Electronic Medical Record Systems Nonresponse Bias Analysis for 2011 NAMCS Mail Survey

Bill Cai[1], Iris Shimizu[1]

[1]National Center for Health Statistic, 3311 Toledo Road, Hyattsville, MD 20782

Abstract[1]

The National Ambulatory Medical Care Survey (NAMCS) is an annual survey of office-based physicians that gathers information about physicians and their practices through in-person interviews. A mail survey was conducted in 2011 on supplemental physician samples to allow for state-level estimates regarding physicians' use of electronic medical record/electronic health records (EMR/EHR). Each physician in the mail survey was sent questionnaires at two week intervals and phone calls were attempted with non-respondents after the third mailing for a total of four data collection waves. Because weighted and unweighted response rates for 2011 were only 61 and 64 percent, respectively, the potential for non-response bias will be investigated. Evaluation of the effect of nonresponse is difficult for a complex survey like NAMCS EMR. The method of response rate comparison across subgroup and the method of sample and frame data comparison were used to provide a basic description of response characteristics.

Key Words: NAMCS, Mail survey, EMR, EHR, Nonresponse bias

1. Introduction

The National Ambulatory Medical Care Survey (NAMCS) is an annual survey of office-based physicians that gathers information on patient, provider, and visit characteristics through in-person interviews. NAMCS is a principal source of information on the provision and use of ambulatory medical care services in the United States.

NAMCS was introduced in 1973 and was conducted annually from 1973 to 1981, in 1985, and annually since 1989 by the National Center for Health Statistics (NCHS).
Beginning in 2006, the survey also includes a sample of visits to Community Health Centers (CHCs).

In addition to the standard in-person NAMCS, a mail survey examining adoption of electronic medical records (EMRs)/electronic health records (EHRs) has been conducted since 2008. The questionnaire is mailed to a supplement sample of physicians eligible for selection to NAMCS. The sample size was increased starting in 2010 so that state-level estimates of EMR/EHR adoption could be created.

---

[1] The findings and conclusions in this report are those of the authors and do not necessarily represent the views of the National Center for Health Statistics or the Centers for Disease Control and Prevention.

Survey nonresponse occurs when a sampled unit does not respond to the request to be surveyed or to particular survey questions. Errors caused by nonresponse are only one of several sources of potential error in surveys, but it is one that has attracted much interest in recent years, as response rates to certain surveys appear to be low. [1]

Nonresponse is of particular concern for several reasons, including (1) biases in point estimators, (2) inflation of the variances of point estimators, and (3) biases in customary estimators of precision.

Section 2 introduces EMR/EHR Response/Nonresponse. Section 3 describes the methodologies used to evaluate non-response bias. Section 4 presents the results from the methods used. Section 5 summarizes the findings from 2011 NAMCS EMR/EHR data.

2. EMR/EHR Response/Nonresponse

In EMR/EHR, we define:
- "EMR/EHR eligible (or eligible)": a physician who sees ambulatory patients in an office-based setting.
- "Respondent to EMR/EHR questionnaire (or respondent)": a physician who is EMR/EHR eligible and answered at least six out of ten EMR/EHR top level questions asked in the EMR/EHR questionnaire.

The EMR/EHR survey is conducted in four waves: three waves by mail survey, and one (the last) wave by phone. Waves two to four targeted sample physicians who had not responded to any of the prior waves.

Following OMB guidelines for response rates [2], the unweighted response rate for EMR/EHR is defined as:

$$RRU = \frac{C}{C+R+NC+O+e(U)} = 64\%$$

with,
- C = Number of sampled eligible physicians deemed respondents
- R = Number of sampled physicians that are known or deemed to be eligible but refused.
- NC = Number of noncontacted sample physicians known to be eligible
- O = Number of eligible sample physicians not responding for reasons other than refusal
- e = estimated proportion of eligible sample physicians among those whose eligibility status is unknown.
- U = Number of physicians with unknown eligibility status

The weighted response rate is defined as:

$$RRW = \frac{\sum_i w_i C_i}{\sum_i w_i[C_i+R_i+NC_i+O_i+e(U_i)]} = \frac{\sum_i w_i C_i}{\sum_i w_i[C_i+R_i]+eW(UW)} = 61\%$$

with,
- w_i = The sampling weight for physician i.
- C_i = 1 if sample physician is deemed eligible and respondent; 0 otherwise.

