Evaluation of Bias and Logistics in a Survey of Adults at Increased Risk for Oral Health Decrements

Gregg H. Gilbert, DDS; R. Paul Duncan, PhD; Andrew M. Kulley, PhD; Raymond T. Coward, PhD; Marc W. Heft, DMD, PhD

Abstract

Objectives: *Designing research to include sufficient respondents in groups at highest risk for oral health decrements can present unique challenges. Our purpose was to evaluate bias and logistics in this survey of adults at increased risk for oral health decrements.* ***Methods:*** *We used a telephone survey methodology that employed both listed numbers and random digit dialing to identify dentate persons 45 years old or older and to oversample blacks, poor persons, and residents of nonmetropolitan counties. At a second stage, a subsample of the respondents to the initial telephone screening was selected for further study, which consisted of a baseline in-person interview and a clinical examination. We assessed bias due to: (1) limiting the sample to households with telephones, (2) using predominantly listed numbers instead of random digit dialing, and (3) nonresponse at two stages of data collection.* ***Results:*** *While this approach apparently created some biases in the sample, they were small in magnitude. Specifically, limiting the sample to households with telephones biased the sample overall toward more females, larger households, and fewer functionally impaired persons. Using predominantly listed numbers led to a modest bias toward selection of persons more likely to be younger, healthier, female, have had a recent dental visit, and reside in smaller households. Blacks who were selected randomly at a second stage were more likely to participate in baseline data gathering than their white counterparts. Comparisons of the data obtained in this survey with those from recent national surveys suggest that this methodology for sampling high-risk groups did not substantively bias the sample with respect to two important dental parameters, prevalence of edentulousness and dental care use, nor were conclusions about multivariate associations with dental care recency substantively affected.* ***Conclusion:*** *This method of sampling persons at high risk for oral health decrements resulted in only modest bias with respect to the population of interest. [J Public Health Dent 1997;57(1):48-58]*

Key Words: epidemiologic methods, health surveys, research design, telephone survey.

The disproportionate burden of disease found in certain subgroups of the population has focused research interests toward a better understanding of its determinants. These high-risk groups include racial and ethnic minorities, persons of low socioeconomic status (SES), and the aged. For most racial and ethnic minorities, minority adults have poorer health status than majority groups (1,2). Similar trends have been observed with adults of low SES (3,4). Additionally, research on residential differences suggests that as a group, residents of small towns and rural communities often have poorer health, higher rates of morbidity and mortality, and less access to health services (5,6). Similar trends among these high-risk groups have been observed specifically with regard to oral health (7,8). Because these high-risk groups of interest constitute a minority of the population at large, designing research to include persons who are representative of these groups, and in numbers sufficient to make meaningful comparisons among groups can present unique challenges.

Several approaches to the recruitment of high-risk groups have been used. Recruitment by advertisement and personal contact in health facilities has been the approach used for many clinical studies. However, given that volunteers for these studies are stereotypically motivated, middle and upper SES individuals, the sample obtained often is not representative of persons at the highest risk for disease. Samples that are the most representative of high-risk groups are usually derived from community-based approaches using probabilistic sampling strategies. For some population groups, driver's license lists and health insurance lists provide nearly complete coverage (9,10). Other studies have used an exhaustive approach by enumerating all the dwelling units in a defined geographic area, identifying all eligible persons in that area, and drawing a sample of subjects from that list. Such an approach, however, is extremely resource intensive.

As an alternative, telephone surveys have now become common in community-based sampling (11-13). Telephone sampling methods can offer substantial advantages, such as cost savings, and approximately 95 percent of US households have telephones (14). However, these methods also have potential disadvantages, particularly with regard to certain population subgroups. There can be substantial variation in telephone coverage by geographic region, race, and SES (14). Consequently, the subgroups that might be targeted in a given research project also might be the most difficult to sample by telephone. One approach to addressing the under-

Send correspondence and reprint requests to Dr. Gilbert, Claude Pepper Center for Research on Oral Health in Aging, PO Box 100416, Gainesville, FL 32610-0416. Internet: gilbert@nervm.nerdc.ufl.edu. Drs. Duncan and Coward are affiliated with the Claude D. Pepper Center for Research on Oral Health in Aging and the Institute for Health Policy Research, University of Florida. Dr. Heft is also with the Claude Pepper Center. Dr. Kulley is with the Response Analysis Corporation, Princeton, NJ. Manuscript received: 6/23/95; returned to authors for revision: 12/14/95; accepted for publication: 2/23/96.

coverage in low-income and minority households has been to supplement telephone sampling with additional lists, such as city directories of households or with house-to-house canvassing in small areas where a substantial percent of low-income and minority persons are known to reside. However, these approaches also have important limitations, such as increased costs or lack of representativeness of the targeted populations (11,15).

Two methods of telephone sampling are common: a random digit dialing (RDD) method and the use of listed telephone numbers. Both approaches offer distinct advantages and disadvantages. About one-fifth to one-third of households with telephones have unlisted telephone numbers (12,13,16,17), and persons with unlisted numbers may differ in relevant characteristics from persons with listed numbers (12,13). The RDD approach offers the advantage of contacting all working telephone numbers, whether these numbers are listed or unlisted. However, this approach increases the required quantity of screening because RDD procedures result in calls to nonexistent telephones, businesses, institutions, and other irrelevant numbers. It is not uncommon to have as many as five or more ineligible telephone numbers for each eligible number sampled (11). Using listed telephone numbers offers the advantage of cost efficiency, but has the potential to yield a biased sample when sampled individuals in households with unlisted numbers differ substantively from those with listings. These disadvantages can be compounded in certain population subgroups who, in addition to having lower rates of telephone coverage, can have lower response rates to surveys in general (18-23).

This study was part of a larger research project (Florida Dental Care Study) designed to develop a risk assessment model of oral health outcomes in middle-aged and older adults, with a special interest in understanding risk in poor individuals, blacks, and residents of rural areas. Although these groups can be difficult to survey and recruit for research studies, their high risk for both oral disease and inadequate dental care attendance makes research on these groups imperative if continued improvements in oral health are to be realized. In this report, we describe the sampling and data collection methodologies that were employed to target these high-risk groups, and then we assess the limitations, logistics, and biases of our approach. An evaluation of what amount of bias, if any, is introduced in a sample because of the methodology used is important to understanding what inferences can be made from the sample. An evaluation of the logistics of the methodology also can be useful for investigators who are planning similar studies and who have an interest in the advantages and disadvantages of this approach to sampling.

Methods

One goal of the study was to ensure that a large number of persons at a hypothesized increased risk for oral health decrements would be included in the sample. High-risk groups of special interest were: (1) lower income persons, who were defined relative to the US poverty level using the definition employed by the US Bureau of the Census (14); (2) blacks; (3) residents of rural areas; and (4) persons who were 45 years old or older. The homeless and persons who resided in nursing homes, adult congregate living facilities, adult foster homes, hospices, military installations, or correctional facilities were excluded from the population of interest. These criteria excluded approximately 4 percent of the 45-year-old and older population in the targeted geographic areas (24). Additionally, because of our interest in tooth loss as an oral health outcome, only persons who had at least one natural tooth remaining were included in the population of interest.

