# PROBABILITY BASED INTERNET SURVEYS: A SYNOPSIS OF EARLY METHODS AND SURVEY RESEARCH RESULTS[1]

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**Abstract**

Successfully targeting a nationally representative panel sample over the Internet has been intractable, primarily because a large proportion of U.S. households do not have Internet access. This paper presents a new methodology created and implemented at Knowledge Networks that overcomes this inherent shortcoming. The new methodology begins with selection of a stratified, random sample of households using RDD telephone methods. By phone, the sampled households are asked to participate in the Knowledge Networks research panel sample. Once recruited, the households are then equipped with simple Internet access devices attached to their televisions that are used to field multi-media based surveys. To improve the efficiency of sampling, panel members are sent profile surveys that collect information on their demographic, economic, political and social characteristics. Once panel members complete the core profile survey, they are available for assignment to specific surveys according to specified sampling criteria. This paper will briefly discuss the sample design and methods of this new survey mode and will then focus largely on the survey research results to date that identify and measure sampling and nonsampling error. Application of this methodology is about two years old and we now have considerable information on response rates, coverage and nonresponse bias, and overall measures of data quality to share.

## I. Introduction

We start with the goal of selecting survey research samples that can statistically support inferences about the total population of households in the United States, and/or subsets within the population. Nationally representative Internet based sampling frames do not currently exist because every household in the U.S. cannot be accessed via the Internet. This results in serious undercoverage that can significantly affect outcome study variables. Statistics from the Current Population Survey for August 2000 indicate that 51% of the U.S. households have computers and 41.5% of households have access to the Internet. [Newburger, 2001] Any serious attempt to do national household surveys needs to take into account this undercoverage.

The Knowledge Networks solution is to utilize standard Random Digit Dial (RDD) sampling to obtain a representative sample of U.S. telephone households and then equip those households with a WebTV unit for survey administration. This approach greatly reduces the inherent problem of non-Internet coverage in a pure random sample of households. Similar to other panel samples, adjustments are made to sample design weights to reduce bias due to noncoverage of nontelephone households, WebTV noncoverage and nonresponse. The result of this survey design approach leads to a representative sample of U.S. households that is basically comparable to RDD sample selection methods.

Since use of this new Internet based survey mode for collecting nationally representative data is still in the early stages, it is critical to analyze and document the methodologies applied and the resulting effects on reported data. To that end, there is an established and ongoing methods

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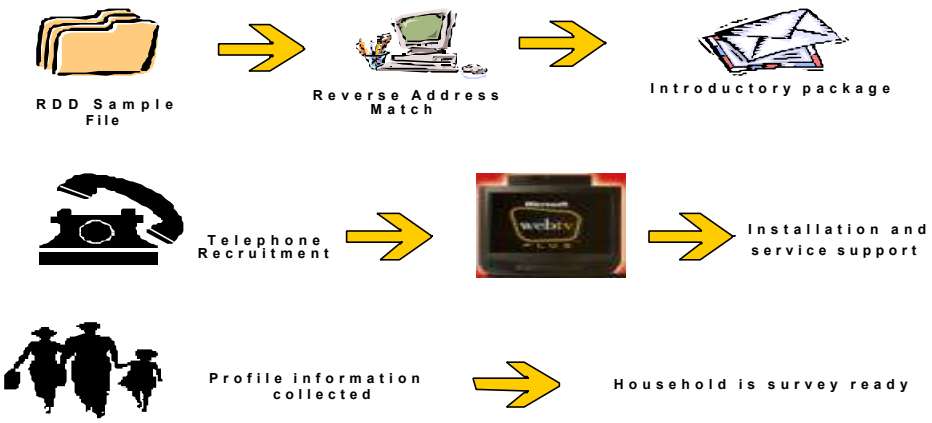
research program for evaluating and improving the survey methods and quality of studies conducted using the Knowledge Networks panel. This research has been conducted by Knowledge Networks, the Research Triangle Institute and supported by academic researchers.[2]

Research results thus far suggest that use of the Knowledge Networks sampling methodology is a viable approach for conducting representative sample surveys. Internet data collection supports in-home data collection, multi-media tools for administering surveys, which can be very helpful for studies with sensitive topics and studies requiring video or audio components. And, Internet data collection offers very fast turnaround even with multi-media enhancements.

Following a more detailed description of the sample design for the Knowledge Networks Panel in section II and a summary of cooperation rates in section III, survey methods research results to date are summarized and presented in section IV. Section V presents sample weighting methods applied to the panel and individual surveys and Section VI closes with a summary of plans for future research.

## II. Sample Design for a Web-based National Probability Sample Panel: A Proposed Solution:




The solution proposed by Knowledge Networks and implemented now for almost two years for establishing a nationally representative probability based panel sample involves a multi-stage process. It begins with an Random Digit Dialing (RDD) sample of households, followed by a reverse address match, and mailing of an introductory letter and incentive to every household for which we are able to obtain an address match. Households (both addressed matched and non-addressed matched) are then recruited by telephone resulting in a cooperation rate of about 56%. Once a household agrees to participate, KN delivers a WebTV unit that essentially transforms the television in the household into a monitor for survey administration. All household members are recruited and all adults (18 and over) are given a welcome survey to familiarize them with use of the WebTV. Then a profile questionnaire is assigned to each household to collect basic

[2] Knowledge Networks and RTI are in an Alliance to competitively bid Federal research projects that involve a web-enabled panel. Knowledge Networks works independently with academic researchers on their own investigator-initiated research projects. For more information on the Alliance, go to the following Internet link: www.knowledgenetworks.ganp

demographic information about the household and its members. Once we have received the profile data, the household is considered ready to receive regular surveys. The cost of the unit and monthly connection fees are borne by Knowledge Networks. In return, the household members agree to complete an average of four surveys a month for the duration of their tenure on the panel. The weekly surveys are usually 5-15 minutes long, although we have fielded longer ones, particularly for our government-sponsored surveys, in which case we have either offered incentives or have excused the member from doing a survey the following week.

Teenagers, aged 13-17, are profiled and surveyed only with parental consent, which can be unconditional or conditional, with conditional consent meaning that the parent needs to see and review the questionnaire that is sent to the teenager. We do not send surveys directly to children under 13 years of age but we have requested parents to conduct a survey with their children.

