

## COVERAGE AND RESPONSE IN RANDOM DIGIT DIALED NATIONAL SURVEYS

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This paper reports the initial results of an assessment of the potential bias that results from the exclusion of nontelephone households and from nonresponse in random digit dialed national surveys. Data on telephone coverage from the 1981 National Health Interview Survey (NHIS) are used to compare the sociodemographic and health characteristics of persons in households with and without telephones. Rates of coverage for selected population subgroups are presented. In addition, based on a special supplement to the NHIS, information is provided on access to telephones by nontelephone households. Estimates of nonresponse for sociodemographic domains are imputed for three national random digit dialed (RDD) surveys. The potential biases from the joint effects of undercoverage and nonresponse are discussed.

### 1.0 TELEPHONE COVERAGE OF HOUSEHOLDS IN THE UNITED STATES

The analysis of telephone coverage is based on data from the 1981 National Health Interview Survey (NHIS) and is an updating of a previous paper by Thornberry and Massey [3] based on 1976 NHIS data. The NHIS is a continuous survey of the civilian noninstitutionalized population of the United States. Its purpose is to provide national data on the incidence of illness and injury, the prevalence of diseases and impairments, the extent of disability, the utilization of health services, and other health-related topics.

Interviews are conducted each week throughout the year in a probability sample of households. The sampling plan for the survey follows a multi-stage probability design which permits a continuous sampling of households. The sample is designed in such a way that the sample of households interviewed each week is representative of the target population, and that weekly samples are additive over time. The data are collected through a personal household interview conducted by interviewers employed and trained by the U.S. Bureau of the Census according to procedures specified by the National Center for Health Statistics (NCHS). The usual annual NHIS sample consists of approximately 40,000 eligible occupied households consisting of around 110,000 individuals. The completion rate for the eligible households averages between 96 and 97 percent. The estimated civilian noninstitutionalized population covered by the NHIS sampling frame is 95 percent.

Beginning in 1963 each household in the NHIS sample was asked to provide a telephone number ("What is the telephone number here?"). Each schedule is coded according to the telephone status of the household (phone available-number provided; phone available-number not provided; no telephone; telephone status not ascertained). Telephone status is generally ascertained for more than 99 percent of the completed interviews.

The percent of NHIS households reported as not having telephone coverage is given in Table 1 for the years 1963 through 1981. According to

these estimates 19 percent of households in the United States were without telephones in 1963. By 1970 this figure had dropped to less than 12 percent. The 1980 NHIS and the 1980 decennial census estimates are 7.4 and 7.1, respectively.

The data presented in the remainder of this section are based on the 1981 NHIS. For that year completed interviews were obtained for 97.0 percent of the 41,265 eligible households. Telephone status was ascertained for 99.5 percent of the completed interviews, resulting in a sample of 39,835 households consisting of 107,552 persons. Of these households 93.1 percent were recorded as having telephones, and 6.9 percent as not having telephones.

#### 1.1 Sociodemographic Characteristics

Data on telephone coverage for selected characteristics of households are presented in Table 2. Households in the South with 10 percent nontelephone are less likely to have coverage than are those in the other three regions, each with six percent or less nontelephone. There is a higher coverage in SMSA than in non-SMSA areas, with the highest percent of telephone households within the noncentral city portion of SMSA's and the lowest coverage within rural-nonfarm areas. Nontelephone households are also more likely to be one-person households.

Data on coverage for selected characteristics of individuals are presented in Table 3. Persons in households without telephone coverage are disproportionately black and under 35 years of age. Ninety-four percent of whites are in telephone households as contrasted to 84 percent for blacks. While young persons are disproportionately in nontelephone households, there is little variation in coverage by age for those over 35 years of age (95 percent or higher). Telephone ownership is higher for persons who are widowed (96 percent) or are married and living with their spouse (95 percent), than for the never married (92 percent), divorced (90 percent), or separated (83 percent).

As would be expected, telephone coverage increases with increasing education and family income. The most important correlate of telephone ownership is family income, with coverage increasing from 72 percent for the lowest income category (less than \$3,000) to 99 percent for the highest (\$25,000 or more). Coverage for persons in families with incomes of \$15,000 or more is relatively complete at 96 percent or higher.

