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1. Introduction and Background

In July 1972, the Bureau of the Census began conducting a survey for the Law Enforcement Assistance Administration in eight central cities (National Crime Survey - Central Cities Sample). The survey was designed to gather data relating to personal crime. The sample consisted of approximately 12,000 housing units from each of the cities designated by the U.S. Department of Justice as "impact aid cities"--Atlanta, Baltimore, Cleveland, Dallas, Denver, Newark, Portland, and St. Louis. These units were surveyed again during the first half of 1975; it is the data relating to this period on which the Interviewer Variance Study (IVS) is based.

The principal objective of the National Crime Survey (NCS) is to obtain estimates of the extent of victimization attributable to the major crimes of assault (including rape), burglary, larceny, auto theft, and robbery.

2. Description of Study

It is generally accepted that the major part of response variance in small areas is the interviewer's contribution. In the NCS, one interviewer usually works in a specified assignment area of about 80 housing units. It has been a concern that there may be large differences between interviewers in their interviewing methods or in the application of their training instructions, which could possibly affect the data. The major intent of the IVS was to obtain estimates of the contribution of interviewers to the correlated response variance of NCS statistics, specifically the victimization rates for some of the major crimes on which the survey focuses.

In order to estimate the correlated component of response variance attributable to interviewers, the method of interpenetrated subsamples originally described by Mahalanobis [5] was used. In each of the eight impact cities, 144 interviewer assignment areas and 18 crew leader districts, each containing eight geographically contiguous interviewer assignment areas were delineated. Then, within each crew leader district, pairs of interviewer assignment areas were formed.

Interviewers were assigned to crew leader districts and interviewer assignment areas based on the geographical proximity of their homes to each of the areas. A random selection of 36 assignment pairs from each impact city was then made in Washington. Finally, within each pair of assignment areas, housing units were assigned in a systematic method, so that each interviewer was assigned approximately half of the units. For each city, this procedure permitted the comparison of the work of pairs of interviewers and the estimation of an average correlated response variance for an NCS interviewer assignment area.

3. The Mathematical Model

The mathematical model used in this study is that developed by Hansen, Hurwitz, and Bershad [4] and used in several other studies previously conducted by the Bureau. The estimator of the sampling variance, though it contains the simple response variance, does not reflect the correlated response variance. Since correlated response variance includes the effect of interviewer differences in the understanding and application of the training instructions in the conduct of the survey, this component could be an important source of variability.

An estimator of the total variance, T^2 , is as follows:

$$T^{2} = \frac{1}{2}(\bar{x}_{1} - \bar{x}_{2})^{2}$$
(1)

where \bar{x}_1 is the mean based on the work of interviewer 1 and \bar{x}_2 is the mean based on the work of interviewer 2. This includes not only the sampling variance, but the simple response variance, the correlated response variance, and the covariance between response and sampling deviations. We needed an estimator of the sampling variance and used the following:

$$S^{2} = \frac{\sum_{j=1}^{2} \sum_{j=1}^{n} (x_{hj} - \bar{x}_{h})^{2}}{2n(n-1)}$$
(2)

where x_{hj} is the value of the j-th unit assigned to the h-th interviewer and \bar{x}_h is the mean for the h-th interviewer.

 S^2 is the average variance for a mean based on a simple random sample of n units, and averaged over the two interviewers. The expected value of S^2 shows that it also includes the simple response variance.

Subtracting S^2 from T^2 , provides an estimator of the correlated response variance. Thus, for each pair of assignment areas, there was available an estimate of the total variance, the sampling variance, and the correlated response variance for each statistic. We then averaged these values over all pairs of assignment areas within the impact city.

Most of the statistics from the crime survey are not simple means, but are rates or ratios of means. For a ratio, $r = \bar{x}/\bar{y}$, the total relative variance was computed as follows:

$$T_{\mathbf{r}}^{2} = \frac{a_{\Sigma}^{a} T_{\bar{x}_{1}}^{2}}{(\sum_{i}^{a} x_{i})^{2}} + \frac{a_{\Sigma}^{a} T_{\bar{y}_{1}}^{2}}{(\sum_{i}^{a} y_{i})^{2}} - \frac{a_{\Sigma}^{a} T_{\bar{x}_{y}_{1}}}{(\sum_{i}^{a} x_{i} y_{i})^{2}} \quad (3)$$

where a is the number of assignment areas, and for the i-th area,

- T_{x}^{2} is the total variance for the mean for \tilde{x} i characteristic X;
- $T_{\bar{y}}^2$ is the total variance for the mean for \bar{y}_i characteristic Y;

 $^{T}\bar{\bar{x}}\bar{y}_{i}$ is the total covariance between the means $^{T}\bar{\bar{x}}\bar{y}_{i}$ of characteristics X and Y;

- \bar{x}_{1} is the mean for characteristic X; and
- \bar{y}_i is the mean for characteristic Y.

