COUNTING RULE BIAS IN HOUSEHOLD SURVEYS OF DEATHS

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INTRODUCTION

A test of the completeness of the death registration system in the United States has not been conducted because a suitable household sample survey has not been designed. Basically, a registration completeness test involves conducting a single time retrospective household sample survey to enumerate deaths and then matching the enumerated deaths with the file of registered death certificates. For some time, we have been working on a network household sample survey design for enumerating rare events which we feel has promise as an effective survey method for testing the death registration completeness [1]. The main innovation of the method relates to the counting rule. This rule defines the households that are eligible to report deaths in the household survey [2]. In the typical household sample survey, the de jure residence rule is used. According to this rule a decedent is eligible to be reported at only one address, namely the address of his former residence. Hereafter, we refer to this address as the key address. On the other hand, a network household sample survey design uses a counting rule that links deaths to networks of households of varying sizes which may or may not contain the households of the key addresses.

We have been investigating rules that link decedents to the households of their surviving relatives. The types of relatives covered by the counting rule must be specified carefully, however, to assure that the decedent is survived by at least one of them. Otherwise the decedent would have no chance of being enumerated in the survey. Counting rule bias is the proportion of decedents that is not linked to any households by the counting rule. In this paper, we present estimates of counting rule bias associated with several kinds of counting rules including (a) the de jure residence rule and (b) consanguine counting rules that link deaths to the households of specified surviving relatives, (c) rules that combine the features of (a) and (b). Also we present estimates of counting rule bias associated with geographic counting rules that circumscribe the area of the households linked to the death by (a), (b) and (c). For instance, one of the geographic rules limits eligibility to linked addresses within the county of the key address. Another limits eligibility to addresses in North Carolina.

DESIGN OF THE PILOT STUDY

Recently, we conducted a pilot study to investigate the error effects of the conventional counting rule and of consanguine and geographic counting rules on estimates of death registration completeness. In Stage 1 of this study we compiled a list of addresses of surviving relatives and key addresses for a sample of registered deaths. In Stage 2 we conducted interviews to see if the households at these addresses would report the deaths in the surveys. In Stage 3 we matched the deaths enumerated in the survey against the State file of registered death certificates.

The estimates of counting rule bias presented in this paper are based on the information collected in the first stage of the pilot study. Therefore, the design of the first stage is described in greater detail below.

A sample of about 1700 death records stratified by age and color was selected from death records on file in the State of North Carolina. Since the names and addresses of the death record informants are reported on the records, these people, who are generally close relatives of the decedents, were contacted by mail as soon as possible after the death was registered. They reported the names and addresses of specified surviving relatives, and the names of the occupants of the key households.

We limited the consanguine network to the relevant and closest relatives of the decedent. This varied depending on the age of the decedent. For decedents under 17 years of age, we obtained names and addresses of the decedent's mother (MO) and her parents (MP), and her siblings (MS). (For these decedents, the key address was defined as the address of the surviving mother.) For decedents aged 17-64, we obtained the names and addresses of the decedent's spouse (SP), siblings (SI), parents (PA) and children (CH), as well as the address of the key household (KH). For decedents 65 and over, we asked for the same names and addresses with the exception of parents.

FINDINGS

The estimates of counting rule bias are presented for four age groups in Tables 1-4. The stub of each of these tables lists the de jure residence rule and the various consanguine counting rules that were tested for the age group and the spread shows the three types of geographic counting rules. For each combination of consanguine and geographic counting rule separate estimates of counting rule bias are presented for (a) all deaths, (b) institutional deaths (decedents who were residents of long term institutions), and (c) noninstitutional deaths (decedents who were not residents of long term institutions). In the following discussion we illustrate our remarks with the findings for the age group 65-84 shown in Table 3.

The bias of the de jure residence rule is 21.8 percent. Actually, this represents the percentage of decedents who were residents of long term institutions and hence did not have a key household (KH). The bias of this rule is virtually zero for deaths that occurred outside of institutions since virtually all of them

formerly resided at a key address.