These correlates of telephone coverage described above generally hold within each region. It is noteworthy, however, that for any given subgroup a comparison among regions reveals minor differences except for the South, where coverage is almost always lower than for the other three regions. For example, while blacks have lower coverage than whites in all four regions, only 81 percent of blacks in the South reside in telephone households, as contrasted to 86 percent or higher for the other three regions. Similarly, while telephone coverage increases with increasing family income within

each region, the level of coverage in the South is lower for each family income category than in the other three regions.

Given that family income is the major correlate of telephone coverage the next step is to assess the extent to which the relationships between telephone ownership and other sociodemographic variables diminish when family income is controlled. The issue thus becomes one of the degree of variation in coverage within categories of family income for selected sociodemographic variables. As would be expected, for any sociodemographic subgroup, telephone coverage increases with increasing income (Table 4). Within specific income categories, however, the following general pattern emerges. The correlates of telephone ownership discussed previously still exist to a limited degree for the lower income groups, but tend to diminish in magnitude with increasing family income. With few exceptions, for households with family incomes of \$15,000 or more, there is very little variation among categories for any sociodemographic variable; in effect, telephone coverage is relatively complete for all population subgroups in households with family incomes of \$15,000 or more.

For persons 65 years of age or more, telephone coverage is relatively complete regardless of income level, with 86 and 92 percent coverage for the lowest two income categories, and 96 percent or higher for the other income groups. These data suggest that if level of coverage were the only consideration, it would be difficult to reject the use of random digit dialing in planning a survey of the elderly.

In summary, there are numerous differences in sociodemographic characteristics between households and persons with telephone coverage and those without coverage. However, it should be kept in mind that nontelephone households represent only seven percent of all households and that many of the subgroups with major telephone-nontelephone differences constitute a very small proportion of the total population. Consequently, estimates of most sociodemographic characteristics based only on telephone households are very similar to estimates based on both telephone and nontelephone households. For surveys of many population subgroups (such as the elderly), the coverage which can be obtained through random digit dialing may be well within accuracy requirements.

### 1.2 Health Characteristics

In the previous section the nature and direction of bias in sociodemographic characteristics of the population resulting from the exclusion of nontelephone households were examined. What remain to be investigated are differences between telephone and nontelephone populations in health characteristics and the extent to which the exclusion of nontelephone households would introduce bias into national estimates of these characteristics.

Tables 5 and 6 provide values of selected health characteristics and use of health services for persons in telephone and nontelephone households. In general, the observed differences are

of the type and in the direction expected, given that the nontelephone population consists disproportionately of persons in low income families. Relative to the population with telephone coverage, the nontelephone population is more likely to be limited in activity because of chronic conditions, to have higher rates of acute conditions and associated restricted activity and bed disability, and lower rates of utilization of health services with the exception of hospitalizations. The most pronounced difference relates to the utilization of dental services, which is the health characteristic most highly correlated with family income. It should be noted that as was true for the sociodemographic characteristics, the differences between the values for the telephone population and the total population are generally small.

With minor exceptions, the relationships described above for the total population are found within each region and each age group. For example, within age groups persons in nontelephone households have higher rates of restricted activity, bed disability, limitation of activity due to chronic conditions, and lower rates of physician visits.

In summary, the health-related characteristics of persons in nontelephone households are very different from those of persons in telephone households. It is clear from the data presented that there are factors in addition to age and income which should be taken into account in any attempt to adjust for the bias introduced by the exclusion of nontelephone households.

### 2.0 ACCESS TO A TELEPHONE

One method that has been suggested for reducing the population undercoverage for RDD telephone surveys is to identify everyone who regularly uses each of the telephones answered in the survey, including persons in other apartments or housing units. One way to approximate how effective such an approach might be is to find out whether persons in households without telephones regularly use non-business telephones outside of their housing units and how accessible these telephones are with respect to a person's residence. In 1982 ten questions were added to the face-to-face NHIS to determine the access and use of telephones outside of the housing units in the survey.