We have not yet determined the optimal tenure on the panel for members. This is under discussion and is being researched although early indications suggest that a period of about 2-3 years strikes a good balance between risk of fatigue and the need to recover the initial investment.

As stated above, the selection of the panel starts with an RDD sample of households. In fact, the entire recruitment process is based on known telephone survey methodology. [Lepkowski, 1988] The novel challenge posed by this new mode is the coverage of households by WebTV, an Internet Service Provider (ISP), which raises issues of telephone connectivity between individual households and the ISP.

To sign on to this service without incurring long distance telephone toll costs, each household must dial a local Point of Presence (POP) of which WebTV has about 3,000 scattered throughout the country. Unfortunately, coverage is not universal and a 6% of households do not have access to one of WebTV's POPs. Most of these households are located in hard-to-reach rural areas. Prior to July 2001, only a few households were recruited out of the Web TV covered areas due to the cost of going through other providers. This led to bias in the panel recruitment due to the undercoverage of rural areas.

However, as of July 2001, a subsample of households outside the WebTV universe is being included in the Knowledge Networks panel using other ISPs for the Internet connection. It is a subsample relative to the sampling rate for households in areas covered by Web-TV service. The size of the sample for the non-Web TV covered areas can grow if the demand for more reliable data from this segment of the population increases.

Drawing samples from the panel for individual surveys is an important part of the process. There were two key objectives in designing the sampling system:

- *Only one survey can be assigned per member per week*
- *Selection of members will be random within sampling criteria*

To ensure appropriate representation, panel post-stratification weights are updated after each sample selection such that the weighted panel distributions match benchmarks as determined from the most recent monthly CPS. We use a 42-stratum cell weighting approach where the

strata are defined using the following variables: age, gender, region, race, ethnicity, and education.

Samples are drawn consecutively throughout the week with probabilities proportional to the panel weights using systematic sampling applied to the sorted panel members. The distributions for the panel samples are consistent with the national population distributions for the above-mentioned variables.

After every sample selection, the panel weights for remaining members are adjusted in preparation for the next sample.

## III. Cooperation/Response Rates

Ensuring high response and cooperation rates is one of the most challenging aspects of this methodology. Clearly in the industry, response rates through the telephone mode of data collection are more and more difficult to maintain. As mentioned earlier, the overall historical cooperation rate at the recruitment stage is approximately 50%. There remain at least three more stages before the member becomes fully profiled, active, and ready for weekly surveys. And at each stage there is some attrition. Thus, the final overall cumulative response rate ranges from 25% to 50% depending on the level of efforts expended for individual projects. We consider this to be one of our major challenges and are carrying out extensive research to maximize the cooperation rate at each stage.

The current and cumulative response rates for fielding an Internet survey from the Knowledge Networks panel are found in Table 1.

We have given considerable thought to strategies for improving these rates. These strategies include in-person recruitment, relaxed requirement to complete only one survey per month, additional incentives for all potential recruits or incentives to convert reluctant or soft refusals, followup of a sample of reluctant or soft refusals with incentives, and closer monitoring of panel health. Several of these are being tested such as additional phone contacts with members at different stages of participation, an incentive program to maintain panel health, and testing of alternative services for advance letter mailing.

The survey completion rates (i.e., specific to the study) are highly correlated with the length of the interview, the interest level of respondents in the survey, the use of advance letters, the use of incentives, the complexity of the interview, etc. A straightforward 10-minute survey of high interest levels with an advance letter and some followup for nonresponse and/or incentives can achieve an Internet survey completion rate as high as 90%. For example, a recent 10 minute survey to estimate purchase intent of a particular phone card resulted in a 94% completion rate after an 18 day field period. E-mail reminders were sent to nonrespondents.

We have initiated studies to evaluate the effect of nonresponse on panel and survey estimates. We also were a subcontractor to the Research Triangle Institute to evaluate the effects of nonresponse on key outcome variables. Selected results from these efforts are described in the section below.

## IV. Panel Quality

Now that over 4,000 surveys have been conducted using the Knowledge Networks Panel, we have substantial data to begin the on-going process of assessing the quality of the panel and individual survey data. No survey is without some level of sampling and nonsampling error – the goal in any study should be to minimize survey error, quantify remaining errors to the extent possible and apply survey procedures and methods to mitigate its effect on the outcome variables. Below, we discuss several areas where analyses have been initiated to investigate sampling and nonsampling error in the conduct of surveys from the Knowledge Networks Panel. We will present summary results in the following areas:

- *Coverage Error*
- *Benchmarking Analyses*
- *Existence of Panel Bias*
- *Nonresponse Bias*
- *Weighting and Sampling Error*

### A. Coverage Error

There are two key sources of coverage error that can affect the representative nature of the Knowledge Networks panel sample: Error arising from noncoverage of nontelephone households and error arising from noncoverage of non-WebTV areas. We discuss the magnitude of each of these and our planned approaches to reduce biases stemming from them.

**Noncoverage of Nontelephone Households**

According to the June 2001 CPS, approximately 5% of households in the U.S. are without a phone at the time of interview. Phone coverage differs by household income (80% for households with income less than $5,000 and 92% for households with income $15-20K), state, metro status, race, ethnicity, etc. Currently, a post-stratification weighting adjustment is made to the Knowledge Networks panel to ensure total population estimates from the RDD based sample are consistent with U.S. population estimates for the phone and non-phone population. The adjustment is made at the state level, and then further refined through post-stratification (raking) using gender, age, race/ethnicity and education level. The complete post-stratification scheme is implemented for two purposes: (1) Reduce the bias in the panel due to coverage and nonresponse error and (2) Reduce the variance for statistics highly correlated with the demographic benchmarks.

We are investigating whether a separate weighting adjustment specifically to account for nontelephone coverage error would be more accurate for potential bias at lower levels in the sample. Specifically, we are investigating the methodology proposed by Frankel (2000) for reducing nontelephone bias in RDD surveys that uses survey data collected on interruption in telephone service to identify respondents more like non-telephone households for weighting purposes. Our investigation supports further evaluation of the approach for the Knowledge Networks panel.

