The Effect of Rate Denominator Source on US Fatal Occupational Injury Rate Estimates

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Background *The Current Population Survey (CPS) is often used as a source of denominator information for analyses of US fatal occupational injury rates. However, given the relatively small sample size of the CPS, analyses that examine the cross-classification of occupation or industry with demographic or geographic characteristics will often produce highly imprecise rate estimates. The Decennial Census of Population provides an alternative source for rate denominator information. We investigate the comparability of fatal injury rates derived using these two sources of rate denominator information.*
Methods *Information on fatal occupational injuries that occurred between January 1, 1983 and December 31, 1994 was obtained from the National Traumatic Occupational Fatality surveillance system. Annual estimates of employment by occupation, industry, age, and sex were derived from the CPS, and by linear interpolation and extrapolation from the 1980 and 1990 Census of Population. Fatal injury rates derived using these denominator data were compared.*
Results *Fatal injury rates calculated using Census-based denominator data were within 10% of rates calculated using CPS data for all major occupation groups except farming/forestry/fishing, for which the fatal injury rate calculated using Census-based denominator data was 24.69/100,000 worker-years and the rate calculated using CPS data was 19.97/100,000 worker-years. The choice of denominator data source had minimal influence on estimates of trends over calendar time in the fatal injury rates for most major occupation and industry groups.*
Conclusions *The Census offers a reasonable source for deriving fatal injury rate denominator data in situations where the CPS does not provide sufficiently precise data, although the Census may underestimate the population-at-risk in some industries as a consequence of seasonal variation in employment.* Am. J. Ind. Med. 46:261–270, 2004. *Published 2004 Wiley-Liss, Inc.*[†]

***KEY WORDS:* occupational injury; statistics; epidemiological methods**

INTRODUCTION

Data on fatal occupational injuries in the United States are compiled at the national level by the National Institute for Occupational Safety and Health's (NIOSH) National Traumatic Occupational Fatality (NTOF) surveillance system as well as by the Bureau of Labor Statistics' (BLS) Census of Fatal Occupational Injuries (CFOI) [Biddle and Marsh, 2002]. The information that comes from these surveillance systems is an important resource for occupational injury epidemiology.

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While these data provide the numerator for analyses of fatal occupational injury rates, neither the NTOF nor the CFOI program directly collects US employment information that can be used as a denominator for rate calculation. In many investigations, rate denominator information has been obtained from the BLS's Current Population Survey (CPS) [Toscano and Jack, 1996; Bailer et al., 2003]. Annual employment estimates derived by aggregating the results of this monthly survey of approximately 50,000 households provide a reliable source of denominator information for the calculation of crude mortality rates in major categories of industry or occupation.

However, many important research questions require more detailed, or highly stratified, analyses of these fatality data. For example, epidemiologists may be interested in examining fatal injury rates by categories of occupation and industry in analyses that adjust for, or stratify by, age, sex, and other demographic factors. In addition, epidemiologists are often interested in occupational mortality rates for a specific state or region, rather than for the country as a whole. Death certificate data are available at the state level, and provide the requisite information to examine fatal occupational injury rates at the geographic level at which regulations and interventions often occur. Given the limited sample size of the monthly CPS, occupation- and industry-specific employment estimates at the state level tend to be highly imprecise [Robinson, 1996]. Consequently, the Bureau of Labor Statistics does not report highly stratified employment estimates, and reported tables of employment data may have cells in which values are suppressed because the coefficient of variation is unacceptably large [Bureau of Labor Statistics, 1999]. This is a noteworthy obstacle to occupational injury epidemiology in the US, since reliable estimates of the labor force are required in order to obtain reliable estimates of occupational fatal injury rates based on NTOF or CFOI data.

An alternative source of employment information that has been used in analyses of fatal occupational injury data is the US Decennial Census of Population [Loomis et al., 1997, 2003; Loomis and Richardson, 1998]. In contrast to the CPS, highly stratified tabulations of Census data are available, permitting investigation of research questions that require refined tabulations of fatal occupational injury rates; annual employment estimates may be derived from Decennial Census data by interpolation/extrapolation.

To date, there has been no published empirical evaluation of the comparability of fatal occupational injury rates based on these alternative sources of denominator data. In this study, we examine the comparability of fatal occupational injury rates calculated using denominator data from the Decennial Census and denominator data from the CPS. These analyses provide information that may be used in conjunction with evidence derived from analyses of simulated data to better understand the strengths and limitations of the US Census as a source of rate denominator information for analyses of US occupational fatal injury rates [Bena et al., 2004].

