INJURIES, ILLNESSES, AND HAZARDOUS EXPOSURES IN THE MINING INDUSTRY, 1986-1995: A SURVEILLANCE REPORT

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FOREWORD

This publication represents the first comprehensive surveillance report on injuries and illnesses in the U.S. mining industry. The tracking of occupational injuries, illnesses, and hazards, documents the Nation's progress in reducing the burden of work-related diseases and injuries and may help identify old and new problems that require additional research and prevention efforts. It is through surveillance data that we have been able to document that during the 20th century, deaths in the mining industry dropped approximately 37-fold and injury fatality rates have decreased approximately 13-fold, to 25 per 100,000 during 1996-1997. Much of this success can be attributed to research, which led to workplace interventions (such as safer equipment and improved ventilation), and regulations. Despite the progress that has been made in reducing the death and injury toll in mining, much work remains to be done.

The National Institute for Occupational Safety and Health is now the only federal agency with a mandate to conduct research and prevention activities for all the nation's workers, including the vital mining workforce. There are many challenges facing NIOSH in the field of mine safety and health in the new millennium. Traditional causes of injuries and fatalities and the potential for underground disasters still exist in U.S. mines today. For example, mine roof collapses account for a large portion of underground deaths and injuries. Respirable coal mine dust, which can lead to "black lung" disease, and harmful noise levels remain persistent health concerns. In addition, the introduction of new mining technologies may create new hazards not yet recognized in the field.

NIOSH is well positioned to meet these challenges and will continue to draw on its strong background of research, partnership, and prevention coupled with solutions-oriented engineering expertise. NIOSH will aggressively continue to develop the science and technology necessary to protect the safety and health of U.S. mine workers into the 21st century.

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ABBREVIATIONS

ANSI	American National Standards Institute
BLS	U.S. Bureau of Labor Statistics
BOC	U.S. Bureau of the Census
CFOI	Census of Fatal Occupational Injuries
CFR	Code of Federal Regulations
CI	confidence interval
CPS	Current Population Survey
dB	decibel(s)
dBA	decibel(s), A-weighted
hr	hour(s)
ICD	International Classification of Disease
ISO	International Organization for Standardization
kHz	kilohertz
L/min	liter(s) per minute
lb	pound(s)
mg	milligram(s)
mg/m^3	milligram(s) per cubic meter
MIPS	Mining Industry Population Survey
MRE	Mines Research Establishment
MSHA	Mine Safety and Health Administration
NCHS	National Center for Health Statistics
NEC	not elsewhere classified
NIOSH	National Institute for Occupational Safety and Health
NOHSM	National Occupational Health Survey of Mining
NOMS	National Occupational Mortality Surveillance
OSHA	Occupational Safety and Health Administration
PEL	permissible exposure limit
PMR	proportionate mortality ratio
SIC	Standard Industrial Classification
U.K.	United Kingdom
USBM	U.S. Bureau of Mines

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INTRODUCTION

This surveillance report summarizes data on work-related fatal and nonfatal injuries, illnesses, and hazardous exposures in the mining industry for the 10-year period 1986-1995. The term "surveillance," as used in public health, may be new to many readers of this report. With regard to occupational safety and health, the goal of surveillance is to describe the occurrence of work-related injuries, illnesses, and known hazardous exposures; to identify new hazards that may occur due to the introduction of new technology or other factors; and to assess the effects of preventive measures designed to improve worker safety and health. Surveillance provides an overall picture, which can be used to focus resources on areas most in need of prevention programs or further research.

Surveillance generally requires the use of multiple sources of data, all of which have their own strengths and limitations. Surveillance in the U.S. mining industry is complicated by the fact that U.S. national data systems that provide information on mining are based on *two different definitions of the mining industry*. One is established by the Mine Safety and Health Administration (MSHA), the other by the Standard Industrial Classification (SIC) System [Office of Management and Budget 1987] and the 1980 U.S. Bureau of the Census (BOC) Classification System [U.S. Bureau of the Census 1982].

The mining industry as defined by MSHA is based on the regulatory jurisdiction of that agency. Reporting requirements for injuries, illnesses, and workplace exposures are stipulated under the Federal Coal Mine Health and Safety Act of 1969 and the Federal Mine Safety and Health Amendments Act of 1977. Of note is that the oil and gas extraction industry falls outside of MSHA jurisdiction. The Occupational Safety and Health Administration (OSHA) was charged with enforcement in the oil and gas industry under the Occupational Safety and Health Act of 1970.