The following results were obtained from the NHIS about the location of telephones used for personal calls by respondents when they are at home:

<u>Location of Telephone</u>	<u>Percent</u>
Telephone in housing unit	92.4
No telephone in housing unit, but telephone elsewhere (on which family can be reached when at home)	2.7
No telephone in housing unit and no telephone elsewhere	4.9

A further analysis of the 2.7 percent of the

households that reported access to a telephone outside of the housing unit shows the following:

Location of Telephone Outside of Housing Unit	Percent
Same building, same floor	8.3
Same building, other floor	4.9
Same building, landlord	7.7
Same building, neighbor	13.9
Adjacent building	25.1
Non-adjacent building	40.1

Thus, for the seven percent of the United States population who live in households without telephones, only about one-tenth or one percent of the total population have easy access to telephones outside of their housing unit. It does not appear that the effort required to identify these persons in RDD surveys would be worthwhile in significantly reducing the potential bias due to undercoverage.

### 3.0 RESPONSE RATES

The issue of telephone coverage in RDD surveys relates to contact with a representative sample of the population. The issue of response relates to obtaining data from a representative sample of that population. The major concern about both noncoverage and nonresponse is the potential for bias. Those persons for whom data are not obtained may have characteristics very different from those for whom data are obtained and consequently there is the concern that the survey estimates may not accurately reflect the characteristics of the target population. It is generally assumed that the higher the rates of noncoverage and nonresponse, the greater the risk of this bias.

In order to speculate on the nature of nonresponse bias in telephone surveys, it is useful to estimate response rates for various population subgroups. We are generally prevented from making this estimation because relative sizes of different demographic groups within the telephone household population are generally not known. However, if the NHIS is taken as a standard, one can estimate response rates for subgroups within a telephone survey. With the assumption of no nonresponse bias in the NHIS data, no response bias in the NHIS or telephone data for variables identifying demographic subgroups, and no better coverage of the population by the telephone survey, we can estimate a response rate for subgroups within a telephone sample by:

$$\frac{P_{i, TEL}}{P_{i, NHIS}} (R_{TEL})$$

where:

$P_{i, TEL}$  is the proportion of respondents in subgroup  $i$  of the telephone sample;

$P_{i, NHIS}$  is the proportion of respondents in subgroup  $i$  of the NHIS sample;

$R_{TEL}$  is the overall person-level response rate for the telephone sample

Table 7 presents estimates of response rate for selected demographic subdomains for three national random digit dialed telephone samples either conducted or sponsored by NCHS [1, 2]. Each of the three surveys used a different respondent rule to obtain information about persons who were 17 years old or older. The first used a "knowledgeable" respondent rule which consisted of a knowledgeable adult responding for all household members. The second used a "random" respondent rule where a random respondent was selected in each household to respond for all household members. The last used a "self" respondent rule where all household members responded for themselves.

As shown in Table 7, for all three RDD surveys, the elderly have the lowest response rates. The rates for blacks are lower than for whites and persons with low levels of education have lower rates of response.

### 4.0 COVERAGE AND RESPONSE

Although the biases associated with undercoverage and nonresponse in sample surveys are often not of the same order of magnitude or even in the same direction, it is instructive to examine the total effect of undercoverage and nonresponse on survey interview rates. Table 8 presents estimates of the percent of target population surveyed by combining the effects of undercoverage and nonresponse. The estimate for population subdomains is derived by multiplying the estimated coverage for the subdomain by the estimated response for the subdomain.

Although telephone coverage for persons 65 years of age or older is higher than for any other age group, the overall interview rate is lower, reflecting the high nonresponse for this age group. The very low overall interview rates for blacks and for persons with low levels of education reflects both low coverage and low response. Some of the combined estimates are alarming. For blacks and the less educated, the overall rates appear to be below 60 percent. In health surveys, these are two of the most important analytical subdomains in the population. The potential of having a substantial bias due to undercoverage and/or nonresponse is very real.

