CONTROL OF THE QUESTIONNAIRE COMPONENT OF NONSAMPLING ERROR IN SURVEYS: A CASE STUDY FROM THE HEALTH INTERVIEW SURVEY 1976-1977 INFLUENZA SUPPLEMENT

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Introduction

Survey measurement errors can be introduced at any stage of the survey design and processing. The survey questionnaire instrument itself can be one of the major contributors to the nonsampling component of survey error. For this reason many factors must be considered in the design of the questionnaire to attempt to minimize this potential error. Determining the concepts to be measured requires great care to ensure that the objectives of the survey are met. Once these concepts are determined, they must be defined in a complete and unambiguous manner. In the wording of the questions these definitions must be conveyed to the respondent in the simplest language with all attempts made to avoid vague terms and words that may have different meanings to different respondents. It is necessary to consider how the questions will "flow" from one subject to another and the effects questions and their responses may have on later question responses. The questions must be individually evaluated, based on previous experience, research, and pretesting, to determine whether respondents will understand and be able and willing to answer and to assess whether the questions measure what they purport to measure.

In this paper we discuss some of the problems we encountered in meeting some of these objectives in the development of a set of questions on influenza and influenza vaccinations in the national Health Interview Survey (HIS). Topics that are discussed include 1) difficulties in appropriately defining the desired concepts to be measured, 2) the questionnaire structure (an indirect versus a direct approach for eliciting acute conditions), 3) the effects of the supplemental set of questions on other questions in the questionnaire, and 4) the respondents' knowledge and ability to recall events. For each of these topics survey findings are presented and used to examine possible effects of the questionnaire design on the survey data.

Background

In February 1976 there was a small outbreak of influenza which was labeled A/New Jersey-76 and called swine flu. Because most people in the U.S. were not immune to this virus, the Public Health Service recommended, and the President approved, a national influenza immunization program. The Center for Disease Control (CDC) was charged with the development of an immunization delivery system and with the assessment of the coverage of the program as well as the surveillance of influenza cases. To help carry out these tasks CDC asked the National Center for Health Statistics to collect morbidity and influenza vaccination data. In response, HIS added a set of questions to the regular ongoing survey starting the first week of September 1976 and continuing until April 1977. The questions concerned influenza incidence and symptoms, incidence of all types of influenza vaccinations and swine flu vaccinations, where the vaccinations were obtained, and the amount paid for them.

In the HIS, a probability sample of households representing the civilian, noninstitutionalized U.S. population is surveyed each week by Bureau of the Census interviewers. Interviewing is done continually throughout the year on a weekly sample of about 800 households. Data are collected on illness, physician visits, dental visits, and hospitalizations. Respondents are asked to name the specific condition that restricted their activity or caused them to seek medical care. Using a checklist of specific chronic conditions, the interviewers also ask the respondents whether they currently have any of these conditions. Various supplements are also included in the HIS each year to collect information on timely subjects.

The HIS sample is designed so that tabulations can be provided for each of four major geographic regions, for large metropolitan areas, and for place of residence of the U.S. The sample is also designed so that households interviewed each week represent those in the target population and that the weekly samples are additive over time.

Definitional Problems in the Influenza Supplement

The measurements that the Influenza Supplement was intended to produce were well delineated. These concepts were: 1) incidence of influenza, 2) incidence of flu shots (and specifically swine flu shots), 3) type of place shot received, and 4) amount paid for shot. Developing a definition of influenza and presenting it in terms that would be consistently understood by the respondents became a problem since, without a medical diagnosis, it is impossible to determine whether a person actually has influenza.

Conditions reported in the HIS are as perceived by the household respondents; no medical examination is performed by HIS personnel. If a physician was seen because of a condition, the respondent is asked what the physician called the condition. However, if a physician was not seen, the condition is coded based on whatever terms the respondent used. Some respondents with symptoms of fever, runny nose, headache, muscle ache, or cough may report that they have "flu." Other respondents with the same symptoms may call their illness a cold, a virus, or something else.

Historically in HIS only those conditions reported by the respondent as being either "flu," "influenza," or "grippe" have been coded and counted as influenza. (Grippe is a regional term that is technically synonymous with influenza.) At CDC's request, each respondent who reported flu was asked further questions in order to establish symptoms experienced in connection with the condition. These three questions were asked:

1. When (name) had the flu did he/she have a fever?
2. Did (name) have a headache, muscle ache, cough, sore throat, or runny nose?
3. Did (name) have diarrhea?

