RESPONSE RATE CALCULATION IN RDD TELEPHONE HEALTH SURVEYS: CURRENT PRACTICES

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INTRODUCTION

In its simplest conception, interview surveying conducted by telephone has intrigued health researchers as a way of dramatically reducing the cost of field operations normally associated with personal interview surveys. For many years, however, use of the telephone was avoided because the distribution of telephone service was neither complete nor uniform. During the decade of the 1970's, and continuing in the 1980's, interest in telephone surveys has become widespread. The distribution of telephones is still not universal, but the non-telephone component of the population has shrunk to a manageable level and the differences between it and the telephone component are better understood.

A primary concern during this renewed period of interest has been the development of an adequate telephone sampling frame for general population surveys. The compiler of a list frame for telephone surveys faces all of the same problems encountered in list development for personal interview surveys; incomplete and out-of-date lists being the two most common faults. For personal interviewing, the area/list frame technique of physically locating and listing dwelling units shortly in advance of interviewing solves both problems and does not add significantly to the marginal cost of maintaining a field staff for interviewing purposes.

Not only is the area listing technique inappropriate for telephone interviewing not only because telephone numbers are unobservable from the street, but its use would defeat the main advantage of telephone surveys, i.e., the substantial cost savings over personal interviewing. An obvious list frame for telephone surveying would be telephone company directories, but these suffer like other lists from incompleteness and a lack of timeliness at publication. Moreover, many residential numbers that might be in-scope for a given survey are unpublished.

Telephone surveyors have turned to a rule-defined frame that minimizes the problems of undercoverage and lack of timeliness of the list frame. Most attention has been focused on the method of random digit dialing (RDD) or modifications thereof. The RDD method involves selecting random telephone numbers from sampled working exchanges.

One complication that arises with telephone surveys, especially RDD telephone surveys, is that a certain category of survey outcome, continuous ringing with no answer or constant busy signaling (No Answer/Busy or NAB), makes it impossible to determine if the sampled number is linked to an eligible reporting unit. Even if the number were drawn from a directory list, such an outcome makes it impossible to determine current eligibility status. Large numbers of NAB outcomes may bias survey estimates, see Thompson (1979).

A uniform method of defining and allocating NAB outcomes for response rate calculation has not yet evolved. Some insight into the eligibility status of such numbers may be available at the expense of contacting the local telephone company, but many surveys do not have the funds for this and, in some cases, the telephone company may not be cooperative.

This paper examines the methods of response rate calculation used in five recently conducted telephone health surveys. Particular attention is given to the various methods of handling NAB outcomes. All of the surveys were either conducted directly by, or under contract for the National Center for Health Statistics (NCHS). First, the basic definition of response rate is reviewed. Second, the methods used to compute the response rate for each survey are expressed in a common notation, and finally the validity of the various practices is discussed.

NOTATION

A recent special report for the Council of American Survey Research Organizations (CASRO) by Frankel, et al (1982), provided a basic definition of a survey response rate. That is,

$$R = \frac{\text{Number of completed interviews with reporting units (C)}}{\text{Number of eligible reporting units in the sample (E)}} = \frac{C}{E}.$$

This definition is easy to apply to traditional area/list and list frame samples. The use of the telephone and, in particular, the random digit dialing technique, however, frequently requires a rule-generated frame. There are a variety of reasons why frame members are ineligible, and it can be nearly impossible, or very expensive, to determine the eligibility status of some types of non-responding units, especially the NAB outcomes. Frankel et al (1982), recommended that units of unknown status be allocated to eligible and ineligible categories in the same proportion as among the units of known status. This leads to a revised formula:

$$R = \frac{\text{Number of completed interviews with reporting units (C)}}{\text{Number of eligible reporting units (E) in sample + p[Number of unknown status reporting units (U)]}} = \frac{C}{E + pU}, \quad (1)$$

$$\text{where } p = \frac{\text{Number of eligible reporting units among all reporting units with known status in the sample (E)}}{\text{Number of known status reporting units in the sample (K)}} = \frac{E}{K}.$$

For the purposes of this paper, expression (1) will be called the CASRO estimator. A classification of telephone numbers in a telephone survey by outcome category is shown in Figure 1.