Four counties in north Florida were selected: three nonmetropolitan counties and one metropolitan county. These counties were selected because they provide a rural-urban contrast; have large proportions of blacks, older adults, and poor individuals; are geographically proximate; and are located near the administrative base for the project, the University of Florida. The metropolitan county, which is large geographically, contains some less densely populated, suburban areas. For this reason, only persons who resided in one of 21 urbanized zip codes in this county were included in the population of interest. Although the "rural" grouping used in this investigation does not conform to the definition used by the US Bureau of the Census (14), the three counties that comprised our "rural" sample are sparsely populated nonmetropolitan counties, wherein the total county populations in 1990 ranged from 10,930 to 16,569. One of these nonmetropolitan counties was "all-rural" (i.e., had no towns of 2,500 or more residents within its boundaries), and the other two each had a place slightly larger than this (specifically, towns of 2,573 and 3,345 residents). According to Census definitions, these latter places would be designated "urban."

A telephone screening methodology was designed; however, following the award of a related study of the race and residence differences in patterns of long-term care among residents 65 years old or older in these same counties, the screening methodology was modified to accommodate the needs of both projects simultaneously. Eligibility criteria for both projects were that the respondent: (1) resided in one of the four counties of interest; (2) for the metropolitan county, resided in one of the urbanized zip codes; (3) was English speaking; (4) was capable of engaging in a cogent telephone conversation; and (5) resided in a household, in contrast to a congregate facility. For the long-term care study, an additional criterion was that the respondent must be 65 years old or older; the number of remaining teeth was not relevant.

The objective of the telephone screening for this projected pool of 5,000 persons (5,254 was ultimately the actual number) was to have approximately 50 percent of the sample be residents of the metropolitan county and 50 percent be residents of the three nonmetropolitan counties, with about one-half being 45–64 years old and the other half being 65 years old or older. Additionally, the objective was to have about 40 percent of respondents be below 150 percent of the US poverty level and to have about 40 percent of respondents be black. All these objectives were met.

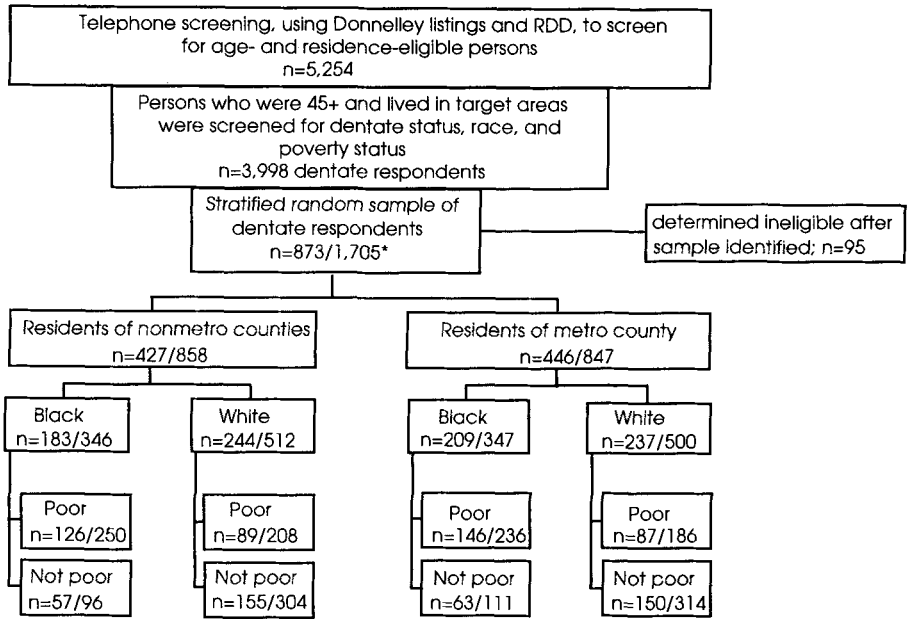
At a second stage, the dental study selected a stratified random sample of 1,800 dentate respondents for further study, which consisted of a baseline in-person interview and a clinical dental examination (Figure 1). Follow-up after the baseline session also was planned to allow for the longitudinal assessment of risk. The long-term care

study selected a stratified random sample of 1,200 respondents 65 years old or older for further telephone interviewing. This report is limited to analyses relevant to the dental study; consequently, dentate status and an age of 45 years old or older were pertinent eligibility criteria.

Dialing Methodology. A dual sampling frame telephone screening methodology was used for this research. Both RDD and directory listed sampling were used to balance the greater coverage of households inherent in RDD against the greater cost efficiency inherent in the listed sample approach. This dual frame approach provides a means to assess the degree to which the use of listed numbers creates underrepresentation in any of the strata of interest, and a basis for the development of weights to correct for bias. The directory listed sample of residential numbers was drawn using fully probabilistic procedures from a computer file that contained all the numbers listed in the white pages of telephone directories serving the target counties. This master file is maintained and continually updated by Donnelley Marketing Services®; numbers listed between the construction of these lists and the actual time of telephone screening would be classified as "unlisted." The RDD telephone numbers were generated, separately for the urban and rural strata, by computer for all telephone exchanges that served the target counties. To eliminate wasteful dialing, a computer program was used to detect duplicate numbers in the respective RDD and listed sample files, and any duplicates found were eliminated from the RDD files. Also, the pool of random numbers generated was matched by computer against a file of known business listings by using the Yellow Pages®, and any known business numbers were eliminated. The remaining numbers were then screened by computer using a procedure that detects nonworking numbers electronically.

The mix of RDD and listed sample varied across strata. In the rural stratum the overall sample fraction was large, and the pool of available unlisted numbers was relatively small. This led to greater reliance on the pool of directory listed numbers. In the urban stratum the overall sampling fraction was small, and the pool of available unlisted numbers was relatively large. Thus, in the urban stratum, a larger proportion of the sample was drawn from the RDD files.

FIGURE 1
Sample Design



*Where the sample size appears as a fraction, the numerator represents the number of persons in each stratum who participated for baseline data gathering. The denominator represents the total number of presumed eligible persons in the stratum. In this figure, poverty is defined as being below 150% of the US poverty level.

A computer-assisted telephone interviewing (CATI) system was used. The CATI program conducts online checks that the data being entered are logical and fall within the ranges allowed. CATI also ensures that questionnaire skip patterns are executed properly; thus, the interviewer can devote full attention to the interview. Online sample control was used in conjunction with CATI. Online sample control performs many of the clerical tasks, such as maintaining a count of respondents and their characteristics, scheduling callbacks, executing call rules, and cycling and rotating calls through various time periods. An extended call rule was implemented. Sample telephone numbers received up to five contact attempts if needed. All initial contact attempts were made on week nights or weekends; however, callback appointments were scheduled to accommodate respondents' time constraints. Calls were made during weekday hours to attempt to contact households for which evening and weekend contacts had been unsuccessful.