MATERIALS AND METHODS

Analyses in this study pertain to fatal occupational injury rates in the United States during the period January 1, 1983 to December 31, 1994. For the numerator for these calculations of injury rates, we used data ascertained from the NIOSH's NTOF database. The NTOF database provides information derived from death certificates from the 50 states, New York City, and the District of Columbia for all deaths of persons aged 16 years or older for whom an external cause of death (International Classification of Diseases, 9th Revision codes E800-E999) was noted and for whom the certifier entered a positive response to the "Injury at work?" item [Stout et al., 1996; Marsh and Layne, 2001]. All decedents included in these analyses were required to have complete information on date of birth, date of death, sex, and usual occupation and industry of employment. Deaths due to medical misadventure, non-work-related choking, and non-occupational poisoning by therapeutic drugs or alcohol were excluded. This resulted in 58,090 deaths being included in rate calculations. Each decedent was categorized by year of death (1983–1994), attained age in eleven groups (16–19, 20–24, 25-29, 30–34, 35–39, 40–44, 45–49, 50–54, 55–59, 60–64, and 65+ years), sex, and major categories of usual industry and occupation of employment. Counts of the number of deaths were then tabulated in the strata defined by the combination of year of death, attained age, sex, industry, and occupation.

Current Population Survey

We derived one set of denominator data for these calculations of fatal occupational injury rates from the CPS. The CPS is a monthly survey of a sample of the civilian non-institutional population encompassing approximately 50,000 US households. Included in these CPS labor force estimates are persons 16 years of age and older, who are not residents of institutions (e.g., penal and mental facilities, long-term care facilities such as nursing homes), and who are not on active duty in the Armed Forces. Monthly employment estimates were obtained for the period 1983–1994. Following the methodology used in previous analyses of NTOF data, average annual employment estimates were calculated from the 12 monthly survey results within each calendar year [Bailer et al., 2003]. Annual employment estimates were tabulated in categories of age, sex, industry, and occupation comparable to those tabulations of the numerator data. Approximate standard errors for annual average employment estimates derived from the CPS were obtained using a published formula [BLS, 2003]. Since these values were derived using parameters that provide information applicable to a wide range of estimated values, these are approximate standard errors rather than the precise sampling error.

US Census of Population

The Decennial Census of Population provides information derived from a nearly complete enumeration of the nation's population. Public use micro datasets (PUMS) are available that allow a researcher to tabulate employment estimates cross-classified by categories of geographic region, occupation, industry, age, sex, and race. The PUMS files that we used provide estimates of the population based upon a 5% sample of the Census records. These PUMS files provide an estimate, rather than a full enumeration, of the population; however, PUMS records provide reliable estimates of population counts in stratified tabulations of demographic and occupational factors. From the 5% PUMS sample of US Census data, estimates of the US labor force were obtained for 1980 and 1990 for all persons aged 16+ years who were employed and not in the US military. A table of employment estimates was constructed in which dimensions included comparable categorizations of age, sex, occupation, and industry to those defined in the tabulation of CPS data described above. Approximate standard errors for employment estimates were derived from the 5% PUMS sample of the 1990 US Census of Population [Bureau of the Census, 1992]. Intercensal estimates of employment were derived via linear interpolation using the 1980 and 1990 Decennial Censuses [Loomis et al., 1997, 2003]. For employment estimates for years after 1990, extrapolation was necessary because appropriate values from the 2000 Decennial Census were not yet available.

Industry and occupation codes are not consistent among the 1980 Census, the 1990 Census, and Current Population Surveys for the period 1983–1994. We used the approach outlined by National Center for Health Statistics for achieving comparability in industry and occupation coding between these classification schemes [US Department of Health and Human Services, 1990, 1997].

Statistical Methods

We begin by evaluating the comparability of Census and CPS rate denominators for a calendar year (1990) in which a Decennial Census occurred. Denominator estimates are tabulated for major categories of occupation and industry, allowing us to compare the Census and CPS in categories for which the CPS provides relatively stable employment

TABLE I. Evaluation of the Comparability of Employment Estimates Derived From the Current Population Survey (CPS) and the Decennial Census of Population: Data for 1990

	CPS employment estimate	Census employment estimate	Ratio (CPS/Census)
Occupation			
Executive/manager/administration	14,863,967	14,193,853	1.05
Professional specialty	15,813,307	16,278,887	0.97
Technicians and related support	3,858,927	4,243,270	0.91
Sales occupations	14,260,446	13,606,120	1.05
Clerical and administrative support	18,697,689	18,823,776	0.99
Service occupations	16,024,441	15,264,359	1.05
Farming/forestry/fishing	3,456,839	2,822,029	1.22
Precision production/craft/repair	13,757,811	13,095,893	1.05
Operators, assemblers, inspectors	8,185,236	7,883,374	1.04
Transportation and material moving	4,888,358	4,717,985	1.04
Handlers, cleaners, helpers, laborers	4,973,882	4,539,804	1.10
Industry			
Agriculture/forestry/fishing	3,401,273	3,094,401	1.10
Mining	730,111	724,748	1.01
Construction	7,791,866	7,200,554	1.08
Manufacturing	21,335,644	20,443,895	1.04
Transportation/public utilities	8,155,130	8,201,129	0.99
Wholesale trade	4,670,299	5,060,003	0.92
Retail trade	19,925,598	19,428,200	1.03
Finance/insurance/real estate	8,051,083	7,975,560	1.01
Services	39,099,244	37,818,939	1.03
Public administration	5,620,657	5,521,921	1.02

