Research summaries

Disabling injuries in longshore operations

Amy Lettman

In colonial times, bells summoned men of varied trades to the hazardous task of manually unloading ships along the shore. Today, cargo handling on the waterfront is quite mechanized, but the risks of disabling injuries are still evident, even for the experienced dockworkers who dominate these jobs. The Bureau of Labor Statistics tracked the incidence of injuries and illnesses among longshore workers as part of its 1987 annual survey; it reported 10 cases in which worktime was lost for every 100 full-time workers in water transportation services, compared with about 4 per 100 in the total private sector. The severity of these disabling longshore cases, moreover, is also evident in the number of workdays lost: an average of 41 days per case, double the national average (18 days).[1]

The frequency and severity of injuries involving longshore operations prompted the Occupational Safety and Health Administration to request a special BLS study.[2] In response, a longshoring study was designed that, unlike the BLS annual survey, focused on the characteristics of workers and their injuries as well as the factors surrounding the incident, such as worksite conditions at the time of the accident and use of personal protective equipment. In addition to loading and unloading ships, this study included cases at shoreside operations of marine terminals and related areas where cargo is handled and stored and where cargo handling and other equipment is maintained.

Four-fifths of the 582 cases included in this study were placed in seven distinct job categories. (See table 1.) The "holdman," who commonly works below the deck of a vessel where the cargo is stowed, was numerically the most important job title, accounting for three-tenths of the total cases. "Driver" (forklifts, tractors, and so forth) accounted for one-sixth, and "dockman"—who assists equipment operators to hook on cargo, for example—made up one-eighth of the injured. Other injured workers were either classified as checker, deckman, maintenance mechanic, or warehouse worker, or

Table 1. **Injuries involving longshore operations, selected characteristics, 1985–86**

Characteristic	Percent of total cases
Job category at time of accident:	
Clerk, checker	7
Deckman	5
Dockman	12
Driver; forklift, tractor, and so forth	15
Holdman	29
Maintenance, mechanic, gearman	7
Warehouse or shedworker	6
Other	19
Nature of injury:[1]	
Cut, laceration, puncture	19
Bruise or contusion	28
Muscle sprain or strain, torn ligament	48
Hernia	1
Fracture	18
Object in eye(s)	4
Other	9
Part of body affected:	
Head, including neck	9
Upper extremities	19
Trunk	28
Lower extremities	28
Multiple parts[2]	14
Activity at time of accident:	
Handling cargo/equipment by hand	31
Helping crane or winch operator to load or unload cargo	19
Driving yard tractor, lift truck, or other mobile equipment	10
Using hand tools	3
Activity at time of accident—Continued	
Climbing or coming down ladder, gangway, vehicle, and so forth	9
Checking cargo	6
Fixing or repairing gear, equipment, or container	6
Other	15
Personal protective equipment worn:[1]	
Dust mask	3
Gloves	59
Hardhat	77
Reflective vest or jacket	3
Safety goggles	5
Steel-toed safety boots or shoes	61
Other	4
Not wearing any safety gear	9
Worksite conditions contributing to the accident:[1]	
Too noisy	2
Poor weather conditions	6
Cluttered work area	8
Slippery work surface	17
Uneven work surface	19
Equipment broke or did not work properly	16
Working in too small or tight an area	13
Hard to see or bad lighting	9
Work area not properly safeguarded	5
Other worksite condition	8
None	29

1 Because more than one response is possible, the sum of the percentages exceeds 100.
2 Applies when more than one major body part has been affected, such as an arm and a leg.

NOTE: Percentages are based on the total number of persons who answered the question.

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were placed in the "other" category—a diverse group ranging from first-line supervisor to general laborer.

Youth and inexperience were not contributing factors to longshoring injuries: Three-fourths of those injured were 35 years or older, and four-fifths had been in their job category for at least 5 years. There were indications that the age-experience profile for injured workers mirrored that for all longshoring workers. Automation and foreign competition, for instance, have greatly reduced the amount of labor needed to handle cargo, thus limiting the entry of new workers into the industry.