A refusal conversion procedure was used to attempt to convince initially uncooperative respondents to participate: after an initial refusal and a waiting period of typically two days, another interviewer skilled in refusal conversion made another attempt. When more than one member of a household was age-eligible, a "next-birthday" protocol was used wherein the household member with the next birth date was selected to represent that household. Proxies were not accepted; only the actual respondent selected was interviewed. The telephone screening phase began in May 1993 and lasted approximately three months. Respondents were asked up to 30 screening questions that queried sociodemographic and health information. The mean (SD) interview time was 6.9 (2.8) minutes.

Recruitment of Subjects for Baseline Data Gathering. A stratified random sample of 1,800 dentate respondents from the pool of 5,254 respondents (3,998 of whom were dentate) was selected. Following a mailing of an introductory letter that explained the purpose and procedures of the project, attempts to contact and recruit these 1,800 respondents were made by

telephone. If the respondent could not be contacted by telephone (due to telephone disconnection or no answer), then a second letter was mailed to the address that the respondent provided during the screening survey, requesting that the respondent establish contact with the study team.

Respondents were asked to participate for a baseline in-person interview, which typically lasted 30 minutes. This interview was followed by a clinical dental examination, the exact protocol of which has been described previously (25-27). Examination data were entered in the field directly into portable microcomputers using software designed specifically for the project. The project successfully recruited 873 respondents for baseline data collection, the field phase of which began in August 1993 and ended in April 1994. Respondents were asked to come to one of 17 clinical, business, governmental, or senior center facilities to participate (the specific site depended on their place of residence). For 96 respondents in the metropolitan county who reported difficulty with transportation, taxicab service was provided at the project's expense. In-home visits were provided for respondents who requested them, although only 52 of the baseline respondents did so. As tokens of appreciation, respondents were given a 1-lb canned ham and an engraved coffee cup, which had affixed a logo of the project and university.

Statistical Methods. Analyses reported here were done using SAS (28) in the microcomputer environment (SAS System for Windows®, version 3.1). Comments about statistical significance refer to probabilities of less than .05. In those instances where we report analyses from the 1990 US Census, the use of statistics is appropriate for those variables for which a sample was taken, rather than a census. The chi-square and Mantel-Haenszel chi-square trend tests were used for bivariate comparisons when variables were nominal or ordinal, respectively. Analysis of variance was used for bivariate comparisons when variables were on a continuous scale. Logistic regressions were used for multivariate assessment of bias among samples. Multicollinearity was measured using a procedure described by Belsley et al. (29) and further explicated by Miller and Farmer (30), although none ultimately was observed.

All results used weighted estimates that reflected the population of interest. Because the population of the metropolitan county is large relative to that of the nonmetropolitan counties, the weights for the nonmetropolitan counties were scaled to force the weighted total to equal that obtained for the metropolitan sample, although the weights for the rural and urban samples were processed separately. A first-stage weight was used as input into an iterative proportional fitting algorithm, along with information from the telephone screening data and demographic targets. The demographic targets were taken from special tabulations done by the US Bureau of the Census that detailed the distribution of target populations by age, sex, race, and poverty status (24). For the nonmetropolitan cases, target marginals that reflected the population of each of the three nonmetropolitan counties also were used. Where national data were used, weighted analyses also were conducted, and multivariate analyses of the national data used SUDAAN® software (31).

Results

Our presentation of results parallels our assessment of bias and generalizability at successive levels of analysis (Table 1). The potential for bias arose at two stages of data collection: (1) telephone screening—because the methodology of necessity is limited to households with telephones, because a predominantly listed number method was used, and because of refusals to participate; and (2) participation for baseline data gathering—because of refusals to participate or the inability to contact persons to request their participation. Consequently, we begin our presentation of results by

TABLE 1
Assessment of Bias at Consecutive Stages of Data Collection

Stage	Comparison	Rationale
Telephone screening	1. Use 1990 Census data on 45-year-old and older persons in the four counties sampled to determine whether persons with telephones are different from those without telephones.	Limiting the sample only to households with telephones may bias the sample with respect to substantively important nondental characteristics of respondents.
	2. Use 1989 National Health Interview Survey data to compare dental characteristics of US persons 45 years old and older who have or do not have telephones.	Limiting the sample only to households with telephones may bias the sample with respect to specific dental parameters of interest.
	3. Compare characteristics of persons who participated for the telephone screen with characteristics of age-eligible persons in the four counties sampled, using 1990 Census data.	Nonresponse bias, as well as limiting the sample to households with telephones, may substantively bias the sample.
	4. Compare characteristics of persons who were identified by telephone listings with those who were identified by random digit dialing.	Bias may be introduced if persons with listed numbers differ from those with unlisted numbers.
Baseline recruitment	5. Of the 1,800 dentate persons randomly selected for baseline participation, compare characteristics of those who did and did not participate for baseline data gathering.	Bias may be introduced if persons who participated were different from persons who did not.

describing the effectiveness of the telephone screening methodology; then we assess bias by comparing sociodemographic characteristics of households with and without telephones (using county-specific Census data; comparison #1, Table 1); then assess bias by comparing the specific dental characteristics of households with and without telephones using national data (comparison #2, Table 1; not possible using county-specific Census data); then assess bias by comparing characteristics of the respondents obtained using our telephone methodology with the "gold standard" (county-specific Census data; comparison #3, Table 1), then assess bias due to using a predominantly listed number method (comparison #4, Table 1); and, finally, we evaluate bias due to nonparticipation for the final stage of data collection, in-person baseline data gathering (comparison #5, Table 1).

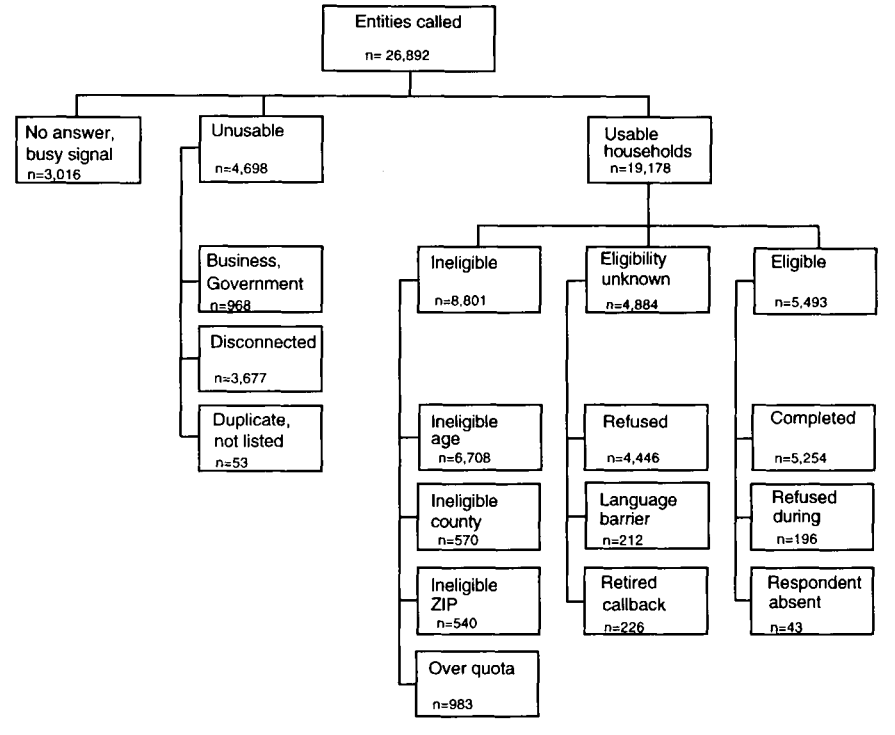
Telephone Screening Results. Figure 2 presents results of the telephone screening procedures. A total of 26,892 entities were called, of whom 5,493 households had at least one eligible person. Eligibility was unknown for 4,884 usable households, because the person speaking for the household refused to provide information, had a language barrier, or was not sufficiently cogent so that eligibility of the household could be determined, or because repeated callbacks to the household had not determined eligibility. A total of 8,801 households were ineligible, of whom 983 were classified as such near the end of the telephone screening phase because target numbers for the individual strata had been reached. Almost 18 percent of entities called (n=4,698) were unusable, a small number of whom (53 persons) were classified as such because a given household had more than one telephone and that telephone number(s) was not listed.

