Effective Conversion of Initial Item Nonresponse to Questions on Age and Income in a Telephone Survey

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Abstract

This paper evaluates techniques used in a telephone survey to "convert" initial item nonresponse in two questions: self-reported age and annual household income. The use of follow-up questions to initial "Don't know/Not sure" and "Refused" responses substantially reduced overall item nonresponse for both age and income. Initial nonresponse to self-reported age was 4.5%. A follow-up question to convert initial item nonresponse brought the proportion of cases without age data down to 0.3%, a 93.6% reduction. Use of a "critical value" follow-up reduced item nonresponse to household income from an initial level of 13.7% to 8.7%, a reduction of 33.7%. These techniques can reduce item nonresponse during data collection, reducing the potential for survey error.

Key Words: telephone survey, item nonresponse, survey error, age, income

1. Item nonresponse as a source of survey error and survey cost

Item nonresponse -- in which a unit is sampled and surveyed, but from which no valid data is obtained for a particular question -- has long been recognized as a source of survey error (Deming 1944). Differential item nonresponse (response error) can result in biased survey estimates, based on the level of nonresponse and the degree of difference between respondents and nonrespondents (Groves 1989). When used for post-survey weighting, a single variable can add bias across all survey estimates. Item nonresponse also increases survey costs (accuracy, time, effort, etc.) by decreasing the sample size available for estimation, with a resulting loss in precision. The impact of missing data on precision is even larger when the initial sample is small, or when nonresponse is concentrated in geographic or demographic subsamples.

2. Item nonresponse to age and income in health surveillance surveys

2.1 Item nonresponse to self-reported age

Levels of item nonresponse to self-reported age are generally low. Although survey respondents may be reluctant to report their age because of perceived or experienced ageism, or out of concern for loss of anonymity, the question requires only minimal cognitive burden. Age is strongly correlated, sometimes directly, with many health risks, behaviors, and conditions. As a result, age is an important covariate, so even low levels of item nonresponse can substantially contribute to survey error. In addition, Federal, state, and municipal health benefits and health initiatives are often targeted to specific ages, so the ability to identify robust age-specific estimates is important.

Item nonresponse to age can also be a complex source of survey error because of its role in weighting and age-adjustment of survey estimates. Age is a common dimension of post-stratification weighting to adjust for differential unit nonresponse. Separate from post-stratification weighting, estimates from health surveys are frequently age-adjusted to allow comparison to other populations with different age distributions. In both these ways, survey error in respondent age can affect analyses conducted on all survey variables, and thus have an amplified impact on survey error.

2.2 Item nonresponse to annual household income

Accurate measurement of household income is also important for health surveillance surveys, even though the causal link between income and health is sometimes indirect. Income is strongly correlated with many health behaviors and conditions, including smoking, drinking, having access to health insurance, and general physical and mental health. Similar to age, Federal, state, and municipal health benefits and initiatives often have income qualifications or population targets. Unlike age, questions on income and other financial information often have high levels of item nonresponse.

2.3 Item nonresponse in two health surveillance surveys

Table 1 provides item nonresponse levels to similar age and income questions asked in two related health surveillance surveys. Data from 2006 Behavioral Risk Factor Surveillance Systems (BRFSS), an annual health surveillance survey conducted by telephone in all 50 states, is shown for both the US overall and for New York State alone. The 2006 Community Health Survey (CHS) is New York City's annual health surveillance survey, and is modeled after the BRFSS. The BRFSS and CHS ask for respondent age the same way (see Table 2) and both ask for annual household income using a series of unfolding values. However, the BRFSS uses fixed dollar values regardless of household size, while the CHS asks about rounded dollar values that are multiples of the poverty level, filled in based on household size (CDC BRFSS 2006; NYC DOHMH 2006; US HHS 2006).