The study reported on how longshore injuries occurred (accident type and source of injury) and described the injury (nature and part of body affected).[3] Most commonly, injuries were the result of being struck by or striking against crates, containers, and other cargo, or similar contact with cargo-handling equipment. Falls and overexertion (from lifting heavy objects) were also characteristics of longshoring accidents. Resulting injuries usually were muscle sprains and strains (especially to the back and lower extremities), serious cuts and bruises, and fractures.

About four-fifths of these longshoring cases resulted in lost worktime; not surprisingly, the most serious injuries, such as fractures and back sprains, usually required several weeks away from the physically demanding work of the docks. One-eighth of all cases resulted in hospitalization overnight; for these cases, hospital stays averaged 6 nights.

Besides recounting the characteristics of their cases, injured workers indicated that they were, with few exceptions, wearing personal protective equipment at the time of their accident. Not surprisingly, though, hardhats, gloves, and safety footwear often did not prevent the types of impact injuries associated with longshoring operations. Instead, workers felt that certain worksite conditions or factors, rather than inadequate safety gear, contributed to their accidents. Most often, they cited slippery or uneven work surfaces, faulty equipment, and confined space as problem conditions, and hurrying or being rushed and being unaware of danger as accident-related factors.

Most injured workers lacked recent safety training in longshore operations, but few cited this omission as a contributing factor to their accident. Of those who had received training during the 3 years preceding their accident, the training commonly covered the operation of mobile equipment and handling cargo. Training aside, a clear majority of the injured workers believed that safety rules were usually enforced.

Almost four-fifths of the workers felt that their accident could have been avoided, citing a wide variety of preventive actions, methods, and procedures. These measures included having more people, more time, and better equipment to perform the task.

A COMPREHENSIVE REPORT, *Injuries Involving Longshore Operations*, Bulletin 2326, may be purchased ($1.50) from the Superintendent of Documents, Government Printing Office, Washington, DC 20402, or from the Bureau of Labor Statistics, Publication Sales Center, P.O. Box 2145, Chicago, IL 60690. The bulletin provides additional information on the characteristics associated with longshoring accidents. □

Footnotes

[1] Marine cargo handling accounts for a clear majority of the workers in water transportation services. The latter group includes substantial numbers of workers doing miscellaneous services incidental to water transportation, such as chartering commercial boats. See *Occupational Injuries and Illnesses in the United States by Industry, 1987*, Bulletin 2328 (Bureau of Labor Statistics, 1989).

[2] The study covers cases processed under the Federal Longshoremen's and Harbor Workers' Compensation Act during October 1985 in the New York Office of Workers' Compensation Programs and during April 1986 for the following other offices: Baltimore, Boston, Houston, Jacksonville, Long Beach, New Orleans, Norfolk, Philadelphia, San Francisco, and Seattle. Excluded were cases in which the employer was engaged in drydock and ship repair activities, cases that were 120 days old or more, and those that involved assaults or resulted in fatalities.

[3] The injury characteristics used in this study—type of accident, source of injury, nature of injury, and part of the body affected—were classified using the American National Standards Institute Z16.2 (1962) *Method of Recording Basic Facts Relating to the Nature and Occurrence of Work Injuries*, as modified by BLS.

Federal agencies seek improvement in quality in establishment surveys

Quality in Establishment Surveys is a Federal report that examines the potential sources of error in Government surveys of business establishments. Not intended as either a springboard for defining standards or a means of evaluating current practices, the interagency report aims to provide survey practitioners with useful reference and guidance in designing and refining establishment surveys. Information for the report was garnered from a questionnaire concerning the survey design practices for 55 Federal establishment surveys from nine agencies.

Errors occur in surveys at two possible points: in the sample design and estimation (sampling error) and in the survey methods and operations (nonsampling error). Errors of either variety can be *variable*, that is, randomly introduced and distributed, or instances of *bias*, that is, nonrandom, systematic error. Control of both of these is important to establishing the quality of the survey.