It is obvious from close examination of Table 8 that our overall estimates of the percent of the target population surveyed are not very stable. One cannot help but conclude, however, that potential biases among certain subdomains are more likely than among other subdomains and the overall coverage and response rates for the total population surveyed may be misleading. We conclude that both coverage and response among subdomains should be examined carefully in the planning, conduct, and analysis of a telephone interview survey. The implications of high undercoverage or nonresponse rates among subdomains depends upon the overall objectives of the survey and the importance of subdomain estimates.

### REFERENCES

- [1] Camnell, C.F., Groves, R.M., Magilavy, L.J., Mathiowetz, N.A., and Miller, P.V., "An Experimental Comparison of Telephone and Personal Health Surveys," 2 vols., Survey Research Center, University of Michigan, final report under NCHS Contract No. 233-78-2034, March, 1982.

[2] Massey, J.T., Barker, P.R., and Hsiung, S., "An Investigation of Response in a Telephone Survey," Proceedings of the American Statistical Association, Survey Research Methods Section, 426-431, 1981.

[3] Thornberry, O.T. and Massey, J.T., "Correcting for Undercoverage Bias in Random Digit Dialed National Health Surveys," Proceedings of the American Statistical Association, Survey Research Methods Section, 224-229, 1978.

Table 1. Percent Distribution of Households by Telephone Status: National Health Interview Survey, 1963-81

Percent distribution				
Year	Telephone Households	Nontelephone Households	Total	Number of households
1981	93.1	6.9	100.0	39,835
1980	92.6	7.4	100.0	37,678
1979	92.5	7.5	100.0	40,247
1978	91.7	8.3	100.0	39,097
1977	91.6	8.4	100.0	39,675
1976	90.5	9.5	100.0	39,759
1975	90.4	9.6	100.0	40,131
1974	90.4	9.6	100.0	39,681
1973	89.8	10.2	100.0	40,310
1972	89.5	10.5	100.0	43,857
1971	88.9	11.1	100.0	43,305
1970	88.4	11.6	100.0	37,055
1969	87.3	12.7	100.0	35,799
1968	86.1	13.9	100.0	40,553
1967	84.6	15.4	100.0	41,671
1966	83.2	16.8	100.0	43,007
1965	*	*	*	*
1964	*	*	*	*
1963	80.8	19.2	100.0	42,129

\*Not available

Table 2. Household Telephone Ownership by Selected Household Characteristics: National Health Interview Survey, 1981

Household Characteristics	Telephone Households	Nontelephone Households	N
All Households	93.1	6.9	39,835
<b>Region</b>			
Northeast	94.1	5.9	8,752
North Central	94.9	5.1	10,515
South	90.1	9.9	12,858
West	94.2	5.8	7,710
<b>Geographic Distribution</b>			
<b>SMSA</b>			
3,000,000 or more	94.2	5.8	6,357
1,000,000-2,999,999	95.1	4.9	9,006
500,000 - 999,999	93.9	6.1	4,597
250,000 - 499,999	93.8	6.2	3,979
under 250,000	92.8	7.2	3,391
Other urban areas	91.7	8.3	4,828
Rural areas (except in SMSA)	89.7	10.3	7,677
<b>SMSA - Non-SMSA</b>			
SMSA - Central City	91.8	8.2	11,531
- Not Central City	96.0	4.0	15,799
Non-SMSA - Nonfarm	90.1	9.9	11,546
- Farm	94.7	5.3	959
<b>Urban - Rural Residence</b>			
Urban	93.7	6.3	28,047
Rural-Farm	95.3	4.7	1,188
Rural-Nonfarm	91.2	8.8	10,600
<b>Number of Persons in Household</b>			
One	90.0	10.0	9,312
Two	94.6	5.4	12,727
Three	93.4	6.6	6,961
Four	94.7	5.3	6,129
Five	93.8	6.2	2,822
Six	91.4	8.6	1,116
Seven	90.1	9.9	444
Eight or more	83.6	16.4	324

Table 3. Percent Distribution of Persons by Telephone Coverage and Selected Characteristics: National Health Interview Survey, 1981