To calculate response rate, we used a procedure accepted by the Council of American Survey Research Organizations (CASRO), which was established to create a uniform formula for measuring response rates for survey research (32). This conservative method includes estimates of the percent of the sample with unknown usability that would become usable and the percent of the sample with unknown eligibility that would become eligible if time were unlimited. The CASRO formula includes these estimates, but does not take the additional step of estimating the percent of the eligible sample with unknown cooperation that would cooperate if time were unlimited. Thus, the denominator is increased by these estimates, but the numerator is fixed. The response rate for the telephone screening portion of the study was 67 percent for the nonmetropolitan counties and 62 percent for the metropolitan county.

Comparison of Households with and without Telephones Using County-specific Census Data. To assess bias due to the inclusion of only households with telephones (comparison #1, Table 1), we used county-specific 1990 Census data to compare households with telephones to households without telephones in the three nonmetropolitan counties and in households from the zip codes of interest in the metropolitan county of interest (24). Although three years had elapsed between telephone screening and the 1990 Census, and even though some population groups may be undercounted in the Census (33), county-specific Census data are the best "gold standard" against which to compare. Albeit 96 percent of households with at least one person 45 years old or older had a telephone, persons who resided in households without telephones were more likely to be residents of nonmetropolitan areas, poor, black, and middle-aged (45–64 years old). However, the subgroup with the lowest telephone coverage (73%) was the 65-year-old or older rural poor black subgroup.

Because these findings from the US Census in these counties suggest that certain subgroups are sampled at a lower rate if the sampling methodology is limited to households with telephones, it is reasonable to question whether the respondents who are identified by telephone are any different on relevant characteristics from their counterparts in the same subgroup who do not have a telephone. Because telephone coverage (and our sampling methodology) differed by age group, race, area of residence, and poverty status, differences between persons with telephones and those without telephones were compared within each of the 16 [(age group) x (race) x (area of residence) x (poverty status)] groups, using the US Census data. For example, characteristics of the middle-aged black rural poor persons with telephones were compared with the characteristics of the middle-

FIGURE 2
Results of Telephone Screening Procedure



aged black rural poor persons who did not have telephones. Four self-reported characteristics were compared: sex, limitation in instrumental activities of daily living (IADL), limitation in activities of daily living (ADL), and household size. In the 1990 Census, IADL was measured by asking, "Because of a health condition that has lasted for six or more months, does this person have any difficulty going outside the home alone, for example to shop or visit a doctor's office?" ADL was measured by asking "Because of a health condition that has lasted for six or more months, does this person have any difficulty taking care of his or her own personal needs, such as bathing, dressing, or getting around inside the home?"

These county-specific Census data suggest that in all but one of the 16 groups (the 45–64-year-old rural black not poor group), females were more likely to reside in households with telephones (58% females in households with telephones vs 43% females in households without telephones). In the 45–64-year-old rural black not poor group, females comprised 53 percent of households with telephones, compared to 60 percent of households without telephones. For the sex and household size data, statistical comparisons are not appropriate because a census was taken.

Including all 16 subgroups, the mean household size in households with telephones was 2.4 persons compared to 2.2 persons in households without telephones. The range of differences between the mean household size in households with telephones and households without telephones for the 16 groups was 0.01–0.86 (mean difference of 0.42). The largest difference (0.86 persons) was observed in the middle-aged poor rural black group.

Households without telephones also were more likely to have IADL-impaired and ADL-impaired persons. Ten percent of persons with telephones had an IADL difficulty compared to 17 percent of persons without telephones ($P<.01$). For the IADL and ADL variables, a sample was taken and statistical tests are appropriate. Ten percent of persons with telephones had an ADL difficulty, compared to 17 percent of persons without telephones ($P<.01$; the identical magnitudes for ADLs and IADLs is a coincidence, not an error). Persons who resided in households without telephones were significantly more likely to have an IADL difficulty in eight of 16 groups, significantly less likely in two of the groups, and there was no statistically significant difference in six of the 16 groups. Persons who resided in households without telephones were significantly more likely to have an ADL difficulty in seven of the 16 groups, and there was no statistically significant difference in the other nine groups.

Therefore, we conclude from these county-specific Census data that, when the population of interest is defined as 45-year-old and older persons who reside in households, limiting the sampling strategy to include only households with telephones biased the sample overall toward more females, larger households, and fewer functionally impaired persons.

Comparison of Households with and without Telephones Using National Dental Health Data. We are not aware of previous reports of the potential bias in specific dental parameters when samples are limited to households with telephones. Recent national data, the 1989 National Health Interview Survey (NHIS), makes this assessment possible (34). The NHIS is an ongoing survey conducted by the National Center for Health Statistics that uses national probabilistic sampling, and is representative of the civilian noninstitutionalized population. Response rates typically exceed 95 percent. The NHIS uses a face-to-face interview, in contrast to the telephone-administered format used for the screening portion of the Florida study. The NHIS analyses we report here were weighted to adjust for design effects and different probabilities of selection, and reflect the extent to which the variances of estimates obtained from stratified and cluster sample-based designs differ from those of a simple random sample (34).

Similar to the aforementioned findings from the US Census in the four counties of north Florida, 97 percent of households with at least one person 45 years old or older had a telephone in the 1989 NHIS. Also similar to findings observed with the Census data, the NHIS respondents who resided in households without telephones were more likely to be residents of nonmetropolitan areas, poor, black, and middle-aged (45–64 years old). However, for the 1989 NHIS the subgroup with the lowest telephone coverage (68%) was the middle-aged rural poor black subgroup. Because the two dental parameters of interest, edentulism prevalence and recency of last dental visit, also are associated with these characteristics, we tested the hypothesis that excluding persons in households without telephones would bias the estimates of edentulism and the recency of last dental visit (comparison #2, Table 1). The analysis of 45-year-old or older blacks and whites in the NHIS found clear differences in edentulism and dental attendance between persons in households with and without telephones: 23 percent of persons in households with telephones were edentulous and 54 percent had a dental visit in the previous year, compared to 33 percent edentulous and 26 percent with dental visits of those without telephones. Therefore, the NHIS data suggest that with respect to these two dental parameters, results from telephone surveys would not be generalizable to those without telephones.