EXAMPLE SURVEYS

To demonstrate the non-uniformity in current practice of outcome definition and allocation in

response rate calculation, the methods used for calculation of response rates in five recently conducted telephone health surveys are summarized in a common notation. The notation reflects the classification scheme for the disposition of telephone numbers in an RDD telephone survey presented in Figure 1.

Example 1.0: Community Health Information Policy Study

As part of the Community Health Information Policy Study (CHIPS) conducted under contract to NCHS, a Health Interview Survey (HIS) was administered in the Florida Gulf Health Service Area in 1981. The CHIPS-HIS consisted of four components, among them a random digit dialed (RDD) telephone survey. The telephone numbers surveyed were classified according to the survey outcome as shown in Table 1. Kulka,et al (1983), computed lower and upper bounds for the telephone survey response rate as shown in Table 2. Although no attempt was made to allocate a fraction of the unknowns expected to be eligible in order to calculate a point estimate in the form of (1), the results were tabulated in sufficient detail to allow others to do so if they wished. The actual estimates of response rate bounds, as well as a recalculated point estimate in the form of (1), are presented in Table 3.

Example 2.0: National Telephone Health Interview Survey (THIS)

During 1979, NCHS staff conducted a number of experimental telephone surveys using national random digit dialing samples. These surveys were conducted to develop procedures and refine methods for health interviewing by telephone, and to investigate methodological concerns. Fitti (1979) and Massey, et al (1979), described a telephone survey cigarette smoking supplement to the National Health Interview Survey (NHIS), where all respondents aged 17+ were required to answer for themselves.

Two response rates were reported, a household response rate and a person response rate. The reporting unit for the household response rate was the household, and the interview was considered complete if at least one eligible respondent was interviewed. Lower and upper bounds were calculated for the household response rate exactly as they were in the first example (see Table 2).

As in the first example, no attempt was made to allocate a fraction of the unknowns expected to be eligible; however, sufficient information was provided to allow independent calculation of response rate in the form of equation (1). The categories of outcome are listed in Table 1 and the actual bounds, as well as a recalculated point estimate in the form of (1), are shown in Table 3.

The reporting unit for the THIS person response rate was defined as an eligible person (anyone 17+), and therefore it was necessary to estimate the number of eligible persons linked with each eligible or potentially eligible telephone number in the cases where all eligible household members were not interviewed. To do this, the noninterview households and NAB telephone numbers were weighted by 2.0 (the average number of persons per household among the completed households). Lower and upper bounds for the person response rate were computed using the estimator that appears in Table 2. The person data were not reported in sufficient detail to allow for recalculation of a point estimate. The actual interval estimate is shown in Table 3.

Example 3.0: National Health Interview Survey Alcohol Supplement

In 1981 a pretest of the NHIS Alcohol Supplement was conducted under contract using random digit dialing. One eligible respondent within each household was randomly selected. Because of a compressed time schedule the survey was terminated before the call rule had been exhausted for a portion of the in-scope telephone numbers. As described by Fitti (1982), these numbers were included (or not) as complete interviews in the computation of lower and upper bounds for the response rate.

This supplement neither computed a point estimate nor included the unknowns (U) in the range calculation. Table 2 presents the estimator and Table 3 shows a revised lower bound including U, as well as a recalculated range based on a point estimate in the form of (1), both with and without early terminations in the numerator.

Example 4.0: National Survey of Family Growth Cycle III Pretest

In 1981, a pretest of the National Survey of Family Growth, Cycle III (NSFG) was conducted under contract in two parts, area and RDD telephone samples. The NSFG heavily oversampled the black population and it was fully administered only to females ages 15 - 44.

This survey provided an interesting test of the adaptability of telephone methods to a two-step interviewing process; screening followed by extended interviewing. During this particular pretest, when an eligible woman was located by telephone, an appointment was made to interview her in person. Response rates were not reported as a range, but rather using a point estimate.

The point estimator for the telephone response rate is shown in Table 2. This is a slightly unusual form because the screener was considered successful if it was completed by ineligible, as well as eligible, reporting units. This is the CASRO recommended estimator for a redefined reporting unit. The personal interview was attempted only for those found eligible by the telephone screener, and the estimator for personal interview response rate is also shown in Table 2.

Although the telephone response rate as defined was a good measure of the efficiency of the screening process, it did not address the central issue, that is, how good was telephone screening at finding eligibles who will complete the interview? The telephone and personal interview response rate estimators were multiplied together to create the overall response rate estimator shown in Table 2.