Characteristics	Percent in Telephone Households	Percent in Nontelephone Households	N
<b>ALL PERSONS</b>	93.2	6.8	107,552
<b>Race</b>			
White	94.3	5.7	93,258
Black	84.5	15.5	11,554
Other	93.0	7.0	2,162
<b>Sex</b>			
Male	92.7	7.3	51,326
Female	93.7	6.3	55,648
<b>Age</b>			
Under 5 years	87.4	12.6	8,093
5-14 years	92.3	7.7	16,718
15-24 years	90.2	9.8	18,982
25-34 years	92.8	7.2	17,439
35-44 years	95.0	5.0	12,591
45-54 years	96.2	3.8	11,018
55-64 years	96.5	3.5	10,671
65-74 years	96.8	3.2	7,211
75 years and over	96.4	3.6	4,251
<b>Marital Status</b>			
Under 17 years	91.2	8.8	28,582
Married-Spouse Present	95.2	4.8	49,658
widowed	95.8	4.2	5,742
Never Married	92.1	7.9	16,163
Divorced	90.1	9.9	4,593
Separated	83.0	17.0	1,733
Married-Spouse Absent	84.9	15.1	503
<b>Education of Household Head</b>			
None	75.7	24.3	652
Elementary	87.4	12.6	16,259
Some High School	87.2	12.8	15,237
High School Graduate	94.2	5.8	36,859
Some College	96.4	3.6	16,800
College Graduate	99.1	0.9	19,819
Unknown	89.8	10.2	1,296
<b>Family Income</b>			
Less than \$3,000	71.6	28.4	3,445
\$3,000 - \$4,999	80.4	19.6	5,420
\$5,000 - \$6,999	84.2	15.8	6,261
\$7,000 - \$9,999	85.4	14.6	7,901
\$10,000 - \$14,999	92.3	7.7	14,459
\$15,000 - \$24,999	96.4	3.6	24,642
\$25,000 or more	99.2	0.8	34,949
Unknown	92.3	7.7	9,897
<b>Family Relationship</b>			
Living alone	89.9	10.1	9,385
Living with nonrelatives	91.3	8.7	2,348
Living with spouse	95.2	4.8	49,627
Living with relative-other	91.9	8.1	45,614
<b>Health Status</b>			
Excellent	94.8	5.2	52,686
Good	92.2	7.8	40,741
Fair	90.9	9.1	9,891
Poor	89.0	11.0	3,191
Unknown	90.8	9.2	465
<b>Main Spanish Origin</b>			
Puerto Rican	77.2	22.8	942
Cuban	88.6	11.4	576
Mexican	85.6	14.4	4,298
Other Latin American	87.6	12.4	550
Other Spanish	91.8	8.2	1,242
Not of Spanish origin	93.9	6.1	98,627
Unknown	86.4	13.6	737

Table 4. Percent of Persons in Telephone Households by Selected Characteristics and Family Income: National Health Interview Survey, 1981

Characteristic	Less than \$3,000	\$3,000-\$4,999	\$5,000-\$6,999	\$7,000-\$9,999	\$10,000-\$14,999	\$15,000-\$24,999	\$25,000 +
<b>ALL PERSONS</b>	71.6	80.4	84.2	85.4	92.3	96.4	99.2
<b>Race</b>							
White	75.1	81.2	86.1	87.2	92.8	96.7	99.2
Black	61.9	77.7	76.7	74.6	88.5	92.8	98.6
Other	78.0	86.5	78.3	86.5	94.0	95.2	99.0
<b>Sex</b>							
Male	68.2	74.9	81.5	83.6	91.1	96.1	99.1
Female	74.0	83.9	86.3	86.8	93.4	96.7	99.3
<b>Age</b>							
Under 5 years	56.2	62.7	72.7	72.7	87.9	95.4	98.7
5-14 years	64.2	76.7	81.3	77.9	92.4	95.8	99.4
15-24 years	73.5	76.6	77.3	79.8	87.6	94.7	98.6
25-34 years	65.8	72.6	79.1	80.7	90.5	96.4	99.0
35-44 years	72.3	76.4	83.4	83.0	92.6	96.5	99.3
45-54 years	68.6	83.9	82.6	90.7	94.9	97.5	99.5
55-64 years	81.5	85.5	89.3	94.3	97.6	98.1	99.7
65-74 years	85.9	90.9	95.5	97.4	98.7	99.4	99.8
75 years and over	86.2	92.7	95.6	98.0	98.0	99.3	99.8
<b>Age</b>							
Under 15 years	60.5	71.2	78.3	76.0	90.7	95.7	99.7
15-44 years	71.6	75.4	79.1	80.7	92.4	95.9	99.6
45-64 years	76.2	84.9	86.6	92.9	96.5	97.8	99.6
65 years and over	86.0	91.7	95.5	97.6	98.5	99.4	99.9
<b>Marital Status</b>							
Under 17 years	60.8	72.2	78.5	77.0	90.8	95.9	99.2
Married-Spouse Present	71.2	77.7	85.5	87.7	93.3	96.6	99.2
Widowed	88.9	94.3	95.8	95.6	97.6	97.7	99.7
Never Married	76.7	81.8	83.1	86.4	91.2	96.8	99.1
Divorced	65.4	79.0	83.6	89.2	92.9	96.2	99.0
Separated	64.8	73.0	79.2	82.7	86.5	92.7	96.4
Married-Spouse Absent	56.8	64.9	76.1	78.6	83.3	94.2	97.5