estimates. The Decennial Census is conducted in March with a goal of producing estimates that reflect the US population on April 1. In contrast, the CPS is a monthly survey with annual estimates produced by aggregating monthly data. Consequently, estimates of employment based on the Census may not reflect average annual employment due to seasonal variation in employment patterns. Monthly CPS data were plotted in order to evaluate seasonal patterns in employment.

We next examine the comparability of fatal injury rates calculated using Census and CPS-based rate denominators for a period (1983–1994) that encompasses intercensal years. Crude fatality rates were calculated as the number of deaths per 100,000 worker-years at risk. Poisson regression analyses, conducted using SAS PROC GENMOD, were used to estimate trends in fatal occupational injury rates over time [SAS, 1999]. The natural log of fatality rates was modeled as a function of calendar year. In order to account for variation in the size of the population-at-risk, the number of deaths served as the response variable and the log of the population-at-risk served as an offset. The model can be expressed as:

$$\log(\lambda) = \beta_0 + \beta_1(\text{year}-1983),$$

where the fatality rate λ was examined in relation to calendar period, "year." The parameter estimate β_0 represents the log fatal injury rate in 1983, and the parameter estimate β_1 represents the average annual change in the log fatal injury rate. Parameter estimates for the annual change have been multiplied by 100 to yield the log percentage change in mortality per year. For small changes over time in fatal injury rate, the log percentage change approximates the absolute percentage change and is discussed as such in the text. Comparisons were made of the sensitivity of rate estimates (and trends in rates over this period) to the choice of rate denominator data.

Finally, we evaluated the sensitivity of estimates of trends over calendar time in fatal injury rates to the choice of rate denominator data within more finely stratified categories defined by the cross-classifications of sex, age group, and major occupation and industry group. The comparability of trend estimates was evaluated graphically by plotting each trend estimate derived from Poisson regression analysis using CPS-based denominator data against the comparable trend estimate derived using Census-based denominator data.

RESULTS

Comparisons of Rate Denominators for a Census Year

Table I presents estimates of the number of workers at risk in the US in 1990 derived from the CPS and from the Census. When examined by occupation, for most groups

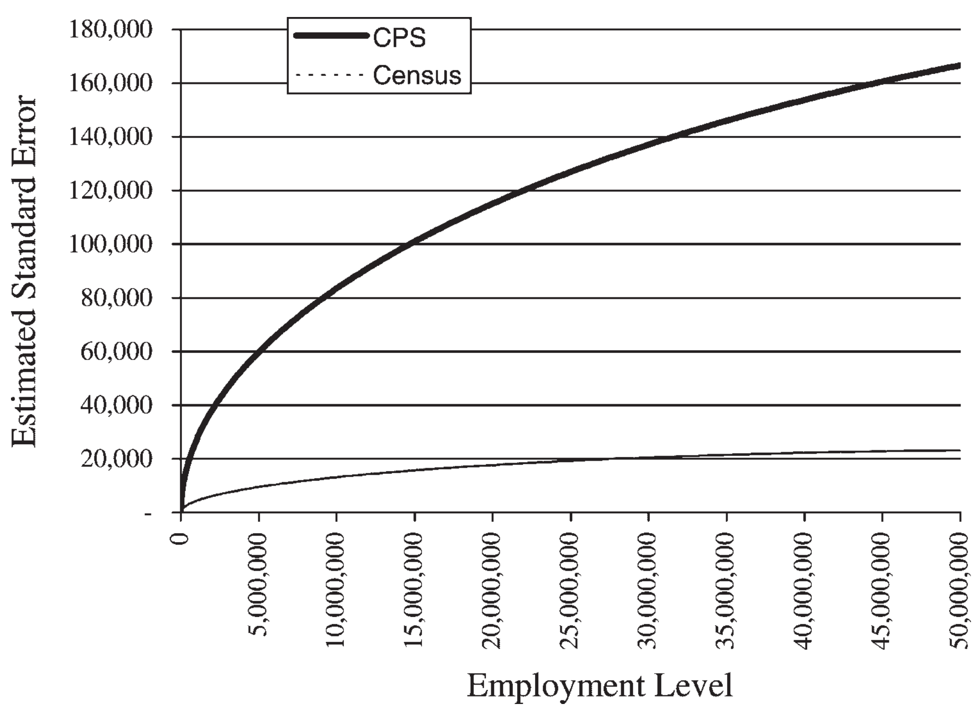

FIGURE 1. Approximate standard errors for employment estimates. Values shown are for annual average employment levels in 1990 derived from the Current Population Survey and from the 5% PUMS Sample of the 1990 Decennial Census. Note: Values for CPS represent approximate standard errors for annual average employment estimates for the total employed civilian labor force. Standard errors for CPS data may be larger for subgroups defined by sex, race, ethnicity, or other characteristics.