As the numerator of the overall estimator contains ineligible reporting units, it clearly misrepresents the overall survey response rate. It does, however, represent a "success" rate for the contractor, though it is somewhat difficult to interpret.

The overall response rate could have been estimated using the CASRO expression in (1).

Table 3 shows the numerical values for these estimators. Ironically, in this case, the CASRO estimate yields a higher response rate.

Example 5.0: National Survey of Personal Health Practices and Health Consequences

The National Survey of Personal Health Practices and Health Consequences (NSPHPC) was conducted under contract in 1979 and 1980. The response rate methodology was summarized in Schoenborn and Drury (1982). This was a two-wave RDD telephone panel survey of adults 20 - 64 years of age. The response rate for the first wave is considered here.

For known household telephone numbers, where the call rule was exhausted and for those undetermined numbers (NAB), a subsample was taken for follow-up. From the results of the follow-up efforts, estimates for eligibles, ineligibles, and expected complete interviews were made. The estimate of expected complete interviews was a prediction made by assuming that the extensive subsample follow-up rules were applied to all undetermined and call rule exhausted numbers. A point estimator was developed for the response rate and it made use of these estimated values in the expression presented in Figure 2.

The formula in Figure 2 simultaneously inflates the numerator, deflates the noninterviews (N) in the denominator, and deflates the estimate of eligibles among the unknowns (U). The reported numerical estimate, along with the CASRO recommended estimate, is presented in Table 3.

DISCUSSION

Not only were the actual response rate calculations different among the five surveys, but the classification of telephone numbers into outcome categories differed among the surveys sometimes in subtle ways. For example, whereas three surveys clearly reported the unknown (or indeterminate) category to include both Ring/No Answer and Busy outcomes, one survey made no mention of Busy outcomes and another classified them as ineligible. Other classification differences are illustrated in Table 1. These differences could lead to varying estimates of response rates.

The first two example surveys presented response rates in a manner most similar to the CASRO recommended procedure. The only difference between the CHIPS-HIS and the THIS (household) equation and the CASRO equation, is that the former produces an interval estimate weighting the unknowns, U, alternatively by 1.0 and 0.0 rather than a point estimate with the unknowns weighted by the proportion of eligible reporting units among the knowns, K.

The THIS (person) response rate, also an interval estimate, adhered to the CASRO guidelines with one modification, that is, household estimates had to be inflated to person estimates for the noninterview and unknown outcomes. This is a reasonable approach if the persons, rather than households, are considered to be the eligible survey reporting units and the actual number of eligible persons associated with each telephone number is unknown.

In the NHIS Alcohol Supplement pretest, the problem of not completing appointments and call-backs with known eligible reporting units outweighed any considerations of unknown status telephone numbers. Although the unknowns could have been prorated for a mid-point estimate, the early terminations cannot be prorated in the numerator; however, the lower bound should at least include the unknown term, U, in the denominator. A narrower interval was recalculated in Table 3 by deleting or including the early terminations in the numerator when holding the denominator constant with a prorated unknown term.

Ordinarily it would not seem proper to vary the numerator, as the number of completed reporting units is usually one of the undisputed results of any survey; however, in a foreshortened pretest situation, this type of estimation provides predictive information for planning future surveys.

The calculation methods reported for estimating response rates for the NSFG telephone screener and personal interview measured the contractor's performance, but not the overall survey efficiency. The product of the telephone and the person rates did not yield a meaningful overall response rate for the survey because identified ineligible reporting units were considered to be completed interviews. These could have been labeled as contractor success rates, and the CASRO method (1) could have been used to evaluate the overall design and implementation success.

The most difficult response rate to interpret was that reported for the NSPHPC. The expression in Figure 2 was used to estimate the overall response rate of the completed survey. Hypothetical complete interviews (actually non-interviews or unknowns) were included in the numerator and eligible noninterviews were deleted from the denominator.

IMPLICATIONS

The advantages and disadvantages of the various methods of response rate calculation depend on the survey resources and goals. The least expensive method is to present a range based on including and excluding unknowns in the denominator. An equally inexpensive method requiring a slightly more sophisticated assumption is to allocate the unknowns in some meaningful way into the denominator. The most technically correct and desirable method, but quite time consuming and potentially expensive, is to double check all unknowns with the telephone company for operating status.