Table A. Number and Percent of Persons Reporting Selected Influenza-like Conditions for Past Two Weeks Who Experienced Selected Symptoms by Type of Symptom Reported, HIS Influenza Supplement, October 1976 - March 1977

Symptom[1]	Selected Conditions Reported					
	"Flu," "Influenza," or "Grippe"		"Virus"		"Cold"	
	Number in Thousands	Percent	Number in Thousands	Percent	Number in Thousands	Percent
All	2,885	100.0	959	100.0	3,746	100.0
Fever	2,125	73.6(2.8)	571	59.6(8.6)	1,961	52.4(5.8)
"Other"[2]	2,533	87.8(4.1)	722	75.3(4.6)	3,514	93.8(0.8)
Diarrhea	1,135	39.3(11.5)	457	47.6(13.6)	481*	12.9*
Fever and/or "Other"	2,644	91.7(1.2)	816	85.1(3.0)	3,578	95.5(0.7)
Diarrhea with NO fever or "Other" symptom	77*	2.5*	62*	6.5*	7*	0.2*
None	165*	5.7*	82*	8.6*	162*	4.3*

Note: One standard error in percent is shown in parentheses for each estimate.

[1] Figures do not add to 100 percent because persons may have reported symptoms in more than one category.

[2] "Other" includes: headache, muscle ache, cough, sore throat, and/or runny nose.

*Figures do not meet standards of precision.

These three questions were also asked for persons reported as having a "virus" or "cold" so that the respondent's choice of condition name could be compared with the selected symptom(s).

Table A, showing data collected on the HIS influenza supplement, illustrates the relationship between the reported conditions and the symptoms experienced. Fever and other specified symptoms were frequently experienced in all three condition categories. Most cases had some combination of these symptoms. A higher percentage of persons with flu cases experienced fever than did those with cold cases (73.6 percent versus 52.4 percent.) Also the survey results indicate a higher percentage of persons with flu cases experienced fever than did those with virus cases but this difference is not significant at the .05 level. The percentage of "other" symptoms was higher for persons reporting cold cases than for persons with virus cases (93.8 percent versus 75.3 percent). The difference in the percentages reporting "other" symptoms for cold versus flu is not significant at the .05 level. Persons with colds reported experiencing a higher rate of either fever and/or "other" symptoms (95.5 percent) than did persons with flu (91.7 percent) or virus (85.1 percent).

The survey results indicate a much lower rate of diarrhea for cold than for flu or virus but the figure for cold is subject to a large sampling error. The estimates of the rates for diarrhea alone with no fever or "other" symptoms and for persons experiencing none of the symptoms are all very low but they are also subject to large sampling errors.

The symptoms experienced for the selected flu-like conditions do not appear to be helpful in distinguishing among these conditions. As shown in Table A almost all of these reported conditions had one or more of the symptoms reported with it. However, the knowledge of the symptoms may be helpful in some types of analyses of the data. For instance, analysts have the option of defining a case of flu-like illness as a condition reported as either "influenza," "grippe," "virus," or "cold" with fever.

Questionnaire Structure

Since the beginning of the HIS, incidence of acute conditions has been ascertained from respondents in what might be considered an "indirect" approach. Rather than giving the respondents a checklist of specific conditions, the survey uses a series of probe questions on behaviors associated with illness. These questions ask for the number of bed days, work and school loss days, and "cut down" days during the past two weeks. If any of these disability days are reported the respondent is then asked what condition caused him/her to stay in bed, miss work, etc. In addition, there are probe questions on doctor visits in the past two weeks and if there were any the respondent is asked to report the conditions discussed with the doctor. Any acute conditions reported that do not have disability days or medical attention are termed "minor acutes" and are eliminated in the processing of the data.

Over the years there has been considerable debate over the exclusion of "minor acute" conditions. On the one hand, reporting of conditions with neither impact in the form of disability days nor medical attention is believed to be less valid (Gleeson 1972). On the other hand, restriction of activity may be less likely to be experienced by certain groups of people. For example, employed persons who lose income when absent from work may be less likely to miss work due to illness than persons whose income may not be affected by absence due to illness. In this case no disability day may be reported and hence the condition would not be counted.