Similarly, the sampling relative variance was computed and the difference between them was used as an estimate of the correlated response relative variance. These are estimates that are shown in column (5) of Table 1.

Because these estimates of variability are based on a sample, they are themselves subject to sampling error. We estimated the variability of these estimates by considering each assignment area as an ultimate cluster. Suppose we wanted to estimate the variability of T_r^2 as shown in equation (3). We estimated T_r^2 for each assignment area and denoted these values by t_i . Then the estimate of variance was:

$$s^{2} = \frac{\frac{a}{\lambda}(t_{1} - T_{r}^{2})^{2}}{a(a-1)} \quad . \tag{4}$$

The square roots of the averages of these values over the eight impact cities are shown in the last column of Tables 2a-2d.

4. Summary of Results

Included among the major statistics computed for the IVS were estimates of the total variance, sampling variance, and correlated response variance for numerous NCS items. The corresponding estimates of relvariance were also computed. An illustration of the manner in which these estimates have been displayed is provided by table 1, which shows data from Baltimore. It should be noted that estimates contained in this table and in those which follow were derived from weighted data. The base (4,823 persons) which appears directly above the table is a weighted estimate of the average number of persons per interviewer assignment area in Baltimore. The corresponding unweighted base is 175 persons. Columns (3), (4), and (5) are respectively the total relvariance, sampling relvariance, and correlated response relvariance for the major personal victimization rates. For these rates, column (6) gives the ratios of correlated response variance to sampling variance. Such ratios represent the relative increase in variability due to the contributions of interviewers. A more detailed discussion of the IVS data from Baltimore will be presented in conjuction with data from the other impact cities.

In order to avoid a paper of unreasonable length, the only estimates which have been provided which pertain to all of the eight impact cities are ratios of correlated response variance to sampling variance for a specific set of personal and household victimization rates.

In table 2a estimated ratios of correlated response variance to sampling variance are given for the major personal victimization rates. Exclusive of those for Cleveland and Denver, the ratios for the overall or total personal victimization rate are equal to or exceed .50. The 1.40 ratio for Newark is exceptionally large. A ratio of this magnitude means that the estimated variance of this item is considerably understated. To get the total variance, one must multiply the sampling variance by one plus this ratio. For example, in Newark, the sampling variance of the total rate must be multiplied by 2.40 to reflect the total variance of this statistic.

The disparity within the cities between the ratios for the major subcategories is apparent. The ratios for assaultive violence are generally higher than those for personal theft without assault. Within the cities, differences can also be detected between the major groups of which the assaultive violence item is comprised. Interviewers appear to have a considerably greater influence on the variability of the victimization rates for "assaultive violence without theft" than for "assaultive violence with theft."

The generally large ratios for the overall victimization rate, as well as for assaultive violence and assaultive violence without theft, suggest that there may have been differences in the method in which NCS interviewers applied the concepts or definitions directly related to a determination of the incidence of assaultive violence without theft. Perhaps the variability among the interviewers may reflect the manner in which they view assaultive violence involving acquaintances or relatives and friends.

In table 2b ratios of correlated response variance to sampling variance are given by the race of the respondent for the major personal victimization rates. The ratios for the "other" category are generally very small and have large sampling errors. Although their sampling errors are also sizable, the other estimates provided in the table are more reliable.

The contention that large interviewer variability is primarily associated with respondents belonging to a specific racial group is not strongly supported by the entries of table 2b. In three of the cities the estimated ratios for the overall victimization rate are higher for whites than for blacks, while in the other five the ratios are higher for blacks. A similar pattern exists for the other four categories. In addition, ratios similar to those which are evident in table 2a are exhibited for blacks in Atlanta, Dallas, and Newark; however in Denver and St. Louis the ratios for the whites compare favorably with those for the combined rates in table 2a.

Since the overall ratio for whites is larger than that for blacks in Portland and Denver and with the exception of these two cities all of the impact cities have a black population which is at least 25 percent of the total population, it might be suspected that in the cities with the larger black populations, the ratios for blacks would be larger. However, in St. Louis, a city whose black population exceeds 40 percent, the overall ratio is larger for whites, while in Dallas, where about 25 percent of the population is black, the ratio is larger for blacks. The ratios presented in table 2c relate to the major household victimization rates. They indicate that the household victimization rates for a number of items, like the personal rates, are affected significantly by interviewers. The ratios for the total household rate are sizable for all of the cities, with four of them being in excess of .50 and one greater than 1.00. Similarly, the ratios for "larceny under \$50" were also fairly large. In contrast, the estimates for the burglary and auto theft items were usually quite small.