Only under special circumstances, such as the projection of pretest results, should allocation or estimation take place in the numerator of the response rate. A slightly more subtle numerator problem involves redefining what a successful response is considered to be. The response must be substantially complete in terms of the major survey objectives to be included in the overall survey response rate numerator. Item response rates should be clearly labeled.

The prospects for obtaining uniformity of effort on the part of surveyors toward obtaining complete response for all or most telephone surveys seem dim. Beyond the willingness of telephone companies to cooperate with dozens of survey organizations, and agreement on uniform outcome classification, such comparability is

more a matter of cost. When surveys are conducted under contract, a response outcome classification scheme should be specified during negotiation. However, cost constraints may dictate less effort toward unknown follow-up in favor of more refusal conversion or additional sample interviewing.

Even though expectations of call-rule uniformity seem unreasonable, adoption of a standard method of computing the survey response rate is feasible. There are two components to a computing convention for response rates. The first is adopting a uniform classification scheme for telephone survey outcomes. The definitions of categories such as those shown in Table 1 and Figure 1 must be standardized. The second component is the development of a uniform response rate formula. This could be the CASRO estimator, but as it stands, there are several drawbacks. Although the CASRO estimator incorporates the Unknowns, the interval estimates used by several example surveys provide a ready measure of size of the Unknown component. The wider the interval, the larger the Unknown component. Furthermore, the CASRO estimator also groups all types of Unknowns together. There are actually several types of Unknowns and these might better be factored in to the response rate computation separately.

To begin the process, however, all telephone surveyors should report their response rate formulae along with the detailed classification and definitions of all outcome categories. Such disclosure will allow readers to recompute response rates in a uniform manner for comparison, and may eventually lead to the uniform and comparable estimation of telephone survey response rates.

SUMMARY

The response rate computation methods for five RDD telephone surveys were compared in the context of a uniform notation. The methods were found to differ substantially in treatment of No Answer/Busy outcomes and in the allocation of telephone numbers into basic outcome categories. Where possible, the rates were recalculated in a standard form to illustrate the computational differences. Finally, the validity of various practices and the feasibility of adopting a telephone survey response rate computation convention were discussed.

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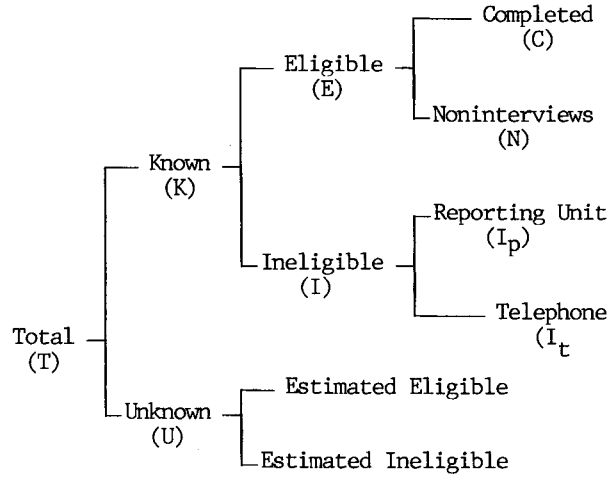
Figure 1 - Disposition of Telephone Numbers in an RDD Telephone Survey



Note: Classification is universe dependent: i.e., if response is necessary to determine reporting unit eligibility, then nonrespondents, refusals, not available, some breakoffs, language barrier, ill, other noncontacts, etc., will be classified as Unknown (U) along with the No Answer/Busys; whereas, if all working residential telephone numbers are eligible, then only the No Answer/Busys will be of Unknown status (U), and the remainder of the above listed responses will be in the Known/Eligible/Noninterview (N) category. Similarly, for most surveys the Ineligibles can be sub-divided into Ineligible telephones (I_t), such as pay stations, and Ineligible Reporting Units (I_p) at potentially eligible telephones.