Because CDC hoped to minimize the underreporting of influenza, they requested that HIS use the direct question, "During the past two weeks did (name) have

the flu (influenza) or grippe?" For the influenza supplement both the indirect and direct methods were used. Persons who had reported influenza, virus, or cold in response to the indirect probes on the main questionnaire were asked further questions about the conditions on the supplement. Persons who did not report such a condition as causing disability days or medical contacts were asked the direct question about having the flu. This permitted analysis of the characteristics of persons who did not restrict their activities or see a physician when they had influenza.

In Table B, the proportion of persons reporting influenza by the two interview methods is shown by various population groups. The percent increase in reporting for the direct over the indirect approach is also shown. (The "direct" category includes persons who answered "Yes" to the direct question on the supplement; it also includes persons who reported influenza/flu/grippe in response to the indirect activity and medical care probes since it is assumed that they would have responded positively to a direct question.)

Table B. Percent of Persons Reporting Influenza in Past Two Weeks and Percent Increase by Interview Method and Population Group; HIS Influenza Supplement, October 1976 - March 1977

Population Group	Interview Method		Percent Increase
	Direct[1]	Indirect	
	Percent of Pop.		
All	4.4	2.7	63.0
Age			
Under 15	5.0	3.4	47.1
15-44	4.7	2.9	62.1
45-64	4.2	2.5	68.0
65+	2.5	1.1	127.3
Residence			
SMSA/Cent. City	4.2	2.5	68.0
SMSA/Not Cent. City	4.4	2.7	63.0
NonSMSA/Nonfarm	4.7	3.0	56.7
NonSMSA/Farm	4.3	2.4	79.2
Educ. of Persons 17+			
0-11 years	4.4	2.4	83.3
12 years	4.2	2.5	68.0
13+ years	4.3	2.8	53.6
Family Income			
Under $5,000	4.6	2.6	76.9
$5,000-9,999	4.9	3.0	63.3
$10,000-14,999	5.0	3.0	66.7
$15,000-24,999	4.3	2.7	59.3
$25,000+	3.8	2.5	52.0
2-week Work Status, 17+			
Currently Employed	4.3	2.7	59.3
Unemployed	4.3	2.2	95.5
Not in Labor Force	4.1	2.2	86.4
Sex			
Male	4.1	2.5	64.0
Female	4.7	3.0	56.7
Race			
White	4.7	2.9	62.1
All Other	2.8	1.7	64.7
Respondent Status			
Responded for Self entirely or partly	4.6	2.7	70.4
Responded by Proxy	4.3	2.8	53.6

[1] Includes persons reporting to indirect method.

The largest increases in reported cases of influenza by asking a direct question were seen among a) older persons (aged 65 and over), b) farm residents, c) persons with less than a high school education, d) persons with low income, and e) persons who were unemployed or not in the labor force. Also, there was a large increase for persons who responded for themselves. Little difference in reporting was evident when persons were compared by sex and race. The factors influencing reporting acute conditions for these categories may be similar and in many cases may interact with each other. For instance, the largest percent increase was for persons 65 years and older who have less education, lower income, and are more often out of the labor force.

A small part of the increased reporting of influenza with the direct approach is due to persons who reported virus or cold with the indirect approach "converting" their responses to flu. (Five percent of virus cases and four percent of the cold cases answered "yes" to the direct flu question.) Another explanation for the increased reporting with the direct method is that more of the cases reported with the direct approach had onset prior to the two-week reference period. However, only five percent more (16 percent versus 11 percent) reported onset more than two weeks ago with the direct approach versus the indirect approach. The reason for most of the increased reporting appears to be that the direct approach includes "minor acute" conditions and the indirect approach does not. A comparison of symptoms experienced for influenza cases by interview method in Table C shows that fever was much more prevalent for the cases reported with the direct method. Almost 74 percent of the cases reported with the indirect method reported fever compared to only half of the additional cases reported by the direct method. The level of reporting of "other" symptoms and diarrhea was about the same for the two methods. If fever is considered a measure of severity then the indirect method excludes some of the less severe flu cases.

Table C. Percent of Persons Reporting Influenza Cases in Past 2 Weeks Who Experienced Selected Symptoms by Type of Symptom Reported and By Interview Method

Symptom[1]	Cases Reported by Indirect Method (n=1531)	Additional Cases Reported by Direct Method (n=927)
Fever	73.6 (1.6)	50.2 (2.3)
"Other"[2]	87.8 (1.2)	86.4 (1.6)
Diarrhea	39.3 (1.8)	33.8 (2.2)
None	5.7 (0.8)	6.7 (1.2)

Note: One standard error in percent is shown in parentheses for each of the estimates.