- R_i = 1 if sample physician is known or deemed to be eligible but refused; 0 otherwise.
- NC_i = noncontacted sample physician known to be eligible = 0.
- O_i = eligible sample physician not responding for reasons other than refusal = 0.
- eW = weighted estimate for the proportion of eligible sample physicians among those whose eligibility status is unknown.
- UW = Weighted estimate for count of sample physicians with unknown eligibility status.

3. Methodologies

The method of response rate comparison across subgroup and the method of sample and frame data comparison were used to examine aspects of nonresponse and the potential effect on the estimates for NAMCS EMR/EHR survey.

3.1 Approach I: response rate comparison across subgroups
This method examines estimates of the response rates for key subgroups of the target population (e.g. groups defined by physician specialty, practice size, State, Metropolitan Statistical Area [MSA] status). It is easy to use, but is one of the least informative about possible nonresponse bias.

While the level of nonresponse does not necessarily translate into bias, large differences between the response rates of subgroups serve as an indicator that potential biases may exist.

It is limited because it does not deal with any nonresponse adjustments made to reduce the bias. Another limitation is that the response rates can be calculated only for those subgroups where the subgroup characteristics are known for both the respondents and nonrespondents from the sample.

Although both weighted and unweighted overall response rates for 2011 are cited in this paper, only unweighted response rates will be investigated across subgroup. This approach does not take any weighting adjustment into account. In the EMR/HER, the weighting adjustments specifically address variation based on physician's specialty and state, consequently, the effect of the adjustments should be to reduce nonresponse bias, especially for characteristics (e.g. physician's MSA status) correlated with physician's specialty and state.

3.2 Approach II: comparison of sample and frame data:
This method compares sample estimates from the "respondent" physicians to the population values computed from the sampling frame. The strength of this approach is that any differences are due solely to sampling and nonresponse error. The limitation is that only variables on the sampling frame can be used in such comparisons.

The sampling frame for the EMR/EHR survey is constructed the same way as that for the NAMCS. That is, the frame is compiled from databases of office-based physicians obtained from the American Medical Association (AMA) and the American Osteopathic Association (AOA). SUDAAN was used to produce the sample estimates and their 95%

confidence intervals; the population values from the sampling frame were produced by using SAS.

The results of sample estimates and sampling frame values are in Table 5. If population estimates lay in the corresponding 95% CI of sample estimates, we concluded there are no significant differences between the sample estimates and frame values at the 0.05 level.

4. Results

4.1 From approach I: response rate comparison across subgroups

The unweighted response rate for the 2011 NAMCS EMR/EHR mail survey was 64%. Tables 1-4 show the results of unweighted response rates across the subgroups defined by physician practice size, physician specialty group, physician's MSA status, and physician's State.

Chi-square tests with hypothesis of no significant differences at the 0.05 level were applied to response rates across each subgroup.

Physicians Practice Size	Response Rate	Physicians Practice Size	Response Rate
Solo	65%	Group	64%
Two	65%	Other	63%

Table 1: Response rates by physicians practice size:

The response rates by physicians practice size range from 63% to 65%. The Chi-square test result is p-value = 0.8845 > 0.05 and, hence, the hypothesis of no significant differences is not rejected. We conclude that there are no significant differences among response rates for different physicians practice sizes at the 0.05 level.

Physician Specialty	Response Rate	Physician Specialty	Response Rate
General/Family practice	65%	Dermatology	66%
Internal Medicine	61%	Urology	58%
Pediatrics	70%	Psychiatry	61%
General Surgery	64%	Neurology	62%
Obstetrics & Gynecology	65%	Ophthalmology	65%
Orthopedic Surgery	61%	Otolaryngology	60%
Cardiovascular Diseases	54%	Other specialties	64%

Table 2: Response rates by physician specialties:

The range of response rates by physician specialty is 54%-70%. The Chi-square test result is p-value = 0.0020 < 0.05 and, hence, we conclude that there are differences among response rates for different physician specialties at the 0.05 level. However, similar tests show that there are no differences among response rates for physician specialties other than pediatrics; while the response rate (70%) of pediatrics is higher significantly at the 0.05 level. Among those physicians groups without significant difference: cardiovascular diseases group has lowest response rate at 54%, which is 4

percent lower than the next lowest response rate at 58% for urology group; while remaining physicians groups have a tight response rate range from 60% to 66%.

MSA	Response Rate
Metropolitan	63%
Non-metropolitan	71%

Table 3: Response rates by MSA status

The Chi-square test result is p-value < 0.0001 and, hence, we conclude that there are differences between response rates by MSA status at the 0.05 level. The response rate for physicians with non-metropolitan status is significantly higher than the response rate for physicians with metropolitan status.

