The Michigan Ambulatory Medical Care Survey

As a supplement to the National Ambulatory Medical Care Survey, the Michigan survey has the advantages of cost savings, of separate and better-quality data for the State, and of providing additional information for the national survey. The authors describe and evaluate the sampling plan and the methods of analysis for the Michigan survey in the hope of helping persons in other States or geographic subdivisions who wish to undertake similar surveys.

RICHARD G. CORNELL, PhD, LARRY E. BROWN, MS, MPH, and THOMAS J. TOMBERLIN, MPH

THE MICHIGAN Ambulatory Medical Care Survey (MAMCS) was started in April 1973 to obtain information about the ambulatory health care provided by office-based physicians in the State. Physicians who practice anesthesiology, pathology, or radiology are excluded. The survey is a supplement to the National Ambulatory Medical Care Survey (NAMCS) of the National Center for Health Statistics (NCHS) and a component of the Cooperative Health Statistics System launched in 1974 by NCHS with State and local health agencies. The background and development of the NAMCS, including descriptions of a pilot study and data-collection methods, and a report on the classification of patients' symptoms have been published by NCHS (*1,2*).

The Michigan survey includes all the data on physicians' practices that would be in the national survey even if the State survey were not being done. Data on patients' visits for additional physicians are being collected primarily for MAMCS, but they are also made available to the national survey. These additional data allow a larger sample to be drawn than would be drawn for the NAMCS; therefore, separate and sufficiently precise data on services given to patients during office visits can be computed for Michigan.

An analysis of the data obtained from April 30, 1973, through April 29, 1974 (*3*), and the fieldwork through December 31, 1975, have been completed. Because the Michigan survey is a supplement to the national survey, the results can be compared directly with the national estimates. The forms and data-gathering procedures are the same for the two surveys.

Personnel of the National Center for Health Statistics compile a list of office-based physicians from the files that are classified and maintained by the American Medical Association (AMA) and the American Osteopathic Association (AOA). The list is then sent to the National Opinion Research Center (NORC) for fieldwork; the list does not differentiate the physicians in the Michigan supplement from the others. Because materials and procedures developed and tested in a pilot survey by NCHS and NORC without cost to the State are used, the cost of the Michigan survey is considerably less and the data are of higher quality than if the State had undertaken such a study independently.

Sampling Plan for the MAMCS

In the sampling plan for both the national and State surveys, a probability sample of primary sampling units

☐ *Dr. Cornell is professor and chairman, Department of Biostatistics, University of Michigan School of Public Health. Mr. Brown is a statistician with Abbott Laboratories, and Mr. Tomberlin is a lecturer with the Department of Social Statistics, University of Southampton, England; both are former graduate students of the University of Michigan.*

The Michigan Department of Public Health was supported in this research by grant No. HS00982–02 from the National Center for Health Services Research and Development and by contract No. HRA–106–74–35 from the National Center for Health Statistics. The authors were assisted by Rita Zemach and Theodore R. Ervin of the Michigan Department of Public Health, E. Earl Bryant and James E. Delozier of the National Center for Health Statistics, and Paul Sheatsley of the National Opinion Research Center.

Tearsheet requests to Dr. Richard G. Cornell, University of Michigan School of Public Health, Ann Arbor, Mich. 48104.

(PSUs), which are either standard metropolitan statistical areas (SMSAs) or counties, is selected. A systematic sample of physicians is then drawn from the sample PSUs. In both surveys, the PSUs are selected by a modified probability-proportional-to-size procedure; the 1970 population is used as a measure of size. The physicians are selected with probability inversely proportional to the probability of selection of the corresponding PSU; thus, each physician has the same overall probability of being selected.

The probability of selection was $f=0.03072$ for each physician in Michigan in the 1973 MAMCS and was larger than that for physicians in other States because of the augmentation of the NAMCS by the MAMCS. It was calculated by dividing the target sample size of 250 by the number of physicians in office-based practice, which was 8,137.

