

# An Estimate of the U.S. Government's Undercount of Nonfatal Occupational Injuries

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## Learning Objectives

- Estimate how many workers—and in which occupations—are presently excluded from the Bureau of Labor Statistics Annual Survey of Occupational Injuries and Illnesses.
- Consider possible reasons for under-reporting of injuries by private firms and their employees.
- Provide the best estimate of the degree of under-reporting, and note the possible consequences for workers' health.

## Abstract

*Debate surrounds the size of the underestimate of nonfatal occupational injuries produced by the U.S. Bureau of Labor Statistics (BLS). We developed models that separated categories of injuries: BLS Annual Survey, federal government, agriculture, state and local government, self-employed outside agriculture, and all other. The models generated varying estimates depending on the assumptions for each category pertaining to job risks and amount of underreporting. We offered justification for the assumptions based on published studies as well as our own analyses of BLS data. The models suggested the Annual Survey missed from 0% to 70% of the number of injuries (from private firms, excluding the self-employed) it was designed to capture. However, when we included firms and governments the Annual Survey was not designed to capture, and considered reasonable assumptions regarding underreporting, we estimated the BLS missed between 33% and 69% of all injuries. We concluded that there was substantial undercapture in the BLS Annual Survey, some due to the excluded categories of government workers and the self-employed, as well as some due to underreporting. (J Occup Environ Med. 2004;46:10–18)*

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Occupational injuries are an underappreciated contributor to overall disability and death.<sup>1</sup> In the United States, occupational injuries have been estimated to cost roughly \$140 billion per year in the 1990s.<sup>2,3</sup> Roughly 97% of these costs are the result of nonfatal injuries. This compares with the annual costs of cancer (\$170 billion) as well as chronic obstructive pulmonary disease (\$24 billion) and acquired immune deficiency (\$30 billion) for the same decade.<sup>1,4,5</sup> The Bureau of Labor Statistics' (BLS) Annual Survey of Occupational Injuries and Illnesses (Annual Survey) has been used to develop the cost estimates for injuries.<sup>3</sup> The raw Annual Survey data were supplied by roughly 174,000 private firms in 1999<sup>6</sup> and by roughly 250,000 firms in previous years.<sup>7</sup> Most private firms with one or more employees are required to maintain a job injury and illness log (OSHA Log 200). Owners and managers of firms, not unions or groups of employees, are responsible for sending the raw data to the BLS.

It is well known that official data sources underestimate occupational injury.<sup>8,9</sup> The Annual Survey is no exception, and the BLS acknowledges many limitations. Yet the BLS Bulletins and news releases minimize these limitations and the *Statistical Abstract of the U.S.*<sup>10</sup> ignores them altogether. As a result, journalists seeking an estimate of the national number of injuries could never know that the Annual Survey primarily excludes over 1 in 5 workers, including injuries incurred by most police officers and firefighters. The

BLS acknowledges the following groups are excluded from the survey: self-employed individuals; farms with fewer than 11 employees; employers regulated by other federal safety and health laws; federal, state and local government agencies; and private household workers.<sup>6,11</sup> These are significant exclusions. In 1999, roughly 14.7% of employed people were government workers and 7.3% were self-employed.<sup>12</sup> One government estimate suggests that 0.4% of employed persons work on farms with fewer than 10 (not 11) workers.<sup>13</sup> However, government estimates of employment of farm workers have been criticized as being especially small.<sup>14</sup>

However, there are further limitations that the BLS does not acknowledge. Firms could under- or overreport injuries. We first consider the causes of the under- and overreporting. Second, we consider empiric evidence.

### **Causes of Under- and Overreporting Among Firms Covered by the Annual Survey**

First, small firms are likely to underreport or not report at all.<sup>15,16</sup> Small firms (fewer than 11 employees) are more likely than medium and large firms to be newly formed and frequently go out of business.<sup>17</sup> New owners might not be aware of the law. BLS penalties for poor recordkeeping and Occupational Safety and Health Administration (OSHA) penalties rarely, if ever, are levied on small firms.<sup>18,19</sup> Finally, the paperwork could be a greater relative burden on small than large firms.