The bias of a counting rule decreases as the consanguine and geographic network expands. For instance, the bias of the rule that links decedents to surviving spouses (SP) residing in the key county is 56.6 percent. It decreases but slightly to 54 percent, when the geographic network is expanded to include spouses living anywhere in the United States. However, the bias decreases substantially when the consanguine network is expanded to include other types of relatives. If, in addition to the spouse (SP), decedents are linked to siblings (SI), or to siblings (SI) and children (CH), the biases decrease to 14.7 percent and 3.7 percent respectively. These figures imply that 54 percent of the decedents did not have a surviving spouse, 14.7 percent had neither a surviving spouse nor sibling, and 3.7 percent were not survived by a spouse, sibling or child. Viewed in this manner, the findings may be of substantive use to various social programs.

It is noteworthy that the counting rule bias was lowered only slightly, from 3.7 percent to 1.2 percent, by expanding the network to include key households (KH) in addition to the households of surviving spouses (SP), siblings (SI) and children (CH). This is one of the most important findings of the survey experiment. It reveals that use of the de jure residence rule is not mandatory to control counting rule bias. Certainly, it would be desirable to forego the conventional rule since the rule is difficult to implement and it is subject to large coverage bias [3]. For instance, more than 15 percent of the adult deaths in the pilot study represented people who were living alone when they died. In addition, 10 percent of the decedents formerly resided at a key address that was not occupied by any former members of his household within three months of his death. In total, a minimum of 25 percent of the key addresses were not occupied by a member of the decedent's former household by the date that the household survey was conducted, and consequently few of the households at these addresses reported any deaths in the survey.

In general, the biases of counting rules that link decedents to the households of their surviving close relatives increase with advancing age of the decedent. The survey using the counting rule that links decedents to their spouses (SP), siblings (SI) and children (CH) would fail to enumerate 10.7 percent of decedents over 85 years. By comparison, the rule that links decedents to the broadest network of close relatives is small for decedents of all age groups under 85 years. When decedents 65-84 years are linked to spouses (SP), siblings (SI) and children (CH), the bias is 3.7 percent. Moreover, the biases of consanguine counting rules are negligible for decedents in age groups under 65 years. The bias of the rule linking decedents under 17 years to households of their mothers (MO) is 1.1 percent and the bias is eliminated entirely if the decedents in this age group are also linked to the households of their mother's siblings (MS)

and parents (MP). The bias is 4.2 percent if decedents 17-64 years are linked to spouses (SP) and siblings (SI) and it is only 1.7 percent if these decedents are also linked to parents (PA) and children (CH).

SUMMARY AND CONCLUSIONS

Counting rule bias in single retrospective household surveys that enumerate deaths varies by type of counting rule and by characteristics of decedent. The de jure residence rule fails to link institutional deaths to households where they would be enumerable in the survey. The seriousness of this problem increases with advancing age of the decedent. Thus, the counting rule bias of the de jure residence rule is 41.7 percent for decedents 85 years and older, 21.8 percent for decedents 65-84, 6.3 percent for decedents 17-64 and it is negligible for decedents under 17. Virtually all decedents under 65, whether or not they resided in an institution, are survived by close relatives of one type or another. Consequently, the bias of broad consanguine counting rules is negligible for these decedents. However, the bias of a broad consanguine rule is 3.7 percent and 10.7 percent respectively for age group 65-84 and 85 and over. If the de jure residence rule as well as a broad consanguine rule is adopted for these age groups the biases are reduced to 1.2 percent and 6.5 percent respectively.

It would be premature to evaluate counting rules entirely on the basis of counting rule bias [4]. Counting rules vary also in their effects on response bias and sampling errors. Error effects of these types were outside the scope of this paper. However, they will be the subject of a forthcoming paper.

REFERENCES

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[2] _____, "The Counting Rule Strategy in Sample Surveys," Proceedings of the Social Statistics Section, American Statistical Association, (1974), pp. 119-123.

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Table 1. Counting Rule Bias (in percent) by Counting Rule and Place of Residence at Death: Decedents Under 17 Years

Consanguine Counting Rule*	United States			North Carolina			Key County		
	All Deaths	Residence at Death		All Deaths	Residence at Death		All Deaths	Residence at Death	
		Institution	Other		Institution	Other		Institution	Other
MO	1.1	--	--	5.1	--	--	5.1	--	--
MS	6.9	--	--	27.2	--	--	40.8	--	--
MP	5.5	--	--	25.4	--	--	40.6	--	--
MO+MS	0.0	--	--	2.5	--	--	5.1	--	--
MO+MP	0.4	--	--	3.0	--	--	5.1	--	--
MS+MP	0.9	--	--	19.2	--	--	32.3	--	--
MO+MS+MP	0.0	--	--	2.1	--	--	5.1	--	--

-- Not applicable
* See glossary in appendix for explanation of abbreviations.