Table 1: Item nonresponse to age and annual household income, 2006 BRFSS and 2006 Community Health Survey	
Age in years	**"Don't know"/"Not sure"/"Refused" (%)**
2006 National Behavioral Risk Factor Surveillance System (BRFSS) (median)	1.1%
2006 New York State BRFSS	1.8%
2006 New York City Community Health Survey (CHS)	4.5%
Annual household income	
2006 National BRFSS (median)*	13.7%
2006 New York State BRFSS*	14.8%
2006 New York City CHS**	13.7%
* Nonresponse at any point across up to six unfolding values	
** Nonresponse to first of up to six unfolding values, asked where the number of children under the age of 18 living in the household was known. Data to permit a more direct comparison to the 2006 BRFSS results were unavailable	

3. Reducing item nonresponse

A variety of methods have been developed for asking questions about sensitive subjects in surveys, including financial information, with the goals of reducing reporting bias and error, including those due to item nonresponse. Skelton (1963, 38) summarizes common techniques to prevent item nonresponse to income-related questions, and these techniques are often used when surveys ask about other sensitive questions as well.

1. Place the item at the end of the survey
2. Provide a preface or rationale
3. Offer explicit value or range brackets rather than asking [respondents to provide] integer values
4. Offer unfolding brackets, one at a time
5. Ask about a "critical income" value

On the CHS, methods used to avoid initial item nonresponse to age and annual household income included placing both questions in the second half of the survey (#1, above), and for income, providing a preface (#2), then presenting explicit values (#3) as a series of unfolding brackets (#4).

To convert initial item nonresponse ("Don't Know/Not Sure" or "Refused") to age, respondents were provided a rationale for answering (#2) and then asked about age as four range brackets (#3). Initial item nonresponse to the first annual household income was followed by a question about a lower, and analytically important "critical income" value (#5). (See Table 2 for full question wordings.)

Table 2: Wording of initial age and income questions with follow-up to convert item nonresponse, 2006 CHS

<u>Age in years</u>

<u>Initial question</u>: What is your age? ___

<u>Item nonresponse conversion</u>: IF RESPONSE IS "DON'T KNOW/NOT SURE", OR "REFUSED", ASK We are only asking this information to make sure that we have talked to enough people in each age group. Can you just tell me if you are 65 or older, 45-64, 25-44, or 18-24?

<u>Annual household income</u>

<u>Initial question</u>: The next question is about your combined household income. By household income we mean the combined income from everyone living in the household including even roommates or those on disability income. Is your household's annual income from all sources less than $ [CALCULATED 200% OF POVERTY]?

<u>Item nonresponse conversion</u>: IF RESPONSE IS "DON'T KNOW/NOT SURE", OR "REFUSED", ASK Can you just tell me if your annual household income is less than $ [CALCULATED 100% OF POVERTY]?

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4. Data and methodology

Data from the 2006 Community Health Survey (CHS), New York City's annual health surveillance survey, were used to evaluate the impact of follow-up questions to reduce item nonresponse to age and income. The CHS is a telephone health-surveillance survey with a stratified random sample designed to provide estimates for 42 neighbourhoods and for the city overall. Data collection for the 2006 survey began in March and ended in December, with 9,683 completed interviews. Interviews were conducted in English, Spanish, Russian, Chinese (Mandarin and Cantonese), and by using live translation services where another language was needed.

For this analysis, "Don't know/Not sure" and "Refused" responses are combined for the sake of simplicity and because the focus is on the level of nonresponse, rather than the degree of difference between respondents and nonrespondents' reasons for non-response. Because this paper focuses on the level of conversion of item nonresponse and because age is also a component of standard post-stratification weighting for the CHS, this paper presents unweighted data, without variance estimates.

5. Results

Table 3 shows initial item response, converted item nonresponse, and remaining item nonresponse to self-reported age and to annual household income.

Item nonresponse for age was reduced from 433 to 28 cases (4.5% to 0.3%). Analyzing the reduction in item nonresponse to annual household income is more complex. Annual household income could be asked only when the household size (adults and children) was known. Due to item nonresponse to an earlier question about the number of children under the age of 18 living in the household (N=148), only 9535 respondents were asked about income. Among those asked, the critical value follow-up question reduced item nonresponse from an initial level of 13.7% to 8.7% (1302 to 813 cases).