If the objective of a study is not to generalize to households without telephones, but instead to ponder the effect on prevalence estimates by excluding adults without telephones, the effect is negligible. For example, if all persons 45 years old or older are included, the percent in the NHIS sample who are edentulous is 23 percent and the percent who report a dental visit in the previous year is 53 percent.

If only persons with telephones in the NHIS are included, the percent of edentulous individuals in the same age group remains at 23 percent, and the percent with a dental visit in the past year is 54 percent. Therefore, using these national data, there is almost no difference in these prevalence estimates whether households without telephones are included or excluded.

We next tested the hypothesis that bias in national estimates of edentulism and dental care recency could be substantive in the subgroup with the lowest telephone coverage, the middle-aged black rural poor group. For this subgroup, the prevalence of edentulism is 24 percent and the percent of persons with a dental visit in the previous year is 13 percent. If only persons with telephones in this subgroup are included, the edentulism

prevalence is 26 percent and the percent of persons with a dental visit in the previous year is 12 percent. Consequently, we conclude from these NHIS data that results are not generalizable to households without telephones, but that limiting a sample of adults 45 years old or older to those who have telephones does not lead to substantively important bias with respect to prevalence estimates of these two dental parameters.

Nonetheless, the purpose of most oral health surveys goes beyond obtaining prevalence estimates. Rather, the purpose also might be one of understanding the complexities of risk for changes in oral health, using multivariable regression models that account for the presence of other risk factors and allow for a quantification of the additive and/or multiplicative increase in risk due to the presence of these risk factors. For this reason, we compared two logistic regression models using the NHIS data, where recency of last dental visit (dental visit in the previous year or not) was the outcome of interest. The NHIS data also queried age, sex, level of formal education, poverty status, area of residence (metro/nonmetro), and race. Because previous dental care utilization studies have identified these variables as covariates of dental care use, these variables were modeled as covariates in the two regression models. Both models included only blacks and whites who were 45 years old or older and who had at least one remaining natural tooth. The first model was limited to persons who met these criteria, but who also had telephones; the second model included all these persons, whether they had telephones or not.

Results of the two regressions were nearly identical. Odds ratios for the covariates were unchanged for two covariates, and did not change more than 5 percent for any covariate. The model fit for the first model was 71 percent pairs concordant, and was 72 percent for the second model. Therefore, the NHIS data suggest that limiting the sample to only households with telephones would have had no substantive influence on understanding the multivariate influence of the selected covariates on dental care recency.

Comparison of Telephone Screening Respondents with Persons in the 1990 Census. To assess bias due to nonresponse (as well as bias due to the exclusion of households without telephones), we paralleled our Census comparisons above by next comparing the characteristics of persons who participated in the screening survey with the persons from the Census (comparison #3, Table 1). We compared household size for persons 45 years old or older. We also compared physical functioning (IADL and ADL) of the telephone screening respondents to persons in the Census from the four counties of interest.

IADL and ADL comparisons were limited to persons 65 years old or older because the physical functioning items were asked during the Florida telephone screen only of persons this age. In the Florida telephone screen, IADL was measured by asking, "In the past two weeks, because of a health or physical problem, have you had any difficulty preparing your meals, shopping, or doing light housework—like doing dishes or straightening up?" ADL was measured by asking, "In the past two weeks, because of a health or physical problem, have you had any difficulty bathing, dressing, getting out of bed, or walking?" Consequently, while the physical functioning questions from the Census and the telephone screen are comparable, they did query the items differently not only with respect to the actual words used, but also with respect to the time frames of reference (two weeks as compared to the past six months).

Table 2 shows the results of these comparisons. Telephone screening respondents were more likely to reside in smaller households than the age-eligible population at large (consistent with our results from the "Comparison of Households with and without Telephones Using County-specific Census Data" section earlier), although the differences were not statistically significant and do not appear to be substantively important. Assuming direct comparability between the IADL and ADL measures, telephone screening respondents were less likely to be IADL-impaired (also consistent with our previous results); however, ADL impairment between the two comparison groups was almost identical..

These analyses suggest that the combination of nonresponse bias and bias due to limiting the sample to households with telephones resulted in a sample that had slightly smaller households. Given the potentially labile nature of IADL and ADL dependence (35) and the differences in time frame between questions in the Census and the Florida study, it is expected that the prevalence of IADL and ADL dependence would be lower in the Florida study. That this was indeed the case suggests that the Florida sample was not biased in an aberrant direction. The magnitude of the differences that were observed suggest that, if present, the bias in the sample due to physical function is small.

Evaluation of Bias Due to the Predominant Use of Telephone Listings.

TABLE 2
Comparison of Telephone Screening Respondents with County-Specific 1990 Census Data*

Comparison Groups	Telephone Respondents (SD)	1990 Census (SD)
Metropolitan county		
Mean household size	2.2 (2.1)	2.4 (2.2)
% with IADL impairment	13% (11%, 15%)	19% (19%, 19%)
% with ADL impairment	14% (13%, 16%)	15% (15%, 15%)
Nonmetropolitan counties		
Mean household size	2.2 (2.3)	2.5 (1.9)
% with IADL impairment	17% (15%, 19%)	23% (22%, 24%)
% with ADL impairment	19% (17%, 21%)	19% (18%, 20%)

*Comparisons of mean household size are for persons 45 years old or older. Comparisons of IADL and ADL impairments are limited to persons 65 years old or older. The wording of IADL and ADL questions in the telephone screen and the 1990 Census were similar, but not identical. See the text for further explication. Point estimates are followed by their 95% confidence intervals or their standard deviations in parentheses.

Although using listed telephone numbers is less costly than RDD, the listed methodology can introduce bias if unlisted households differ from listed households in the population of interest. To assess potential bias due to the predominant use of telephone listings (comparison #4, Table 1), we compared six self-reported characteristics of listed and RDD respondents: sex, general health status, whether the respondent had been to a dentist within the previous 12 months, dentate status (any remaining teeth or not), household size, and age. RDD respondents included both listed and unlisted subsets; consequently, the comparison made is between the listed method and the RDD method, not between listed and unlisted numbers. Analyses were not subdivided into the 16 subgroups used earlier because listed versus RDD comparisons created cell sizes too small for reliable estimation.

The results of these listed versus RDD comparisons are shown in Table 3. Differences between the two groups were modest, although persons identified using listings were significantly more likely to have had a dental visit in the previous year, and to be female, dentate, in better general health, older, and reside in smaller households.

Evaluation of Bias Due to Nonparticipation in Baseline Data Gathering. A total of 1,800 dentate respondents who participated in the telephone screening interview were selected randomly within strata and contacted to participate in the baseline data collection. Eight hundred seventy three (873) of these respondents participated, 707 were contacted but refused, and 125 were unreachable (usually because of disconnected telephone service). Ninety-five respondents had died between the telephone screen and follow-up contact, or were judged ineligible because they had been admitted to a nursing home, were not at least 45 years old, had had all their remaining teeth extracted between telephone screening and follow-up contact, or had moved from the geographic areas of interest. The unweighted participation rate was 51 percent (873 divided by 1,705), and presumes that none of those who were unreachable were ineligible.