Similarly, the probability of selection for each PSU in Michigan was higher in the MAMCS than it would have been if only the NAMCS were carried out, with the exception of the Detroit SMSA that enters both samples with certainty, that is, the probability is 1. In general, let p_i denote the probability that the i^{th} PSU in Michigan would be in the national sample, that is, would be included in the NAMCS without the MAMCS augmentation. Then the probability that the i^{th} PSU will be in the MAMCS, whether as a result of the national or the subsequent State selection, is kp_i for some $k>1$, or the probability is 1. The proportionality constant k is specified to make efficient use of the national sample and to give a total State sample size of the magnitude desired. A way to determine and achieve the probabilities of selection for PSUs for the MAMCS, which includes the determination of k given the p_is used for the national selection, follows.

First it was noted from the AMA and AOA lists that slightly more than half of the physicians in office-based private practice in Michigan were in the Detroit SMSA and a majority of the others were in PSUs with large urban centers. Therefore, it seemed reasonable to form two strata of PSUs. The first, labeled stratum 1, contained the larger PSUs, each of which was given a probability of 1 of being included in the MAMCS. This is called the self-representation stratum. The sampling fraction for physicians within each of these self-representation PSUs is f. In the 1973 MAMCS, all PSUs with more than c/f physicians were included in stratum 1, with c set equal to 8. The rationale for the c/f figure is that these PSUs would have been represented with certainty if a systematic sample of physicians with sampling fraction f and cluster size c had been taken. This is the sampling method that would have been used if the survey had been designed just for Michigan without supplementation of the NAMCS. The division of the State into these two strata is not only appropriate for Michigan, but also for the many other States with large urban concentrations of population. For States for which a self-representation stratum is not appropriate, all the probabilities of selection would be calculated like those for stratum 2, the non-self-representation stratum, in Michigan. For the 1973 Michigan survey, stratum 1 contained the Detroit, Flint, Lansing, Grand Rapids, and Washtenaw SMSAs. Sample sizes of the PSUs in stratum 1 and the sample sizes that would have been used if only the NAMCS had been done are shown in table 1.

For stratum 2, there are two opportunities for selection for each PSU. The probability of being chosen during the national selection procedure is p_i and is known for each PSU. To achieve an overall probability of selection of kp_i, the probability q_i of selection during the State selection for any PSU not selected during the national selection must be

$$q_i=(k-1)\ p_i/(1-p_i) \qquad (1)$$

For the i^{th} PSU in stratum 2, the sampling fraction for physicians, if that PSU is selected for the sample, should be

$$f_i=f/kp_i \qquad (2)$$

in order to have the overall probability of selection for physicians equal to f, as in stratum 1. Moreover, the number of PSUs selected for the sample from stratum 2 during the State selection should be

$$t=R(k-1) \qquad (3)$$

where $R=\Sigma_i p/(1-p_i)$ and where the summation is over all PSUs in stratum 2. Use of these equations requires that kp_i be $\geq f$; for this to hold for Michigan, some small neighboring counties were combined in the formation of PSUs. The derivations and details of the implementation of these equations have been published previously (*4*). For the purposes of this paper it is sufficient to note that all these formulas require the specification of k for their use. We next illustrate the determination of k for the 1973 MAMCS.

The PSU selected for 1973 from stratum 2 during the national stage of selection were Gogebic, Marquette, and Newaygo Counties. The sample sizes for the NAMCS for these PSUs are given in the last column

Table 1. Number of physicians in self-representation primary sampling units (PSUs) for the 1973 Michigan Ambulatory Medical Care Survey (MAMCS)

PSU	Frame (N_i)	NAMCS [1]	MAMCS (n_i)
Detroit SMSA	4,205	24	129
Grand Rapids SMSA	520	0	16
Flint SMSA	468	11	[2] 11
Washtenaw SMSA	388	0	12
Lansing SMSA	329	0	10
Total	5,910	35	178

[1] National Ambulatory Medical Care Survey (NAMCS) before augmentation by MAMCS.

[2] The calculated value of 14 was changed to the NAMCS sample size of 11 because the difference was too slight to warrant changes in calculation procedures for the NAMCS.

Table 2. Sample size ($n_i f_i N_i$) for Gogebic, Marquette, and Newaygo Counties and PSUs for the MAMCS for $t = 2$, 3, and 4 and for the NAMCS

PSU	N_i	p_i	MAMCS $t=2$	MAMCS $t=3$	MAMCS $t=4$	NAMCS
Gogebic	12	0.010	16	13	10	12
Marquette ..	56	0.032	24	18	15	18
Newaygo ...	13	0.014	12	10	8	13
Total	81	....	52	41	33	43

of table 2. Sample sizes for $t=2$, 3, and 4 are given in the preceding three columns. These sizes were calculated from the sampling fractions given by equation (2) after substituting for $R(=1.556$ for the 1973 MAMCS) and t in equation (3) and solving for k.