Table 3: Initial item nonresponse and follow-up results, 2006 CHS

__Age__	__n__	__%__	__Annual Household Income__	__n__	__%__
Total asked question	9683	100.0%	Total asked question	9535	100.0%
Response from initial question	9250	95.5%	Response from initial question	8233	86.3%
Initial item nonresponse	433	4.5%	Initial item nonresponse	1302	13.7%
Response from follow-up	405	4.2%	Response from follow-up	489	5.1%
Remaining item nonresponse	28	0.3%	Remaining item nonresponse	813	8.5%

6. Discussion

6.1 Effective Conversion of Initial Item Nonresponse to Questions on Age and Income

The use of follow-up questions substantially converted initial item nonresponse to questions on age and annual household income, two variables commonly measured in health surveillance surveys and closely related to health conditions and outcomes. Most dramatically, asking a 4-bracket follow-up question to "Don't Know/Not Sure" or "Refused" reduced item nonresponse for age by 93.6%, from 4.5% down to just 0.3%. This is particularly valuable for the CHS because age is used for the survey's post-stratification weighting, and because survey estimates are frequently age-adjusted. The critical value follow-up to income reduced item nonresponse by a more modest 37.6%. However, because the initial sample size available for estimation is smaller for income than for age and the raw number of converted initial nonresponse cases is greater, conversion of income item nonresponse provides a larger improvement in precision.

6.2 Reduction of survey cost

"Preventive" reduction of item nonresponse decreases the need for post-survey treatment of item nonresponse, which can also be a source of survey error and survey cost. Simple treatment of missing data due to item nonresponse includes discarding a case entirely ("complete-case analysis") or discarding a case with missing a value only for estimates of that variable ("available case analysis") (Rubin and Little 2002, 31, 54). Both forms of deletion assume that the data missing due to item nonresponse are missing randomly or at least at random with respect to the variable itself. These conditions are rarely met (Rubin and Little 2002).

Sophisticated models and methods of imputation for missing data have been developed to deal with both unit nonresponse and item nonresponse, including item nonresponse to questions on income and age. Regardless of the method, it is possible that imputed values can bias both survey estimates and sample variance of the estimate itself (Little and Rubin 2002). Finally, even when (or if) modeling or imputation results in perfect replacement of values and variance, additional staff hours, expertise, and processing time are needed, also increasing survey cost.

6.3 Constraints on reduction of item nonresponse

The follow-up question to age provided some respondent information at the expense of detail and analytic flexibility. These follow-up ranges were tailored specifically to the post-stratification weighting used in the CHS, rather than for specific analytic needs. As a result, item nonresponse to age can still be a problem when evaluating initiatives or clinical recommendations that use different age categories (e.g., monitoring levels of colon cancer screening among adults 50 years of age or older (Henning et al. 2004)), when age adjustment involves different ranges, or when age is included as a continuous variable in statistical models.

The use of follow-up questions to reduce item nonresponse has both practical and ethical limits. Adding questions to reduce item nonresponse is unlikely to add to the average length of the survey, but may add to the length of an individual interview. Moreover, if a respondent's every "Don't Know" or "Refused" response is followed by a different version of the same question, he or she may break off the interview completely (converting initial item nonresponse to unit nonresponse). Excessive follow-ups to item nonresponse may also conflict with the voluntary nature of survey participation. Efforts to reduce item nonresponse, like efforts to reduce unit nonresponse, must respect the principles of human subjects research. Methods to reduce item nonresponse should be used carefully.

6.4 Limitation of the data and analysis

Analysis of the 2006 CHS data set was limited to completed cases, those with non-missing values for at least three of the following variables: age, Hispanic status, race, marital status, education, employment and the number of phone lines in the household. A more complete analysis of item nonresponse would include all cases asked the age or income questions, regardless of their ultimate inclusion in a final data set.

As mentioned earlier, nonresponse can be viewed as the product of the rate of nonresponse and the degree of difference between respondents and nonrespondents (Groves 1989). In evaluating the use of follow-up questions to reduce item nonresponse, this paper focuses entirely on the first of these. This limitation suggests the opportunity for a more complex exploration of response error in CHS estimates.

7. Summary and Next Steps

Like unit nonresponse, item nonresponse is a potential source of direct and indirect survey error and survey costs. This paper looked at item nonresponse to two variables strongly related to health conditions and health outcomes, and commonly used in analysis for public health purposes: age and annual household income. Use of follow-up questions was an effective "preventive", reducing item nonresponse during the data collection process, thereby reducing the potential for survey error.

Disclaimer

The findings and conclusions in this paper are those of the authors and do not necessarily represent the views of the New York City Department of Health and Mental Hygiene.

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