Table 2 presents comparative estimates of household characteristics of panel members who were asked whether they had an interruption in telephone service for 1 week or more in the past year. It is quite clear from the table that the group with interruption in telephone service and the group

without are different. Estimates of the number of children under 18, household size, household type, number of computers in the household, and access to the Internet are all statistically different between the groups with and without telephone interruption. Approximately 3.6% of recruited households reported being without telephone service for 1 week or longer in the previous 12 months.

Frankel et.al. showed that estimates from the group with an interruption in telephone are much more like those that had no phone in the population. The estimates examined were:

- Did not get medical care for cost reasons in past 12 months
- Looking for work last week
- Race of person is Black
- Age of person is less than 5 years

These are certainly important characteristics for many of the surveys conducted using the Knowledge Networks Panel. The next steps are to look at mean square error for selected estimates if the weighting approach is administered at the state/msa level. Since we won't know the true bias, we will do some sensitivity analysis on a range for the bias. We will also investigate whether other variables such as having access to a computer at home and/or access to the Internet or household type might well be good predictors as well. The advantage to using these characteristics is that is does not require asking respondents about interruptions in the telephone service, which can be interpreted negatively by respondents.

**Noncoverage of NonWebTV Service Areas**

As discussed earlier, the Knowledge Networks panel suffered from noncoverage of households due to the fact that the Internet Service Provider – WebTV – does not cover all areas of the U.S. Using available information at the exchange level, demographic estimates for the phone numbers in and outside of WebTV Service Areas were calculated. As expected, non-WebTV covered areas are much more rural (78% versus 22% for covered areas), a little more elderly and with a lower income distribution. Estimates are highly variable due to significant levels of missing data at the exchange level. However, the direction of the coverage error is consistent with other derived analyses.

The good news is that we have begun recruiting households in these non-covered areas using different Internet providers so we will definitely be reducing panel bias associated with this noncoverage. In addition, we will have the ability to better measure the effects of excluding non-WebTV covered areas by using data collected on newly recruited members in non-WebTV covered areas.

## B. Benchmarking Analyses

One method for analyzing the quality and representativeness of a study or sample is to compare a variety of estimates from the study or sample to known and/or official benchmark estimates. This section presents results of several comparisons of data from the Knowledge Networks panel to several other sources including the Current Population Survey, the Behavior Risk Factor Surveillance Survey (BRFSS) 2000, and the Ohio State University RDD Survey on Public Opinion and Voting Intentions for the 2000 U.S. Presidential Elections. Comparisons across demographic estimates and topical estimates are covered.

Table 3 presents a comparison between the unweighted KN panel and the Current Population Survey (CPS) for selected demographics as of June 2001. Column 1 contains estimates for active, profiled members after post-stratification to CPS benchmarks using selected characteristics. Column 2 contains estimates from the panel using the entire recruited panel sample with the associated weight from the initial selection probabilities. Column 3 presents June 2001 CPS estimates and the last two columns present calculated differences of the two sets of Knowledge Networks estimates from the CPS benchmarks.

As you can see from table 3, column 2, the Knowledge Networks panel under represents the elderly, is skewed towards the upper end of the socioeconomic scale, and under represents the African American minority. The differences in the race estimates is an primarily a difference in the way Census asks race as compared to Knowledge Networks, with Knowledge Networks offering "Other" as a race category. The panel also slightly underrepresents the Hispanic population. Column 1 presents estimates after final weighting is applied to the Knowledge Networks active and profiled members. Due to the large sample sizes associated with both the Knowledge Networks panel and the Current Population Survey, small differences are statistically detectable as asterisked in columns 5 and 6 of table 3. In general, none of the average deviations are huge, and sample representative ness is never dramatically poor. Approximately 74% of the estimates moved closer to the CPS benchmarks as a result of final weighting procedures.

As mentioned earlier, an anti-rural bias existed in the panel because of the WebTV coverage issue. However, with the sampling underway to recruit households in non-WebTV covered areas, this coverage error will be greatly mitigated.

Benchmarking of results from several surveys conducted using the Knowledge Networks panel has also been conducted. Table 4 presents comparative results from a Study on Smoking to comparable estimates from the BRFSS. [Dennis, 2001] Table 4 presents estimates on current smoking behavior for Veterans aged 22-80. According to the Knowledge Networks sample, 26% of Veterans between the ages of 22 and 80 currently smoke. The BRFSS survey of year 2000 shows that 24% of Veterans between the ages of 22 and 80 currently smoke.

Table 5 displays the demographic characteristics of male veterans in the U.S. by two data sources: the Knowledge Networks Panel and BRFSS Survey 2000. On age, race, and education, the Knowledge Networks data are consistent with those of BRFSS. On income there are some differences as noted before with the Knowledge Networks income distribution being somewhat skewed to the higher end. Other estimates from the two sources were compared with the small number of differences identified primarily attributable to different question concepts and question wording.

Table 6 presents a demographic comparison between Knowledge Networks Panel data for the population with Internet access to the August 2000 CPS data from the Computer Usage Supplement. Generally, the results are very comparable. Estimates from the Knowledge Networks panel on education level, gender, marital status, employment and most importantly broadband use are consistent with the CPS, even though the large sample sizes generally detect statistically significant differences between the two sources. There are some substantive differences between the sources on presence of children, income and race/ethnicity.

In an independent study conducted by Jon Krosnick and LinChiat Chang at Ohio State University [Krosnick, 2001], Knowledge Networks survey results were compared to results from both a random digit dial study conducted by the Ohio State University Center for Survey Research and the Harris Interactive Internet opt-in panel. The same questionnaire to gauge public opinion and voting intentions for the 2000 U.S. Presidential Election was administered under each of the survey modes and standard data collection methods. Krosnick and Chang compared:

*Demographic characteristics*
*Distributions of survey responses*
*Reliability of individual questions*
*Survey satisficing*
*Predictive validity*

Krosnick and Chang concluded that Internet based data collection represents a viable approach to conducting Random Digit Dialing surveys. And the Knowledge Networks methodology resulted in a more representative sample than the opt-in panel sample utilized by Harris Interactive. Results also suggest that Internet data collection improves the accuracy of the reports respondents provide over accuracy obtained through telephone interviews.

In summary, benchmark comparisons of Knowledge Networks estimates to the CPS, BRFSS 2000, the U.S. Census and other sources show reasonable consistency considering what we know about potential coverage and nonresponse levels.