To quantify the association between participation and selected respondent characteristics simultaneously (comparison #5, Table 1), we conducted analyses of factors associated with participation status. Race was associated with participation. Fifty-seven percent of blacks participated for the baseline phase, compared to 48 percent of whites (chi-square=12.7; 1 df; $P<.001$). We also conducted an unweighted multivariate logistic regression analysis of participation status (0=eligible or presumed eligible, but did not participate; 1=eligible, and did participate). Race remained significantly associated with participation (odds ratio for blacks=1.5; 95% CI=1.3, 1.9), with the other covariates taken into account. In the same regression, poverty status (below 100% of US poverty level), recency of the last dental visit, sex, age, area of residence, and self-reported general health status were not significantly associated with participation (at 50% probability level, model fit: % pairs correct=52%; sensitivity=31%; specificity=70%). The poor model fit suggests that much of the variation in participation was unexplained and/or random.

Because the sampling weights accounted for differential participation between subgroups, a weighted version of the aforementioned regression is not appropriate other than to confirm the quality of the weighting procedures, and to test variables that were not used as part of the weighting procedures. Odds ratios should not be statistically different from one if weighting was adequate, and this was the case when the regression was repeated using weighted values. Self-reported general health status was included in this latter regression, although it was not a variable used in the weighting procedure. Its parameter estimate was not different from one, which suggests that participation was not associated with general health status.

Comparisons with National Dental Health Data. Assessment of bias must precede any assessment of generalizability of findings from the sample. Having addressed this former issue, we next proceeded to assess generalizability by comparing selected characteristics of our sample with national data. The more similarity we find between key measures in the regional sample (northern Florida) and comparable measures in the national probability sample, the more confidence we have that this regional sample is not aberrant, and the more confidence we have that the inferences drawn from these regional data are generalizable to the larger US population. This assessment also amounts to a final assessment of whether the end result of several possible biases introduced by the survey methodology resulted in an aberrant sample.

TABLE 3
Comparison of Respondents Identified Using Telephone Listings with Those Identified Using Random Digit Dialing*

Characteristic	Respondents: Listed (n=4,580)	Respondents: Random Digit Dialing (n=674)	P-value
Dental visit in previous year	56% (55%, 57%)	50% (46%, 54%)	<.01
Has at least one natural remaining tooth	81% (80%, 82%)	79% (76%, 82%)	ns
Sex: % female	57% (56%, 58%)	53% (49%, 57%)	<.05
Self-reported general health			
Excellent	21% (20%, 22%)	21% (18%, 24%)	
Very good	27% (26%, 28%)	21% (18%, 24%)	
Good	27% (26%, 28%)	30% (27%, 33%)	
Fair	16% (15%, 17%)	17% (14%, 20%)	
Poor	9% (8%, 10%)	12% (9%, 15%)	<.05
Mean household size	2.2 (1.3)	2.3 (1.2)	<.05
Mean age	61.9 (11.7)	60.0 (11.1)	<.01

*Chi-square tests were used for comparisons of nominal data, Mantel-Haenszel chi-square trend test for ordinal data, and ANOVA Bonferroni paired comparison tests for interval data. Point estimates are followed by their 95% confidence intervals or their standard deviations.

Paralleling our comparisons of households with and without telephones using the 1989 NHIS data, we compared the prevalence estimates of edentulism and dental care recency in the Florida data to the national data (Table 4). Differences in edentulism prevalences between the Florida study and the national sample were statistically significant, with the Florida sample suggesting that the age group-specific prevalence of edentulism is lower than that indicated by the national data. Estimates of recency of last dental visit for the dentate rural elderly and urban middle-aged respondents differed significantly from comparable estimates from the national sample. Recency estimates for the rural middle-aged and urban elderly of north Florida did not differ from comparable national estimates.

Given that the purpose of the Florida study was to understand determinants of dental care behaviors and oral health outcomes and not to generate prevalence estimates of a small geographic region, we proceeded to test multivariate associations between dental care recency and hypothesized determinants. Multivariate comparisons were pursued by duplicating for the Florida sample the logistic regression of dental care recency. Parameter estimates and standard errors were converted to odds ratios and 95 percent confidence intervals to facilitate comparisons (Table 5). Separate models of the national data were constructed for metropolitan and nonmetropolitan areas. Analyses for metropolitan residents were limited in the national sample to those who lived in city sizes of 250,000 to 999,999 persons to parallel the situation for the Florida sample. The confidence intervals of the odds ratios overlapped for each of the four covariates in the model between the Florida study model and the NHIS, suggesting that the conclusions drawn from each sample regarding determinants of dental care recency would have been the same.

TABLE 4
Comparison of Estimates from the Florida Dental Care Study (FDCS; n=5,254) with Estimates from the 1989 National Health Interview Survey (NHIS; n=17,969)*

	Nonmetropolitan (%)		Metropolitan (%)	
Age (Years)	FDCS	NHIS	FDCS	NHIS
Dentate				
45–65	87 (85, 89)	80 (79, 81)	90 (89, 91)	86 (85, 87)
65+	68 (65, 71)	59 (57, 61)	74 (72, 76)	69 (67, 71)
Dental visit in previous year (dentate persons only)				
45–65	61 (58, 64)	61 (59, 63)	69 (67, 71)	65 (64, 66)
65+	57 (54, 60)	63 (61, 65)	67 (64, 70)	64 (62, 66)

*Comparisons were limited to blacks and whites 45 years old or older. Urban residents were limited to those residing in cities with populations of 250,000 to 999,999 persons. Dentate is defined as reporting at least one remaining natural tooth. Point estimates are followed by their 95% confidence intervals.

TABLE 5
Comparisons of Logistic Regression Results of Dental Care Recency from the Florida Dental Care Study (FDCS; n=873 dentate baseline respondents) with Estimates from the 1989 National Health Interview Survey (NHIS; n=13,326 dentate respondents)*

	Odds Ratios (95% CI)	
Covariate	FDCS	NHIS
Urban sample (dentate persons only)		
Intercept	5.8 (2.0, 16.9)	2.0 (1.6, 2.4)
Age group	1.1 (0.7, 1.7)	0.8 (0.7, 0.9)
Sex	1.2 (0.9, 2.0)	1.2 (1.1, 1.4)
Race	3.2 (1.9, 5.4)	2.8 (2.3, 3.5)
Poverty status	3.1 (1.6, 6.2)	3.1 (2.4, 4.1)
Rural sample (dentate persons only)		
Intercept	4.5 (1.4, 14.7)	1.4 (1.2, 1.6)
Age group	1.1 (0.7, 1.7)	1.2 (1.0, 1.3)
Sex	1.4 (0.9, 2.2)	1.3 (1.1, 1.4)
Race	3.4 (2.1, 5.4)	3.5 (2.7, 4.5)
Poverty status	1.7 (1.0, 2.9)	2.7 (2.2, 3.2)

*Comparisons were limited to blacks and whites 45 years old or older. Urban residents were limited to those residing in cities with populations of 250,000 to 999,999 persons. Dentate is defined as reporting at least one remaining natural tooth. The outcome of interest is whether the respondent reported having had a dental visit in the previous year or not (0=did not report a visit, 1=did). The age group variable was defined as 0=45–64 years old, 1=65 years old or older. Sex was defined as 0=male, 1=female. Race was defined as 0=black, 1=white. Poverty status was defined as 0=below 100% of US poverty level, 1=at or above the 100% poverty level. Point estimates of the odds ratios are followed by their 95% confidence intervals.

