ESTIMATING THE RESPONSE RATE IN A TELEPHONE SURVEY WITH SCREENING

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1. Introduction

The National Immunization Survey (NIS) has been conducted by the Centers for Disease Control and Prevention (CDC) during 1994 and 1995. The objective of the NIS is to measure the immunization coverage of children 19 to 35 months old in 78 different immunization action areas (IAP) throughout the United States. The NIS is a random-digit-dialed telephone survey with data from other sources being used to adjust for the undercoverage of households without telephone. Since the target population of the NIS represents only about 5 percent of the total U.S. population, extensive screening is required to identify households with children 19 to 35 months old. A more detailed description of the NIS is given by Ezzati-Rice et al (1995).

The calculation of national and IAP response rates was initially assumed to be straightforward by multiplying the household screener response rate by the interview completion rate for eligible households (households with one or more eligible children). When the response rates were calculated in this manner, the overall rates were considerably higher than has usually been observed in RDD telephone surveys. This led to further investigations of the method and assumptions being made to calculate the response rates for the NIS. This paper presents the results of the investigations along with a description of the changes made to recalculate the NIS response rates.

2. Review of RDD Response Rates

Although there have been a number of different methods used to calculate telephone RDD survey response rates by different survey organizations, conceptionally the task is straightforward. CASRO (1982) has recommended that the RDD survey response rate, R, be defined as:

$$R = \frac{\text{completed interviews}}{\text{eligible reporting units}} \qquad (1)$$

The CASRO report goes on to give some examples and special cases of how this concept can be applied in practice. White (1983) presents a number of examples of calculating response rates for NCHS telephone surveys using the CASRO principles. The situation that best applies to the NIS is referred to as a "Sample Type II," and is described in the following manner.

Single Stage -	Not all units in frame eligible - screening required.
General Rule:	Attempt to determine eligibility for each element in frame.

Screening will yield (1) eligible, (2) non-eligible, and (3) not ascertained (NA).

Distribute NAs in the ratio of (1) to (2) to estimate the number of eligible units.

The general rule applies to personal, mail, or telephone studies. However, (1) method of determining eligibility may vary, (2) degree of eligibility will vary - depending upon the frame.

The CASRO (1982) paper goes on to indicate that the response rate is equal to the screening completion rate, i.e., the proportion of units where a decision has been reached as to whether or not a unit is eligible multiplied by the interview completion rate, that is, the proportion of screened eligible responses who completed an interview. The CASRO paper later points out that this ratio-estimating procedure may not always be the best method of estimating the number of eligible households. For the NIS, the CASRO estimator of multiplying the screening completion rate by the interview completion rate was initially used.

Groves and Lyberg (1988) provide a more operational definition for calculating the response rate for telephone surveys. The following expression is used to estimate the response rate, R.

$$R = \frac{I}{I + P + NC + p(RNA) + R + NI} \qquad (2)$$

where

I = completed interviews

P = partial interviews

NC = noncontacted but known eligible

RNA = unanswered numbers

R = refused eligible numbers

NE = noneligible units

NI = other noninterviewed units

p = proportion of unanswered numbers that are working household numbers

Under this scheme Groves and Lyberg have implicitly assumed that all refusals are eligible numbers.

For the Groves and Lyberg example the CASRO report would recommend that p be estimated as

$$p = \frac{I + P + NC + R + NI}{I + P + NC + R + NI + NE} \qquad (3)$$

Westat Corporation has estimated p by calling telephone business offices to determine the percent of RNAs that are households. Westat found that 40 percent of the RNA dispositions were households after reducing the percent of RNAs to around 4 percent in the 1993 National Household Education Survey (NHES). Sebold (1988) indicates that the percent of households in the noncontacted category will depend on the relative size of the concontacted category.

3. NIS Response Rates

To apply the general framework of CASRO and Groves and Lyberg to the NIS a few additional dispositions and parameters are defined below.

Let

NWOS = nonworking and nonhousehold out of scope numbers

RNA = ring no answers and other noncontacted numbers

U = identified households with undetermined eligibility status

IH = ineligible households identified in survey

EH = eligible households identified in survey

C = completed households interviews

NC = noninterviewed eligible households including refusals and partial interviews

p = proportion of RNAs that are working household numbers

q = proportion of households with undetermined eligibility status that are eligible households

r = proportion of eligible households among households with an RNA disposition

Note that EH = C + NC.

