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Estimating the Rate of Rural Homelessness: A Study of Nonurban Ohio

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ABSTRACT

Recently, much effort has been directed towards counting and characterizing the homeless. Most of this work, however, has focused on homeless persons in urban areas. In this paper, we describe efforts to estimate the rate of homelessness in nonurban counties in Ohio. The methods for locating homeless persons and even the definition of homelessness are different in rural areas where there are fewer institutions for sheltering and feeding the homeless. There may also be a problem with using standard survey sampling estimators, which typically require large population sizes, large sample sizes, and small sampling fractions. We describe a survey of homeless persons in nonurban Ohio and present a simulation study to assess the usefulness of standard estimators for a population proportion from a stratified cluster sample.

KEY WORDS: Biased estimator; Regression estimator; Small sample size; Stratified cluster sample; Simulation.

1. INTRODUCTION

When we think of the homeless, we often think of "street people" and "bag ladies". We picture people sleeping on park benches, on heating grates, and in homeless shelters. These stereotypes of the homeless originated in large cities, however, and do not necessarily provide an accurate picture of homeless persons in rural areas.

Many of the studies of homeless persons have been carried out in larger cities. For example, the 1987 Urban Institute Study counted homeless persons in 20 major cities in the U.S. Another major study by Rossi was carried out in Chicago. (See Burt and Taeuber (1991) for an overview of survey methods for these and other studies that counted homeless populations.)

During the 1990 United States Population Census, a special attempt was made to include homeless persons in the population count through the S-Night (Shelter and Street Night) count. For this effort, a special national list of shelters and locations in which homeless persons sleep was compiled. The highest elected official of over 39,000 rural and urban local governments was asked to provide a list of shelters, street locations, and open public locations where the homeless stay at night. The homeless were counted by Census enumerators during a single night, March 20. Note that the main goal of S-Night was to include homeless persons in the Census count; relatively little information on characteristics of the homeless is available in the Census data. Details on the S-Night procedures are provided by Taeuber and Siegel (1990).

In contrast to surveys of homeless persons in urban areas and to the Census S-Night, the goal of the survey described here was to locate and count the nonurban homeless wherever they might be, and to collect information to describe these homeless persons. In Section 2 of this paper, we describe the design of the 1990 survey of rural homeless persons in Ohio. We present our definition of rural homelessness and we describe the methods used to locate and survey the homeless. In Section 3 we present our estimates of the rates of rural homelessness obtained using the standard estimator of a proportion from a stratified cluster sample. Since these estimates are likely to be biased, we also present the results of a simulation study conducted to assess the likely size of the bias. In Section 4 we consider a regression estimator for the rate of homelessness and compare the regression estimator to the standard estimator of Section 3. In Section 5 we present our conclusions.

2. THE SURVEY

There are 88 counties in Ohio. Of these, 13 are urban counties with large cities and 75 are defined as rural or nonurban. These 75 counties of interest include counties that are completely rural, counties that are not adjacent to urban counties and that have moderately populated county seats, and suburban counties that border counties with large metropolitan areas.

The design used in this 1990 survey was selected to facilitate comparisons with a 1984 study of Ohio rural homeless persons (Roth *et al.* 1985). In the earlier study, Ohio's counties were divided into five regions, northeast, northwest, central, southeast, and southwest, and a stratified random sample of 16 rural counties was selected. The 21 counties selected for the 1990 study included the