Under the SIC, the definition of mining covers the extraction of naturally occurring minerals, including liquids (petroleum), gases (natural gas) and solids (coal, metal, and nonmetallic minerals). Exploration and development of mineral properties are also included in the SIC definition of the mining industry. The SIC was developed by the Office of Management and Budget for use in classifying establishments based on the type of economic activity in which they are engaged and serves as the industry classification standard for all establishment-based Federal economic statistics. This classification is important for occupational safety and health surveillance because it also serves as the industry classification system for all data on work-related injuries and illnesses collected by the U.S. Bureau of Labor Statistics (BLS).

The U.S. Bureau of the Census uses an industry coding scheme similar to that used by the SIC. For the mining industry, the categorization is identical in both systems. Death certificate data made available by the National Center for Health Statistics (NCHS) are categorized under this system. Death certificate data are particularly important for surveillance of mortality from work-related illnesses.

Key differences between the SIC/BOC categorization system and the MSHA system can be summarized as follows:

- MSHA excludes the oil and gas industry, which is classified as part of the mining industry under SIC/BOC.
- MSHA excludes work that is done off of mine property; work off of mine property is included under SIC/BOC if it is performed by an establishment falling into one of the SIC/BOC mining industry codes.
- MSHA includes mine-associated mills and processing plants; these are classified under the manufacturing industry, rather than mining, according to the SIC/BOC coding structure.

Since the data collected by MSHA and the data collected by BLS and NCHS using the SIC/BOC classification system are both important sources of information on the mining industry and in many cases serve different purposes, data from both systems are presented in this report. In general, data using the SIC/BOC system are comparable across U.S. industries and should be used when comparing mining to other U.S. industries.

Much of the data in this report are presented in the form of frequencies or rates. A frequency provides only a count of the number of cases without providing any information about the risk of occurrence. Rates provide an estimate of the risk of injury or illness. *The reader is cautioned, however, that rates based on small numbers can be unstable; thus, any inferences should be drawn with care.* In this report, no rates are presented for groups in which there were fewer than three cases.

The incidence of most injury and illness conditions differs by age, sex, and race. For this reason, data in many surveillance reports are adjusted for these demographic factors. It was not possible to do this for most of the rates in this report because information on demographics was not available. With the exception of the proportionate mortality ratios (PMRs), all data presented are unadjusted.

A detailed account of the sources of data is in appendix A. The methods used in data selection and analysis are described in appendix B.

CHAPTER 1. FATAL INJURIES IN THE MINING INDUSTRY: CENSUS OF FATAL OCCUPATIONAL INJURIES

An examination of the Census of Fatal Occupational Injuries (CFOI) data for the period 1992-1995 shows that 659 fatalities occurred in the mining industry as defined by the SIC. Oil and gas accounted for slightly more than one-half of all fatalities (figure 1-1). The coal industry had the highest fatality rate for the 4-year period, with 35.6 deaths per 100,000 full-time workers, followed by metal (23.1 per 100,000), oil and gas (23.1 per 100,000), and nonmetal (20.1 per 100,000). The fatality rate for all U.S. industries during this same period was 5.1 per 100,000 full-time workers. Figure 1-2 compares the fatal injury rates by year for the four major industry sectors of mining to the fatality rate for all industries combined.

Figure 1-3 compares age-specific fatality rates in the mining industry to those seen for U.S. industry as a whole. Fatality rates for all industries combined were lowest for young workers and steadily increased in relation to workers' ages. In the mining industry, fatality rates by age group show a U-shaped curve. Young workers under 20 years of age had the highest injury rate (54.6 per 100,000), followed by workers aged 20-24 (50.8 per 100,000) and workers over age 65 (37.7 per 100,000).

Table 1-1 shows the distribution of injuries by type of injury event. The mining industry, in comparison with all industries, had a considerably larger proportion of fatalities classified as *caught in or crushed by collapsing materials* (9.1% and 1.9%, respectively) and *fires and explosions* (10.0% and 3.1%, respectively). *Transportation events* comprised the largest proportion of fatal injuries in both the mining industry and all industries. Within the mining industry only, *transportation* accounted for the largest proportion of fatalities in all mining sectors except coal. A more detailed examination of the transportation events within the mining industry showed that highway incidents (50.5%) were the most common, followed by nonhighway incidents (22.2%), pedestrian incidents (10.6%), and those incurred during rail, water, and air transport (15.7%). Incidents involving *caught in or crushed by collapsing materials* comprised a higher percentage of injuries in the coal and metal sectors, while fall-from-height incidents were more frequent in the oil and gas sector. The classification system used in CFOI for type of injury event is not compatible with any variables contained in the MSHA data; therefore, direct comparisons are not attempted.