Second, there are economic incentives to both underreport and overreport. Workers' compensation (WC) systems create incentives to underreport. Firms that are WC experienced-rated and that report an increasing number of injuries over time could experience increases in their premiums. There are also incentives to underreport outside WC. First, firms

seeking government contracts could fear being denied a contract if their injury rate is too high.<sup>20</sup> Second, a (recorded) high injury rate could trigger an OSHA inspection.<sup>19</sup> Third, firms could also seek to minimize the reported injuries so as to maintain an image as safe places to work. The economic theory of compensating wages suggests that firms that maintain a safe image need not pay the high wages other firms pay with poor safety images.<sup>21</sup>

For nonfatal injuries, economic incentives discourage employees from reporting. Employees could be fearful that their employers will label them "accident-prone" or that they could be denied a promotion or laid off if they report too many injuries.<sup>22</sup> They might fear that a WC claim or litigation surrounding a claim (which is public information) could harm their chances of finding a new job. Workers might not be knowledgeable of the WC system.<sup>23</sup> The worker might not know whom to ask about applying for WC apart from the boss. Workers could receive a yearly bonus if none in their work group report a WC claim for a year.<sup>24</sup> They might not report if there is a social stigma associated with filing for WC. This stigma would be similar to that associated with applying for welfare.<sup>25</sup> Finally, some workers, especially men, could feel it is a sign of weakness to report an injury. Conway and Svenson<sup>26</sup> and Azaroff et al.<sup>27</sup> offer additional reasons for underreporting.

Economists argue that the more generous the indemnity payment, the more likely workers will report greater numbers of workdays lost.<sup>28</sup> This effect has several causes. First, generous benefits could result in workers taking fewer precautions and subsequently experiencing more injuries. Second, the more generous the benefit, the greater the chance of fraud. Third, once workers begin receiving the benefits, they have less incentive to return to work.

For purposes of this study, only the middle effect, fraud, is relevant.

That is, our primary objective is to estimate the number of injuries, not the cause of the injury or the number of days lost. We are unaware of scientific studies on the extent of WC fraud. The General Accounting Office under the Bush Administration estimated unemployment insurance (UI) fraud to be 2.16% of all UI spending.<sup>29</sup> Allegations of serious amounts of WC fraud have been made, particularly by WC insurance companies. These companies have an incentive to find and prosecute fraudulent claims. State government Departments of Insurance frequently assist insurance companies in these efforts.<sup>30</sup> Bold warnings of imprisonment "up to 5 years" appear on WC claim forms, and these likely have a chilling effect on claimants and physicians alike. The litigious nature of WC is cited by many physicians as the reason they prefer not to be involved in WC cases.<sup>31</sup>

### **Empiric Evidence on Inaccurate Reporting**

In the mid-1980s, the *Wall Street Journal* reported that a number of firms were willfully underreporting.<sup>16</sup> Committee hearings in the U.S. Congress on underreporting were held.<sup>32</sup> Subsequent to those hearings, OSHA required several large firms to pay substantial fines for willful underreporting.<sup>33</sup> These penalties likely increased reporting thereafter,<sup>7</sup> but primarily among very large firms.

Evidence suggests that small firms are especially prone to underreport. First, Seligman et al.<sup>15</sup> found that OSHA recordkeeping was the worst for small firms and the best for large firms. Second, the BLS Annual Survey data indicate that small firms have among the lowest reported injury rates of all firms.<sup>34</sup> However, data from the BLS's Census of Fatal Occupational Injuries (CFOI)<sup>35</sup> and 8 studies<sup>36-43</sup> show small firms have the highest rates.

Glazner et al.<sup>20</sup> estimate that data from the construction of the Denver

Airport resulted in injury rates that were “at least 2.3 times those published by the BLS” (p.108). Let A be the Annual Survey estimate. This implies  $A + (A \times 2.3) = 100$ . Solving for A yields  $A = 30.3$ . The Annual Survey counts 30.3% but misses 69.7%. Glazner et al.<sup>20</sup> also estimate that the Annual Survey misses fewer lost work-time injuries than injuries that do not result in lost work time.