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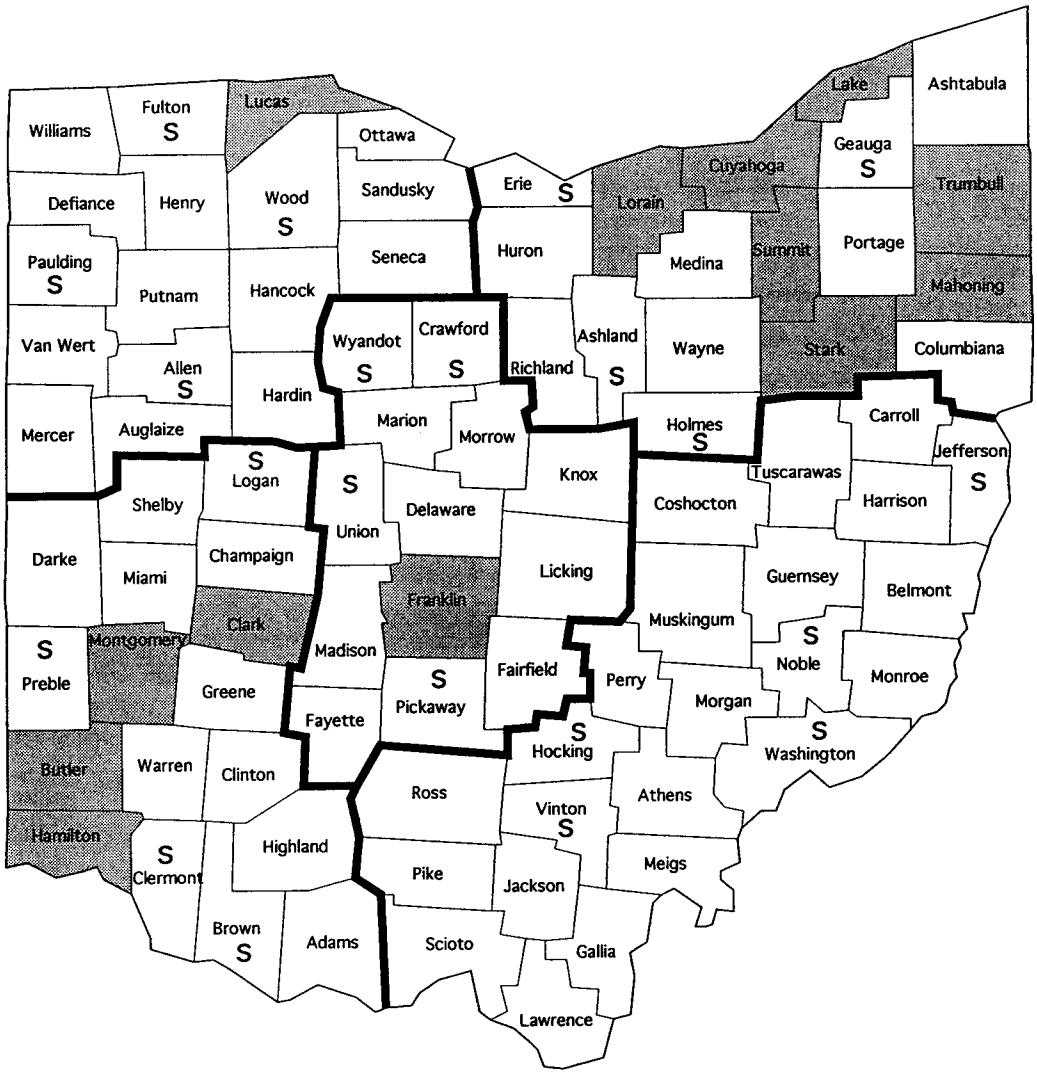

Note: Shaded counties are urban counties that were excluded from the study. An "S" indicates a county in the sample. The heavy boundaries divide the state into the five geographical strata: northeast, northwest, central, southeast, and southwest.

Figure 1. County Map of Ohio

16 counties from the original study and one additional county selected at random from within each region. (We should note that analysis of data from the present study suggests that stratification of Ohio into the five regions is not useful for improving the estimate of rural homelessness.) A map of Ohio showing the five regions, the urban counties, and the sampled counties is provided in Figure 1.

The following is a brief description of the 1990 survey methodology. More detailed descriptions are given by First *et al.* (1994) and Toomey *et al.* (1993).

2.1 Survey Personnel

A census of all homeless persons within the 21 sampled counties was attempted. Because there are not typically homeless shelters or other gathering places for the homeless in nonurban areas, the survey was conducted over a six-month period and made use of a network of advisors to locate the homeless. The survey period began with the first full week of February 1990. Homeless persons were identified and located by a referral network within each sampled county. Each network was supervised by a local county coordinator. The principal investigators supervised

the county coordinators and the central office staff. They monitored the data collection, through bi-weekly phone calls and field visits, to assure uniformity and to control quality.