employment estimates based on CPS data were within 10% of estimates derived using Census data; however, the estimate for farming/forestry/fishing was 22% higher than the value derived using Census data. When examined by industry, the number of worker-years in agriculture/forestry/fishing calculated using CPS-based denominator data was 10% higher than the number estimated using Census data, while estimates for other industries differed by less than 10%. Approximate standard errors for annual average employment estimates derived from the CPS and the Census are illustrated in Figure 1.

Examination of monthly CPS data helps to explain the observed difference in denominator estimates for agriculture/forestry/fishing industry derived using CPS data when compared to estimates derived using Census data (Fig. 2a). There is clear seasonal variation in employment in the agriculture/forestry/fishing industry, with peak employment in June and July. The CPS-based annual estimate of employment in this industry group is a composite of the 12 monthly CPS results (dashed line). The annual average estimate of employment in the agriculture/forestry/fishing industry is substantially higher than the Census estimate of employment (circle). The 1990 Decennial Census of Population is conducted in mid-March with the objective of estimating the US population on April 1st of that year; the Census estimate of employment in agriculture/forestry/fishing is close to the estimate for March/April derived from the CPS. However, this value is less than the average annual employment in this industry group as derived via the average of monthly CPS survey results. Figure 2b–d illustrates comparable data for

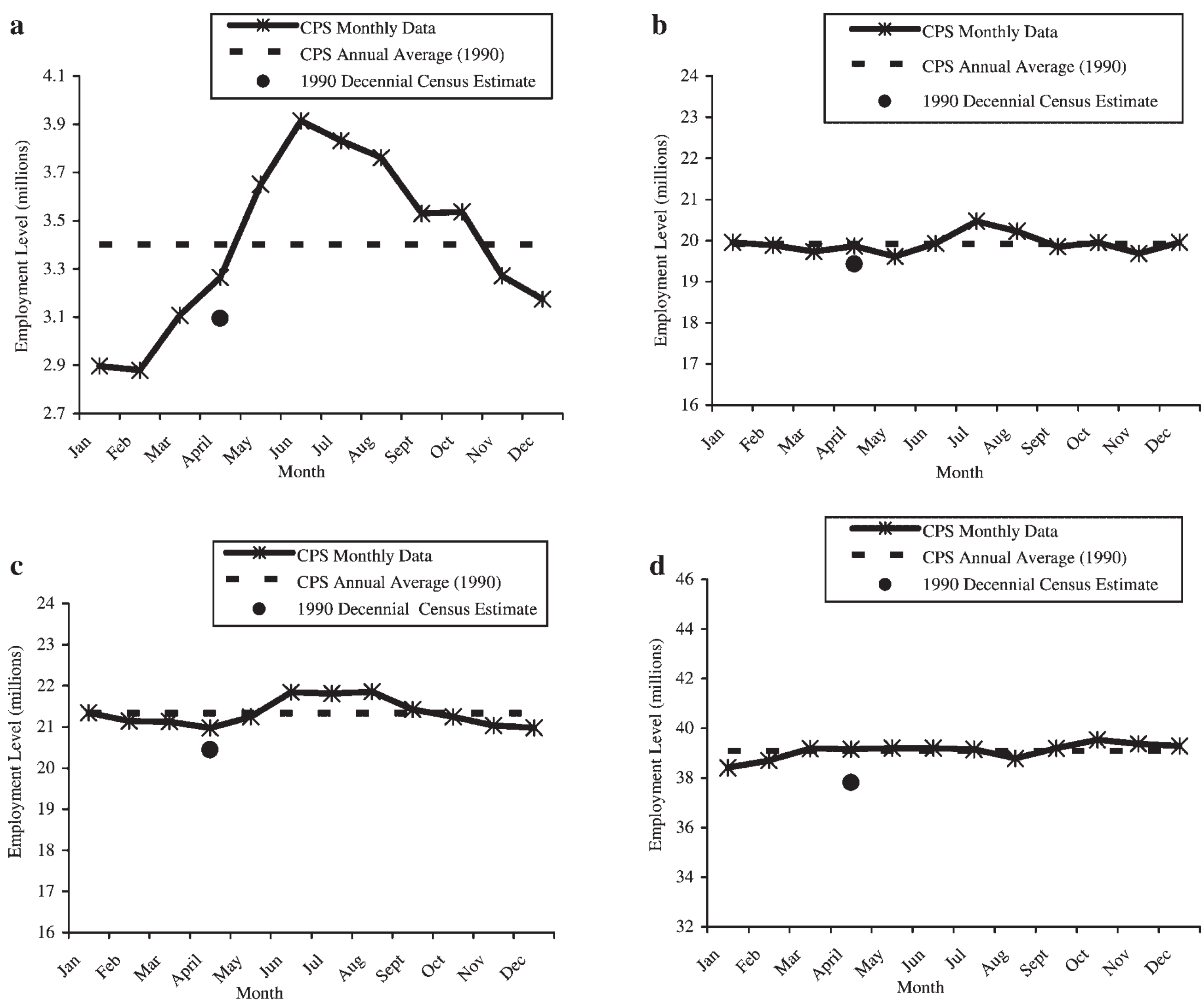

FIGURE 2. Seasonality in US employment in four major industry groups. Estimates of employment in 1990 are based on monthly CPS data and the 1990 Decennial Census of Population. **a**: Agriculture/forestry/fishing; (**b**) Retail; (**c**) Manufacturing; and (**d**) Service.

retail, manufacturing, and service industries. In these industry groups, there is less evidence of seasonal variation in employment, and the Census estimate of employment in each of these industry groups is within 5% of the CPS annual estimate of employment (Table I).

Comparison of Fatal Injury Rates for the Period 1983–1994

Table II presents US fatal occupational injury rates for the period 1983–1994 calculated using estimates of person-time at risk derived from the CPS and from the Census. The rate ratios comparing the two rates were between 0.97 and 1.04 for 9 of the 11 occupational groups. However, the fatal injury rate in farming/forestry/fishing calculated using Census-based denominator data (rate = 24.69/100,000 worker-years) was 24% higher than the rate calculated using CPS data (rate = 19.97/100,000 worker-years). The fatal injury rate for technicians and related occupations calculated using Census-based denominator data was 11% lower than the rate calculated using CPS data. When examined by industry, the fatal injury rate for agriculture/forestry/fishing calculated using Census-based denominator data, 19.25/100,000 worker-years, was 11% higher than the rate calculated using CPS data, 17.41/100,000 worker-years. The fatal injury rate in wholesale trade calculated using Census-based denominator data (rate = 3.07/100,000 worker-years) was approximately 8% lower than the rate calculated using CPS data (rate = 3.33/100,000 worker-years). For the other major industry groups, rates calculated using Census and CPS denominator data differed by less than 5%.

Table III presents estimates of the average annual change in fatal occupational injury rates over the study period by industry and occupation. Trends in fatal injury rate estimates tend to be of similar direction and magnitude whether based on Census or CPS data. When examined by major industry groups, trends based on Census-based denominator data were generally of the same direction but greater magnitude than estimates based on CPS data for agriculture/forestry/fishing, mining, construction, and wholesale trades. Trend estimates were of small magnitude but opposite direction for the financial industry group, and were of the same direction but smaller magnitude when calculated using Census-based denominator data as compared to estimates derived using CPS data for public administration, manufacturing, transportation/public utilities, retail trade, and service industries.

TABLE II. Evaluation of the Comparability of US Fatal Occupational Injury Rates for the Period 1983–1994

	Rate[a] CPS	Rate[a] Census	Rate ratio (Census/CPS)
Occupation			
Executive/manager/administration	2.20	2.25	1.02
Professional specialty	1.23	1.19	0.97
Technicians and related support	3.55	3.15	0.89
Sales occupations	2.50	2.60	1.04
Clerical and administrative support	0.58	0.56	0.97
Service occupations	2.31	2.39	1.03
Farming/forestry/fishing	19.97	24.69	1.24
Precision production/craft/repair	7.84	8.03	1.02
Operators, assemblers, inspectors	3.07	2.99	0.97
Transportation and material moving	19.03	19.37	1.02
Handlers, cleaners, helpers, laborers	11.58	11.93	1.03
Industry			
Agriculture/forestry/fishing	17.41	19.25	1.11
Mining	24.62	25.12	1.02
Construction	13.61	14.10	1.04
Manufacturing	3.75	3.75	1.00
Transportation/public utilities	10.87	10.75	0.99
Wholesale trade	3.33	3.07	0.92
Retail trade	2.46	2.48	1.01
Finance/insurance/real estate	0.87	0.86	0.99
Services	1.42	1.45	1.02
Public administration	4.22	4.13	0.98

Rate denominators derived from 1980 and 1990 Decennial Censuses of Population and the Current Population Survey, 1983–1994.

