MULTI-MODALITY SURVEYS: ASSESSING THE COST EFFECTIVENESS OF BIAS REDUCTION

Michael P. Battaglia and Robert J. Schmitz, Abt Associates
Michael P. Battaglia, Abt Associates Inc. 55 Wheeler Street
Cambridge, MA 02138

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1. Introduction

Household surveys typically employ a single mode of data collection -- mail, telephone or in-person interview. Use of more than one mode of data collection for a single survey is uncommon, but has been increasing in order to reduce survey costs and to achieve a higher response rate than is possible using a single mode (Dillman, 1991). An earlier paper (Battaglia and Hassol 1993) discussed the results of a survey of Medicare beneficiaries using three modes of data collection and investigated the reduction in bias associated with the incremental use of mail surveys and in-person interviews over a telephone survey. The paper computes the cost-effectiveness of expanding survey modes in this way to increase response rate and reduce bias. It derives the relative cost of a unit-reduction in bias as successively more expensive survey modalities are added to a telephone-only modality.

2. Survey Methodology

The Medicare Influenza Vaccine Demonstration, authorized by provisions of the Omnibus Budget Reconciliation Act of 1987, was designed to evaluate the cost-effectiveness of Medicare coverage of influenza vaccine. The Health Care Financing Administration (HCFA) funded the demonstration in 10 geographically dispersed sites throughout the country from September 1988 through May 1992. Each site consisted of an *intervention area* in which influenza vaccine was provided to Medicare beneficiaries free of charge, and a *comparison area* in which vaccine was not covered, consistent with then-current Medicare policy.[1] Technical assistance to site staff, survey efforts, and demonstration evaluation were performed by Abt Associates Inc. of Cambridge MA, under contract to HCFA.

In order to estimate rates of vaccination in each of the four years of the demonstration, annual surveys of beneficiaries were conducted in each of the intervention and comparison areas. The goal of the survey effort was to achieve a response rate of 90 percent or higher while completing approximately 500 questionnaires per area. In addition to providing area estimates, the study was also intended to provide age, sex and race vaccination estimates. Each year a random sample of Medicare Part B enrollees, stratified by age, race and sex was drawn from Medicare eligibility files for each of the annual surveys. These files contain names and addresses of enrollees but not telephone numbers. Telephone numbers were obtained for 74 percent of the sampled enrollees through a private vendor.

The survey methodology aimed to reach a high response rate at reasonable cost by first completing as many interviews as possible by telephone. A questionnaire, containing the same questions as the telephone survey instrument, was subsequently mailed to those beneficiaries who could not be interviewed by telephone, including those without directory-listed telephone numbers, those without telephones, and those for whom telephone contacts were unsuccessful. Finally, a field effort was mounted to interview the remaining nonrespondents, though at much higher cost per completed interview than for the other two modalities.

All beneficiaries who were to be contacted by telephone first received a postcard informing them that they would receive a telephone call asking about their health practices and requesting their cooperation. Up to six attempts were made to complete each telephone interview, using computer-assisted telephone interviewing (CATI). All beneficiaries who were not interviewed by telephone (including refusals and break-offs)

received a printed copy of the survey in the mail. The instructions accompanying the survey also contained an 800 number which the beneficiary could dial to complete the interview by telephone, if desired. The names and address of the individuals who had completed neither telephone nor mail surveys were sent to field interviewers in each site. Field staff first attempted to contact the beneficiary by telephone. If this was unsuccessful at least two attempts were made to locate and interview the respondent in person. Those beneficiaries who returned a blank mail survey or who called the 800 number to refuse the survey were not pursued by field staff.

Completion rates by survey modality are shown in Table 1. The most pronounced differences are seen in whites versus nonwhites. Just over 65 percent of completed interviews for whites were performed by telephone; for nonwhites only 49 percent were completed by telephone. By contrast 21 percent of completed questionnaires for nonwhites were done in the field, versus about 11 percent for whites.