Advisors and interviewers, selected for their knowledge of the counties in which they worked, identified people who met the criteria for homelessness. Advisors included church leaders, hospital staff, civic club leaders, elected community officials, informal community leaders, bartenders, hotel clerks, laundromat attendants, and professional service providers such as health department staff, librarians, agricultural extension agents, postal workers, ministers, park rangers, neighborhood action groups, human service case workers, mental health workers, and law enforcement officers. One hundred interviewers conducted the interviews with the homeless. Interviewers attended a four-hour training session and were provided with a training manual of field guidelines. Interviews took place in offices, diners, motel rooms, cars, state parks, barns, laundromats, bars, and under railroad trestles. Interviewers were trained to know about available community resources and to make referrals for respondents who wanted services. In addition, interviewers had access to funds to offer a meal or minor assistance if necessary (less than $600 was spent on such purchases). Assistance provided through interviewers was limited so that people would not have an incentive to falsely identify themselves as homeless.

2.2 Definition of Rural Homeless

Screening questions were used to identify homeless persons. The definition of homelessness used in this study was necessarily somewhat different from the definition used for studies in urban areas. In rural areas there are fewer public shelters and housing alternatives specifically for the homeless. Respondents were counted as homeless if they did not have a permanent residence they considered home and if, on the previous night, they had slept in (1) limited or no shelter, (2) shelters or missions that serve homeless persons, (3) cheap hotels or motels when the actual stay or intent to stay was 45 days or less, or (4) other unique situations when the actual stay or intent to stay was 45 days or less. Included in the fourth category were people who stayed in sheds, barns, old buses, and old trailers without water or power, provided the person did not own the property and was not paying rent to stay there. Also included as homeless were people who were temporarily staying with friends or relatives, had not been staying in that household more than 45 days, were not a part of the household, and were planning on moving out in 45 days or less. Persons who were staying in battered women's shelters, hospitals, prisons, migrant workers camps, *etc.* were not counted as homeless unless they were leaving the facility and had nowhere to go.

Our definition of homelessness may be contrasted with that used in studies of homeless persons in urban areas. The common criteria of the definition of homelessness for such studies is based on the Stewart B. McKinney Homeless Assistance Act (1987). The Act defines a homeless person as "an individual who lacks a fixed, regular, and adequate nighttime residence and an individual who has a primary nighttime residence that is (a) a supervised publicly or privately operated shelter designed to provide temporary living accommodations (including welfare hotels, congregate shelters, and transitional housing for the mentally ill); (b) an institution that provides a temporary residence for individuals intended to be institutionalized; or (c) a public or private place not designed for, or ordinarily used as, a regular sleeping accommodation for human beings." From this definition comes the notion of "literally homeless" as suggested by Rossi *et al.* (1987). These standard definitions do not include, for example, those homeless persons who double up with family or friends. We did include such persons in our count of the rural homeless. Our analysis indicates that about a third of the persons counted in our census would not be counted under the urban definition of homelessness. It is not known how much counting those doubling up would increase estimates in urban areas.

2.3 The Interview Period

The use of a six-month survey period for counting the rural homeless is different from the typical one-day survey period used most often in surveys conducted in urban areas. In a review of seven studies of the homeless, Burt and Taeuber (1991) report that these studies used single nights, or one or two weeks as the interview period at a single location. Most of these studies relied on locating the homeless in shelters, soup kitchens, abandoned buildings, or similar locations. Since the homeless in rural areas are less likely to have shelters or soup kitchens available to them, they are harder to find and a longer survey period is recommended.

To facilitate comparisons with single-day or single-week surveys, homeless persons found in this study were asked how long they had been homeless. Using this information we were able to determine the number of persons in the sampled counties who were homeless during the first week of the survey, the first full week of February 1990.