[a]Deaths per 100,000 worker-years.

TABLE III. Evaluation of the Comparability of Average Annual Change in US Fatal Occupational Injury Rates for the Period 1983–1994

	Trend based on CPS (%)	Trend based on Census (%)
Occupation		
Executive/manager/administration	−2.0	−1.7
Professional specialty	−1.6	−1.5
Technicians and related support	−4.0	−4.5
Sales occupations	0.9	−0.4
Clerical and administrative support	0.0	0.0
Service occupations	−1.0	−1.1
Farming/forestry/fishing	−1.9	−2.5
Precision production/craft/repair	−2.0	−2.0
Operators, assemblers, inspectors	−1.1	0.0
Transportation and material moving	−3.3	−2.6
Handlers, cleaners, helpers, laborers	−3.9	−3.4
Industry		
Agriculture/forestry/fishing	−1.3	−2.3
Mining	−3.4	−3.5
Construction	−3.0	−4.1
Manufacturing	−2.1	−1.6
Transportation/public utilities	−3.2	−3.0
Wholesale trade	−1.0	−1.9
Retail trade	1.9	1.4
Finance/insurance/real estate	0.6	−0.5
Services	−1.7	−1.5
Public administration	−3.2	−2.0

Rate denominators derived from 1980 and 1990 Decennial Censuses of Population and the Current Population Survey, 1983–1994.

Figure 3a–d helps to interpret the findings for trends in fatal injury rates. For example, estimates of annual employment in the agriculture/forestry/fishing industry based on interpolation/extrapolation from the Decennial Census (solid line) are of smaller magnitude, and the trend in annual employment estimates based on Census data increases more rapidly over calendar time, than the trend based on the CPS (dashed line) (Fig. 3a). Consequently, estimated fatal injury rates are of larger magnitude when based on Census than CPS data (Table II), and the decline in fatality rates with calendar time in this industry group is greater when based on Census data than when based on CPS data (Table III). In contrast, when examining the retail industry (Fig. 3b) and the service industry (Fig. 3d), trends in estimates of annual employment based on the interpolation/extrapolation from the Decennial Census are nearly identical to the trends based on the CPS. Consequently, estimates of trends in fatality rates are very similar for these industry sectors whether based on Census or CPS data (Tables II and III). The trend in estimates of employment in the manufacturing industry based on Census data decreases more rapidly over time than the trend based on the CPS (Fig. 3c); consequently, the decline in fatality rates with calendar time in this industry group is smaller when based on Census data than when based on CPS data (Table III).

Figure 4 shows fatal injury trend estimates derived using CPS data plotted against fatal injury trend estimates derived using Census data for the smaller groups defined by the cross-classification of categories of age, sex, and major industry and occupation groups. Estimates of employment derived from the CPS may be highly imprecise for sub-groups defined by this cross-classification of demographic and employment characteristics; however, estimates of trends in fatal injury rates over calendar time tend to be of similar magnitude and direction to fatal injury trend estimates derived using Census-based denominator data (Fig. 4).

DISCUSSION

These analyses compare US fatal injury rate estimates in major categories of industry and occupation categories using rate denominator information derived from the Current Population Survey and from the Decennial Census of Population. Overall, fatal occupational injury rates for major occupation and industry groups calculated using Census based denominator data were comparable to rates calculated using CPS-based denominator data. This suggests that the Census may serve as a reasonable source for deriving fatal injury rate denominator data in situations where the precision of CPS-based rate denominator is poor. However, it is necessary to be cautious when drawing conclusions from these empirical analyses. These analyses provide empirical evidence just for the period 1983–1994. In order to calculate annual employment estimates for the period 1983–1994 based on Decennial Census data, we used a simple method of linear interpolation/extrapolation between the 1980 and 1990 Censuses; this method has been applied in previous published studies of national trends in fatal injury rates in the US and in analyses of fatal injuries in NC [Loomis et al., 1997, 2003]. The appropriateness of linear interpolation/extrapolation between Decennial censuses to derive annual employment estimates may vary depending upon the historical period under investigation and the study population. This issue is explored in some detail in a companion study [Bena et al., 2004].