[1] Figures do not add to 100 percent because persons may have reported symptoms in more than one category.

[2] "Other" includes: headache, muscle ache, cough, sore throat, and/or runny nose.

Supplement Effects

The HIS questionnaire is organized into a "core" set of questions, which remain basically unchanged from year to year, and one or more sets of supplemental questions which may be used one time only or on a rotating basis. The core questions obtain information on acute and chronic conditions, disability days, doctor visits, limitation of activity and sociodemographic and economic characteristics. The supplemental topics over the years have been extensive, including such areas as health insurance, health habits, and home care for the disabled. Since it is well known that altering question wording or ordering can have an effect on response, the core questions are kept basically the same from year to year so that trend estimates may be made.

Less well known, however, is the effect of including supplemental topics on the estimates produced by core items. On the HIS, this problem was experienced during the 1973-1974 supplement on acute conditions. For that period, the estimate from the core of the number of acute conditions with onset in the two weeks before the interview dropped dramatically. Wilder (1975) believed that the actual number of acute conditions did not decrease to such an extent, but that the introduction of the supplement biased the estimates. Since interviewers were required to ask a large number of supplemental questions about conditions with two-week onset, it was to their benefit to probe in such a way as to reduce the number of conditions with onset in the past two weeks. Other supplemental effects have been noted on other HIS years, as well as on other surveys; several have been discussed by Gibson, et.al. (1978) and Cowan, et.al.(1978). With regard to these design problems, some have suggested that it may be safer to produce trend estimates based on years when only the core set of questions is asked. Alternating core only and core plus supplements from year to year possibly could achieve this purpose.

The introduction of the influenza supplement had the potential for biasing the regular estimates for upper respiratory conditions. To reduce the likelihood of interviewers failing to record influenza cases in the main questionnaire so that they would not have to ask additional questions, the supplement was designed so that it had to be filled for every person in the HIS sample, regardless of previously reported conditions. The number of questions an interviewer asked for each supplement was about the same regardless of the responses to the core questions. However, there may have been some overestimation due to an hypothesized interviewer tendency to pick up more influenza cases due to the emphasis on the topic of influenza and the media publicity concerning influenza and swine flu shots.

So that the presence of a supplement effect could potentially be detected, bronchitis was included among the conditions for which supplemental questions had to be asked. Although data analysts are not concerned with bronchitis in connection with incidence of influenza-like illnesses, if the estimates of bronchitis differ substantially from other years, this could indicate that the supplement had introduced a bias into the data.

Table D shows the incidence and the number of cases per 100 people of acute bronchitis, influenza, and cold for identical periods in five successive years. It is difficult to detect the presence of a supplement effect by comparison of the incidences of these acute conditions because the levels fluctuate widely from year to year. Incidence of acute bronchitis for the time period of the supplement was about the same as the level for the preceding time period and period after. Incidence of influenza for the period of the supplement was lower than for the period before or the period after but about the same level as for the first time period shown. Cases of cold for the supplement period were up (about 9.5 million from the preceding period and 8.6 million from the next); however, these differences are not significant at the .05 level.

Knowledge of Type of Shot

The questionnaire designers for the Influenza Supplement made the assumption that almost all respondents would know whether or not an individual received a shot within a short recall period. It

Table D. Incidence and Number Per 100 Persons of Acute Bronchitis, Influenza, and Cold for Five Time Periods

Time Period	Acute Bronchitis		Influenza		Cold	
	Incidence in Thousands	Number of cases per 100 persons	Incidence in Thousands	Number of cases per 100 persons	Incidence in Thousands	Number of cases per 100 persons
October 1973 - March 1974	1,937	0.9	60,134	29.0	50,774	24.5
October 1974 - March 1975	2,739	1.3	80,746	38.8	53,495	25.7
October 1975 - March 1976	3,289	1.6	84,399	35.4	61,153	29.1
October 1976 - March 1977	3,985	1.9	62,694	29.7	70,685	33.4
October 1977 - March 1978	3,996	1.9	80,500	37.8	62,046	29.1

Note: One Relative Standard Error for the incidence estimates of Influenza and cold is approximately four percent. One Relative Standard Error for the Acute Bronchitis estimates ranges from approximately 15 percent to 19 percent.