State	Response Rate	State	Response Rate
ALABAMA	64%	MONTANA	75%
ALASKA	76%	NEBRASKA	69%
ARIZONA	68%	NEVADA	62%
ARKANSAS	59%	NEW HAMPSHIRE	70%
CALIFORNIA	56%	NEW JERSEY	55%
COLORADO	66%	NEW MEXICO	77%
CONNECTICUT	65%	NEW YORK	59%
DELAWARE	67%	NORTH CAROLINA	66%
DISTRICT OF COLUMBIA	50%	NORTH DAKOTA	63%
FLORIDA	63%	OHIO	63%
GEORGIA	64%	OKLAHOMA	63%
HAWAII	68%	OREGON	68%
IDAHO	70%	PENNSYLVANIA	68%
ILLINOIS	51%	RHODE ISLAND	67%
INDIANA	57%	SOUTH CAROLINA	52%
IOWA	62%	SOUTH DAKOTA	62%
KANSAS	63%	TENNESSEE	61%
KENTUCKY	60%	TEXAS	64%
LOUISIANA	56%	UTAH	73%
MAINE	62%	VERMONT	78%
MARYLAND	59%	VIRGINIA	67%
MASSACHUSETTS	60%	WASHINGTON	65%
MICHIGAN	54%	WEST VIRGINIA	67%
MINNESOTA	64%	WISCONSIN	63%
MISSISSIPPI	60%	WYOMING	80%
MISSOURI	65%		

Table 4: Response rates by states

The range of response rates is 50%-80%. The Chi-square test result is p-value < 0.0001 and, hence, we conclude that there are differences among response rates for different physician's states at the 0.05 level. However, if the eight states with response rates of 70% or better are excluded from the sample, a similar test shows that there are no differences among response rates for the remaining states at the 0.05 level.

One may note that seven out of the nine states with response rates of 69% or better (Wyoming, New Mexico, Alaska, Montana, Utah, Idaho, and Nebraska) are among the ten least densely populated states while nine out of the eleven states with response rates of 59% or worse (District of Columbia, Illinois, South Carolina, Michigan, New Jersey, California, Indiana, New York, and Maryland) are among the twenty most populated states. This appears to agree with the difference in response rates observed between MSA and non-MSA areas.

4.2 From approach II: comparison of sample and frame data:
Table 5 shows the results of comparing the sampling frame population percent values and the corresponding sample estimates for each of 39 physician groups.

Of those 39 groups, 28 frame population percent values are covered by the 95% confidence interval for the corresponding sample estimates. The hypotheses of no significant differences at the 0.05 level for those 28 groups were not rejected; hence, we conclude that they are not significantly different at the 0.05 level. The remaining 11 frame population percent values are not covered by the 95% confidence intervals for the corresponding sample estimates; hypotheses of no significant differences at the 0.05 level for those 11 groups were rejected and, hence, we conclude they differ significantly at the 0.05 level.

- Both the percent values for *MSA status* variable are different significantly between frame values and corresponding sample estimates.
- Both the percent values for *physician's sex* variable are different significantly between frame values and corresponding sample estimates.

- Both the percent values for *practice type* variable are not different significantly between frame values and corresponding sample estimates.
- All the percent values for *speciality* variable except internal medicine are not different significantly between frame values and corresponding sample estimates.

- For *primary present employment* variable, four percent values are different significantly while nine are not different significantly between frame values and corresponding sample estimates.
- For *physician's age group* variable, two percent values are different significantly while three are not different significantly between frame values and corresponding sample estimates.