## C. Preliminary Research on the Existence of Panel Bias

Research panels may be susceptible to two types of panel effects. The first type is the possibility of conditioning research subjects in a panel sample, turning them into "professional respondents" whose attitudes and behaviors are changed by panel participation. The second type of effect that panels are potentially vulnerable to is selection bias, which can make successive samples less representative. Preliminary research, using data from a variety of different studies, has not detected serious levels of panel effects. The discussion below present results that illustrate these findings. More detail can be found in Dennis (2001).

**Attitudes toward new products.** The question arises whether more experienced panelists have the same orientation toward new products and new technology as less experienced panelists. In a survey of more than 6,000 panelists about hybrid electric cars, responses are not related to panel tenure. As shown in table 7, the future of hybrid electric cars appears equally bleak across the tenure groups. There are also no significant differences across responses when grouped by levels of survey participation.

**Personal finance**

The area of personal finance relates directly to panelists' demographics (wealth), orientation toward risk (ownership of individual stocks), and inclination to use computers and the Internet to increase personal productivity (online banking). A personal finance survey of about 6,500 panelists in January 2001 showed that less and more experienced panelists have similar behaviors – table 8. While not a statistically significant finding, the most experienced panelists show indications of using the Internet more for investing than less experienced panelists.

There are also no significant differences across responses when grouped by levels of survey participation. For instance, panelists who had completed fewer than 15 surveys and those who had completed more than 35 surveys use online banking at the same rate (12%).

**Sensitive questions**

Panel members with more tenure might be expected to be more comfortable with the survey environment and be less affected by the impulse to give socially desirable answers. Although the surveys are taken in a self-administered setting, some newer panelists might feel an urge to be more positive and conforming. However, the data from a survey of approximately 6,000 panelists provides limited support for this hypothesis.

When asked about their comfort level with a shop owner with AIDS, newer panel members were more likely to provide the socially pleasing response of comfortable – see table 9. We should not read too much into this finding because most of these small-scale effects evident in the other questions disappeared or were diminished when controlling for panelists' demographic characteristics within each tenure group. Overall, the effects are small and are almost certainly less serious than the social desirability effects well documented in telephone and face-to-face interviewing.

Survey participation is significantly related to attitudes in only three of the 30 pair-wise comparisons, a not surprising result given the large number of significance tests performed.

An earlier study to evaluate panel effects found similar results. [Clinton, 2000] Five groups of respondents, each with different panel tenure, were assigned an identical instrument dealing with politics, views of the economy, media consumption, and Internet usage. Very few significant differences were found between the responses of the five tenure groups. The behavioral differences that were detected appear to reflect an increase in news consumption and Internet usage during the early stage of panel recruitment. However, behavior appears to return to normal afterwards.

**Results of Selection Bias**

While the unreachable ideal is to observe no panel attrition, the second-best goal is for attrition to be evenly distributed across key demographic dimensions and to replace dropped-off panelists with demographically representative individuals and households. In this circumstance, selection bias is minimized for any follow-up studies using a panel.

Table 10 presents selected panelists' demographic characteristics for groups defined by length of panel tenure. If panel attrition is evenly distributed across demographic groups, then the statistics should be constant across the table. For instance, the proportion of the currently active panel is between 50% and 51% female across the tenure groups, showing that the participation rate for males and females is independent of length of panel tenure.

One way to gauge the relevance of the table is to conceptualize that random survey samples drawn from any of the tenure groups will resemble each other on key demographic dimensions. This is an indication that the effects of panel attrition do not meaningfully increase selection bias. The slight fluctuations in the exhibit are not statistically significant ($p < 0.05$).

## D. Nonresponse Bias

As described in section III above, nonresponse or cooperation bias can creep in at several different stages, from RDD recruitment, WebTV installation, profiling of members, and completion of project-specific surveys. Different levels and detail for data are available on nonrespondents at the different stages. For example, in evaluating the differences in nonresponders and responders to completion of the household and member profile surveys, we have information about the household from the recruiting interview as well as geographic information associated with the household phone number. But for evaluation of responders and nonresponders from RDD recruitiment, we only have the aggregate demographic and geographic information associated with sampling the telephone number.

Currently, a weighting adjustment to reduce nonresponse bias from panel recruitment through profiling implemented with the use of post-stratification to CPS population totals prior to sample selection of weekly surveys. Then, after a survey is fielded, a separate nonresponse adjustment to reduce nonresponse bias for individual surveys is applied. The variables used include age, race, sex, ethnicity, income, education, computer usage, access to the Internet, and metro status. The number of variables and cross-classification structure are dependent on the survey needs and sample size. The construction of survey specific nonresponse adjustments has been implemented on a very ad-hoc basis. There is a definite need for more consistency and a better understanding of the effect on the MSE of estimates generated.

Our goal is to identify the best combination of weighting adjustments to account for nonresponse bias from all stages of panel activation. We need to determine whether separate adjustments for nonresponse are needed at each stage or whether more global adjustments suffice. There is a trade-off in evaluating the MSE of key estimates from making multiple weighting adjustments as well as keeping the weighting methodology as simple as possible since time required for weekly preparation of the panel sample and many profile components has to be minimized.

The steps we are taking in investigating enhanced nonresponse weighing include:

1. Evaluate differences in nonresponders and responders at each stage of panel construction and survey implementation.
2. Conduct nonresponse studies to better measure differences and evaluate the effect on key outcome variables.
3. Identify and test adjustments at each stage as well as combinations of adjustments to minimize the MSE for key outcome variables.

As part of step 1, we have been able to compare selected characteristics of responders and nonresponders at the point where recruited households are asked to complete the household profile questionnaire. The recruiting interview collects information about household decision maker, use of a computer, access to the Internet, and household composition. Table 11 presents 5 variables from the recruiting interview by whether or not the household completed the household core profile survey. Table 11 shows statistical differences between responders and nonresponders about whether a computer exists in the home (78.7% yes for nonresponders, 69.6% for responders) and whether the computer is connected to the Internet (86.9% and 78.7% respectively for nonresponders and responders). Also, there is a slight skewness for households with a smaller number of members completing the household core profile versus not completing

it. These variables can be considered for use in a nonresponse adjustment for profiled households to better adjust for non-profiled households.