OSHA began issuing heavy fines for recordkeeping violations in April 1986. However, these fines were most visibly directed at very large manufacturing companies. From 1985 to 1988, manufacturing plants with more than 2500 workers increased their reported rates of cases (per 100 employees) from 4.4 to 10.5.<sup>7</sup> This is a 139% increase. At the same time, rates for all firms combined rose only a small amount, from approximately 8.2 to 8.5, a 4% increase. The great majority of firms in the United States are not large manufacturing concerns and likely did not feel threatened by OSHA’s penalty policy. If we assume a 3-year upward trend in rates for all firms, then we can subtract 4% from 139% to yield 135%. Although Ruser<sup>7</sup> does not draw any conclusions from these numbers, one could argue that this 135% indicates the amount of “willful” underreporting by firms that are covered by the Annual Survey. This 135% implies the BLS is counting 42.6% of injuries and missing 57.4%.

The Annual Survey estimated 2800 injury and disease deaths in 1991 (the last year it estimated deaths).<sup>1</sup> The CFOT, just 1 year later, counted 6063 injury deaths alone.<sup>44</sup> In an analysis available from authors, we adjusted for: 1) government workers, 2) illness deaths, and 3) a time trend. We estimated that in 1992, the Annual Survey would have missed 43% of all injury deaths from businesses that were required to report them to the BLS.

McCurdy et al.<sup>45</sup> studied 16 sites from different firms in the semicon-

ductor industry. They found 40% of cases were excluded from OSHA logs.

Carpal tunnel syndrome (CTS) is defined as an illness but must be reported to the BLS. Nelson et al.<sup>46</sup> compared records on OSHA 200 Logs with insurance claims data among unionized automobile workers. Their data suggest that the Annual Survey missed 21%. This undercount is especially significant because it is frequently argued that unionized automobile industry employees would be among the most likely employees to exercise their rights for WC benefits.<sup>47</sup>

Fingar et al.<sup>48</sup> estimated that the Annual Survey misses 20% of cases in one county in Georgia.

OSHA has paid for outside audits of firms’ injury and illness records.<sup>26,49</sup> More than 250 firms have been audited each year since 1997. The audits suggest that firms underestimate injuries and illnesses by roughly 11% overall and 22% to 23% for lost-workday cases. However, there are problems with these audits. First, the audits primarily check whether a firm’s internal records are consistent. If a worker never reports an injury in the first place, the OSHA audit would not likely uncover this case. Second, firms whose records are not in compliance with OSHA standards are not audited. They are fined. However, firms with noncompliant records are more likely to be the ones that underreport than compliant firms. Third, small firms (those with fewer than 40 employees) are not audited at all. However, it is likely that small firms underreport more than large firms. Fourth, all construction firms are excluded from the audit. Yet, as Glazner’s<sup>20</sup> research demonstrates, construction firms underreport.

In 1999, the Annual Survey reported 23,225 assaults and violent acts that resulted in at least 1 day away from work. We compared this BLS estimate with that of the National Crime Victimization Survey (NCVS) data. The BLS and NCVS

estimates did not differ at the 95% confidence level. We concluded that the Annual Survey’s number of 23,225 is a reasonable estimate so that a 0% undercount applied.

Although not directly addressing BLS undercounting, there are studies that have demonstrated undercounting in WC records and other government registries. Studies by Biddle et al.,<sup>50</sup> Morse et al.,<sup>51</sup> Rosenman et al.,<sup>52</sup> and Shannon et al.<sup>53</sup> (Canada) suggest that the percentages of people who could qualify for WC but who never file are 55%, 79%, 75%, and 35%, respectively. In addition, capture-recapture studies have demonstrated government undercounting of 41.4% (Maryland),<sup>8</sup> 91% (Connecticut),<sup>53</sup> 16.2% (Canada),<sup>54</sup> and 64.4% (The Netherlands).<sup>9</sup>

The National Health Interview Survey (NHIS) has also been used to estimate the number of occupational injuries.<sup>55</sup> It has an advantage in that economic incentives for workers not to report are weak to nonexistent. Nevertheless, it has serious sampling problems (available from authors). The 1994 estimate from the NHIS suggests the Annual Survey missed roughly 28.2% (NHIS = 8777,000; Annual Survey = 6300,000). We assumed this estimate already accounts for underreporting by workers.