Variables	Values	Sample				Frame	Frame Estimates in Sample Estimates 95% CI
		Percent	Std. Error	Lower 95% limit	Upper 95% limit	Percent	
MSA Status	Metropolitan	88.63	0.54	87.52	89.65	90.83	No
	Non-metropolitan	11.37	0.54	10.35	12.48	9.17	No
Specialty	General/Family practice	14.97	0.80	13.46	16.61	14.27	Yes
	Osteopathic	5.17	0.44	4.36	6.11	5.82	Yes
	Internal Medicine	11.96	0.78	10.52	13.57	14.96	No
	Pediatrics	10.58	0.71	9.26	12.06	10.56	Yes
	General Surgery	3.53	0.43	2.79	4.47	3.52	Yes
	Obstetrics & Gynecology	7.21	0.64	6.06	8.57	6.68	Yes
	Orthopedic Surgery	4.66	0.53	3.73	5.81	3.76	Yes
	Cardiovascular Diseases	4.09	0.55	3.14	5.31	3.27	Yes
	Dermatology	2.18	0.34	1.61	2.95	1.76	Yes
	Urology	1.96	0.34	1.39	2.75	1.60	Yes
	Psychiatry	5.91	0.73	4.63	7.52	5.81	Yes
	Neurology	2.51	0.43	1.79	3.49	1.90	Yes
	Ophthalmology	3.79	0.46	2.98	4.81	3.05	Yes
	Otolaryngology	1.85	0.37	1.24	2.74	1.49	Yes
	Other specialties	19.64	1.00	17.76	21.67	21.55	Yes
Physician's Sex	Female	26.74	1.06	24.72	28.87	29.83	No
	Male	73.26	1.06	71.13	75.28	70.17	No
Practice Type	AMA-Direct patient care	94.83	0.44	93.89	95.64	94.18	Yes
	AOA-Direct patient care	5.17	0.44	4.36	6.11	5.82	Yes
Primary Present Employ-ment	11	22.32	1.09	20.25	24.54	18.94	No
	13	4.79	0.46	3.96	5.78	3.87	No
	20	1.89	0.29	1.40	2.54	2.03	Yes
	21	0.79	0.17	0.52	1.21	1.09	Yes
	22	2.80	0.33	2.21	3.53	3.08	Yes
	23	0.18	0.07	0.08	0.39	0.17	Yes
	30	55.98	1.22	53.57	58.36	51.54	No
	31	0.02	0.01	0.01	0.07	0.04	Yes
	35	0.49	0.26	0.17	1.37	0.34	Yes
	40	1.12	0.23	0.75	1.67	1.63	Yes
	64	1.05	0.36	0.53	2.07	0.81	Yes
	97	0.07	0.03	0.03	0.16	0.16	Yes
	110	8.50	0.74	7.15	10.08	16.31	No
Physician's Age Group	Under 35 years	2.64	0.38	1.99	3.51	3.54	No
	35-44 years	22.97	1.01	21.04	25.01	24.88	Yes
	45-54 years	28.26	1.06	26.23	30.39	29.86	Yes
	55-64 years	32.08	1.16	29.85	34.40	27.32	No
	65 years and over	14.05	0.92	12.33	15.95	14.40	Yes

Note: For Primary Present Employment, 11='AMA-Self-emp, solo prac'; 13='AMA-Two phy. prac' ; 20='AOA-Office prac. solo'; 21='AMA-Oth pat care/AOA-Off prac. partnp'; 22='AOA-Office prac group'; 23='AOA-Off prac ofc employee'; 30='AMA-Grp prac/AOA-Off prac HMO staff'; 31='AOA-Office prac. walk-in clinic'; 35='AMA-HMO'; 40='AMA-Medical school'; 64='AMA-County/Cty/State, not hosp.'; 97='AOA-other office or clinic practice'; 110='AMA-No classification'

Table 5: Estimated and frame percent distributions of physicians by physician characteristics.

5. Summary

There was concern about non-response bias in the 2011 EMR/EHR survey due to weighted and unweighted response rates of only 61 and 64 percent, respectively.
The effect of nonresponse on estimates for NAMCS EMR/EHR survey was evaluated using the method of response rate comparison across subgroups and the method of sample and frame data comparison with the following results:

- There are no significant differences in response rates at the 0.05 level among subgroups defined by physician practice size, and physician specialty group (excluding pediatrics). There are significant differences in response rates at 0.05 level among subgroups defined by the physician's MSA status and the physician's State.
- Of 39 physician groups investigated, the sample estimates and the corresponding sampling frame values for population percent values for 28 of those groups are not significantly different at the 0.05 level. For the remaining 11 of the 39 physician groups, those differences are significant at the 0.05 level.
- Both the percent values for *MSA status* variable are different significantly between frame values and corresponding sample estimates, while the response rates are differ significantly by MSA status. Both pointing to potential bias for characteristics correlated with physician's MSA status.
- All the percent values for *speciality* variable except internal medicine are not different significantly between frame values and corresponding sample estimates, while there are no differences among response rates for physician specialties other than pediatrics. Both pointing to little if any bias for characteristics correlated with physician's speciality.

References

[1] Groves R, Dillman R, Eltinge J, Little R. 2002. Survey Nonresponse. Wiley Series in Survey Methodology. John Wiley & Sons, Inc.
[2] Office of Management and Budget. 2006. Standards and Guidelines for Statistical Survey.
[3] Hsiao C, Hing E, Socey T, Cai B. Electronic Health Record Systems and Intent to Apply for Meaningful Use Incentives Among Office-based Physician Practices: United States, 2001–2011.