As was expected, these ratios vary among the cities. For Denver and Cleveland they tend to be lower than those for the other cities, as was the case with the ratios involving the personal victimization rates; the ratios for Newark and Atlanta are again among the highest reported for the eight cities.

Table 2d, which is the last of the tables relating to all eight cities, provides ratios by race of household head for the overall household victimization rates.

It is interesting to observe that in the five cities where the black population is about 40 percent or more of the total population, the ratios are larger for this group. In addition, in the cities where blacks are in the majority (Newark and Atlanta) the combined (both sexes) ratios are largest. Perhaps this finding may be related to differences in the races of the interviewers and the respondents and to the possibility of their having varying perceptions of household crimes. Again, the number of sample cases for the "other" category is much too small to provide adequate estimates.

In spite of the large household ratios for blacks, the ratios for whites in all of the cities except Newark and St. Louis were sizable. This result is consistent with that involving personal victimizations, and it strengthens the argument against the suggestion that large interviewer effects are peculiar to households headed by a person of a particular race.

Far more data from the IVS are available than are included in the tables which accompany this paper. In addition to assessing the effects of interviewers on estimates of certain personal and household victimization rates, the IVS provided estimates of the component of response variance attributed to interviewers for labor force, occupation, income, and education attainment items. For many of these items large estimates of correlated response variance were also observed. Additional reports which will provide more comprehensive information relevant to the study will be forthcoming.

5. Limitations of Data

Several cautions must be emphasized regarding inferences which might be drawn from the IVS data. Initially, it must be remembered that the IVS provided estimates of correlated response variance which are only applicable to the eight impact cities and to areas about the size of the average interviewer assignment area for the respective cities. Therefore, these estimates should not be used definitively to assess the quality of crime statistics in other cities or for the total United States.

Secondly, measurement errors attributable to interviewers reflect general survey conditions which affect their individual performances. Included among such conditions are the qualifications and training of the interviewers, their salaries, the frequency with which data are collected from sample units, the survey's recall period, and the organization selected to collect the data. Consequently, it is inappropriate to compare IVS statistics to statistics from similar studies for which these "controllable" general conditions differ substantially from those of the IVS.

Finally, another problem which limits the IVS data, but probably not to a great extent, is the fact that the actual conduct of the study deviated somewhat from the experimental design. Despite three levels of control, some interviewers completed units originally assigned to another interviewer. These violations undermined the objectives of randomizing the interviewer assignments, and forced the deletion of some of the sample units.

6. Conclusion and Recommendations

Two general inferences can be immediately drawn from the data which have been presented.

- The 1975 NCS statistics for the eight impact cities are subject to interviewer variability. The extent to which interviewers influenced these statistics varied considerably among the cities and according to the nature of the statistics.
- 2. Data users may develop misconceptions regarding the quality of NCS data. To the extent that response variances are sizable, the total variances of these estimates are understated. Caution should therefore be exercised regarding the interpretation of differences among the impact cities in the reported victimization rates. These differences may be obscured by sampling and nonsampling variances.

What can be done to adequately assess the effects of interviewers on NCS statistics and to eventually reduce such effects? Obviously, researchers should initially thoroughly review the data from the IVS and other related research to attempt to more accurately categorize the effects of interviewers on the data.

Secondly, the training and observation of NCS interviewers could possibly be revised so that greater emphasis is placed on the concepts related to items for which large interviewer variability is reported.

Thirdly, some form of additional research on the interviewers is recommended. Perhaps interviewers with certain characteristics or qualifications are more prone to commit errors. These interviewers may require supplemental training and more observation.

Finally, more studies similar to the IVS are suggested, so as to provide a number of

estimates for the same statistic under different conditions. Hopefully some or all of these procedures would contribute to the development of "optimum" sample designs for the NCS-related surveys.

References

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TABLE 1. $\frac{1}{--}$ ESTIMATED SAMPLING RELVARIANCES, CORRELATED RESPONSE RELVARIANCES, AND TOTAL RELVARIANCES FOR MAJOR PERSONAL VICTIMIZATION RATES FOR BALTIMORE (Base for rates - 4,823 Persons $\frac{2}{}$)

	Number 2/	Potos (Vistim-		Relvaria	Ratios of	
Kinds of victimizations	of victim- izations	izations per person)	Total	Sampling	Correlated response	response to sampling
	(1)	(2)	(3)	(4)	(5)	(6)
Total	525	.1088	.1586	.0989	.0598	.60
Assaultive violence total	292	.0605	.2625	.1612	.1013	.63
Assaultive violence with theft	55	.0115	.7512	.6452	.1060	.16
Assaultive violence with- out theft	236	.0490	.2943	.1915	.1028	. 54
Personal theft without assault	233	.0484	.2211	.1711	.0500	.29

1/ These estimates are applicable to an area approximately equal in size to an average NCS interviewer assignment area in Baltimore.

