-response occurs when a respondent skips a question or otherwise fails to answer a question. When a N.C. CHAMP respondent has not answered the items necessary for development of the rake weights, the missing values are imputed using a tool called "Hotdeck imputation" and each missing value is replaced with one from a record with a similar profile of auxiliary variables. In 2011, values of Child Sex, Child Age and Child Race were imputed for 16 N.C. CHAMP records. The PROC HOTDECK (SUDAAN® v.10.0.1, RTI, 2010) implementation was used.

## Development of Rake Weights

Raking adjusts the child base weights to match population control totals for selected demographic variables obtained from an external source. Five demographic variables are used as control totals: 1) child sex, 2) child age, 3) child race/ethnicity, 4) parent educational attainment and 5) telephone ownership type. The control totals provide the number of children in each of the categories of a demographic variable. The population control totals for child sex, child age and child race/ethnicity used in developing the 2011 N.C. CHAMP weights were obtained from the 2011 Nielsen Child Population Report supplied by the CDC. The control totals for telephone ownership were obtained from the Blumberg estimates from the National Immunization Survey and those for parental educational attainment were obtained using the 2010 ACS 1-year Public Use Micro-data Sample (PUMS) person-level dataset.[7] Details on the development of the educational attainment control totals can be found in Appendix 2.

The program used to rake the 2011 N.C. CHAMP child weights is the IBF SAS® macro developed by Izrael and Battaglia of ABT Associates and accessible from the ABT website.[8,9] Raking is an iterative procedure and the SAS® macro continues to execute until the raked weights differ from the control totals by less than one unit. The 2011 N.C. CHAMP data converged after 28 iterations.

## Weight Trimming After Raking

Weight trimming is the process of increasing the value of very low weights and decreasing the value of very high weights. The effect of weight trimming is to reduce the variance of the weighted estimates but also could be a source of bias if the estimates produced from untrimmed and trimmed weights are different. The trimming method used for 2011 N.C. CHAMP is the Individual and Global Cap Value (IGCV) method that is incorporated into the IBF macro.[10] The IGCV trimming procedure is implemented during the iterative raking process and limits the change of individual weights to a user-specified upper and lower multiple of the input weights. In previous years, N.C. CHAMP used a trimming method of truncating the weights at the fifth and 95$^{th}$ percentiles before rescaling the weights to equal the population of N.C. children. When comparing the IGCV method to the truncation trimming method using 2011 N.C. CHAMP, the increase in variance that the extreme weights contribute (unequal weighting effect) is lower for the truncation method than the IGCV method (2.175 versus 2.999). However, the IGCV method seemed to reduce the bias of the post-trimmed estimates (as measured by the mean squared error for several selected measures). The IGCV method also has the additional advantage that the final weights match those of the marginal control totals.

## Changes to Web Tables and Data Dissemination

Detailed data tables for N.C. CHAMP survey items are posted on the SCHS website on an annual basis (www.schs.state.nc.us/SCHS/champ/results.html). State level estimates are available for survey items tabulated by characteristics of the child, including sex, race, Hispanic origin, age group, school enrollment type (public/private), grade level, health insurance status, Special Health Care Needs status, as well as parental education level. Rows of the Web tables present results for children sharing demographic characteristics (e.g., results for male and female children will be in separate rows), columns of the Web tables represent the various survey response options, and individual cells are the intersection of a demographic category row and response option column.

In 2011, criteria were established to improve the reliability of the data results disseminated on the Web tables. The criteria were modeled after similar criteria used to present national BRFSS Prevalence and Trends Data and the National Crime Victimization Survey.[11] For every cell of the Web tables, three additional data elements were computed: the confidence interval (CI) half-width of the point estimate, the number of respondents in the Web table row and the number of respondents in the Web table cell. Table results are displayed only when all of the following criteria are met: 1) the CI half-width was less than 20 percentage points, 2) the number of respondents in the row was greater than 49 and 3) the number of respondents in a table cell was greater than nine. Data results that failed to meet any of the three reliability criteria above were suppressed in the Web table outputs and indicated by three asterisks, (***).

The structure of N.C. CHAMP Web tables can be modified in ways that increases the reliability of estimates (and reduces data suppression) by combining Web table rows and response categories. Tables for which many data results were suppressed were restructured to minimize data suppression. Combining rows increases the number of respondents in the row and decreases the size of the CI half-width. Since response categories with few respondents will result in low cell counts, combining Web table columns can reduce the data suppressed for that reason. As an example, the 2010 N.C. CHAMP Web table for the duration of exclusive breastfeeding presented rates for five response categories: “Less than one month,” “one to three months,” “four to five months,” “six months to one year” and “one plus year” and three racial categories: “White,” “African American” and “Other Minorities.” As a result of the smaller sample size in 2011 relative to 2010, many of these estimates would have been suppressed in the 2011 N.C. CHAMP Web table. To reduce data suppression, we restructured the 2011 N.C. CHAMP Web table to present results for

two racial categories: "White" and "Other" and four response categories: "Less than one month," "one to three months," "four to five months" and "six months and longer." As a result, the reliability of the estimates was improved and less data suppression was necessary.

SUDAAN 10.0.1® (Research Triangle Institute, 2010) software was used to calculate the point estimates and confidence intervals. This software takes into account the complex sampling design when computing the variance, or sampling error, associated with the estimates. Respondents who refused to answer or did not know the answer to a survey question were excluded from calculation in the data tables.

## Summary

Since 2005, the N.C. CHAMP survey has served as a comprehensive surveillance system used to assess the health characteristics of North Carolina children and adolescents between ages 0 to 17. Beginning in 2011, the inclusion of cell phone respondents into the N.C. BRFSS sample frame resulted in changes to the N.C. CHAMP sampling design and modifications to the weighting methodology. This methodological change improves the reliability of the N.C. CHAMP estimates, but prevents the comparison of 2011 N.C. CHAMP data to earlier results.

More information including questionnaires, data tables and publications, is available on the SCHS website at www.schs.state.nc.us/SCHS/champ.

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## Appendix 1: Formulas Used to Compute the AAPOR Outcome Rates

$$RR6 = \frac{(I + P)}{(I + P) + (R + NC + O)} \quad \text{Eq. 1}$$

$$COOP2 = \frac{(I + P)}{(I + P) + (R + O)} \quad \text{Eq. 2}$$

$$REF3 = \frac{R}{(I + P) + (R + NC + O)} \quad \text{Eq. 3}$$

$$CON3 = \frac{(I + P) + R + O}{(I + P) + (R + O) + NC} \quad \text{Eq. 4}$$

Where:

RR6 = Response rate (AAPOR formula 6)
COOP2 = Cooperation rate (AAPOR formula 2)
REF3 = Refusal rate (AAPOR formula 3)
CON3 = Contact rate (AAPOR formula 3)
I = Complete interview
P = Partial interview
R = Refusal and break-off
NC = Non-contact
O = Other

## Appendix 2: Development of Educational Attainment Control Total

The distribution of parental educational attainment was calculated using the 2010 ACS 1-year Public Use Micro-data Sample (PUMS) person-level dataset. In the person-level file, all individuals that are in the same household share an identification number. The weighted distribution of the educational attainment for the head-of-household was computed for all households with children. In order to obtain the *percentage of children* residing in households of various levels of educational attainment, the child weight was used. The control totals are obtained by multiplying the Nielsen-supplied N.C. child population by the calculated percentages for each educational category.

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