In Section 3 we present estimates of the homeless rate for both the six-month period and the single week. The six-month rate includes anyone who met the definition of homelessness at any time during the six-month interview period. The one-week rate includes those interviewed throughout the six months who reported being homeless during the first full week of February.

To avoid duplication of respondents over the six-month period, each subject was assigned a unique identification number which included the subject's birth date, gender,

and first three letters of the last name. Only a single duplicate interview was found in the data base; it was removed from the data base. (We do not have information on duplicates found in the field.) Because of this control for duplicate counting, we feel that any bias in our data collection procedures would be in the direction of an undercount of the rural homeless.

During the six-month interviewing period, 1,100 adults and 480 accompanying children were identified as homeless in the 21 sampled counties.

2.4 The Survey Questionnaire

If the responses to the screening questions indicated that a person was homeless, that subject was asked to respond to a questionnaire designed to obtain information about the person and his or her life experiences. Of the 1,100 adults identified as homeless, 919 completed the full interview. Although the focus of this paper is on estimating the number of rural homeless, we will describe briefly the questionnaire used to collect information to characterize the homeless.

The full questionnaire contained three sections. The first included questions on demographics and life experiences (for example, reasons for being homeless, use of mental health and other human services, employment history, drug and alcohol usage, family structure, and general well-being). The second section contained ten scales (including, for example, depression-anxiety, disorientation-memory impairment, and retardation-lack of emotion) from the Psychiatric Status Schedule developed by Spitzer, *et al.* (1970). The final section was an interview post-mortem which was completed by the interviewer and included information on where the interview occurred, respondent characteristics (for example, gender and unusual behaviors), and an assessment of the accuracy of the respondent's answers. The findings from this portion of the study are summarized by First *et al.* (1994).

3. THE ESTIMATES OF RATE OF HOMELESSNESS

3.1 The Estimator

The regional estimate of the rate of rural homelessness was obtained using the standard estimator for a proportion from a stratified cluster sample with unequal cluster sizes. In this case, the cluster is the county, the cluster size is the population within the county, and the strata size is the population within a region. The estimator is as follows:

For the i-th region, the estimated rate of homelessness is r_i where

$$r_i = \frac{\text{number of homeless in sampled rural counties in the } i\text{-th region}}{\text{total population in sampled rural counties in } i\text{-th region}}.$$

Then the estimated homeless rate for the state is

$$r_{\text{state}} = \frac{\sum_i [r_i \times \text{rural county population in } i\text{-th region}]}{\text{total rural county population in Ohio}},$$

where the summation is over the five geographical regions shown in Figure 1. The population totals for the 75 nonurban counties were obtained from 1990 Census data.

The estimated one-week and six-month rates of homelessness, given as number of homeless persons per 10,000 population, are shown in Table 1.

Because the above estimator involves the ratio of two random variables, the number of homeless and the population size for sampled clusters, the estimator is biased (see, for example, Cochran 1977). The bias decreases as sample size (number of counties sampled in this case) increases. Since our sample size is small, we recognize that our estimates are likely to be biased. On the other hand, our sampling fraction is large because the number of rural counties is small. Hence, we wish to assess the likely amount of bias in our estimates. (Note that the small sample sizes could also make the standard errors given in Table 1 inaccurate.)

Table 1

Estimated Rates of Homelessness per 10,000 in Rural Ohio

Area	One-Week Rate (February 4 – February 10, 1990)	Six-Month Rate (February – July 1990)
State	5.68 (0.99)	14.00 (2.09)
Northeast	3.44 (0.79)	12.00 (2.19)
Northwest	5.21 (3.51)	12.77 (5.18)
Central	5.85 (1.86)	12.11 (3.05)
Southeast	6.89 (1.93)	15.90 (5.91)
Southwest	7.25 (2.44)	16.78 (5.32)

Note: Standard errors are given in parentheses after each estimate.