It is clear that $t=3$ leads to calculated sample sizes for the MAMCS which nearly duplicate those that would be taken anyway for the NAMCS. Therefore, the samples for the NAMCS as described in the last column were used for the MAMCS, and three $(=t)$ additional PSUs, in addition to those listed in table 2, were drawn for the MAMCS without replacement with probabilities proportional to $p_i/(1-p_i)$ in accord with equation (1). Information on the samples from these PSUs is displayed in table 3.

The last columns of tables 1–3 taken together give the sample sizes for the 1973 MAMCS. The total sample size is 265, which is slightly larger than the target sample size of 250. The selection of clusters of physicians in PSUs, as prescribed in this sampling plan, means that the target sample size will seldom be matched exactly.

The details of only the 1973 MAMCS are presented here for illustrative purposes. Because of cost constraints, the abbreviated (April 30–December 31) 1974 survey augmented the NAMCS in only two (the Detroit and Flint SMSAs) of the four Michigan PSUs in the NAMCS. The NAMCS samples, without supplementation, were used in the other two PSUs (Marquette and Roscommon Counties). This survey will be particularly helpful in combination with the 1973 survey in obtaining a large enough Detroit sample to provide separate estimates for the Detroit SMSA. The 1975 MAMCS was planned following the procedure illustrated here for 1973. So far, physicians have been drawn without replacement over the entire period for which the MAMCS was planned; therefore, no physicians have been asked more than once to provide information for the MAMCS during the time from April 30, 1973, through December 31, 1975.

Table 3. Sample sizes (n_i) for PSUs selected during the State selection for PSUs in stratum 2 and corresponding values of p_i, N_i,kp_i, and f_i

PSU	P_i	N_i	kp_i	f_i	n_i
Kalamazoo ..	0.099	220	0.297	0.103	23
Monroe	0.058	54	0.174	0.177	10
Shiawassee ..	0.031	32	0.093	0.330	11
Total	..	306	..	..	44

Efficiency of Sample Design

During the 1973 MAMCS, 265 physicians were asked to participate if they were engaged in office-based patient care during the week chosen for their participation. The second column of table 1 and the last column of table 2 show that 78 of these physician contacts would have been made if only the NAMCS were being done. Thus, the State of Michigan had to pay only the marginal cost for the other 187 contacts; this resulted in a saving of 29 percent in addition to savings for the costs of items such as the design and pretesting of forms. The question then arose: Could similar savings have been obtained by the use of a different sample design that did not require clustering in PSUs already selected for the NAMCS? To answer this question, we conducted a sampling experiment on the AMA portion of the frame for the study.

The AMA membership list contains most of the physicians in the frame and is less expensive to deal with because the location of physicians is given by county, instead of by zip code as on the AOA list, and counties can be identified more easily with PSUs in this study. Two variables were analyzed for the population under study and for each sample of physicians drawn: (*a*) number of years since graduation from medical school (variable 1) and (*b*) sex (variable 2). Variable 1 was chosen because it is continuous and because it may be related to the way a physician practices medicine and hence to several of the variables for which data are obtained on the induction-interview form for physicians and on the form for patient visits. Variable 2 was chosen because it is a discrete one with a low probability for one of its two categories (female) and because it may also be associated with physicians' specialties and other characteristics of their practices. Both variables are conveniently included on the AMA membership list.

For the experiment, two sampling plans were compared. Plan 1 is the sampling plan described in this paper, including both the national and State selections of PSUs, followed by the selection of physicians within PSUs. Plan 2 is a systematic statewide sample of physicians starting from a single random selection. Plan 2 appears to be the main competitor to plan 1. We assumed that physicians in the overlap between plan 2 and the NAMCS would be included in the MAMCS under plan 2. A target sample size of 200 was used for plan 1. The actual sample sizes ranged from 171 to 260, with an average of 207.8 and a standard deviation of 18.3. For plan 1, 100 samples were

Table 4. Results of the computing experiment for the comparison of two sampling plans