Sampling error results from (1) the sample design itself and (2) the method of estimating the probability of occurrence in the entire population of a feature characterizing the sample population. The sample design may contribute to errors in a number of different ways. First, because establishment surveys are usually dominated by a select few units, differential sampling by establishment size is performed, often involving certainty selection for the larger units. In some cases, very small units may be given zero probability of selection and may thereby be altogether excluded from the target population. Second, conflicting design objectives may result in tradeoffs having to be made wherein reliability may be compromised, or at least not improved. For example, when detailed publication cells are required, the size of the sample must be increased, often without a concomitant increase in reliability in the aggregate cells. Finally, the requirement for revision and updating of the survey design may result in several kinds of error. Issues that must be faced during survey redesign involve the continuity, availability, and current analyzability of the data. In respect of the first of these, very often the usefulness of the data depends on longitudinal features as much as on current measurement.

Errors resulting from sampling estimation have two sources: the actual estimator used and the approach to the estimation of variance used. As regards the former, there are four commonly used estimators, each with its own peculiar advantages and disadvantages. The *direct expansion estimator*, given by

$$\hat{Y} = \sum_{i=1}^{n} W_i Y_i \ ,$$

where $\hat{Y}$ is the estimated total, W_i is the weight applied to sample unit i, and Y_i is the reported value of sample unit i, has the advantage of being operationally simple, unbiased, and linear in its variance estimator. Its chief disadvantage is that is it not very efficient. The *ratio estimator*,

$$\hat{Y}_R = \frac{\hat{Y}}{\hat{X}} X = \frac{\sum_{i=1}^{n} W_i Y_i}{\sum_{i=1}^{n} W_i X_i} X \ ,$$

where X and Y are at least moderately positively correlated features of the population of interest and X is the complete enumeration total of the X_i, is an improvement over the direct expansion estimator because of the existing correlation, but is biased due to its nonlinear form and confronts the researcher with the problem of deciding whether to use ratio estimates formed separately for each sampling stratum and then summed across all strata or formed for all the strata combined. The *link-relative estimator*, which is similar to the ratio estimator except that only reported values of X_i and Y_i are used and weights may not be included, is considerably biased in practice because the units reporting are rarely representative of the universe in question. The *unweighted estimator* is severely biased, even as regards trends, but is sometimes employed because it is simple and inexpensive to use.

Estimating variance usually results in the computation of the mean squared error of an estimator. The mean squared error in turn is composed of two parts: the sampling variance and (the square of) a bias component. Although the latter may be the dominant part of the total mean squared error, it is very difficult and expensive to measure, so that in practice it is rarely reported on in establishment surveys. By contrast, sampling variance is often readily estimable from the data, although for one reason or another, by the time they go to print, only one-half of Federal establishment surveys actually include this statistic. The simplest approach to the calculation of sampling variance is to base the variance on the sampling design. When the design is linear, no problems ensue and the calculation is straightforward. However, more often than not, the estimator used is nonlinear, and then it is impossible to use a design-based variance. More complex calculations of variance bring higher level difficulties with them, and in the end it may be that the variance is not computed at all because of the cost of the computer time involved, or, if it is computed, it may not be published, again because of cost considerations. Finally, aside from monetary cost, the considerable delay needed to compute variances may be seen as too great a price to pay in time.

The second major category of establishment survey errors is the nonsampling errors that occur in the survey methods and operations. Generally speaking, there are five kinds of nonsampling error: specification error, coverage error, response error, nonresponse error, and processing error. *Specification error* is the error that arises during the planning stage of a survey because data specification is either inadequate or inconsistent. It can result from poorly worded questionnaires or instructions, or it may be a reflection of the difficulty of measuring abstract concepts. Specification error is measured by performing record checks, cognitive or validation studies, pretests of questionnaires, and comparisons with independent estimates. It is controlled by requirement reviews, industry consultations, expert reviews, and, again, cognitive studies and questionnaire pretests.