3.2 The Simulation Study

We conducted a simulation study to help us assess the likely amount of bias in our estimates. We first generated five "populations" each with counts of the homeless for all 75 nonurban counties in Ohio. For all five simulated populations, the observed numbers of homeless persons for the 21 sampled counties were used as the counts in those counties. Counts for the remaining 54 counties were generated randomly as described below. Note that the simulated counts represent the six-month counts of the homeless.

The first simulated population was created by generating the natural log of the rate of homelessness from a single normal distribution. The log of the rate was used because the observed rates for the 21 sampled counties have a highly skewed histogram but the histogram for the log of the rates is approximately mound shaped. The mean of the observed log rates is 2.465 with a standard deviation of 0.7154. Thus, the generated log rates of homelessness were randomly sampled (using the statistical package S) from a normal distribution with this mean and standard deviation. After the log rates were generated for the 54 nonsampled counties, they were used along with the population counts from the 1990 Census for each county to obtain the simulated numbers of homeless persons for those counties.

The second simulated population was created in a manner similar to the first except that separate normal distributions were used within each of the five geographic regions of Ohio. The means and standard deviations of the log rates of homelessness for the sampled counties within each region were used as the parameters of the normal distributions from which the simulated values were generated. Again the simulated log rates were used to obtain the numbers of homeless persons for the 54 nonsampled rural counties.

The third simulated population was generated using the regression of rate of homelessness per 10,000 on the percent elderly in each sampled county. (This choice of predictor variable is based on the selection of a regression estimator as described in Section 4.) The fitted regression model is

$$\widehat{\text{rate}} = -9.02 + 2.32\%\text{elderly},$$

with $R^2 = 0.197$, $\sqrt{\text{MSE}} = 9.03$, and p-value $= 0.044$ for the overall F-test for the regression line. The simulated population was created by estimating the rate of homelessness in each nonsampled county from the percent elderly in the county and then adding a random normal error term. Because a plot of the residuals from the regression line suggested that the variance in the residuals is larger for counties with higher percentages of elderly, the random error terms were generated from two different normal distributions depending on whether the percent elderly in the county was more or less than 10%. The standard deviations used for the two normal distributions were the standard deviations in the residuals for the counties with 10% or more elderly and with less than 10% elderly.

The fourth simulated population was generated using the regression of rate of homelessness per 10,000 on the percent elderly in each sampled county and on the indicators of the region of the state to which the county belongs. Using I_{NE}, I_{NW}, I_C, and I_{SE} to represent indicator variables for the northeast, northwest, central, and southeast regions respectively, the fitted regression model is

$$\widehat{\text{rate}} = -10.40 + 3.23\%\text{elderly} - 6.47I_{NE} - 8.55I_{NW} - 8.64I_C - 14.25I_{SE},$$

with $R^2 = .407$ (R^2-adjusted $= .210$), $\sqrt{\text{MSE}} = 8.73$, and p-value $= 0.127$ for the overall F-test for the regression line. The simulated population was created by estimating the rate of homelessness in each nonsampled county from the regression equation and then adding a random normal error term. A residual plot again suggested that the variance in the residuals is larger for counties with higher percentages of elderly. Thus the random error terms were generated from two different normal distributions depending on whether the percent elderly in the county was more or less than 10%. Again, the standard deviations for the two normal distributions were the standard deviations of the appropriate subsets of residuals.

The fifth simulated population was generated to be somewhat different from the other populations. It was generated using a regression model to predict number of homeless directly from the population size within each county. The fitted regression model is

$$\widehat{\text{homeless}} = 13.23 + 0.001154\text{population},$$

with $R^2 = 0.386$, $\sqrt{\text{MSE}} = 54.29$, and p-value $= 0.003$ for the overall F-test for the regression line. The simulated population was created by estimating the number of homeless persons in each nonsampled county from the fitted regression equation and then adding a random normal error term. Because a plot of the residuals suggested that the variance in the residuals is larger for counties with larger populations, the random error terms were generated from two different normal distributions depending on whether the county population was more or less than 30,000. The standard deviations for the two normal distributions were the standard deviations of the appropriate subsets of residuals.