We are continuing to look at differences in nonresponders and responders at the other stages of panel recruitment and fielding of surveys.

The Research Triangle Institute sponsored a formal study of the effects of nonresponse on key outcome variables in the recent Survey on Health and Aging. [Wiebe, 2001] The methodology included re-sampling of nonrespondents, fielding the core survey to the nonrespondents, and weighting the nonrespondent completes using the resampling design. Implemented in 2000, telephone interviews were conducted with samples from the following nonresponse groups:

- RDD Panel Recruitment Refusers (n=71 completes)
- RDD Acceptors: Agreed to participate in the Web-enabled panel but had not yet hooked up Web TV (n=129 completes)
- Telephone prompting encouraged Panel Nonrespondents to complete the survey on the Internet Appliance (n=238 completes)

Data collection from the resample of nonrespondents was conducted using both telephone and web assisted methods. Where possible, nonrespondents were contacted by phone and asked to complete the Survey of Health and Aging (SHA) on the web device. If this was not possible, they were asked to complete the survey over the phone.

The weighted response rate for the study increased from 25% to 43% as a result of nonresponse followup by phone. Different participation groups appear to report different answers in the survey with no clear pattern in the responses.

The primary question that motivated the study was whether the followup would change the key study estimates. The conclusion made by the researchers was that the nonresponse follow-up did not make any significant changes in the overall representativeness of the sample. The representativeness of the sample was actually achieved through the standard procedures used by Knowledge Networks to select the sample from the full panel. Inclusion of additional recruitment groups did not affect the estimates. When all components of the nonresponse followup are included with the intial WebTV based estimate, no significant changes in the outcome estimates resulted.

Table 12 presents the estimates for the question on coping with serious injury split out by response and nonresponse stages as well as estimates using data combining the nonresponse sample results with the original Survey of Health and Aging Results. We can see by examining the cumulative results that the additional weighted responses from NRFUS had little impact on the overall prevalence estimates

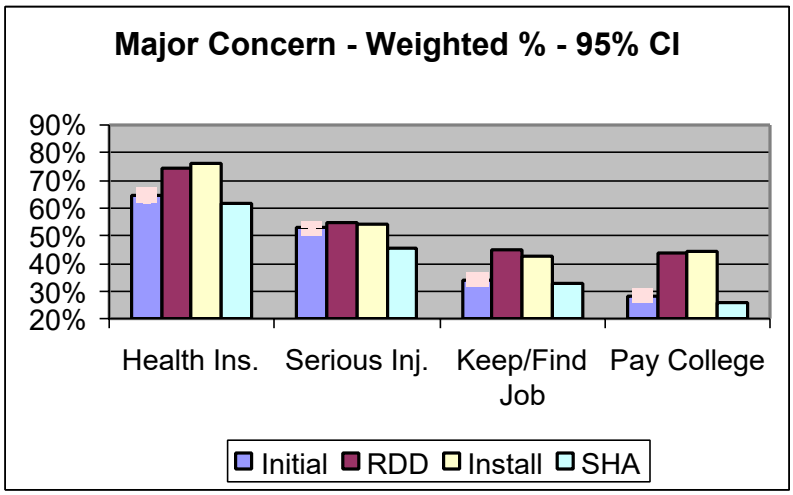
The graph below presents one set of results that illustrate the findings. Respondents were asked about how concerned they were with having adequate health insurance, coping with serious injury or illness, keeping a job, job hunting, or changing careers, and paying for children's

college education. Figure 1 shows the responses provided on these questions for the four types of respondents:

- Those who completed during the initial study
- Those who refused the RDD recruitment but completed the nonresponse follow-up survey (NRFUS)
- Those who failed to install the WebTV device but completed the NRFUS
- Those who refused the initial survey but completed the NRFUS.

The results indicate that the persons who refused the RDD recruitment and those who failed to install the device provided significantly different responses on topical questions than did those who cooperated with the initial survey. This suggests that the respondents and nonrespondents may be different and should be carefully evaluated in future studies.

Figure 1: Effect of Nonresponse on Substantive Estimates?




## V. Weighting and Sampling Errors

Whereas the sample design is an equal probability design that is self-weighting, in fact there are several known deviations from this guiding principle. We address these sources of survey error globally through the poststratification weights which we describe below.

### Sample Design Weights

The five sources of deviation from an equal probability design are:

1. Half-sampling of telephone numbers for which we could not find an address,
2. RDD sampling rates proportional to the number of phone lines in the household,
3. Minor oversampling of Chicago and Los Angeles due to early pilot surveys in those two cities,
4. Short-term double-sampling the four largest states (CA, NY, FL, and TX) and central region states, and
5. Selection of one adult per household.

A few words about each feature:

1. Once the telephone numbers have been purged and screened, we address match as many of these numbers as possible. The success rate so far has been in the 50-60% range. The telephone numbers with addresses are sent a letter. The remaining, unmatched numbers are half-sampled in order to reduce costs. Based on previous research we suspect that the reduced field costs resulting from this allocation strategy will more than offset increases in the design effect due to the increased variance among the weights. We are currently quantifying these balancing features.

2. As part of the field data collection operation, we collect information on the number of separate phone lines in the selected households. We correspondingly downweight households with multiple phone lines.

3. Two pilot surveys carried out in Chicago and Los Angeles increased the relative size of the sample from these two cities. The impact of this feature is disappearing as the panel grows, but we still include it as part of our correction process.

4. Since we anticipated additional surveying in the four largest states, we double-sampled these states during January-October 2000. Similarly, the Central region states were oversampled for a brief period.

5. Finally, for most of our surveys, we select panel members across the board, regardless of household affiliation. For some surveys, however, we select members in two stages: households in the first stage and one adult per household in the second stage. We correct for this feature by multiplying the probabilities of selection by $1/a_i$ where $a_i$ represents the number of adults (18 and over) in the household.

The final sample weights are scaled to sum to the final sample size representing the total number of completed surveys.

Once the samples are drawn, assigned, and the data returned, we currently subject the final respondent data to a poststratification process to adjust for variable nonresponse and noncoverage. Once the individual surveys are completed in the field, a nonresponse adjustment to reduce the effects of differential nonresponse for the individual survey are applied as discussed earlier. Depending on the sample size of the survey, noninterview cells are collapsed.