3. Eligibility, Coverage, and Response Rates

After each of the three waves of the survey, sample beneficiaries were placed into one of four categories: 1) eligible-completed (EC), 2) eligible-not completed (ENC), 3) ineligible (I), or 4) unknown eligibility status (U). Beneficiaries who were noninstitutionalized and were living in the designated treatment or comparison area as of October 1991, were considered eligible. Response, eligibility, and coverage rates were computed for the telephone-only modality, and also for the telephone plus mail (T+M) and the telephone plus mail plus field (T+M+F) modalities. The overall response rate is computed as the product of the screener response rate and the interview response rate. The screener response rate is defined as the ratio [EC+ENC+I]/[EC+ENC+I+U]. The interview response rate is given by [EC/EC+ENC], and the eligibility rate by [EC+ENC]/[EC+ENC+I]. The proportion with unknown eligibility is defined as U/[EC+ENC+I+U]. The rates just defined are reported in Table 2. Because the telephone-only modality can only be used to draw inferences about the population of beneficiaries with listed telephone numbers, calculation of rates for this mode ignores the subsample of beneficiaries without such numbers.

The overall response rate for the telephone-only modality was 79 percent.[2] The addition of the mail modality raised this rate only slightly, by 3.8 percentage points. The addition of the field mode, however, raised the overall response rate to 96 percent. Notice that the eligibility rate declines as modalities are added, reflecting a disproportionate shift of beneficiaries from unknown to ineligible status.

The telephone modality coverage rate and increments to response rates as modalities are added are displayed in Table 3 according to the three stratification variables. Beneficiaries who were nonwhite and who were under 65 years old exhibited the lowest telephone modality coverage rates.[3] The telephone modality response rates ranged from 73 to 83 percent. The addition of the mail modality generally raises the response rate by a small amount. Addition of the field modality, however, raises the response rates substantially in every category, with the largest increase observed for nonwhites and beneficiaries either under age 65 or aged 75 and over.

4. Modality Bias Estimates

We can estimate the magnitude of the bias associated with the telephone-only modality, and the telephone plus mail modality by treating the telephone plus mail plus field modality as the "gold standard". That is, we can assume it provides estimates that are subject to little if any nonresponse bias. Our analysis concentrates on the key survey variable: whether the beneficiary received a influenza vaccine shot during the fall or winter prior to the survey, that is, for the winter of 1991-92.

Table 4 shows the bias and relative bias of the estimates for the telephone-only, and telephone plus mail modalities. The bias of the telephone plus mail estimates can be attributed almost entirely to nonresponse, while the bias of the telephone-only modality estimates is due to a combination of nonresponse and noncoverage.

The relative biases shown in Table 4 are almost all negative, indicating that the telephone-only and telephone plus mail modalities

overestimate the vaccination rate. The relative bias is largest for beneficiaries under 65 years of age, and for nonwhites. The relative bias of the telephone-only modality estimates is particularly large for nonwhites, around -20 percent.

The relative bias almost always declines in absolute value when one moves from the telephone-only modality to the telephone plus mail modality. On average, the addition of the mail modality reduces the absolute value of the relative bias of the telephone-only modality by about 30 percent.

5. Cost-Effectiveness Of Bias Reduction

The largest gains in response rate resulted from the addition of the field modality, although the mail modality did serve to increase the coverage rate to 100 percent. The addition of the mail modality decreased the relative bias of the telephone-only estimates by 30 percent, on average, indicating that a substantial portion of relative bias still remained. One might conclude from this that a telephone plus field modality survey would have been preferable to a telephone plus mail plus field modality design. This conclusion however ignores survey costs. That is, it does not take into account the cost-effectiveness of the bias reduction resulting from the addition of the mail modality to the telephone modality, followed by the addition of the field modality to the mail modality.