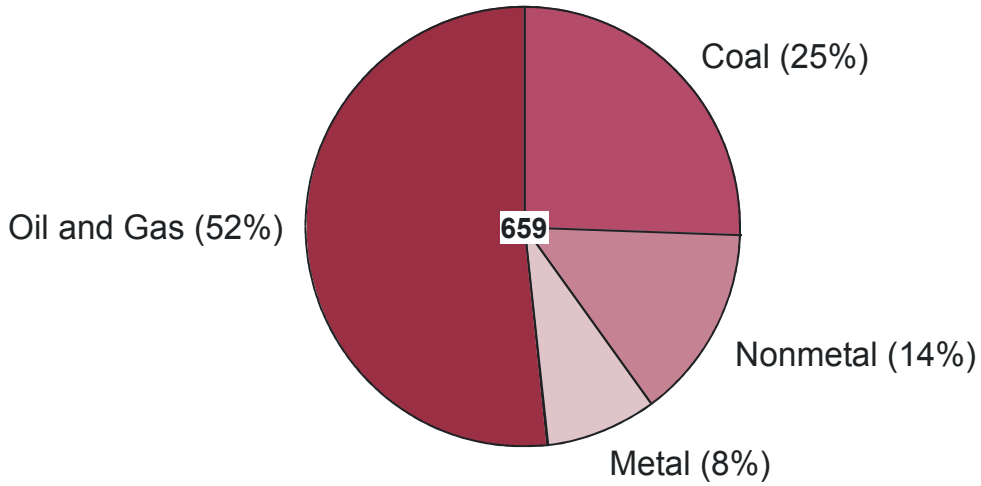


Figure 1-1.—Percentage of fatal injuries in the mining industry by industry sector, 1992-1995. (Note: "Nonmetal" Includes nonmetallic minerals, stone, and sand and gravel.) (Source: CFOI data-BLS)