Post-stratification is then applied to the sampling weights (after noninterview adjustment) to bring the survey estimates in line with CPS benchmarks by age, race, sex, ethnicity, census region, and education.

Currently, design effects are almost always less than 1.5 and the average design effect for most study estimates is 1.3. The effect of differential sampling for non-Web TV covered areas will be assessed on the sampling error for key characteristics.

## VI. Future Research

The innovative Internet survey methodology launched by Knowledge Networks has been underway for almost two years during which time we have learned a great deal about this new mode of survey research, its strengths as well as its weaknesses. Survey researchers should consider this mode of data collection as one more tool in the kit for collecting data national, subnational and subpopulation data about the nation. Its key advantages include a rich panel, quick-turnaround capability, video and audio capabilities, and a panel selected and maintained using probability methods. It also provides a rich base for identifying and surveying low incidence populations and supports longitudinal analyses. Finally, the panel is an excellent resource for basic methods research on web-enabled panels and classical problems in general survey research.

Research thus far has indicated that survey results for a wide variety of estimates calculated from the Knowledge Networks panel are not critically affected by nonsampling error such as non-coverage, nonresponse, and panel bias. This statement is made based on current needs and uses of the panel data. Even so, we will continue to dedicate resources and methods to reduce current levels of nonsampling error and measure potential effects on other survey results. Also, some future studies may require more stringent levels of reliability and preciseness. The goal is to improve data quality and continue to implement sound statistical methods that meet customer requirements.

The methodological issues presented in this paper will continue to be investigated. These include teasing out panel effects, mode effects, nonresponse and noncoverage bias, and response bias. We also shall address instrument design issues on the Internet raised by Mick Couper [Couper, 2000] and others. More topical benchmarking is needed as well. Knowledge Networks and the Research Triangle Institute will jointly conduct basic research on the panel, experimenting with the use of incentives, assessing panel bias as the panel ages, and expanding nonresponse studies. As new surveys and new research related to this new survey mode for large scale panel data collection continues, we will continue to clarify the problems and pose potential solutions.

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**Table 1: Knowledge Networks Cooperation/Response Rates**

| Component of Overall Response | Rate | Cumulative Response Rate |
|---|---|---|
| Panel Recruitment Cooperation | 56% | 56% |
| WebTV Installation | 80% | 45% |
| First-survey Profile Completion | 88% | 39% |
| Internet Survey Response | 85% | 34% |

* Varies according to design choices between 75% and 90%.

**Table 2. Characteristics by Interruption in Telephone Service**

| Characteristic | Interruption: Yes | Interruption: No |
|---|---|---|
| # of Children <18 | .79* | .61 |
| # of Computers in the household | 1.76* | 2.03 |
| HH Type – Single, detached | 45%* | 67% |
| Tenure - Owner | 45%* | 73% |
| Have Internet | 66%* | 75% |

* Indicates statistical significance for p<.05 (2-sided)

**Table 3. Knowledge Networks Panel and Current Population Survey (CPS) Demographics: June 2001**

| Characteristic | Knowledge Networks Active Panel (Note 1) | Knowledge Networks Entire Panel (Note 2) | Adult U.S. Population CPS | Difference (Active Panel and U.S. Pop.) | Difference (Entire Panel and U.S. Pop.) |
|---|---|---|---|---|---|
| **Gender** | | | | | |
| Male | 47.3% | 49.4% | 47.9% | -0.6% | 1.5% |
| Female | 52.7% | 50.6% | 52.1% | 0.6% | -1.5% |
| **Age** | | | | | |
| 18-24 | 11.0% | 12.5% | 13.2% | -2.2%* | -0.7%* |
| 25-34 | 20.0% | 21.8% | 18.3% | 1.7%* | 3.5%* |
| 35-44 | 22.1% | 25.9% | 21.9% | 0.2% | 4.0%* |
| 45-54 | 20.3% | 20.9% | 18.7% | 1.6%* | 2.2%* |
| 55-64 | 13.1% | 10.3% | 11.8% | 1.3%* | -1.5%* |
| 65 or over | 13.4% | 8.6% | 16.1% | -2.7%* | -7.5%* |
| **Race** | | | | | |
| White | 79.4% | 79.3% | 83.2% | -3.8%* | -3.9%* |
| Black/African-American | 12.0% | 10.5% | 11.9% | 0.1% | -1.4%* |
| American Indian/Alaska Native | 1.7% | 2.0% | 0.9% | 0.8%* | 1.1%* |
| Asian/Pacific Islander | 1.9% | 3.0% | 4.0% | -2.1%* | -1.0%* |
| Other | 5.0% | 5.2% | n/a | n/a | n/a |
| **Hispanic Ethnicity** | | | | | |
| Hispanic | 10.9% | 6.4% | 10.7% | 0.2% | -4.3%* |
| Non-Hispanic | 89.1% | 93.5% | 89.3% | -0.2% | 4.2% |
| **Employment Status** | | | | | |
| In the Labor Force | 72.1% | 76.8% | 66.1% | 6.0%* | 10.7%* |
| *Working full-time* | 58.7% | 62.8% | 56.2% | 2.5%* | 6.6%* |
| *Working part-time* | 13.4% | 14.0% | 9.9% | 3.5%* | 4.1%* |
| Not in the Labor Force | 29.9% | 23.2% | 33.9% | -4.0%* | -10.7%* |
| **Marital Status** | | | | | |
| Married | 61.3% | 61.6% | 57.5% | 3.8%* | 4.1%* |
| Not married | 38.7% | 38.4% | 42.5% | -3.8% | -4.1% |
| **Level of Education** | | | | | |
| Less than High School Diploma | 9.0% | 7.4% | 17.1% | -8.1%* | -9.7%* |
| High School Diploma or Equiv./Some College | 59.6% | 55.7% | 51.6% | -5.0%* | -4.1%* |
| Associate Degree | 5.5% | 7.0% | 7.6% | -2.1%* | -0.6%* |
| Bachelor's Degree or Beyond | 25.8% | 29.8% | 23.8% | 2.0%* | 6.0%* |
| **Household Income** | | | | | |
| Under $10,000 | 4.2% | 3.7% | 7.3% | -3.1%* | -3.6%* |
| $10,000-$24,999 | 15.4% | 12.5% | 18.4% | -3.0%* | -5.9%* |
| $25,000-$49,999 | 35.7% | 33.0% | 29.7% | 6.0%* | 3.3%* |
| $50,000-$74,999 | 24.4% | 26.0% | 20.0% | 4.4%* | 6.0%* |
| $75,000 or more | 20.3% | 24.8% | 24.6% | -4.3%* | 0.2%* |

| Census Region | | | | | |
|---|---|---|---|---|---|
| Northeast | 19.0% | 18.3% | 19.1% | -0.1% | -0.8%* |
| Midwest | 22.5% | 23.7% | 22.9% | -0.4% | 0.8%* |
| South | 36.0% | 35.5% | 35.6% | 0.4% | -0.1% |
| West | 22.5% | 22.5% | 22.4% | 0.1% | 0.1% |
| | | | | | |