## Methods

The idea behind our method was first to estimate the numbers of injuries among categories of workers omitted by design from the Annual Survey and second to consider the effects of underreporting. Our general model allowed for one estimate of the undercount when we assumed no underreporting and multiple estimates when we assumed multiple percents for underreporting. The general model and each specific model consisted of injury estimates for 6 broad categories of workers: our modified version of the BLS Annual Survey estimate, an estimate for federal government employees, for agriculture, for all state and local

government employees, for the non-agricultural self-employed, and for all “other” persons not covered by the Annual Survey such as private household workers. The reasons for the 6-fold classification were simple. First, we used existing injury data when available. We began with the Annual Survey. We looked for injury data for the excluded groups (federal government employees through “others”). We found reliable injury data for federal government employees<sup>56</sup> and agriculture (self-employed and farm workers).<sup>57,58</sup> However, for the other categories (state and local government workers, self-employed

outside agriculture, and “all others”), we created injury estimates. The last 3 categories were estimated with ratios of employment and estimates of relative risks. All 6 categories were assumed to be affected by underreporting. Our injury estimate was:

$$\begin{aligned}
 & \text{Total injury estimate} = (\text{number of injuries} \\
 & \text{in annual survey minus agriculture}) \times \\
 & \text{(underreporting)} \\
 & + (\text{federal government injury}) \times \text{(underreporting)} \\
 & + (\text{agricultural injury}) \times \text{(underreporting)} \\
 & + (\text{state and local gov't injury est.}) \times (\text{risk1}) \times \\
 & \text{(underreporting)} \\
 & + (\text{non-agriculture, self-employed injury est.}) \times \\
 & (\text{risk2}) \times \text{(underreporting)} \\
 & + (\text{others not in annual survey injury est.}) \times \\
 & (\text{risk3}) \times \text{(underreporting)}
 \end{aligned}$$

Because we had a separate estimate for agriculture injuries, the Annual Survey estimate for agricultural injuries was omitted from the first term in parentheses.<sup>57,58</sup> Percents of *underreporting* were discussed in the introduction and summarized in Table 5. The state and local injury estimate, the nonagricultural self-employment injury estimate, and the “others” estimate relied on ratios of employment multiplied by the Annual Survey estimate minus agriculture. Employment figures for state and local government, the Annual Survey excluding agriculture, self-employed, and “others,” were drawn from the BLS’s Covered Employment and Wage Program.<sup>59</sup> The following is an example for state and local:

$$\text{state and local gov't injury est.} = [(\text{employment} \\
 \text{in state and local gov't}) / (\text{employment in} \\
 \text{annual survey minus agriculture})] \times (\text{number} \\
 \text{of injuries in annual survey minus agriculture})$$

**TABLE 1**  
Employment and Fatality Statistics From BLS, Private Industry Only

Category	Employment (in millions)	Deaths*
Workers represented by annual survey	107.6†	
Workers not represented by annual survey		
Government		
Federal workers	2.8	67‡
State workers	4.3	108
Local workers	12.3	301
Additional state and local	0.9	0
Subtotal	20.3	475
Self-employed		
Self-employed farmers	1.3	395§
All other self-employed	8.8	744
Subtotal	10.1	1,139
Other		
Wage and salary, agriculture	0.1	
Domestics	0.5	
Unpaid family members	0.1	
Other	0.2	
Grand total	138.3	

† This 107.6 million is drawn from the Covered Employment and Wage Program. (<http://146.142.4.24/cgibin/surveymost?ew>; and Employment and Wages, Annual Averages, 1999, Appendix). The number published by BLS for employees covered by the Annual Survey in 1999 was 107,611.8 (thousand).

([www.bls.gov/news.release/osh.t02.htm](http://www.bls.gov/news.release/osh.t02.htm)), and according to Janice Devine at BLS (e-mail April 25, 2001).

\* Census of Fatal Occupational Injuries for 1999.

The Covered Employment and Wages (CEW) program does not include the self-employed and the self-employed are excluded from the Annual Survey. The CEW does include employment in households, whereas the Annual Survey does not cover households. CEW includes employees on farms with fewer than 11 employees, whereas these workers are excluded from the Annual Survey. The CEW excludes railroad workers, whereas the Annual Survey includes them. The “other” categories account for the difference between the CEW and the Annual Survey.

‡ Excludes 80 military deaths. 67 + 108 + 301 + 80 = 556, which <562. However, these numbers (147 federal includes military + 108 + 301) are from <http://www.bls.gov/iif/oshwc/foi/cftb0131.txt>.