Table 2. Counting Rule Bias (in percent) by Counting Rule and Place of Residence at Death: Decedents 65-84 years

Consanguine Counting Rule*	United States			North Carolina			Key County		
	All Deaths	Residence at Death		All Deaths	Residence at Death		All Deaths	Residence at Death	
		Institution	Other		Institution	Other		Institution	Other
SP	40.0	74.2	37.7	43.6	77.5	41.3	46.1	88.4	43.2
SI	11.8	14.5	11.6	28.6	23.3	28.9	44.1	52.7	43.5
PA	56.3	84.1	54.4	64.9	84.1	63.6	73.5	100.0	71.7
CH	28.5	54.4	26.7	36.6	62.8	34.9	43.3	73.7	41.2
SP+SI	4.2	14.5	3.5	8.5	17.8	7.8	17.0	52.7	14.6
SP+PA	23.6	63.7	20.9	28.1	67.0	25.5	32.7	88.4	29.0
SP+CH	20.1	48.3	18.2	25.1	56.7	23.0	29.2	67.6	26.6
SI+PA	7.0	10.9	6.7	22.8	19.6	23.0	38.1	52.7	37.1
SI+CH	4.3	14.5	3.6	10.0	14.5	9.7	19.6	43.5	18.0
PA+CH	15.9	46.9	13.8	24.0	55.3	21.9	32.5	73.7	29.7
SP+SI+PA	2.6	10.9	2.1	6.2	14.2	5.6	15.1	52.7	12.5
SP+SI+CH	2.6	14.5	1.8	5.1	14.5	4.5	11.2	43.5	9.0
SP+PA+CH	10.6	40.7	8.5	14.7	49.1	12.4	20.3	67.6	17.1
SI+PA+CH	3.0	10.9	2.5	8.3	10.9	8.1	17.6	43.5	15.8
SP+SI+PA+CH	1.7	10.9	1.1	3.6	10.9	3.1	10.1	43.5	7.8
KH	6.3	100.0	0.0	6.5	100.0	0.0	6.5	100.0	0.0
SP+KH	4.7	74.2	0.0	4.9	77.5	0.0	5.8	88.4	0.0
SI+KH	0.9	14.5	0.0	1.7	23.3	0.0	3.5	52.7	0.0
PA+KH	5.3	84.1	0.0	5.5	84.1	0.0	6.5	100.0	0.0
CH+KH	3.4	54.4	0.0	4.2	62.8	0.0	4.9	73.7	0.0
SP+SI+KH	0.9	14.5	0.0	1.1	17.8	0.0	3.5	52.7	0.0
SP+PA+KH	4.0	63.7	0.0	4.2	67.0	0.0	5.8	88.4	0.0
SP+CH+KH	3.1	48.3	0.0	3.6	56.7	0.0	4.5	67.6	0.0
SI+PA+KH	0.7	10.9	0.0	1.4	19.6	0.0	3.5	52.7	0.0
SI+CH+KH	0.9	14.5	0.0	1.1	14.5	0.0	2.9	43.5	0.0
PA+CH+KH	3.0	46.9	0.0	3.7	55.3	0.0	4.9	73.7	0.0
SP+SI+PA+KH	0.7	10.9	0.0	0.9	14.2	0.0	3.5	52.7	0.0
SP+SI+CH+KH	0.9	14.5	0.0	0.9	14.5	0.0	2.9	43.5	0.0
SP+PA+CH+KH	2.6	40.7	0.0	3.1	49.1	0.0	4.5	67.6	0.0
SI+PA+CH+KH	0.7	10.9	0.0	0.9	10.9	0.0	2.9	43.5	0.0
SP+SI+PA+CH+KH	0.7	10.9	0.0	0.7	10.9	0.0	2.9	43.5	0.0

*See glossary in appendix for explanation of abbreviations.