Note 1: Estimates calculated using the post-stratified weight for active, profiled members.
Note 2: Estimates calculated using the base sampling weight for the entire recruited Knowledge Networks panel.
* Indicates statistical significance for p<.05 (2-sided)

**Table 4. Current Smoking Prevalence Rates on Knowledge Networks Profile Data and BRFSS 2000: Males Age 22-80 Years**

| Smoking Status | Veteran Status | | | |
|---|---|---|---|---|
| | Yes | | No | |
| | KN | BRFSS | KN | BRFSS |
| Currently Smoke | **26%** | **24%** | **28%** | **24%** |
| No, Do Not Smoke | **74%** | **76%** | **72%** | **76%** |
| Total | **100%** | **100%** | **100%** | **100%** |

**p*-value < .05 (two-sided)

**Table 5: Demographic Characteristics of Veterans: Knowledge Networks and BRFSS 2000**

| Characteristic | BRFSS | Knowledge Networks |
|---|---|---|
| **Age** | | |
| 18-34 | 9% | 8% |
| 35-54 | 33% | 35% |
| 55-74 | 44% | 44% |
| 75+ | 14% | 13% |
| **Race** | | |
| White | 88% | 87% |
| Black | 8% | 9% |
| Asian/Pacific Islander | 1% | 1% |
| American Indian, Alaska | 1% | 2% |
| Other | 2% | 2% |
| Education | | |
| Less than high school | 9% | 8% |
| High school graduate | 31% | 34% |
| Some college | 30% | 32% |
| College graduate or more | 30% | 26% |
| Household Income | | |
| Less than $25,000 | 24% | 15% |
| $25,000 to $34,999 | 16% | 12% |
| $35,000 to $49,999 | 22% | 24% |
| $50,000 to $74,999 | 19% | 28% |
| $75,000 or more | 20% | 21% |

**p*-value < .05 (two-sided)

**Table 6. Demographics of the Population with Internet Access†**

| Characteristics | US Internet Population August 2000: CPS Age 13-17 | 18-45 | Total | US Internet Population Knowledge Networks Panel Age 13-17 | 18-45 | Total |
|---|---|---|---|---|---|---|
| **Presence of kids < 18 in HH** | | | | | | |
| Yes | NA | 49% | | NA | 55.97% | |
| No | NA | 51% | | NA | 44.03% | |
| **Gender** | | | | | | |
| Male | 50.21% | 48.60% | | 49.38% | 49.68% | |
| Female | 49.79% | 51.40% | | 50.62% | 50.32% | |
| **Marital Status** | | | | | | |
| Married | 0.13% | 59.06% | | NA | 58.70% | |
| Widowed | 0.03% | 0.43% | | NA | 0.34% | |
| Divorced | 0.38% | 6.44% | | NA | 7.01% | |
| Separated | 0.24% | 1.38% | | NA | 1.63% | |
| Never Married | 99.22% | 32.69% | | NA | 32.32% | |
| **Education** | | | | | | |
| HS & Less than HS | 99.60% | 30.37% | | 99.45% | 33.54% | |
| Some College | 0.25% | 34.52% | | 0.55% | 34.18% | |
| Bachelor or Higher | 0.15% | 35.11% | | NA | 32.28% | |
| **Employment Status** | | | | | | |
| Employed | NA | 82.32% | | NA | 84.22% | |
| Unemployed | NA | 17.51% | | NA | 14.49% | |
| Retired, Not in labor force | NA | 0.17% | | NA | 1.29% | |
| **HH Income (4 category)** | | | | | | |
| <$10,000 | 1.67% | 2.55% | | 2.12% | 2.84% | |
| $10-49,999 | 34.11% | 35.70% | | 38.64% | 41.87% | |
| $50-74,999 | 25.46% | 25.80% | | 31.32% | 28.84% | |
| $75,000+ | 38.77% | 35.86% | | 27.92% | 26.45% | |
| **Ethnicity (Hispanic vs. Not)** | | | | | | |
| Yes | 6.90% | 6.94% | | 8.74% | 13.06% | |
| No | 93.10% | 93.06% | | 91.26% | 86.94% | |
| **Race** | | | | | | |
| White | 86.51% | 86.07% | | 82.51% | 83.85% | |
| Black/African-American | 8.06% | 7.55% | | 13.17% | 11.76% | |
| American Indian or Alaska Native | 0.50% | 0.58% | | 2.62% | 1.68% | |
| Asian/Pacific Islander | 4.93% | 5.80% | | 1.71% | 2.71% | |
| Other | | | | | | |
| **Region (4 Census)** | | | | | | |
| Northeast | 19.55% | 19.89% | | 16.66% | 16.19% | |
| Midwest | 24.79% | 23.06% | | 29.12% | 30.15% | |

| | | | | | |
|---|---|---|---|---|---|
| South | 31.82% | 33.14% | | 32.30% | 32.85% | |
| West | 23.84% | 23.91% | | 21.93% | 20.81% | |
| **Broadband Access** | | | | | | |
| **Teens 13-17** | | | | | | |
| With broadband | 10% | | | 5.51% | | |
| Without broadband | 90% | | | 94.49% | | |
| **Young adults 18-25** | | | | | | |
| With broadband | | 12% | | | 11.28% | |
| Without broadband | | 88% | | | 88.72% | |
| **Adults 26-45** | | | | | | |
| With broadband | | 11% | | | 8.89% | |
| Without broadband | | 89% | | | 91.11% | |
| **Total broadband age13-45** | | | 11% | | | 9.19% |
| **Total not broadband age13-45** | | | 89% | | | 90.81% |

† Most, if not all comparisons of KN estimates will be statistically different from CPS estimates due to large sample sizes.