§ Assume 34.68% self-employed are farmers<sup>62</sup> (Personick and Windau, 1995).

The first 2 risk variables, *risk1* and *risk2*, were estimated assuming non-fatal injury rates were proportional to fatal injury rates across industries. We assumed *risk3* = 1, because deaths were not available for “others.” We therefore assumed that persons in the “others” category held jobs that had the same riskiness as those held by persons in the Annual Survey, excluding agriculture.

We ran regressions using data from the Annual Survey and the Census of Fatal Occupational Injuries (CFOI) to estimate *risk1* and *risk2*. The Annual Survey provided rate data on over 200 industries in 1999. The Census of Fatal Occupational Injuries provided data on roughly 80 industries.<sup>60</sup> However, many of these 80 overlap, ie, the 1-digit SIC industry mining contained 3 2-digit SIC industries: metal mining, coal mining, and oil and gas extraction. To avoid double counting, we selected only 2-digit SIC industries and 1 1-digit SIC industry, construction, because the latter was the only 1-digit industry with no 2-digit categories. The sample size was 43. Rates were expressed as a ratio to the mean rate for all industries (5.9 per 100 for nonfatalities (*percent nonfatal*) and 4.8

**TABLE 2**  
Calculations of Employment Weights and Relative Risks

Risks and Weights Categories	Category of Employment					Annual Survey Excluding Agriculture
	State and Local Government	Nonfarm Self-employment	Other	Federal Government	All Agriculture	
Nonfatal injuries	—	—	‡	136,172 <sup>¶</sup>	388,294 <sup>#</sup>	5,235,000 <sup>††</sup>
Fatal injuries	409*	744*	‡	67 (no military)*	809	3,914 <sup>‡‡‡</sup>
Employment	17,500,000	8,800,000	600,000 <sup>§</sup>	2,800,000 <sup>†</sup>	**	105,580,000 <sup>§§</sup>
Ratios of deaths to employment	0.0000233	0.0000845	‡	0.0000239		0.00003707
Employment weights (eg, State and Local to Annual Survey)	0.165751	0.0833491	0.0056828			—
Relative risks, ie, predict values of generalized least squares regression of (nonfatal rate/5.9) on (fatal rate/4.8)	0.9638	1.0765	‡			—

\* Source is BLS Census of Fatal Occupational Injuries (CFOI).

† Source is BLS Covered Employment and Wage Program, and Appendix to *Employment and Wages Annual Averages, 1999*, which provides estimates for noncovered persons.

‡ We assume relative risk for persons in the “other” employment category is 1, ie, risk is identical to risks for persons covered by the Annual Survey. The CFOI does not provide an estimate of deaths in the “other” category.

§ Domestic (500,000) + unpaid family (100,000).

¶ Source is Office of Workers’ Compensation Program (OWCP) for federal employees.

|| We have estimates of nonfatal injuries for the federal government and agriculture. As a result, we do not need to estimate employment weights or relative risks.

# This estimate relies on the Traumatic Injury Surveillance of Farms (TISF) (Myers, 1997). The TISF estimated 201,081 lost-time work injuries in 1993. The TISF defined lost-time injuries as those resulting in 1/2 or more of one day of work lost. The “disabling” term used in many other analyses of injuries refers to at least one full day of work loss. The number associated with 12 a day or more will be bigger than the number associated with one day or more. A personal communication with the author of the NIOSH study (Myers, January 28, 1999) indicated that requiring one or more full days of loss to qualify as a disabling injury would yield a figure roughly 16% smaller than 12 of one day of work loss. Subtracting 16% yields 168,908 full-day disabling injuries. We assume that the same total number of injuries to lost-day injuries ratio applies to the TISF as applies to BLS Annual Survey estimates within agriculture, in 1993 (113.1/43.5 = 2.6) (U.S. Bureau of Labor Statistics, 1996). Multiplying this 2.6 with 168,908 yields 439,161 total injuries for 1993. We assume the same mix of nondisabling to disabling (69.6 and 43.5, respectively), then our estimate would be 270,053 nondisabling and 168,908 disabling for 1993. However, we require a 1999 estimate. We therefore assume that the same ratio of our TISF estimate (439,161) to Annual Survey Agriculture estimate for 1993 (113,100) applies to 1999: (439,161/113,100) × 100,000 = 388,294 where 100,000 is the BLS Agriculture estimate for 1999. US Bureau of Labor Statistics. Occupational Injuries and Illnesses: Counts, Rates, and Characteristics, 1993. Bulletin No. 2478, US Department of Labor, Washington, DC, US Government Printing Office, August 1996.