One can now define the telephone survey response rate similar to Groves and Lyberg as

$$R = \frac{C}{EH + qU + pr(RNA).} \qquad (4)$$

Now let

HSRR = household screening response rate,

and

HCR = household cooperation rate.

Further define

$$HSRR = \frac{IH + EH}{IH + EH + U}, \text{ and}$$

$$HCR = \frac{C}{EH}.$$

If one ignores the RNAs by setting p = o, it can be shown that

$$R = HSRR * HCR$$

if and only if

$$q = \frac{EH}{IH + EH} .$$

This implies that in order to estimate the NIS response rate by multiplying the screening response rate times the household cooperation rate, the proportion of nonscreened households that are eligible for the survey must be equal to the proportion of screened households that are eligible. When p is not equal to zero, then r must also be equal to EH/(IH + EH) for R to be equal to HSRR*HCR.

For the NIS this condition was not met, and thus one could not use HSRR*HCR to estimate the response rate. In the NIS, approximately 4.1 percent of screened households where determined to be eligible for the survey. Independent estimates of the percent of telephone households that are eligible in the population range from 5.1 to 5.6 percent. The following estimates have been obtained.

Source	Percent of HH with 19-35 month old
1993 National Health Interview Survey	5.2
1990 Census	5.6
1992 Current Population Survey	5.2
1993 National Household Education Survey	5.1

Each of these estimates was adjusted for households without telephones, oversampling of minorities, and distribution of sample (when possible).

The estimates of the overall eligibility rate indicate that the eligibility rate for NIS is much lower than it should be and implies the eligibility rate for nonscreened households is significantly higher then the eligibility rate for screened households.

The lower than expected eligibility rate among the household screened in the NIS did raise some concerns. After ruling out the sampling frame as a possible explanation, several other explanations seem plausible. Most ineligible households only have to answer the one global screening question about children under 4 years of age to produce a completed interview. Eligible households must answer very specific questions about the birth date and sex of 19-35 month old children to complete the screener questionnaire. These are often very sensitive questions for mothers and other household members, especially over the telephone. It also would be reasonable to suspect that converting screening refusals to completed screener interviews would be easier among ineligible households, especially if completing the one screener question was emphasized by the interviewers.

There is another situation when neither R nor HSRR*HCR will accurately estimate the survey response rate. This occurs when the proportion of eligible households among all screened households is not accurately estimated. That is, some of the eligible households are misclassified as ineligible. Thus, the proportion of eligible households is underestimated. This might occur when respondents indicate no eligible children rather than indicate they do not want to participate in the survey. Some respondents might consider this an easy way out of the survey without having to actually refuse. Other eligible respondents might misclassify themselves because of a mistrust of people they do not know over the telephone. For whatever reason respondents misclassify themselves, the end result is additional nonresponse in the survey. Use of equation 4 to estimate the survey response rate implicitly assumes that misclassification does not occur.

4. Redefining the NIS Response Rate

In order to estimate the overall response rate for NIS, another estimator was needed. There are several other alternative candidates for estimating the NIS overall response rate. One could use equation 4 and attempt to estimate q and r, the proportion of eligible households among the nonscreened households and noncontacted household telephone numbers. Although there is some information available, several questionable assumptions would have to be made to estimate q and r.

The most direct method of estimating the response rate is to use the basic CASRO estimator R = C/EH. In this equation the number of completed interviews, C, is known from the survey. The number of eligible households, EH, is unknown, but can be estimated by

$$EH = PEH * HH$$

where

PEH is the percent of eligible households, and

HH is the number of households in the sample.

PEH can be estimated from independent data sources such as these given in the previous text table. For the NIS PEH was assumed to be 5.2 percent.

This was later adjusted to 5.08 percent to account for a fewer number of eligible households with more than one telephone number.

The number of households, HH, in the NIS sample was estimated by

$$HH = .9\,(A+S2) + S1 + IH + C + P$$

where

A = unresolved answering machines and answering service numbers,

S2 = refusals and breakoffs that are likely to be households, and

S1 = Noninterviewed households with unknown eligibility.