## Table 7. Attitudes toward hybrid electric cars

| Question | Panel Tenure (months) | | | |
|---|---|---|---|---|
| | **2-3** (*n*=721) | **4-6** (*n*=2,316) | **7-9** (*n*=1,646) | **10-12** (*n*=1,117) |
| How does a hybrid car compare to a standard car on price (% worse)? | 64 | 66 | 68 | 67 |
| How does a hybrid car compare to a standard car on maintenance costs (% worse)? | 42 | 39 | 38 | 38 |
| Plan to purchase or lease a new car in next two years (5 Yes) | 39 | 37 | 38 | 37 |
| How likely to consider a hybrid electric car for purchase (% likely)? | 10 | 9 | 10 | 9 |

*$p$-value < .05 (two-sided)

## Table 8. Investments and financial services (%)

| Question | Panel Tenure (months) | | | |
|---|---|---|---|---|
| | **0-6** (*n*=1,016) | **7–9** (*n*=2,245) | **10–12** (*n*=1,853) | **> 12** (*n*=1,471) |
| Owns $50,000 or more in investment assets | 14 | 15 | 14 | 16 |
| Owns individual stocks | 22 | 19 | 19 | 22 |
| Invests online | 4 | 4 | 4 | 6 |
| Banks using personal computer | 13 | 12 | 12 | 11 |
| Use of online bill payment | 7 | 5 | 6 | 5 |

*$p$-value < .05 (two-sided)

**Table 9. Attitudes on sensitive questions**

| Question | Panel Tenure (months) | | | |
|---|---|---|---|---|
| | <3 (n=667) | 4-6 (n=2,137) | 7-9 (n=1,515) | 10-12 (n=1,003) |
| People with AIDS deserve it (% agree) | 15 | 18 | 19 | 21 |
| How likely to get AIDS from sharing same drink glass (% likely)? | 25 | 25 | 23 | 24 |
| How likely to get AIDS from someone coughing or sneezing (% likely)? | 22 | 23 | 20 | 22 |
| Plan to purchase or lease a new car in next two years (% yes)? | 60** | 54* | 52* | 53* |
| Is there currently a cure for AIDS (% yes)? | 19 | 19 | 18 | 18 |

*$p$-value < .05 (two-sided)

**Table 10. Panelists' demographics by length of panel tenure (%)**

| Demographics | Panel Tenure (months) | | | | |
|---|---|---|---|---|---|
| | < 7 | 7–9 | 10–12 | > 12 | Total |
| *Female* | 50 | 51 | 51 | 51 | 51 |
| Age 18 – 34 years | 36 | 34 | 33 | 32 | 33 |
| Age 35 – 64 years | 48 | 47 | 46 | 47 | 47 |
| Age 65 and over | 16 | 19 | 21 | 21 | 19 |
| High school graduate or equiv. | 33 | 30 | 30 | 34 | 32 |
| BA degree or more | 29 | 29 | 33 | 32 | 31 |
| Household income less than $40,000 | 38 | 34 | 35 | 33 | 35 |
| Household income $40,000 - $74,999 | 38 | 40 | 39 | 39 | 39 |
| Household income $75,000 or more | 24 | 26 | 26 | 28 | 26 |

*$p$-value < .05 (two-sided)

**Table 11: Comparison of Respondents and Nonrespondents - Recruiting Interview Data**

| Question | Completed the HH Profile Survey? | | |
|---|---|---|---|
| | | No | Yes |
| **Heard about the World Wide Web** | | | |
| **or Internet before being recruited?** | **Yes** | 77.4% | 79.1% |
| | **No** | 22.6% | 20.9% |
| **Has respondent or anyone else in the household,** | | | |
| **ever used a computer, either at home, school or at work?** | **Yes** | 91.5% | 91.0% |
| | **No** | 8.5% | 9.0% |
| **Is there a computer in your home?** | | | |
| | **Yes** | 79.8% | 71.5% |
| | **No** | 20.2% | 28.5% |
| **Is your home computer connected to the World Wide** | | | |
| **Web and/or the Internet?** | **Yes** | 87.0% | 78.9% |
| | **No** | 13.0% | 21.1% |
| **Number of members in the household?** | | | |
| | **1** | 8.3% | 9.4% |

| | | | |
|---|---|---|---|
| | **2** | 29.6% | 34.3% |
| | **3** | 21.0% | 21.3% |
| | **4** | 22.6% | 20.3% |
| | **5** | 12.3% | 9.5% |
| | **6** | 4.2% | 3.4% |
| | **7** | 1.2% | 0.9% |
| | **8** | 0.4% | 0.4% |
| | **9** | 0.2% | 0.1% |
| | **10** | 0.1% | 0.1% |
| | **11** | 0.0% | 0.0% |
| | **12** | 0.0% | 0.0% |
| | **14** | 0.0% | 0.0% |

**Table 12. How concerned are you with coping with serious injury or illness? Recruitment Group with Weighted Percentages**

| | Recruitment Group | | | | | | |
|---|---|---|---|---|---|---|---|
| | A | B | C | D | Cumulative | | |
| | Web (standard) | Web with Phone Prompt | Phone - Refused Web Panel Recruitment | Phone - Failed to Install Web Device | A + B | A+B+C | Total |
| **Not at all a concern** | 4.1% | 7.1% | 4.2% | 5.3% | 4.2% | 4.2% | 4.2% |
| **2.00** | 6.0% | 8.4% | 2.8% | 6.1% | 6.1% | 6.1% | 6.1% |
| **3.00** | 16.9% | 14.6% | 15.5% | 16.0% | 16.8% | 16.8% | 16.8% |
| **4.00** | 19.7% | 22.8% | 19.7% | 18.4% | 19.9% | 19.9% | 19.8% |
| **Major concern** | 52.8% | 45.5% | 54.9% | 54.1% | 52.5% | 52.5% | 52.5% |
| **Did Not Answer** | .5% | 1.6% | 2.8% | | .6% | .6% | .6% |
| **Total** | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% |