\*\* This estimate is not necessary given our estimate of 388,294 for agricultural nonfatal injuries.

†† The Annual Survey recorded 5,335,000 injuries in 1999. Within Agriculture, Forestry and Fishing, it recorded 100,000. Difference is 5,235,000.

‡‡ CFOI all-US estimate = 6023. 6023 – 80 (domestic military) – 409 (state and local) – 744 (no-farm self-employed) – 67 (federal) – 809 (agriculture (farm)) = 3,914.

§§ Assume ratio of agriculture injuries from Annual Survey to all injuries applies to agricultural employment covered by the Annual Survey: 100,000/5,335,000 = 1.87441%.

Subtract same from Annual Survey employment 107.6 – (107.6 × 0.0187441) = 105.58. Agriculture is more hazardous, but likely much more underreporting as a result of seasonal workers when compared with typical Annual Survey industry.

per 100,000 for fatalities (*percent fatal*). Because employment within industries varied significantly, we multiplied the injury rates by the square root of level of employment. This square root factor weights the rates in inverse proportion to their variances (generalized least squares).<sup>61</sup> We regressed *percent nonfatal* on *percent fatal*. Results were the following:

$$\text{percent non-fatal} = 0.9209 + .0884 (\text{percent fatal}).$$

Both the intercept and slope coefficients generated *P* values smaller than 0.001. *R*<sup>2</sup> was 0.55.

The variables *risk1* and *risk2* corresponded to the predicted values for *percent nonfatal* for state and local government and nonagricultural self-employment. Plugging in values for *percent fatal* for state and local and self-employed yields estimates of 0.96 and 1.08, respectively. The relative risks suggested that state and

local government work was roughly 96% as dangerous (4% less dangerous) as work covered by the Annual Survey excluding agriculture, but that nonagriculture self-employment was 1.08 as dangerous (8% more dangerous) as work covered by the Annual Survey excluding agriculture.

The variable *underreporting* is defined as 1/(1-p) where “p” is the assumed percentage for the underre-

**TABLE 3**

Model 1, Assuming *Underreporting* = 1 (no underreporting)

Category	1 Employment Weight	2 Relative Risk (risk1, risk2)	3 Annual Survey Injuries minus agriculture (millions)	Product: Column 1 × 2 × 3 or Estimate From Table 2
State and Local Government	0.1658	0.9638	5.235	0.8365
Nonfarm self-employment	0.0833	1.0765	5.235	0.4694
All others	0.0057	1	5.235	0.0297
Federal Government				0.1362
Agriculture				0.3883
Subtotal				1.8601(million)
Ratio to actual Annual Survey estimate (1.8601/5.335)				34.87%
Undercount as percent of total (1.8601/7.0952)				26.22%
Grand total (Annual Survey less agriculture + 1.8601 million)				7.0951 million

**TABLE 4**

Estimates for Models 1 and 2

Category	Model	
	1: Assumes No Underreporting	2: Assumes 40% Underreporting
1. Annual Survey minus agriculture	5.235 million	8.7252 million
2. Agriculture	0.3883 million	0.6472 million
3. Federal Government	0.1362 million	0.2270 million
4. State and Local Government	0.8365 million	1.3942 million
3. Nonfarm self-employment	0.4694 million	0.7823 million
4. Other	0.0297 million	0.0496 million
5. Total	7.0951 million	11.8252* million
6. Underestimate (row 5 — 5.335)	1.7601 million	6.4902 million
7. Percent underestimate (row 6 divided by row 5)	24.8%	54.9%
8. Percent captured by Annual Survey (100% - row 7)	75.2%	45.1%

\* Does not sum precisely as a result of rounding. However, (7.0951/0.6) = 11.8252.

porting. Our base estimate, model 1, assumes  $P = 0$ , ie, *underreporting* = 1 and there was no underreporting.

Model 1 estimate =

(number of injuries in annual survey minus agriculture)

- + (federal government injury)
- + (agricultural injury)
- + (state and local gov't injury est.) X (risk1)
- + (non-agriculture, self-employed injury est.) X (risk2)
- + (others not in annual survey injury est.)