Discussion

Two strategies were used in this sampling methodology to substantially improve efficiency: (1) identifying respondents by telephone; and (2) using a predominantly listed dialing methodology. With regard to the first strategy, judging from county-specific Census data and from the NHIS in which households with and without telephones were compared, persons who reside in households without telephones do differ in important dental and dentally relevant sociodemographic characteristics. Therefore, it is unlikely that results from a dental sample identified by telephone will be generalizable to households without telephones. However, because households without telephones comprise such a small percent of the population at large, it is unlikely that any substantive bias in prevalence estimates of dental parameters will result, nor that dentally relevant multivariate distri-

butions will be affected substantively. In prior studies, minimal bias because of exclusion of households without telephones has been observed for most health-related parameters of interest (11,36,37), although this was not the case in one instance when understanding the effects of health insurance coverage was the main goal of the research (36). Before initiating a study, investigators' considerations of how bias can be introduced should be parameter specific.

Based on our analyses and depending upon the purpose of the dental research project, it seems reasonable to intentionally limit the population of interest to households with telephones. In the counties targeted for the Florida Dental Care Study (FDCS), the 4 percent of the age-eligible population excluded because of no telephone matched the 4 percent of the age-eligible population excluded who were homeless or resided in a variety of institutional settings. However, some research designs may include only a subgroup with low telephone coverage, such as middle-aged poor blacks. In that case, if one of the goals is to generalize to that subgroup, it may be prudent to supplement telephone-based sampling with other techniques, such as enumeration of all dwelling units in defined geographic areas (e.g., Census tracts) where the subgroup of interest is known to be concentrated.

Using a predominantly listed telephone number method apparently introduced some bias into the sample, although results in Table 3 suggest that the magnitude of bias was small. Respondents who had unlisted numbers were more likely to have been younger, to be in poorer health, to reside in slightly larger households, to be male, to be edentulous, and not to have had a recent dental visit. Given the sample design used in the Florida study (i.e., oversampling of selected telephone exchanges based on race and poverty characteristics), assessment of race and poverty bias due to the listed method was not possible. Psaty and colleagues (13) compared health behaviors and health status of persons who were identified by telephone listings with those identified by RDD. Of 23 variables compared, only one differed at a statistically significant level. Orden and colleagues (12) surveyed adults aged 18–30 years old in the Chicago area, and concluded that there was a bias in estimates of sociodemographic characteristics if unlisted telephone numbers were excluded, because of different rates of listings among racial and sex groups. Fifty percent of black men and women had unlisted telephone numbers, compared to 11 percent for white men and 17 percent for white women. However, when recruitment was stratified according to race, sex, and education level, there was minimal bias. These findings and FDCS results in Table 3 suggest that it is prudent to stratify analyses based on these factors when a listed number method is used exclusively or predominantly.

Lower participation rates in health surveys have been observed among blacks when compared to whites (20,38-40). Quite the opposite occurred in the Florida study during baseline recruiting; we do not have information on participation rates by race at the telephone screening phase. Because we did not maintain quantitative statistics during the recruitment phase regarding the success of various strategies, we can only speculate as to why we were more successful at recruiting blacks. Following the suggestion of others (38), we matched recruiter/interviewers on a racial basis for the first two months of the baseline recruitment stage, but abandoned this strategy at the request of one of the urban recruiter/interviewers who judged that this technique was actually detrimental. We do know that greater success with recruitment of blacks was due to fewer refusals, and not because there were any racial differences in ability to contact potential respondents to participate for the baseline session. There is precedent for higher participation rates by blacks (41), while other studies have reported similar rates between blacks and whites (42,43).

Recent community-based dental studies of adults in North America have conducted clinical examinations exclusively or predominantly in respondents' homes (8,44-46). This study used a combination of sites to conduct the in-person interviews and clinical examinations. Before the baseline phase of the study began, we expected that the number of respondents who would request in-home visits would be much higher than the 6 percent that actually occurred. Conducting a large number of the baseline examinations at centrally located facilities led to savings in time, effort, and monetary costs. Further, we sometimes found it difficult to locate residences of respondents in remote rural areas because directions typically relied on nondescript landmarks. We found that the use of a mobile telephone was helpful, although we did encounter areas where reception was absent or inadequate. Using centrally located examination sites also limited the examination team's exposure to circumstances that have the potential to jeopardize personal safety, such as those which may occur when searching for and entering respondents' residences, especially in high-crime neighborhoods.

Respondents always were requested initially to come to one of the central examination sites, and always were informed that a free dental examination, canned ham, and engraved coffee cup would be provided. If respondents declined to come to a central site, then they were always offered taxicab transportation (urban respondents only) and/or a home visit. We had anecdotal reports during recruitment that some respondents would have refused a home visit had that been the only option, because they preferred to come to a central site due to safety concerns or embarrassment at the condition of their residences.

Given sufficient resources, including all households is the preferred method of identifying the population of interest for health surveys. However, analyses from the national dental data (1989 NHIS) suggest that only minimal bias is introduced in dental studies when households without telephones are excluded. Further, given sufficient resources, RDD is the preferred method to achieve unbiased samples. However, as findings from the Florida study suggest, a predominantly listed methodology can result in a largely representative sample. The methodology used in this study successfully identified a large number of persons in groups at the highest risk for oral health decrements and resulted in only modest bias with respect to the population of interest.

Acknowledgments

This investigation was supported by USPHS contract DE-12587 and grants DE-08845, AG-11183, DE-11020, and AG-00392.

Additional support was provided by funds from the University of Florida. We acknowledge the contributions of D. E. Antonson, T. A. Dolan, U. Foerster, D. W. Legler, and M. L. Ringelberg, who in addition to G. H. Gilbert, served as clinical examiners for the study. We are also grateful to J. L. Earls and B. A. Ringelberg, who served as regional coordinators for the baseline phase of the study. The opinions and assertions contained herein are those of the authors and are not to be construed as official or necessarily representing the views of the University of Florida, Response Analysis Corporation, or the funding agencies. The informed consent of all subjects who participated in this investigation was obtained after the nature of the procedures had been explained fully.