The average cost per completed interview was computed for each of the three modalities. The cost estimates are considered proprietary; however, the relationship between cost per complete can be released. If we let x equal the cost per complete for the telephone modality, the cost per complete for the mail modality equals 1.6x, and the cost per complete for the field modality equals 13.8x. It should be kept in mid that these cost per complete relationships are a function of the ordering of the modalities. The cost per complete for the telephone-only modality was lower than the cost per complete for the mail modality due to the large number of interviews completed by CATI, and the fairly intensive follow-up procedures used in the mail survey.

The total cost of each modality was computed for the entire sample and for the categories of each of the three stratifiers. In these calculations, we have implicitly assumed that the average cost per complete does not vary by much across the categories of age, sex, and race. The cost-effectiveness of the mail modality was then determined by first calculating the percent increase in total survey cost resulting from the addition of the mail modality to the telephone modality. The ratio of the absolute value of the relative bias of the telephone modality influenza vaccination estimate in relation to the telephone plus mail modality estimate **to** the percent increase in survey cost was then computed. This ratio gives the percentage point reduction in relative bias per percentage point increase in survey cost. The higher the ratio, the more cost-effective the addition of the mail modality to the telephone modality. The results are shown in Table 5. For the entire sample, the addition of the mail modality caused a 0.028 percentage point reduction in relative bias for each percentage point increase in survey cost. An examination of the cost-effectiveness ratio by age, sex, and race shows some striking differences. For nonwhite beneficiaries, the addition of the mail modality caused a 0.081 percentage point reduction in relative bias for each percentage point increase in survey cost. This is 4.5 times larger than the cost-effectiveness ratio for white beneficiaries. The cost-effectiveness ratio was also high for beneficiaries with an unknown race, for male beneficiaries, and for beneficiaries under 65 years of age.

Table 5 also shows the cost-effectiveness ratio for the field modality. The denominator of the ratio was computed as the percent increase in total survey costs resulting from the addition of the field modality to the telephone plus mail modality. The numerator equals the absolute value of the relative bias of the influenza vaccination estimate in relation to the telephone plus mail plus file estimate. For the entire sample, there was also a 0.028 percentage point reduction in relative bias per percentage point increase in survey cost. The highest cost-effectiveness ratio is for nonwhite beneficiaries, at 0.045 percentage points. This is 1.8 times higher than the ratio for white beneficiaries. There is no difference between male and female beneficiaries. Beneficiaries under 65

years of age and those 75 years and older have a slightly higher effectiveness ratio than beneficiaries age 65 to 74 years.

6. Conclusions

When the addition of the mail modality is compared with the addition of the field modality, cost-effectiveness is judged to be equal at the total sample level. Contrary to the earlier statement regarding the usefulness of the mail modality, the cost-effectiveness ratio is actually higher in the mail modality than in the field modality for beneficiaries under age 65, males, beneficiaries with an unknown race, and nonwhite beneficiaries. Those finding validate the decision to use the mail modality before resorting to field interviews.

REFERENCES

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1. In April 1993, the Department of Health and Human Serviced announced the addition of influenza vaccine to the Medicare Part B benefit package.

2. The telephone-only mode of data collection offers 74 percent coverage because beneficiaries without directory-listed telephone numbers were excluded from this wave of the survey.

3. Medicare beneficiaries who are under the age of 65 include the disabled, those suffering from End Stage Renal Disease (ESRD) and dependents of beneficiaries aged 65 and over.

Table 1: Number And Percent of Completed Questionnaires By Survey Modality

	Telephone	Mail	Field	Total Number Of Completed Questionnaires
Entire Sample	64.1%	24.4%	11.5%	10,815
Age:				
<65	52.2%	31.7%	16.2%	1,077
65–74	66.6%	23.3%	10.1%	5,644
75+	63.8%	24.1%	12.1%	4,094
Sex:				
Male	66.5%	22.5%	11.0%	4,434
Female	62.4%	25.8%	11.8%	6,381
Race:				
White	65.2%	24.1%	10.7%	9,746
Nonwhite	49.4%	29.6%	21.1%	802
Unknown	68.5%	22.1%	9.4%	267