Table 1

Selected Reported Outcome Groupings By Survey

Survey	Noninterviews	Ineligibles	Unknowns
CHIPS-HIS	Refusal Breakoff Eligible respondent not present Temporarily absent Other	No hh member present Nonworking Nonresidential Other	Ring/No answer[1]
THIS (hh)	Refusal Breakoff No interview appropriate Other	Nonresidential Nonworking Wrong connection Busy Other	Ring/No answer
THIS (person)	[same as THIS (hh)]	[same as THIS (hh)]	[same as THIS (hh)]
NHIS Alcohol Supplement	Refusal Breakoff (appointment callback) (unscheduled callback)	Nonworking Disconnected Not-in-service Changed Nonresidential No hh member eligible	Ring/No answer Busy
NSFG (telephone)	Refusal	No hh member eligible Ineligible telephone	Ring/No answer Busy
(extended)	Refusal Other	none	none
NSPHPC	Ill, etc. Refusal Language barrier Other	Nonresidential No hh member eligible	Ring/no answer Busy

[1] No mention of Busy outcomes in survey report.

Figure 2 - NSHPHC Estimated Response Rate

$$\text{Estimated Response Rate} = \frac{\text{Total Completes (2998)} + \left[\frac{\text{Total No Answer/Busy (1034)}}{\text{No Answer/Busy subsampled for follow-up (154)}} \times \text{Completes achieved during follow-up of No Answer/Busy subsample (23)}\right] + \left[\frac{\text{Total Call-Rule Exhausted (203)}}{\text{Call-Rule Exhausted subsampled for follow-up (30)}} \times \text{Completes achieving follow-up of Call-Rule Exhausted subsample (4)}\right]}{\text{Total Completes (2998)} + \frac{\text{Total Completes (2998)}}{\text{(Completes + Ineligibles) (3801)}} \left[\left[\text{Ill, etc. + Refusals (554)}\right] + \left[\text{Household numbers found during follow-up of No Answer/Busy subsample (52)} \times \frac{\text{Total No Answer/Busy (1034)}}{\text{No Answer/Busy subsampled for follow-up (154)}}\right] + \text{Total Call-Rule Exhausted (207)}\right]}$$

The estimated response rate for NSHPHC is shown in Figure 1. For the numerator, conversion results observed during the follow-up of subsamples drawn from the Call-Rule Exhausted and No Answer/Busy households were used to develop an expected number of completes. The expected number is assumed to be what would have occurred if the extensive follow-up procedures used in the subsample had been applied to all Call-rule Exhausted and No Answer/Busy households. For the denominator, the expected number of in-scopes was also estimated. To do this, Language Barrier cases were omitted, and the expected number of in-scopes among the Refusals and the Ill, etc., households were assumed to occur in the same proportion as the number of completes occurred among the complete plus the screened out households. These were the procedures used by a contractor to calculate the Wave I response rate which was reported to NCHS.

Table 2

Response Rate Estimation Formulae

Survey	Estimator
CASRO	$R = \dfrac{C}{C + N + \dfrac{E}{E + I} U}$
CHIPS-HIS and THIS (household)	$\dfrac{C}{C + N + U} < R < \dfrac{C}{C + N}$
THIS (person)	$\dfrac{C}{C + 2.0(N + U)} < R < \dfrac{C}{C + 2.0(N)}$
NHIS- Alcohol Supplement*	$\dfrac{C}{C + N} < R < \dfrac{C + N'}{C + N}$
NSFG (screener)	$R_t = \dfrac{C + I_p}{I_p + C + N + \dfrac{I_p + E}{I + E} U}$
(extended)	$R_p = \dfrac{C}{C + N}$
(overall) $R_O = R_t \; R_p =$	$\dfrac{C + I_p}{(1 + \frac{N}{C})(C + N + I_p + \dfrac{I_p + E}{I + E} U)}$

* N' is the number of appointments and unscheduled call-backs not completed due to the abbreviated survey period.

Table 3

Reported and Recalculated[1] Response Rate Estimates

Survey	Lower Bound	Response Rate Mid-Point (CASRO)	Upper Bound
CHIPS-HIS	0.62	(0.66)	0.70
THIS (hh)	0.78	(0.82)	0.85
(person)	0.71	--[2]	0.76
NHIS Alcohol Supplement	0.59 (0.40)	[(0.45), (0.59)]	0.79
NSFG (telephone)		0.87	
(extended)		x 0.73	
(overall)		0.64	
recalculated	(0.59)	(0.68)	(0.73)
NSPHPC	0.61	0.81 (0.69)	(0.77)

[1] Recalculated estimates are shown in parentheses, see text for exact recalculation methods (CASRO guidelines adhered to in all recalculations).

[2] Data not reported in sufficient detail for recalculation.