IH, C, P have been previously defined as ineligible households, completed interviews, and partial interviews respectively.

The factor 0.9 was selected to represent the proportion of S2 and A that are suspected to be households. This factor can be refined by resolving as many of these numbers as possible before the end of the survey. A proportion of the noncontacted numbers, RNA, can also be assumed to be households.

The NIS response rate can now be estimated by

$$R = \frac{C}{HH * .0508} \qquad (5)$$

The response rate above can also be expressed in terms of a household screening response rate, HSRR, and a household cooperation rate, HCR.

Let

$$R = \frac{C}{EH} * \frac{EH}{HH * .0508} \qquad (6)$$

where

$$HCR = \frac{C}{EH}, \text{ and}$$

$$HSRR = \frac{EH}{HH * .0508}$$

Note that HSRR differs from the screening completion rate as defined by CASRO. The CASRO screening completion rate represents the proportion of all households that have been screened for eligibility. The household screening response rate above is the estimated proportion of eligible households that have been identified as eligible households from the survey screening procedure, that is, the eligible household screening completion rate.

When the revised response rate estimators were applied to the NIS data set for three quarters of data from 1994, the household screening response rate dropped from 91 percent to 73 percent while the household cooperation rate remained the same at 95 percent. The overall response rate dropped from 87 percent to 70 percent. This response rate is very consistent with other telephone survey response rates in similar studies. The response rates have simply been adjusted by the ratio of the observed percent of eligible households over the expected percent of eligible households. The high household cooperation rate indicates that almost all of the households that were not participating in the NIS were not completing the household screening questionnaire. This further indicates that the first minute of a telephone interview is the most critical time for obtaining cooperation.

5. Discussion

The publication of the CASRO report in 1982 was a significant contribution towards a set of standard definitions for survey response rates. Since that time the definitions and estimators presented in the report have been used many times to calculate response rates in a variety of surveys. The report was especially helpful for the calculation of more uniform response rates for telephones surveys. The guidelines for surveys with a screening component to identify eligible sampling units have provided an easy method for calculating the response rates. These guidelines, however, should only be used under certain conditions. The key condition for surveys with screening is that eligible sampling units are screened at the same rate as ineligible sampling units. This key condition has not always been evaluated in the reporting of response rates for telephone surveys. When the screening response rate for eligible sampling units does not equal the screening response rate for ineligible units, other estimators should be used to more accurately calculate the response rate. Groves and Lyberg provide an alternative estimator for telephone surveys. The major operational drawback of their estimator is that a number of components need to be known or estimated. The components are more difficult to estimate when screening is required. The Groves and Lyberg response rate does, however, apply to the situation of

differential response rates among eligible and ineligible sampling units. When eligible units are misclassified during the screening process, however, neither estimator is appropriate.

This paper presents an alternative estimator for calculating response rates in a telephone survey with screening. The estimator is appropriate in the presence of either differential screening nonresponse or misclassification of eligible sampling units. The estimator does, however, require that the percentage of eligible households (PEH) for a survey be estimated from an independent source. The survey is used to estimate the total number of sample households. In telephone surveys, the estimation of the number of sample households is often subject to error. In most telephone surveys, however, the estimation of the number of sample households is usually less subject to error than the estimation of the number of eligible sample households. The percentage of eligible households in the target population can be estimated from other surveys or the decennial census. For the National Immunization Survey (NIS), the PEH with one or more 19-35 month old children was available from several sources. For large national surveys, the PEH in the survey sample should be close to the percentage in the target population. In smaller surveys in state or local areas, the PEH in the population is often either not readily available or more difficult to estimate. The PEH in smaller samples is also more subject to random variation. Sampling frame problems may also effect the PEH for a survey.

The calculation of an accurate response rate for a telephone survey is not always straight forward. One should take care in applying standard definitions without evaluating the underlying assumptions. Comparing several alternative estimators is one way of checking the relative accuracy of the response rate. For the NIS, the standard response rate estimator was found to be very poor and an alternative estimator was required. The recalculation of the response rate produced a better understanding of the dynamics of the telephone survey which lead to some changes in the survey screening procedures.

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