Table 5. Selected Health Characteristics by Telephone Coverage: United States, 1981

Health Characteristics	Nontelephone Households	Telephone Households	All Households
<b>DISABILITY DAYS</b>			
Number Per Person Per Year			
Restricted activity days	22.3	18.8	19.1
Bed disability days	9.3	6.7	6.9
Work loss days	5.2	4.9	4.9
<b>ACUTE CONDITIONS</b>			
Number Per 100 Persons Per Year			
Acute conditions	220	212	212
Restricted activity days <sup>a</sup>	1,181	943	960
Bed disability days <sup>a</sup>	580	407	419
Work loss days <sup>a</sup>	390	333	337
<b>CHRONIC CONDITIONS</b>			
Percent With			
Limitation in activity <sup>b</sup>	14.6	14.3	14.4
Limitation in major activity <sup>b</sup>	11.7	10.8	10.9

<sup>a</sup>Associated with acute conditions

<sup>b</sup>Due to chronic conditions

Table 6. Use of Selected Health Services by Telephone Coverage: United States, 1981

Health Services	Nontelephone Households	Telephone Households	All Households
<b>PHYSICIAN VISITS</b>			
Number of physician visits per person per year	4.0	4.7	4.6
Percent seeing a physician within the past 6 months	53.7	57.9	57.6
<b>DENTAL VISITS</b>			
Number of dental visits per person per year	0.8	1.8	1.7
Percent seeing a dentist within the past 6 months	19.9	37.1	36.0
<b>HOSPITAL DISCHARGES</b>			
Number of hospital discharges per 100 persons per year	18.2	13.9	14.2
Average length of stay for hospital discharges	7.3	7.4	7.4

Table 7. Estimated telephone response rates for selected demographic subdomains for three RDD samples

Subdomain	Knowledgeable Respondent Survey	Random Respondent Survey	Self Respondent Survey
Sex			
Male	83	72	72
Female	81	79	76
Age			
17-24 years	82	62	80
25-44 years	88	86	79
45-64 years	81	81	69
65 years and over	66	57	63
Race			
White	82	77	75
Black	82	69	68
Education			
0-11 years	74	58	62
12 years	80	72	75
13 years or more	91	96	85
Total	82	76	74
Sample size	4127	3874	10795

Table 8. Estimated telephone interview rate (coverage X response) for selected demographic subdomains for three RDD samples

Subdomain	Knowledgeable Respondent Survey	Random Respondent Survey	Self Respondents Survey
Sex			
Male	77	67	67
Female	76	74	71
Age			
17-24 years	73	56	72
25-44 years	83	81	74
45-64 years	78	78	67
65 years and over	64	55	61
Race			
White	77	72	71
Black	69	58	57
Education			
0-11 years	64	50	54
12 years	75	68	71
13 years or more	89	94	83
Total	76	71	69
Sample size	4127	3874	10795