was reasoned that most persons receiving a shot would know they were receiving one at the time they received it and would be able to remember it for some defined period of time. There was some discussion that there would undoubtedly be some respondents who, although they were aware of receiving a shot, would not know whether it was for a flu vaccination or for some other purpose. Of much greater concern to the designers was whether respondents would be able to accurately report the type of flu vaccination. In addition to the swine flu vaccine, two other types of vaccinations were available at the time; these were for the B-Hong Kong and the A/Victoria flu strains. In the earlier questionnaire development stages it was believed that persons who received only one flu shot would most likely receive the swine flu type and persons who received more than one shot would probably receive the swine flu type first. For this reason the questions only asked about the first "flu shot" (any type). A decision was made to add the question, "Was this for the swine flu?" because of concern that earlier assumptions regarding the likelihood of shots being for swine flu may have been incorrect. Furthermore, the availability of the other types of vaccinations was unclear. Normally this question would not have been added in this manner because it is phrased in a leading or biasing way. It is stated as though the respondent is expected to answer "yes." It would have been better to ask, "What type of flu shot was this?" and then list for the respondent all of the types of flu shots from which the respondent could choose. Because of printing deadlines it was impossible to change the question in this manner.

It is not possible to definitively evaluate the accuracy of the respondents' reports concerning whether or not they received a swine flu shot. Only by record checks or blood tests could this be ascertained. However, the CDC's independent estimate of the doses of swine flu administered compared favorably with HIS's estimate. CDC's estimate for doses administered until the suspension of the program was about 42 million and HIS's was 41 million. CDC's estimate included the military and institutionalized populations whereas HIS's did not. Four percent of respondents in the HIS volunteered that they didn't know whether the flu shot they received was for swine flu. Thirteen percent said it was not.

Recall on Influenza Shots

Careful consideration must always be given to the choice of the length of the recall periods in designing questionnaires. The important issue, of course, is whether respondents will be able to remember the events they are asked to report. Several research endeavors have attempted to estimate for particular types of items the optimum recall period to use. For instance, the work of Cash and Moss (1972) led to the recommendation of the selection of a 3-month interval preceding the week of interview as the optimum recall period for reporting injuries in motor vehicle accidents. These investigators compared the error of the estimates which is composed of a bias component which reflects the respondent underreporting and a variance component. The bias is generally expected to increase as the length of the recall period increases and the variance decreases due to increasing sample size. Massey and Gonzalez (1976) similarly examined the optimum recall period for estimating all types of accidental injuries on the HIS. They recommended a two-week or four-week period depending on the detail of the analysis and the severity of the accident.

Prior research on the reporting of hospitalizations and doctor visits (Cannell et.al, 1965 and Cannell and Fowler, 1963) led to the conclusions (among others) that as the time between the event and the interview increases, there is increased underreporting of the event and that events that have more of an impact on an individual are reported more completely and accurately.

The HIS uses a two-week reference period for the reporting of acute conditions, restricted activity and doctor and dental visits. For the influenza supplement the estimates for incidence of influenza and influenza shots are also based on a two-week recall period. To classify individuals for analysis according to whether or not they received a shot, however, all persons were asked whether they had received a shot since August 1 (1976). For "yes" responses the next question was, "When was this shot received?" The interviewer coded the response into the following categories:

- Last week (week ending Sunday night before interview)
- Week before (week ending two Sunday nights before interview)
- Past 2 weeks - DK which
- 2 weeks - 1 month
- Over 1-3 months
- Over 3-6 months
- Over 6 months

The way the questions were asked allows us to compare the level of reporting of shots received using a two week reference period versus an increasing length reference period.