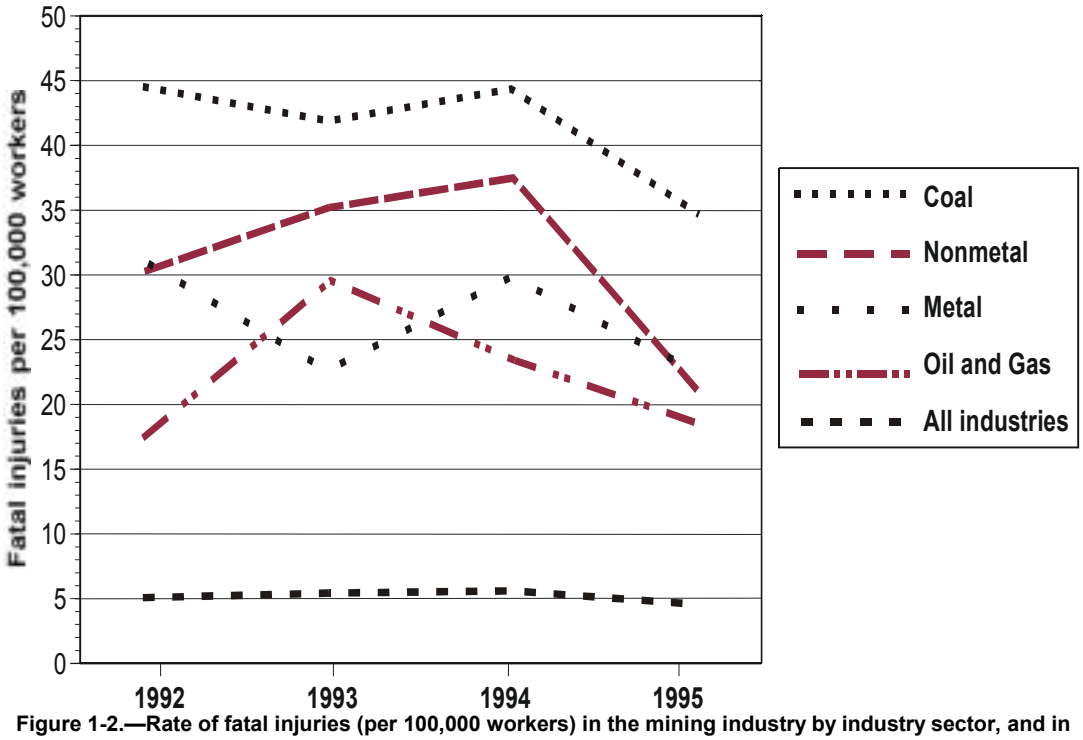


Figure 1-2.—Rate of fatal injuries (per 100,000 workers) in the mining industry by industry sector, and in all industries, 1992-1995. (Note: "Nonmetal" includes nonmetallic minerals, stone, and sand and gravel.) (Source: CFOI data-BLS)

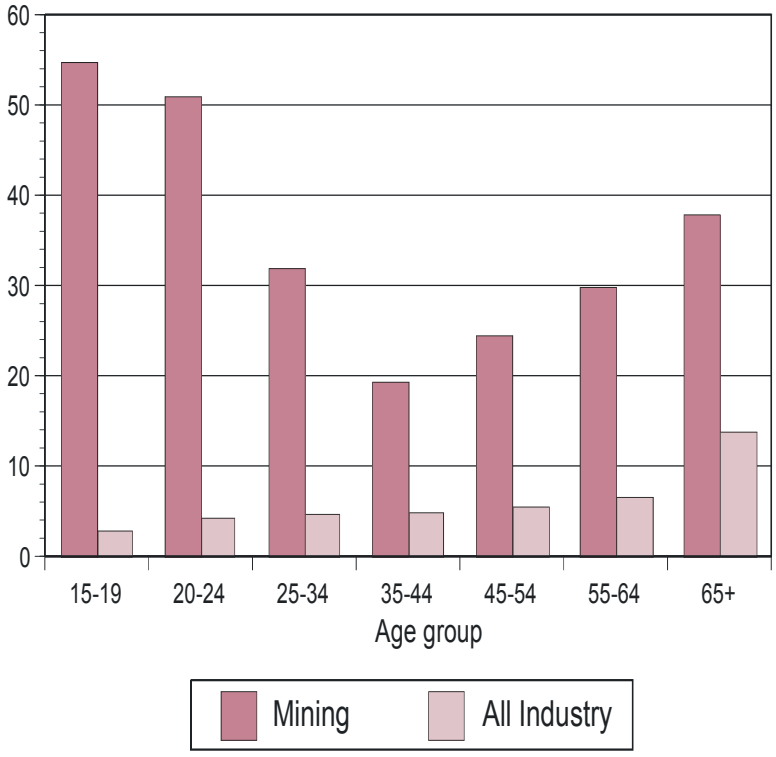


Figure 1-3.—Rates of fatal injuries (per 100,000 workers) by age group in the mining industry and in all industry, 1992-1995. (Source: CFOI data-BLS)

Table 1-1.—Number and percent of fatal injuries by type of event for all U.S. industries and for the mining industry by sector, 1992-1995.

Injury event	Coal	Nonmetal	Metal	Oil and gas	All mining	All industries
Struck by falling object	18 (10.7%)	2 (2.1%)	7 (12.7%)	43 (12.6%)	70 (10.6%)	1,400 (5.6%)
Caught in or compressed by equipment or Objects	31 (18.5%)	9 (7.4%)	2 (3.6%)	15 (4.4%)	57 (8.6%)	1,157 (4.6%)
Caught in or crushed by collapsing materials	35 (20.8%)	11 (11.6%)	10 (18.2%)	4 (1.2%)	60 (9.1%)	478 (1.9%)
Fall from height	3 (1.8%)	6 (6.3%)	2 (3.6%)	28 (8.2%)	39 (5.9%)	2,113 (8.4%)
Electric current	13 (7.7%)	6 (6.3%)	1 (1.8%)	26 (7.6%)	46 (7.0%)	1,348 (5.4%)
Transportation	34 (20.2%)	37 (38.9%)	21 (38.2%)	106 (31.1%)	198 (30.0%)	10,251 (40.8%)
Fires and explosions	19 (11.3%)	7 (7.4%)	4 (7.3%)	36 (10.6%)	66 (10.0%)	772 (3.1%)
All other	15 (8.9%)	17 (17.9%)	8 (14.5%)	83 (24.3%)	123 (18.7%)	8,991 (35.8%)
Total	168 (100%)	95 (100%)	55 (100%)	341 (100%)	659 (100%)	25,110 (100%)

Source: Census of Fatal Occupational Injuries.