Table 2: Response, Eligibility and Coverage Rates – Entire Sample

Modality	Coverage Rate	Screener Response Rate	Interview Response Rate	Overall Response Rate	Elegibility Rate	Percent With An Unknown Status
Telephone Only	74.3%	87.0%	90.8%	79.0%	96.9%	13.0%
Telephone & Mail	100.0%	85.9%	96.4%	82.8%	94.7%	14.1%
Telephone & Mail & Field	100.0%	98.6%	97.5%	96.1%	92.2%	1.4%

Table 3: Coverage Rates, and Response Rate Changes by Modality For Key Domains of the Population

Category	Telephone Coverage Rate	Telephone Response Rate	Response Rate Change: T+M Versus T Only	Response Rate Change: T+M+F Versus T+M	Response Rate Change: T+M+F Versus T Only	Percent Change: T+M+F Versus T Only
Age:						
<65	57.2%	76.7%	−0.2%	15.8%	15.7%	20.5%
65–74	77.3%	81.8%	4.0%	10.8%	14.8%	18.1%
75+	75.3%	75.7%	5.2%	15.7%	20.9%	27.6%
Sex:						
Male	76.3%	79.9%	3.5%	12.6%	16.1%	20.2%
Female	73.0%	78.2%	4.2%	13.8%	18.1%	23.1%
Race:						
White	75.5%	79.2%	4.5%	12.7%	17.1%	21.6%
Nonwhite	59.0%	72.6%	−1.1%	21.6%	20.4%	28.1%
Unknown	78.0%	83.2%	3.9%	10.4%	14.3%	17.2%

Table 4: Magnitude of Bias and Relative Bias of the Telephone Only and Telephone Plus Mail Modalities For Influenza Vaccination Rate Estimates

		Magnitude of Bias For:		Relative Bias For:	
	T+M+F Estimate	T+M+F Versus T Only	T+M+F Versus T+M	T+M+F Versus T Only	T+M+F Versus T+M
Entire Sample	53.9%	−3.4%	−2.4%	−5.9%	−4.3%
Age					
<65	35.4%	−4.0%	−2.4%	−10.2%	−6.2%
65−74	55.0%	−2.5%	−4.0%	−4.3%	−3.4%
75+	57.5%	−3.5%	−3.0%	−5.6%	−4.9%
Sex:					
Male	55.5%	−4.1%	−2.4%	−6.9%	−4.1%
Female	52.8%	−2.9%	−2.5%	−5.1%	−4.5%
Race:					
White	55.4%	−2.7%	−2.1%	−4.7%	−3.6%
Nonwhite	39.3%	−10.0%	−6.2%	−20.3%	−13.6%
Unknown	48.1%	−3.4%	−2.1%	−6.7%	−4.1%

Table 5: Cost−Effectiveness Of Bias Reduction For Influenza Vaccination Rate Estimates

	Mail Versus Telephone:			Field Versus Telephone Plus Mail:		
	Percent Change in Cost	Absolute Value of Relative Bias	Percentage Point Reduction in Rel Bias Per Percentage Point Increase in Survey Cost	Percent Change in Cost	Absolute Value of Relative Bias	Percentage Point Reduction in Rel Bias Per Percentage Point Increase in Survey Cost
Total:	61.50%	1.75%	0.028%	152.79%	4.26%	0.028%
Age						
<65	97.88%	4.23%	0.043%	215.85%	6.24%	0.029%
65−74	56.41%	0.92%	0.016%	133.47%	3.37%	0.025%
75+	61.00%	0.95%	0.016%	163.16%	4.91%	0.030%
Sex:						
Male	54.64%	2.97%	0.054%	147.01%	4.09%	0.028%
Female	66.58%	0.72%	0.011%	156.77%	4.45%	0.028%
Race:						
White	59.59%	1.08%	0.018%	142.32%	3.62%	0.025%
Nonwhite	96.54%	7.77%	0.081%	299.55%	13.58%	0.045%
Unknown	52.01%	2.64%	0.051%	123.98%	4.12%	0.033%