After the five populations had been generated, they were each used to assess the amount of bias in the estimates of the rate of rural homelessness. Since we had created the entire "population", we could compute the "true" rate of homelessness within the entire state and the five geographical regions for each of the five populations.

In the simulation, samples of 21 rural counties were selected using the stratified sampling scheme that was used for the actual study. That is, four counties were sampled at random without replacement from each of the northeast, northwest, central, and southwest regions; five were sampled from the southeast region. The estimated rates of homelessness were computed for the five regions and for the state using the formulas given in Section 3.1. These estimates were compared to the population rates of homelessness for the simulated population to determine the bias in the estimate. This process of selecting a sample,

computing estimates, and determining the bias was repeated 1 million times with replacement for each simulated population. (The number of possible samples is more than 7.15×10^{15}.) The same stream of random numbers was used to select the samples for each of the five populations. The results of the simulation are presented in Table 2.

Table 2

Bias in the Estimate of the Homeless Rate per 10,000 for Five Simulated Populations (Based on 1,000,000 simulated samples)

	Population				
	1	2	3	4	5
STATE	0.0406	0.1308	0.2618	0.2433	0.2547
	(2.056)	(1.759)	(2.144)	(1.807)	(1.605)
REGION					
NE	−0.0406	−0.0379	0.1538	0.0317	0.0993
	(3.333)	(2.923)	(3.748)	(4.034)	(1.937)
NW	−0.0578	−0.2948	0.0529	0.0254	0.3234
	(3.591)	(3.194)	(3.474)	(3.460)	(4.249)
C	−0.2442	0.2700	0.3974	0.1362	0.1901
	(3.122)	(3.762)	(3.426)	(2.260)	(2.869)
SE	−0.1034	−0.0279	−0.1132	−0.1798	0.0427
	(6.512)	(4.298)	(6.600)	(3.892)	(3.973)
SW	0.6184	0.8093	0.9196	1.277	0.6716
	(4.215)	(4.990)	(4.610)	(5.173)	(4.274)

Note: The standard deviation of the simulated sampling distribution of the estimator is given in parentheses below each value.

From Table 2 we see that the size of the bias in the overall state estimate of homelessness is about 1/100th of the size of the estimate itself. (Recall that the actual estimated six-month rate of homelessness for the state is about 14 per 10,000 population. The simulated populations have state rates between about 13 and 15 per 10,000.) At the regional level, the size of the bias is also about 1/100th of the size of the regional estimates even though the regional estimates are based on much smaller sample sizes. These results suggest that the size of the bias in our actual estimate is likely to be relatively small.

As would be expected from the small number of counties in the sample, the variance of the sampling distribution of the estimator is fairly large. The standard deviation in the estimates from the simulation study was about 10 times the size of the bias. (The standard deviations of the 1,000,000 estimates in each of the five simulations are of the same order of magnitude as the standard error of the actual estimate shown in Table 1.) This result suggests that the bias in the actual estimate is likely to be rather unimportant when compared to the standard error of the estimate.

Finally, we assessed the shape of the sampling distribution of our estimator by looking at histograms of the 1,000,000 estimates from each of our five simulation studies. The histograms appeared symmetric, mound shaped, and remarkably like histograms of normal data. Thus, confidence intervals based on the normal approximation are likely to be fairly accurate.

4. A REGRESSION ESTIMATOR

There is a great deal of information available, for example from the Bureau of the Census, on the economic conditions in a county. We hoped to be able to use some of this information to improve our estimate for the rate of homelessness by using a regression estimator. To this end, we searched for a regression model relating either the number of homeless persons in a county or the rate of homelessness with a variety of predictor variables which we thought might be useful in explaining homelessness. These possible predictor variables included county population, percentage change in population from 1980 to 1990, unemployment rate, percent elderly, public welfare expenditures, average weekly earnings, percent of rental property, median rent, poverty rate, percent female head of household, percentage of land in farming, average value of farms, average income per farm, ratio of manufacturing to farm jobs, indicator of Beale scores - a classification system for degree of ruralness (see Thomas 1977), and regional indicators.