CHAPTER 2. PROPORTIONATE MORTALITY RATIOS: NATIONAL OCCUPATIONAL MORTALITY SURVEILLANCE DATA

This chapter presents proportionate mortality ratios (PMRs) derived from death certificate data in the National Occupational Mortality Surveillance (NOMS) database for the years 1986 through 1993. At the time this report was prepared, 1993 was the latest year for which data were available. Industry is classified under the 1980 U.S. Bureau of the Census classification system [Bureau of the Census 1982]; cause of death, under the International Classification of Diseases, Ninth Revision (ICD-9) [World Health Organization 1977].

A PMR of 100 indicates a mortality risk for a particular industry group that is similar to that for all industry groups combined. A PMR over 100 suggests a higher risk; a PMR under 100 suggests a lower risk. PMRs are subject to many factors that affect their reliability and validity and may not be comparable across populations with very different causes of death. An elevated PMR for a specified cause of death among an occupational or industry group *may* indicate a relationship between a work exposure and the cause of death specified. However, there are many limitations of PMRs as a measure of risk; they are most useful for generating hypotheses about exposure-disease relationships, which can then be tested in other studies.

Selected PMRs are presented separately for males and females for coal mining, metal mining, nonmetallic mineral mining and quarrying (which includes nonmetal, stone, and sand and gravel), and for oil and gas extraction. All PMRs have been adjusted for age and race. In general, PMRs are presented only if the lower 95% confidence limit exceeded 100. If a PMR in an ICD-9 subcategory was above 100, however, the PMR for the larger category into which the subcategory falls is always presented and may be less than 100.

PMRs can be expected to be elevated for conditions that have a high prevalence in particular occupational groups. PMRs showed elevated values for conditions known to affect miners, such as coal workers' pneumoconiosis, pneumoconiosis due to silica, tuberculosis, chronic pulmonary heart disease, and injuries. Additional findings of interest were—

- An elevated PMR for myocardial infarction among male coal miners (table 2-1);
- Elevated PMRs for neurologic disease in general and anterior horn cell disease, in particular among male metal miners (table 2-3);
- An elevated PMR for rheumatic heart disease in male metal miners (table 2-3);
- Elevated PMRs for malignant neoplasms of the digestive organs and peritoneum and for malignant neoplasms of the colon and rectum in female nonmetal miners (table 2-6); and
- Elevated PMRs for non-A, non-B hepatitis and arteriosclerotic heart disease among male oil and gas workers (table 2-7).

Table 2-1.—Male workers age 18 and older with usual industry on death certificate listed as coal mining, selected States: proportionate mortality ratios and 95% confidence intervals for selected ICD classified causes of death, 1986-1993; adjusted for age and race. Total deaths = 46,451

Cause of death (ICD-9 code)	No.	PMR	95% CI
Infectious and parasitic diseases (001-139)	575	74	68, 80
Tuberculosis (010-018, 137)	73	204	160, 256
Pulmonary tuberculosis (011)	62	233	179, 299
Malignant neoplasms (140-208)	10,205	90	88, 91
Malignant neoplasm, trachea, bronchus, and lung (162)	4,173	108	105, 111
Diseases of the heart (390-398, 402, 404-429)	16,848	98	97, 99
Ischemic heart disease (410-414)	11,856	97	96, 99
Acute myocardial infarction (410)	6,621	103	101, 105
Other ischemic heart disease (411-414)	5,235	91	88, 93
Diseases of the respiratory system (460-519)	8,771	175	172, 177
Chronic obstructive pulmonary disease (490-496)	3,335	128	125, 132
Coal workers' pneumoconiosis (500)	3,145	3,743	3,722, 3,764
Pneumoconiosis due to silica (502)	49	513	380, 679
Other and unspecified pneumoconiosis (503-505)	151	1,686	1,428, 1,977
External causes of injury and poisoning (E800-E999)	2,279	108	104, 112

Source: National Occupational Mortality Surveillance (NOMS) database.