We first evaluated the reliability of Census-based denominator data for major occupation and industry groups for which Census data could be compared to highly stable estimates derived from the CPS. We then went on to compare trend estimates for cross-classification of industry, occupation, age, and sex. Trends were comparable for this finer stratification of data as well (Fig. 4). The primary reason to use Census-based estimates of employment is to derive denominator data for highly stratified tabulations for which reliable estimates cannot be obtained from the CPS. Occupation- and industry-specific employment estimates for

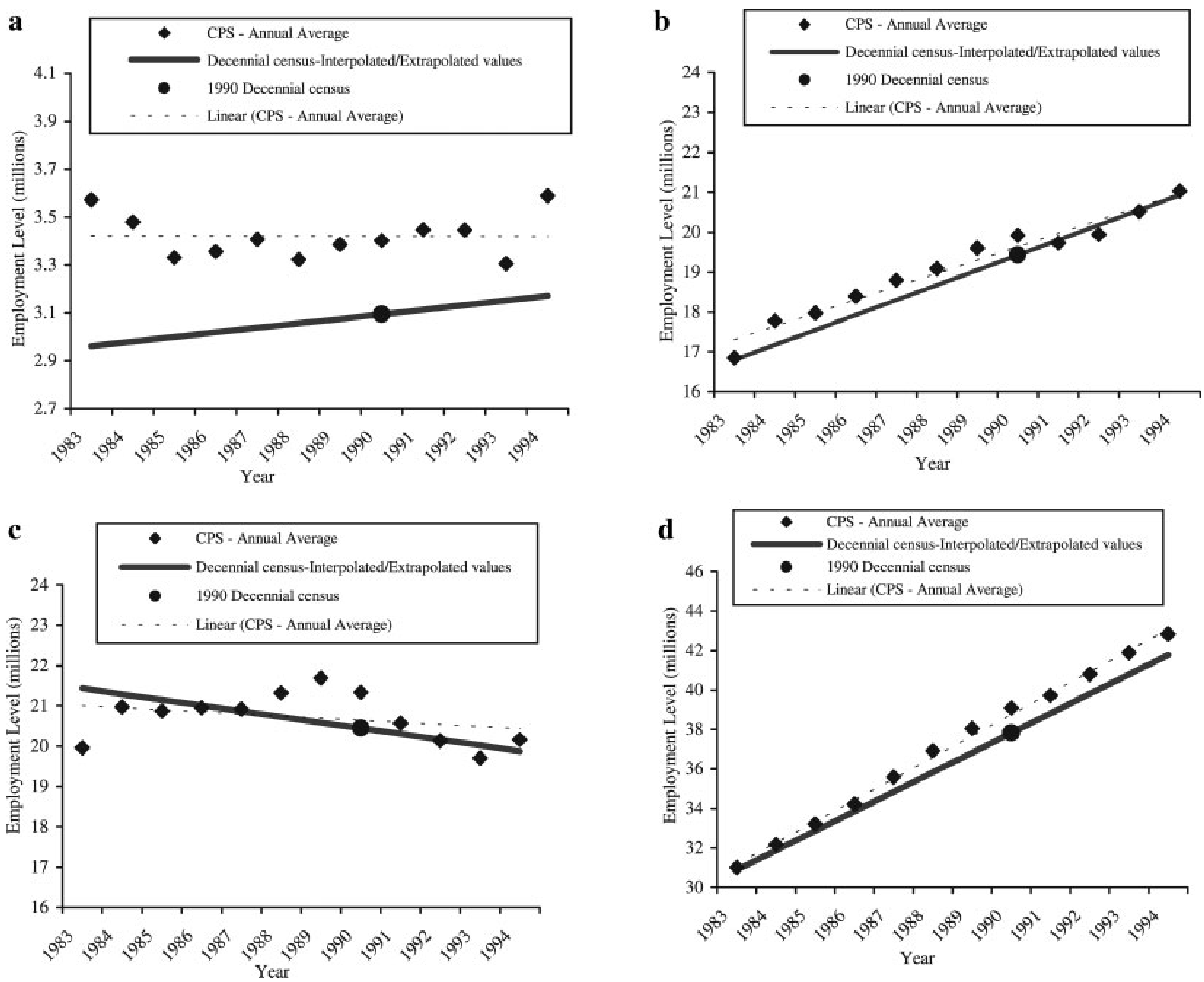

FIGURE 3. Annual estimates and trends in average annual employment in four major industry groups. Estimates of average annual employment are based on monthly CPS data and the 1980 and 1990 Decennial Censuses of Population. **a**: Agriculture/forestry/fishing; (**b**) Retail; (**c**) Manufacturing; and (**d**) Service.

individual states, for example, may be highly imprecise if based on the CPS. The results of these analyses suggest that this method for deriving Census-based denominator tends to provide reliable information for more highly stratified tabulations of data in cases where the CPS may not provide stable estimates of employment (and in cases where BLS may suppress labor force estimates due to their instability). Of course, the statistical precision of a fatal injury rate estimate is directly linked to numerator of the rate. Consequently, for highly stratified tabulations of study data, standard approaches to estimating the statistical precision of an epidemiological rate (under which the denominator is treated as though it is a value that is measured without error) will indicate high levels of uncertainty in rate estimates if the numbers of cases in the rate numerators are small [Breslow and Day, 1987].