Table 3. Counting Rule Bias (in percent) by Counting Rule and Place of Residence at Death: Decedents 65-84 years

| Consanguing Counting Rule* | United States | | | North Carolina | | | Key County | | |
| | All Deaths | Residence at Death | | All Deaths | Residence at Death | | All Deaths | Residence at Death | |
		Insti-tution	Other		Insti-tution	Other		Insti-tution	Other
SP	54.0	85.1	45.3	55.4	85.7	47.0	56.6	88.8	47.7
SI	22.3	26.9	21.1	38.9	45.5	37.1	59.3	72.8	55.5
CH	24.2	31.4	22.2	30.6	36.6	28.9	37.3	54.7	32.4
SP+SI	14.7	21.7	12.7	22.9	34.9	19.6	35.9	63.9	28.1
SP+CH	16.0	29.9	12.2	19.3	35.1	14.9	25.0	54.2	16.9
SI+CH	5.7	5.3	5.8	12.3	11.1	12.6	23.2	36.2	19.6
SP+SI+CH	3.7	5.3	3.2	7.9	11.1	7.0	16.1	35.7	10.7
KH	21.8	100.0	0.0	22.1	100.0	0.0	22.1	100.0	0.0
SP+KH	18.5	85.1	0.0	19.0	85.7	0.0	19.7	88.8	0.0
SI+KH	5.8	26.9	0.0	10.3	45.5	0.0	16.2	72.8	0.0
CH+KH	6.8	31.4	0.0	8.0	36.6	0.0	12.3	54.7	0.0
SP+SI+KH	4.7	21.7	0.0	8.0	34.9	0.0	14.3	63.9	0.0
SP+CH+KH	6.5	29.9	0.0	7.6	35.1	0.0	12.1	54.2	0.0
SI+CH+KH	1.2	5.3	0.0	2.4	11.1	0.0	8.2	36.2	0.0
SP+SI+CH+KH	1.2	5.3	0.0	2.4	11.1	0.0	8.1	35.7	0.0

*See glossary in appendix for explanation of abbreviations.

Table 4. Counting Rule Bias (in percent) by Counting Rule and Place of Residence at Death: Decedents 85 years and over

| Consanguine Counting Rule* | United States | | | North Carolina | | | Key County | | |
| | All Deaths | Residence at Death | | All Deaths | Residence at Death | | All Deaths | Residence at Death | |
		Insti-tution	Other		Insti-tution	Other		Insti-tution	Other
SP	84.0	95.4	75.9	84.1	95.4	76.1	84.1	95.4	76.1
SI	56.5	58.5	55.0	64.8	63.9	65.4	79.9	82.9	77.8
CH	23.6	31.3	18.2	25.2	32.0	20.4	35.9	52.2	24.4
SP+SI	48.2	57.6	41.4	54.8	62.9	49.0	67.1	80.6	57.5
SP+CH	20.8	29.1	14.9	21.4	29.9	15.4	31.2	50.0	17.7
SI+CH	12.9	16.6	10.2	15.4	19.2	12.6	28.8	43.8	18.0
SP+SI+CH	10.7	15.7	7.2	12.7	18.3	8.6	24.6	42.9	11.6
KH	41.7	100.0	0.0	42.1	100.0	0.0	42.1	100.0	0.0
SP+KH	39.8	95.4	0.0	40.2	95.4	0.0	40.2	95.4	0.0
SI+KH	24.4	58.5	0.0	27.1	63.9	0.0	35.0	82.9	0.0
CH+KH	13.0	31.3	0.0	13.3	32.0	0.0	22.2	52.2	0.0
SP+SI+KH	24.0	57.6	0.0	26.7	62.9	0.0	34.1	80.6	0.0
SP+CH+KH	12.1	29.1	0.0	12.4	29.9	0.0	21.3	50.0	0.0
SI+CH+KH	6.9	16.6	0.0	8.0	19.2	0.0	18.7	43.8	0.0
SP+SI+CH+KH	6.5	15.7	0.0	7.6	18.3	0.0	18.3	42.9	0.0

*See glossary in appendix for explanation of abbreviations.

APPENDIX: Glossary of Terms

Network survey: The events being enumerated are linked to networks of households.

Counting rule: Defines the network of households which are eligible to report events in a survey.

Counting rule bias: The fraction of events that are not linked to any households by the counting rule.

Key address:

Decedents over 16 years: Address of the noninstitutional decedent at the time of death.

Decedents under 17 years: Address of the decedent's mother at the time of the survey.

Counting rule abbreviations:

MO....Mother
MS....Maternal siblings
MP....Maternal grandparents
SP....Spouse
SI....Siblings
PA....Parents
CH....Children
KH....Key household
(Household occupying the key address)

Consanguine counting rule: A rule that links decedents to the households of surviving relatives.

Geographic counting rule: A rule that circumscribes the area within which the eligible households must be located.