Multiple estimates were generated by allowing *underreporting* and “p” to vary.

Total injury estimate = (Model 1 estimate) X (1/(1-p)).

The ratio 1/(1-p) is an underreporting multiplier similar in mathemati-

cal structure to the simple Keynesian multiplier,  $1/(1 - \text{marginal propensity to consume})$ .

**Results**

Table 1 presents employment statistics from the BLS’s Covered Employment and Wage Program for 1999 (CEW99) as well as *Employment and Wages, Annual Averages, 1999, Appendix*<sup>59</sup> (which includes a table entitled “Excluded From Private Sector Coverage in 1999 Were Approximately. . .”). The population that CEW was designed to represent was nearly identical to the one the Annual Survey was designed to represent. In fact, they published the

same number covered: 107.6 million. The total number of employees and self-employed was 138.3 million. The Annual Survey was therefore intended to cover 77.8%.

Model 1 estimates involved calculations presented in Table 2, which included estimates of employment weights and estimates of relative risks. Employment weights are ratios of employment in the categories omitted from the Annual Survey to employment included in the Annual Survey. The state and local government employment weight was 0.165751 (Table 2). Death rates indicated state and local government work was relatively safe (2.33 per 100,000), and nonagriculture self-employment was dangerous (8.45 per 100,000) compared with employment covered by the Annual Survey excluding agriculture (3.71 per 100,000) (Table 2).

Results for model 1 are given in Table 3. The total estimate was 7.0951 million, some 35% larger than the BLS Annual Survey estimate of 5.335 million, including agriculture.

Model 1 assumed no underreporting. Model 2 began with the simple estimate from model 1 but adjusted for underreporting. Model 2 assumed 40% underreporting ( $p = 0.4$ ). A summary of the results on models 1 and 2 is presented in Table 4. Note

**TABLE 5**  
Estimated Percentages of Injuries Missed by the Annual Survey

Annual Survey	Underreporting Estimate From Separate Studies	Estimates from Our Model	
		No. of Injuries (millions)	Percent Missed by Annual Survey
Firms and Workers Covered by Annual Survey			
Glazner et al., <sup>20</sup> total	70%	23.6503	77.4%
Glazner et al., <sup>20</sup> lost worktime only	59%	17.3051	69.2%
Our analysis of Ruser's data	57%	16.5002	67.7%
Our analysis of Census of Fatal Occupational Injuries	43%	12.4475	57.1%
McCurdy et al. <sup>45</sup>	40%	11.8252	54.9%
Nelson <sup>46</sup>	20%	8.8689	39.8%
Fingar et al. <sup>40</sup>	20%	8.8689	39.8%
OSHA audit <sup>49</sup>	11%	7.9720	33.1%
Our analysis of National Crime Victimization Survey	0%	7.0951	24.8%
Workers' Compensation, Capture–Recapture, and National Health Interview Survey			
Morse et al. <sup>51,53</sup>	79%	33.7862	84.2%
Rosenman et al. <sup>23</sup>	75%	28.3804	81.2%
Van Charante, Mulder <sup>9</sup>	64%	19.7086	72.9%
Biddle et al. <sup>50</sup>	55%	15.7669	66.2%
Cormack et al. <sup>8</sup>	41%	12.0256	55.6%
Shannon et al. <sup>52</sup>	40%	11.8252	54.9%
Rosignol <sup>54</sup>	16%	8.4465	36.8%
Warner et al. <sup>55</sup>	28%*	—	28.2%*

\* Estimate from National Health Interview Survey. We assume it accounts for underreporting. This 28.2% was not an estimate from our model.

that model 2's estimates were (1/(1-.4)) or 1.6667 times model 1's estimates.