Means and variances	Variable 1		Variable 2	
	Plan 1	Plan 2	Plan 1	Plan 2
Population mean (variable 1) or proportion (variable 2)	26.05	26.05	0.040	0.040
Mean of sampling distribution of means or proportions	26.13	26.05	0.042	0.040
Estimated variances	0.7590	0.6501	0.000203	0.000191
Variance of sampling distributions of means or proportions	0.6911	0.5779	0.000189	0.000201

drawn independently, and the sampling distribution of the means of the number of years since medical school and of the proportion of women was computed for these samples. The distributions of means for both variables were also computed for all 31 possible samples under plan 2. The means and variances of these sampling distributions were computed for the two statistics of primary interest for both plans and for estimated standard deviations. For plan 1, these estimates were computed with the equations published earlier (*4*). For plan 2, equations based on an assumption of random sampling were used. Table 4 summarizes the results of this study.

The true mean for the length of time in years since completion of medical school was 26.05, and the true proportion of women was 0.040. We computed these values by using all the physicians in scope on the AMA membership list. The corresponding average estimates for plan 1 were 26.13 and 0.042. These averages are well within 2 standard errors—as calculated from corresponding variances of the sampling distributions—of the corresponding true values, indicating that plan 1 is not appreciably biased. Plan 2 is known to be unbiased and this is borne out by the experimental results. The means of the estimated variances for both variables for plan 1 are larger than and approximately 2 standard errors from the corresponding sampling-distribution variances: 0.7590 versus 0.6911 for time since graduation and 0.000203 versus 0.000189 for the proportion of women. This finding indicates that the variance estimation formulas presented previously (*4*) for plan 1 work well and are conservative despite the use of some simplifying assumptions in their derivations. The mean estimated variance for variable 1 for plan 2 was slightly larger than the corresponding sampling distribution variance, as it was for plan 1. For variable 2 it was slightly smaller.

Of primary interest concerning this experiment is the comparison of the sampling-distribution variances for plan 1 and plan 2. For variable 1, the variance of means for plan 2 was less than that for plan 1 by 6 percent. This is comparable to a saving in sample size, which means that a sample size of 188 for plan 2 would be comparable to a target sample size of 200 for plan 1. Furthermore, at least 24 of the physicians selected by plan 2 in this experiment would have been obtained as part of the 1973 NAMCS. This overlap would occur because Detroit enters the NAMCS with certainty. Additional overlap between plan 2 and the NAMCS would have occurred in 1973 in the Flint SMSA, but would be minimal. Thus, at most, 164 of the equivalent sample size of 188 would have to be paid for by the State of Michigan under plan 2 with the sampling fraction used in the 1973 NAMCS. This represents a saving of at least 18 percent for plan 2 relative to the target sample size of 200 for plan 1. This saving is considerably less than the 29 percent saving obtained with plan 1 for the 1973 MAMCS. Therefore, our experiment leads to the conclusion that plan 1 is preferred for variable 1, at least for a sampling fraction of the order of magnitude used in the NAMCS for 1973 and a sample size of 200 or larger. It is also preferable even for NAMCS sample sizes twice as large, as in the 1974 and 1975 samples. For variable 2 a different pattern occurred. The variance of means for plan 1 was less than that for plan 2. Because plan 1 is considerably less expensive, it obviously would be the preferred sampling plan for variable 2 as well.

In summary, the conclusions reached from this small sampling experiment are that the sampling plan presented in this paper is suitable in terms of cost saving and statistical properties and that the estimation equations published earlier (*4*) for use with this plan are appropriate.

References

1. National Center for Health Statistics: National ambulatory medical care statistics: background and methodology. Vital and Health Statistics, Series 2, No. 61, Publication No. (HRA) 74–1335. U.S. Government Printing Office, Washington, D.C., March 1974.
2. National Center for Health Statistics: The national ambulatory medical care survey: symptom classification. Vital and Health Statistics, Series 2, No. 63, Publication No. (HRA) 74–1337. U.S. Government Printing Office, Washington, D.C., May 1974.
3. Cornell, R. G., Ozgoren, F. H., and Rutherford, J. A.: The 1973 Michigan Ambulatory Medical Care Survey: May 1973–April 1974. Michigan Department of Public Health, Lansing, March 1976.
4. Cornell, R. G., and Tomberlin, T. J.: The sampling plan for the Michigan Ambulatory Medical Care Survey. Michigan Department of Public Health, Lansing, November 1974.