2/ These numbers are weighted counts.

Kinds of personal victimizations	Atlanta (1)	Baltimore (2)	Cleveland (3)	Dallas (4)	Denver (5)	Newark (6)	Portland	St. Louis (8)	Average estimated standard error (9)
Total	.69	.60	.18	.50	. 34	1.40	.59	.98	. 33
Assaultive violence	.70	.63	.31	.45	.09	.85	.68	1.17	.28
Assaultive violence with theft	.00	.16	. 33	.00	.00	.10	.24	.00	.15
Assaultive violence without theft	. 79	.54	.37	.50	.12	1.21	.70	1.17	.27
Personal theft with- out assault	.27	.29	.00	.22	.47	.79	.27	.07	.25

TABLE 2a.--RATIO OF CORRELATED RESPONSE VARIANCE TO SAMPLING VARIANCE FOR THE 1975 IMPACT CITIES (Personal Victimizations)

TABLE 2b.--RATIO OF CORRELATED RESPONSE VARIANCE TO SAMPLING VARIANCE FOR THE 1975 IMPACT CITIES (Personal Victimizations By Race)

Kinds of personal victimizations	Atlanta (1)	Baltimore (2)	Cleveland (3)	Dallas (4)	Denver (5)	Newark (6)	Portland (7)	St. Louis (8)	Average estimated standard error (9)
Total									
White Black Other	.39 .90 .00	.17 .42 .00	.00 .01 .00	.29 .71 .00	.40 .00 .02	.64 1.13 .64	.54 .00 .04	1.20 .19 .00	.25 .23 .17
Assaultive violence White Black Other	.33 .83 .08	.48 .08 .00	.09 .24 .00	.35 .41 .00	.08 .00 .07	.11 .63 .49	.61 .36 .08	1.37 .38 .00	.23 .18 .18
Assaultive violence with theft White Black Other	.00 .21 .08	.23 .00 .00	.00 .58 .00	.00 .01 .22	.00 .00 .00	.00 .14 .59	.10 .00 .02	.20 .00 .97	.12 .14 .18
Assaultive violence without theft White Black Other	.28 .97 .08	.34 .04 .05	.32 .00 .00	.47 .34 .00	.08 .09 .12	.56 1.05 .13	.66 .49 .08	1.14 .63 .00	.24 .18 .21
Personal theft with- out assault White Black Other	.63 .00 .00	.00 .44 .00	.00 .00 .00	.07 .00 .22	.43 .13 .00	.60 .79 .00	.32 .00 .00	.00 .10 .97	.21 .17 .17

Kinds of household victimizations	Atlanta (1)	Baltimore (2)	Cleveland (3)	Dallas (4)	Denver (5)	Newark (6)	Portland (7)	St. Louis (8)	Average estimated standard error (9)
Total ·	1.21	. 76	.40	. 37	.43	1.00	.56	.40	. 38
Burglary, forcible entry something taken	.01	.00	.09	. 44	.10	.00	.00	.28	.22
Burglary, unlawful entry without force	.00	.70	.04	.56	.02	.08	.35	.00	.21
Burglary, attempted forcible entry	.64	.07	.00	.21	.00	.00	.17	.17	.20
Larceny under \$50	1.00	.55	. 31	.64	.37	.60	.64	.41	. 34
Larceny \$50 or more	.57	. 32	.28	.29	.28	.10	.55	.56	.27
Larceny NA amount	.45	.00	.00	.48	.00	. 39	.03	.00	.15
Attempted larceny	.41	.48	.36	.00	.14	.42	.31	.38	.20
Auto theft, theft of car	.00	.13	.13	.00	.00	.00	.04	.40	.18
Auto theft, attempted theft of car	. 38	.18	.00	.07	.20	.00	. 42	.00	.12

TABLE 2c.--RATIO OF CORRELATED RESPONSE VARIANCE TO SAMPLING VARIANCE FOR THE 1975 IMPACT CITIES (Household Victimizations)

TABLE 2d.--RATIO OF CORRELATED RESPONSE VARIANCE TO SAMPLING VARIANCE FOR THE 1975 IMPACT CITIES (Household Victimizations by Race)

Race of household head	Atlanta (1)	Baltimore (2)	Cleveland (3)	Dallas (4)	Denver (5)	Newark (6)	Portland (7)	St. Louis (8)	Average estimated standard error (9)
White	.70	.96	.41	.68	.85	. 32	.97	.14	.33
Black	2.20	1.28	.85	.62	.00	1.65	.58	.75	. 39
Other	.00	.13	.03	.00	.35	.57	.37	.00	.13