We focused on a comparison of the CPS and the Decennial Census of population, two large population-based surveys that provide employment information and have been used in epidemiological research on occupational injuries. Employment estimates can also be derived from employer-based surveys, such as the Census Bureau's Annual Survey of Manufacturers and Current Business Survey. However, employer-based surveys do not provide information about characteristics of individual workers (such as employees' age, sex, and race), nor do they provide information about self-employed workers, domestic service workers, railroad employees, agricultural production workers, or most government workers. Consequently, occupational epidemiologists tend to rely on denominator information derived from population-based surveys such as the CPS and Census [Biddle and Kisner, 1998].

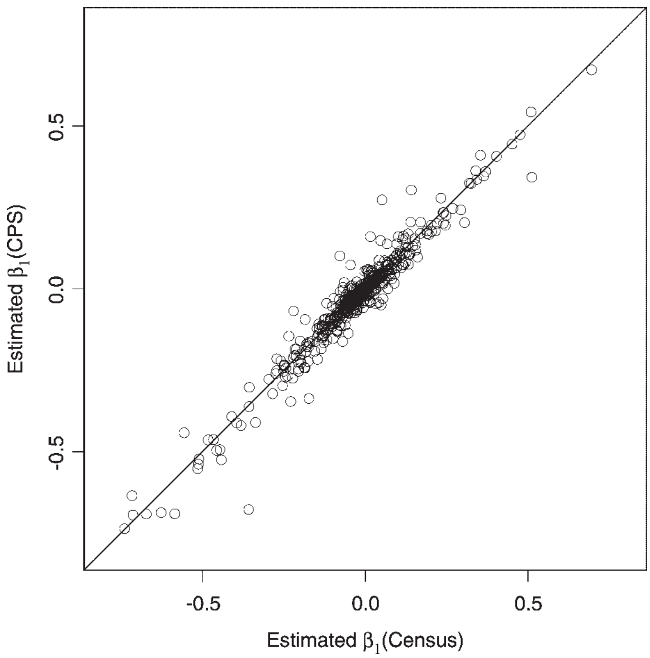

FIGURE 4. Estimates of the average annual trend in fatal occupational injury rates for the period 1983–1994 for groups defined by the cross-classification of age, sex, and major industry and occupation categories. For each group, the trend estimate derived from Poisson regression analysis using CPS-based denominator data, Estimated β_1(CPS), is plotted against the comparable trend estimate derived using Census-based denominator data, Estimated β_1(Census). Note: Thirteen outlying observations were suppressed in this figure, representing 2.6% of the data.

While rate estimates generated from CPS and Census data were generally comparable, a notable discrepancy in the CPS and Census derived rate estimates was observed for fatal injury rates for farming/forestry/fishing occupations where CPS-derived rate estimates were appreciably smaller than Census estimates (Table II). We believe that the Census-based rate is an overestimate because the Census-based denominator is an underestimate of the true number of people employed in this occupation group. We should note that for the purposes of rate modeling via Poisson regression, we assumed that the denominator data were correct (i.e., conditional on the offset in the Poisson regression model being known). While the CPS rate denominator data may be imprecise, we believe that the CPS is an unbiased source of information. In contrast, the Census provides a more precise source of rate denominator information, however, it appears to be biased for certain groups of workers. This appears to be a consequence of the fact that the Census aims to ascertain employment on April 1st, which may not provide a good measure of the average annual employment in industries (or occupations) where employment varies with season. This conclusion is supported by our examination of monthly CPS employment estimates (Fig. 2a). The potential effects of seasonal variation in employment in specific segments of the work force should be taken into consideration when evaluating findings that rely on Census-based employment estimates. Given this limitation, it may be useful to consider an alternative population-based survey (such as the Census of Agriculture) as a source of rate denominator information for analyses of fatal agricultural injury rates [U.S. Bureau of the Census, 1994].

Further work could be done to develop an estimate of employment that would combine the CPS and Census data. The CPS offers a population-based monthly survey of US employment, although these sample-based estimates of employment may be unstable if they pertain to strata where the base population is small (Fig. 1). The Census of Population, in contrast, provides data obtained from a decennial survey and provides estimates that have minimal sampling error. A composite annual estimate of employment might be obtained, for example, via Bayesian methods in which the CPS provides a prior estimate of employment in each month, and the Census informs posterior employment estimates for the period near the date of the Census.

While the CPS provides an extremely valuable source of information for analyses that do not require highly stratified tabulations of person-time and events, many important research questions do require examination of data at finer levels of stratification than supported by the CPS. These findings suggest that the Decennial Census offers a useful source for estimating rate denominator data for analyses of US fatal occupational injury rates in situations where CPS data is unavailable due to statistical imprecision.

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