References

1. Braithwaite RL, Taylor SE, eds. Health issues in the black community. San Francisco, CA: Josey-Bass Co., 1992.
2. Manton KG, Patrick CH, Johnson KW. Health differentials between blacks and whites: recent trends in mortality and morbidity. Milbank Mem Q 1987;65 (Suppl 1):129-99.
3. Williams DR. Socioeconomic differentials in health: a review and redirection. Social Psychol Q 1990;53:81-99.
4. Feinstein JS. The relationship between socioeconomic status and health: a review of the literature. Milbank Mem Q 1993;71:279-322.
5. Rowland D, Lyons B. Triple jeopardy: rural, poor, and uninsured. Health Serv Res 1989;23:975-1004.
6. Dwyer JW, Lee GR, Coward RT. The health status, health services utilization, and support networks of the rural elderly: a decade review. J Rural Health 1990;6:379-98.
7. Aday LA, Forthofer RN. A profile of black and Hispanic subgroups' access to dental care: findings from the National Health Interview Survey. J Public Health Dent 1992;52:210-15.
8. Hunt RJ, Slade GD, Strauss RP. Differences between racial groups in the impact of oral disorders among older adults in North Carolina. J Public Health Dent 1995;55:205-9.
9. Hatten J. Medicare's common denominator: the covered population. Health Care Fin Rev 1980;2:53-64.
10. Lynch CF, Logsden-Sackett N, Edwards SL, Cantor KP. The driver's license list as a population-based sampling frame in Iowa. Am J Public Health 1994;84:469-72.
11. Marcus AC, Crane LA. Telephone surveys in public health research. Med Care 1986;24:97-112.
12. Orden SR, Dyer AR, Liu K, et al. Random digit dialing in Chicago CARDIA: comparison of individuals with unlisted and listed telephone numbers. Am J Epidemiol 1992;135:697-709.
13. Psaty BM, Cheadle A, Curry S, et al. Sampling elderly in the community: a comparison of commercial telemarketing lists and random digit dialing techniques for assessing health behaviors and health status. Am J Epidemiol 1991;134:96-106.
14. US Bureau of the Census. Census of Population and Housing, 1990: public use microdata samples. Washington, DC: US Technical Documentation, 1992.
15. Stanek EJ, Pastides H, Darity WA, Elkins M. City directories as sources for survey work in low- and middle-income black communities. Am J Public Health 1990; 80:1125-6.
16. Glasser GJ, Metzger GD. National estimates of nonlisted telephone households and their characteristics. J Marketing Res 1975;12:359-61.
17. Traugott MW, Groves RM, Lepkowski JM. Using dual frame designs to reduce nonresponse in telephone surveys. Public Opinion Q 1987;51:522-39.
18. Forthofer RN. Investigation of nonresponse bias in NHANES II. Am J Epidemiol 1983;117:507-15.
19. Howard CA, Samet JM, Buechley RW, Schrag SD, Key C. Survey research in New Mexico Hispanics: some methodological issues. Am J Epidemiol 1983;117: 27-34.
20. Vernon SW, Roberts RE, Lee ES. Ethnic status and participation in longitudinal health surveys. Am J Epidemiol 1984;119: 99-113.
21. Herzog AR, Rodgers WL. Age and response rates to interview sample surveys. J Gerontol 1988;43:S200-5.
22. Kelsey JL, O'Brien LA, Grisso JA, Hoffman S. Issues in carrying out epidemiologic research in the elderly. Am J Epidemiol 1989;130:857-66.
23. Zapka JG, Chasan-Taber L, Bigelow C, Hurley T. Methodological issues for health-related surveys of multicultural older women. Eval Health Prof 1994; 17:485-500.
24. US Bureau of the Census. Unpublished special tabulations for the University of Florida from the 1990 Census of population and housing for the US and four counties in north Florida, 1994.
25. Gilbert GH, Antonson DE, Mjör IA, et al. Coronal caries, root fragments, and restoration and cusp fractures in US adults. Caries Res 1996;30:101-11.
26. Ringelberg ML, Gilbert GH, Antonson DE, et al. Root caries and root defects in urban and rural adults: the Florida Dental Care Study. J Am Dent Assoc 1996; 127:885-91.
27. Dolan TA, Gilbert GH, Ringelberg ML, et al. Behavioral risk indicators of attachment loss in adult Floridians. J Clin Periodont (in press).
28. SAS Institute, Inc. SAS/STAT user's guide. Version 6. 4th ed. Cary, NC: SAS Institute, Inc., 1989.
29. Belsley DA, Kuh E, Welsch RE. Regression diagnostics: identifying influential data and sources of collinearity. New York, NY: Wiley, 1989.
30. Miller MK, Farmer FL. Substantive nonadditivity in social sciences research: a note on induced collinearity and measurement and testing of effects. Quantity Quality 1988;22:221-37.
31. Shah BV, Barnwell BG, Hunt PN, LaVange LM. SUDAAN® user's manual. Release 6.0. Research Triangle Park, NC: Research Triangle Institute, 1992.
32. Council of American Survey Research Organizations. On the definition of response rates. Report of the CASRO Task Force on Completion Rates, Jun 1982.
33. Mulry MH, Spencer BD. Accuracy of the 1990 Census and undercount adjustments. J Am Stat Assoc 1993;88:1080-91.
34. National Center for Health Statistics. 1989 National Health Interview Survey. CD-ROM series 10, no 3. Washington, DC: US Department of Health and Human Services, 1993.
35. Branch LG, Ku L. Transition probabilities to dependency, institutionalization, and death among the elderly over a decade. J Aging Health 1989;1:370-407.
36. Corey CR, Freeman HE. Use of telephone interviewing in health care research. Health Serv Res 1990;25:129-44.
37. Fenig S, Levav I, Kohn R, Yelin N. Telephone vs face-to-face interviewing in a community psychiatric survey. Am J Public Health 1993;83:896-8.
38. Brown LM, Tollerud DJ, Pottern LM, et al. Biochemical epidemiology in community-based studies: practical lessons from a study of T-cell subsets. J Clin Epidemiol 1989;42:561-8.
39. Kingery DW. Sampling strategies for surveys of older adults. In: Fowler FJ, ed. Health survey research methods: fifth conference proceedings. DHHS pub no (PHS) 89-3447. Rockville, MD: Public Health Service, 1989.
40. Grotzinger KM, Stuart BC, Ahern F. Assessment and control of nonresponse bias in a survey of medicine use by the elderly. Med Care 1994;32:989-1003.
41. McGraw SA, McKinlay JB, Crawford SA, Costa LA, Cohen DL. Health survey methods with minority populations: some lessons from recent experience. Ethnicity Dis 1992;2:273-87.
42. Montero D. Research among racial and cultural minorities: an overview. J Soc Iss 1977;33:1-10.
43. Anderson BA, Silva BD, Abramson PR. The effects of race of the interviewer on measures of electoral participation by blacks in SRC national election studies. Public Opinion Q 1988;52:53-83.
44. Hunt RJ, Beck JD. Methodological considerations in a dental epidemiologic survey of an elderly population. J Public Health Dent 1985;45:257-60.
45. Locker D, Leake JL. Periodontal attachment loss in independently living older adults in Ontario, Canada. J Public Health Dent 1993;53:6-11.
46. Douglass CW, Jette AM, Fox CH, et al. Oral health status of the elderly in New England. J Gerontol 1993;48:M39-46.