Table 5 presents estimates for a variety of assumed percentage undercounts; it summarizes our review of the literature and our own analyses of existing data. The studies fall into 2 different sets. First are those studies that look at firms which the Annual Survey is designed to represent (Glazner et al.,<sup>20</sup> OSHA penalty data, our analysis of the CFOI, McCurdy,<sup>45,46</sup> Finger,<sup>48</sup> OSHA audit,<sup>49</sup> and NCVS). Second are the studies: on reporting to WC; using the capture–recapture method; by government agencies in general (Van Charante et al.,<sup>9</sup> Cormack et al.<sup>8</sup>); and the National Health Interview Survey (NHIS).<sup>55</sup> The percentages in the first set range from 0% to 70%; the

percentages in the second from 16% to 79%. These percentages in the first set apply to underreporting, not to the injuries among persons in categories omitted by the Annual Survey or WC. If we take the lowest percent, 0%, this would be our model 1, which assumed 0% underreporting. The total underestimate, including categories excluded by the Annual Survey, generated by model 1 is 24.8%. If, instead, we take the median value in the top panel of Table 5, 40%, our model suggested the Annual Survey missed 54.9% of all injuries.

The range in Table 5 is from 24.8% to 84.2% for underreporting. A 24.8% underreporting estimate implies the actual number of injuries was 33.0% (24.8/75.2) more than the BLS estimates. A 70% underreport-

ing estimate, the highest number in the Annual Survey set (top panel of Table 5), implies the actual number was 233% more. The estimates for firms covered by the Annual Survey in the top panel of Table 5 are likely the most credible. If we exclude the highest (70%) and lowest (0%) estimates for the percentage of underreporting (p), we have a range of 11% to 59%. This corresponds to the Annual Survey missing from 33% to 69% of all injuries.

## Discussion

Our models suggest there was substantial undercapture in the BLS Annual Survey, much of it in the excluded categories (government workers, the self-employed). At a minimum, assuming no underreporting, the Annual Survey missed 24.8% of all injuries, on a par with the percent of employment (22.2%) attributed to excluded categories. Given the literature and analyses summarized in Table 5, however, we believe there was underreporting and that the Annual Survey missed between 33% to 69% of all injuries.

## Limitations

We used data from only 1 year, 1999. However, our estimates were based on exceptionally large national datasets. For example, the Annual Survey was drawn from 165,000 business establishments. The CFOI was a count (not an estimate) of deaths that employs data-gatherers for the Departments of Labor and Industrial Relations in all 50 states. The BLS Covered Employment and Wage Program collected data from roughly 7.6 million business establishments. The National Institute of Occupational Safety and Health study of farm injuries was based on responses from 12,990 farmers.<sup>57</sup>

A limitation pertains to the employment ratios in the models. Government employment likely had a smaller percent of part-time workers than private employment. However, these ratios were used only for state and local government, not federal.

In our model, the *underreport* variable was the same for all categories of workers. However, no evidence was available suggesting how *underreport* should vary across categories.

We counted injuries associated with workdays lost together with those that did not result in workdays lost. Workdays-lost injuries were more serious than those without loss. Nevertheless, injuries without loss could still have been serious. A broken arm could have occurred in the morning, have been set in the afternoon, and a worker could have returned to light duty the next day without missing a full day of work. Moreover, nonworkloss days are numerous and costly.<sup>44</sup>

We assumed nonfatal injuries were proportional to fatal ones. If our objective were to estimate an undercount for a particular occupation or industry, this assumption might be problematic. However, our goal was to estimate the undercount for all occupations and industries combined. So, for example, this assumption might have resulted in an overestimate of nonfatal injuries among especially dangerous self-employment jobs, but it was likely to result in an underestimate in jobs for which mortality was low but strain injuries were high (government hospitals).

It is worth noting that all reasonable estimates of *risk1*, *risk2*, *risk3*, regardless of whether nonfatal injuries were assumed to be proportional to fatal ones, yielded similar final conclusions regarding the overall undercount. This was because these categories, state and local government, self-employment, and "other," comprised roughly 25% of all employment. They were unlikely as a group to have a nonfatal rate considerably more or less than the rate for all industries combined in the Annual Survey.

A final potential limitation was our decision not to compare National Health Interview Survey (NHIS) estimates with the Annual Survey. However, there are serious reserva-

tions about the accuracy of the NHIS data pertaining to injuries, eg, small sample sizes.

## Conclusion

It is likely the Annual Survey missed from 33% to 69% of nonfatal injuries in 1999. Given that no substantive changes have been made to the Annual Survey since 1999, similar undercounts likely persist today. The government statistics seriously undercount the national burden of occupational nonfatal injury. Because many employer groups, unions, scientific associations and the media rely on these statistics, an undercount of this size might result in too few resources directed toward improving occupational safety.

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