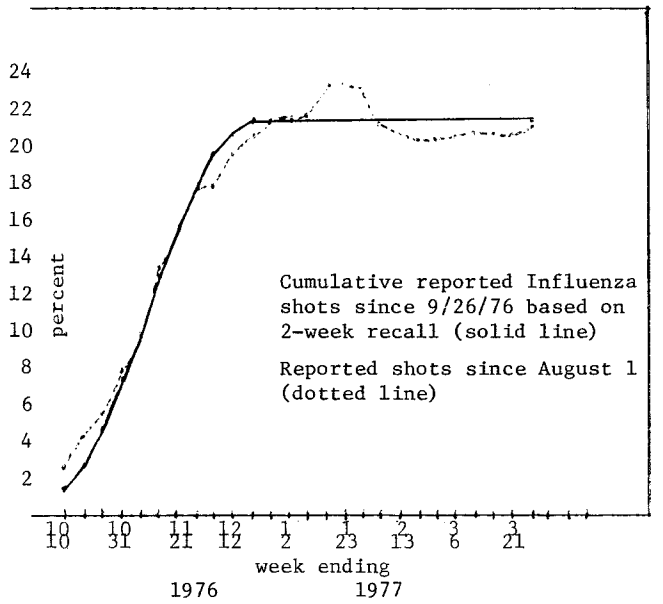
Figure 1 shows the results. The dotted line indicates by week the percentage of persons who reported receiving an influenza shot since August 1 (1976). The solid line shows the cumulative percent of persons reporting influenza shots received since September 26 (1976) using the short, two-week recall period.

The range of the recall period for the increasing lengths reference periods is from 10 weeks for the first week ending October 10 to 36 weeks for the last week ending April 3, 1977. The expected difference between the curves, in the absence of any recall error, is the percentage of shots received between August 1 and September 26. We estimate this to be about one percent.

As seen in Figure 1 the level of reporting for the increasing recall period remains fairly close to the estimated level using the two-week recall period over the entire survey period. On December 17, 1976 the swine flu vaccination program was suspended because of an outbreak of a type of paralysis called Guillain-Barré syndrome which was believed by many to have been associated with the vaccination. Although the program was recontinued on February 7, 1977 it was very limited. As can be seen from

Figure 1 there were very few reports of influenza shots based on the two-week recall after the week ending December 19, 1976. From that time until the end of the first quarter of 1977 only about half of one percent of the population reported receiving an influenza shot. It is interesting to note that the level of reporting with the increasing length reference period began to lag behind the level with two-week recall in late November but in January started to exceed that level. For the week ending January 16, 1977, with a 24-week reference period (since August 1), the level of reported shots reached 23.5 percent or about one percent higher than the expected level using the estimate based on the two-week recall.

Figure 1. Reported Influenza Shots Since August 1 Based on Increasing Recall Period Compared to Cumulated Reported Shots Received Since September 26 Based on Two-week Recall Period



Note: The Relative Standard Error (RSE) of the estimates shown on the dotted line for the weeks prior to the week ending December 19 is approximately $(.03)\sqrt{\frac{p(1-p)}{p}}$ where p equals the estimate of the percent; for subsequent weeks the RSE is approximately six percent. The RSE for the estimates on the solid line is approximately $28/\sqrt{n}$ where n equals the number of weeks accumulated.

In February and March the level dropped off and stabilized at about one percent under the level for the two-week recall estimate or about two percent under the expected level using the two-week recall estimate as the benchmark. A possible explanation for the increased level of reporting starting in late December is the extent of the concern over the possibility of ill effects from a flu shot with the great deal of media publicity on the outbreak of the Guillain-Barré cases. After this publicity had subsided and perhaps persons receiving the shot felt more at ease, the level of reporting dropped.

On the basis of this analysis it appears that the classifier variable, shot since August 1, is of reasonably high reliability. Also the analysis provides evidence that a longer recall period may be warranted for the collection of shot data. Further investigation in this area will be conducted using a childhood immunization supplement which is currently on the HIS questionnaire. In this supplement respondents are asked about shots received since the first of the month prior to the month of interview week. The actual date of the shot is obtained. Analysts will be able to assess the reliability of a four-week recall period and, if warranted, revert to a two-week reference period.

Summary

In this paper we discuss some of the major concerns we had in the development of a set of questions on flu-like illness and flu shots. The objective of the work we are reporting on was to reduce response error. Although in the absence of controlled experiments or validation studies it is not possible to definitively determine the success of our efforts, we believe that giving serious attention to these types of issues is essential to producing accurate survey data.

We strongly advocate building into the questionnaire instrument itself, to the extent feasible, methods of evaluating the accuracy of the answers after the survey. For instance, questions may be added to see how respondents define certain concepts (such as the questions we added on symptoms of influenza). In addition, for questions requiring a defined recall period when the optimum recall period is not known prior to the survey, it is useful to structure the questions in such a way that the optimum recall period can be approximated after the survey. This allows analysts the flexibility of choosing an appropriate reference period.

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