None of these possible predictors individually or in combination provided a good predictor of the number of homeless persons or rate of homelessness. The best single predictor was percent elderly, the model which was used in generating the third simulated population described in Section 3.2, but it explained less than 20% of the variability in the rate of homelessness. No other variable was useful in addition to percent elderly and we could not find another reasonable regression model. Thus we used percent elderly in a regression estimator for the state rate of rural homelessness. Note that percent elderly is a plausible predictor of the rate of homelessness because poor economic conditions in a rural county appear to result in out-migration of the young; the elderly remain behind making up a greater proportion of the population. Therefore, it is possible that the percentage of elderly in a county is a proxy for poor economic conditions and out-migration. We cannot, however, rule out the possibility that percent elderly appears to be related to rate of homelessness in our data due to chance. We also realize that unavoidable errors in the county-based data collection procedures, such as interviewer effect, amount of services available, and geographic factors, may contribute to the lack of association between rate of homelessness and theoretically relevant variables.

We used the combined regression estimator (see, for example, Cochran 1977) to obtain the state estimate of 14.85 rural homeless per 10,000 with a standard error of 1.64. This compares with the original estimate of 14.00 with a standard error of 2.09 as shown in Table 1. Because the regression estimator is also biased with the bias decreasing for larger sample sizes, we again used a simulation study to assess the bias in this regression estimator.

The simulation study for the regression estimator was carried out using the third and fourth simulated populations described in Section 3.2 because those populations were generated using a regression model involving percent elderly. The simulation again computed the bias in the estimate for 1 million stratified cluster samples chosen with replacement from each population. The same stream of random numbers was used to generate the samples in both cases. A summary of the results of the simulation study for both the original estimator and the regression estimator is given in Table 3.

Table 3

Comparison of Estimators of State Homeless Rate per 10,000 (Summary for 1,000,000 repetitions from two simulated populations)

	Original Estimator		Regression Estimator	
	Population		Population	
	3	4	3	4
Average Bias	0.2618	0.2433	1.7115	0.8360
Standard Deviation	2.144	1.807	1.820	1.246
MSE	4.664	3.325	6.242	2.250

Note that the average bias is larger for the regression estimator than for the standard estimator for a rate from a stratified cluster sample. The standard deviation of the sampling distribution for the regression estimator, however, appears to be slightly smaller than that of the original estimator for each of the two simulated populations. The mean squared errors for the regression estimator fell above and below those of the original estimator. Thus, the choice of which estimator to use was unclear from the summary information in Table 3.

Because the regression estimator does not provide a clear improvement over the original estimator, the bias on average appears to be larger for the regression estimator, and the percent elderly variable may have been selected out of the many variables we tried due to chance, we chose to use the standard estimator of Section 3 for estimating the rate of rural homelessness.

5. CONCLUSIONS

The most often quoted national figures on homelessness were published by Burt and Cohen (1989) who estimated rates of homelessness in urban areas at 37.4 per 10,000 population in cities of more than 100,000 and 9 per 10,000 outside of SMAs. This current study of homeless persons in nonurban Ohio gives a six-month rate of about 14 homeless per 10,000 population and a one-week rate of 5.68 per 10,000 population.

The results of our simulation study suggest that the bias in the usual estimate of a rate based on our small cluster sample is not likely to be important, particularly in comparison to the size of the standard error of the estimate. The bias in the estimates for the five geographic regions in Ohio was found to be of a similar, relatively small size. The simulation study suggests that statistical biases and errors are not likely to discredit the substantive results of the survey of rural homeless.

Our regression analysis of the numbers of homeless persons from sampled counties suggests that it is difficult to explain the numbers of homeless persons in nonurban counties using economic and demographic variables that might be thought to be related to homelessness. It may be that each county is so different from the others, because of its location relative to population centers and related economic characteristics, that it is impossible to find a suitable stratification of the nonurban counties within Ohio. The use of a geographically stratified sample in Ohio did not appear to reduce the variance of the estimate and no other stratification variable was suggested by our regression analysis. This may be the case for other states as well, although stratification by some variable may be possible over, say, the entire United States.

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