Coverage error is the error that results from either (1) failure to include in the survey all of the units belonging to the defined population (undercoverage) or (2) failure to exclude from the survey some units that do not really belong in it (overcoverage). Coverage error may occur either because of defective sampling frames, that is, frames that are definitionally or intrinsically deficient in meeting the requirements of producing a representative, unbiased sample, or because of defective processes associated with an otherwise adequate sampling frame, for example, selecting samples that do not correctly represent the frame. Coverage error is measured by comparing current survey data with the results of earlier surveys or with data from external sources. Often such measures as the rate of unclassified units, rate of misclassified units, and rate of duplication are used. Control is achieved by identifying the areas where coverage error is most serious and assigning resources to reduce the error there. Among the techniques used are those which reduce miscoding, duplication, and omission of data, and those which get at the root of lack of timeliness and rectify it.

Response error may be thought of as the differences between the data values actually collected in the survey and the correct values. Response errors result from the failure of (1) the respondent to report the correct value, (2) the interviewer to record the value correctly, or (3) the survey instrument to measure the value correctly. Sometimes response error occurs because of subtle factors connected with the peculiarities of the situation, as, for example, when the interviewer inadvertently cues the respondent to a given answer. Measurement of response error requires a (usually complicated) mathematical model and is aimed at (1) estimating the precision of survey results, (2) identifying specific survey problems, (3) identifying improvements to the survey methodology, or (4) monitoring the effects of changes in the survey methodology. Response error is controlled most commonly by identifying those areas and classes of respondents of a survey which are more susceptible to unreliability in reporting than others and then changing the survey methodology to deal with them.

Nonresponse error is the result of a failure to collect complete information on all units in the selected sample. Nonresponse produces error in two ways: (1) The decrease in sample size or amount of information collected produces larger standard errors, and (2) to the extent that nonrespondents differ from respondents in a selected sample, bias is introduced into the survey. Nonresponse error is measured either directly, through collecting data from nonrespondents by means of a followup survey or from a source external to the survey, or indirectly, by calculating unit response rates (weighted or unweighted), item response rates, and rates of refusal. Only the direct measures give accurate estimates of bias, although the indirect measures give an indication of how serious the bias may be. Nonresponse error is controlled by making a strong effort to produce successful first contacts and by initiating vigorous followup efforts in the event of initial failure. Periodic benchmark surveys and quality control procedures also aid in controlling nonresponse error.

Processing error is the error in the survey results that arises from faulty implementation of otherwise correct survey methods. Categorized generally, such tasks as preparation of the questionnaire, data collection, clerical handling of the forms, and processing of the data by clerks, analysts, or computers all may result in processing errors. Processing error is measured mostly indirectly, through the keeping of performance statistics; only rarely does the opportunity for direct measurement of processing error arise, usually because processing error is inseparably mixed in with response, nonresponse, and coverage errors. Processing error is controlled most commonly by instituting standard quality control procedures like acceptance sampling and process-control techniques. Concomitantly, many surveys are designed to allow later processing stages to correct errors made in earlier stages.

Quality in Establishment Surveys is prepared by the Subcommittee on Measurement of Quality in Establishment Surveys of the Federal Committee on Statistical Methodology, under the joint sponsorship of the Statistical Policy Office, Office of Information and Regulatory Affairs, and Office of Management and Budget. Thomas J. Plewes, Associate Commissioner, BLS Office of Employment and Unemployment Statistics, chaired the subcommittee. The report, priced at $21.95, is available from NTIS Document Sales, 5285 Port Royal Road, Springfield, VA 22161. □

Shiskin prize awarded to Frank de Leeuw

Frank de Leeuw, an economist with the Bureau of Economic Analysis, received the 10th annual Julius Shiskin Award for Economic Statistics. de Leeuw was honored for "his wide range of contributions to economic statistics that were characterized by the efficient use of statistical techniques and a practical analytical focus." The award was presented at the Washington Statistical Society's annual dinner in June, along with an honorarium of $500. The prize is named in honor of the ninth U.S. Commissioner of Labor Statistics.

The Shiskin award program is designed to honor unusually original and important contributions in the development of economic statistics or in interpreting the economy. Participating organizations in the program are the Bureau of Labor Statistics, Bureau of the Census, Bureau of Economic Analysis, Office of Management and Budget, National Bureau of Economic Research, National Association of Business Economists, and the Washington Statistical Society. The late Commissioner Shiskin was associated with all of these organizations during his long career.