Table 2-2.—Female workers age 18 and older with usual industry on death certificate listed as coal mining, selected States: proportionate mortality ratios and 95% confidence intervals for selected ICD classified causes of death, 1986-1993; adjusted for age and race. Total deaths = 387

Cause of death (ICD-9 code)	No.	PMR	95% CI
Malignant neoplasms (140-208)	79	91	72, 114
Malignant neoplasm connective and other soft tissue (171)	3	521	107, 1522
Diseases of the respiratory system (460-519)	40	117	84, 159
Coal workers' pneumoconiosis (500)	2	73,000	8,839, >9,999
Other and unspecified pneumoconiosis (503-505)	1	22,000	540, >9,999
External causes of injury and poisoning (E800-E999)	24	182	117, 271

Source: National Occupational Mortality Surveillance (NOMS) database.

Table 2-3.—Male workers age 18 and older with usual industry on death certificate listed as metal mining, selected States: proportionate mortality ratios and 95% confidence intervals for selected ICD classified causes of death, 1986-1993; adjusted for age and race. Total deaths = 5,542

Cause of death (ICD-9 code)	No.	PMR	95% CI
Infectious and parasitic diseases (001-139)	67	65	51, 83
Tuberculosis (010-018, 137)	12	271	140, 173
Diseases of the nervous system and sense organs (320-389)	116	120	99, 144
Anterior horn cell disease (335)	19	180	108, 280
Diseases of the heart (390-398, 402, 404-429)	1,733	86	83, 90
Rheumatic fever and rheumatic heart disease (390-398)	19	182	110, 284
Other forms of heart disease, including diseases of pulmonary circulation (415-429)	574	110	101, 119
Diseases of the respiratory system (460-519)	784	141	131, 151
Pneumonia and influenza (480-487)	223	122	107, 139
Chronic obstructive pulmonary disease (490-496)	423	144	131, 158
Pneumoconiosis due to silica (502)	37	3,575	2,517, 4,928
Other and unspecified pneumoconiosis (503-505)	6	598	220, 1302
External causes of injury and poisoning (E800-E999)	472	137	125, 150

Source: National Occupational Mortality Surveillance (NOMS) database.

Table 2-4.—Female workers age 18 and older with usual industry on death certificate listed as metal mining, selected States: proportionate mortality ratios and 95% confidence intervals for selected ICD classified causes of death, 1986-1993; adjusted for age and race. Total deaths = 189

Cause of death (ICD-9 code)	No.	PMR	95% CI
Diseases of the respiratory system (460-519)	24	156	100, 232
External causes of injury and poisoning (E800-E999)	19	147	89, 230

Source: National Occupational Mortality Surveillance (NOMS) database.

Table 2-5.—Male workers age 18 and older with usual industry on death certificate listed as nonmetallic mining and quarrying, selected States: proportionate mortality ratios and 95% confidence intervals for selected ICD classified causes of death, 1986-1993; adjusted for age and race. Total deaths = 5,384

Cause of death (ICD-9 code)	No.	PMR	95% CI
Infectious and parasitic diseases (001-139)	69	66	51, 83
Tuberculosis (010-018, 137)	9	202	92, 383
Pulmonary tuberculosis (011)	8	242	105, 478
Malignant neoplasms (140-208)	1,306	96	92, 101
Malignant neoplasm of respiratory and intrathoracic organs (160-165)	525	110	101, 120
Diseases of the heart (390-398, 402, 404-429)	1,884	98	95, 102
Chronic pulmonary heart disease (416)	11	238	119, 426
Diseases of the respiratory system (460-519)	643	122	113, 132
Chronic obstructive pulmonary disease (490-496)	372	134	121, 148
Pneumoconiosis due to silica (502)	24	2,318	1,485, 3,450
External causes of injury and poisoning (E800-E999)	393	116	105, 128

Source: National Occupational Mortality Surveillance (NOMS) database.

Table 2-6.—Female workers age 18 and older with usual industry on death certificate listed as nonmetallic mining and quarrying, selected States: proportionate mortality ratios and 95% confidence intervals for selected ICD classified causes of death, 1986-1993; adjusted for age and race. Total deaths = 185

Cause of death (ICD-9 code)	No.	PMR	95% CI
Malignant neoplasms (140-208)	50	111	83, 147
Malignant neoplasm, digestive organs, and peritoneum (150-159)	19	182	109, 283
Malignant neoplasm, colon (153)	13	275	146, 470
External causes of injury and poisoning (E800-E999)	15	205	115, 337

Source: National Occupational Mortality Surveillance (NOMS) database.

Table 2-7.—Male workers age 18 and older with usual industry on death certificate listed as petroleum and natural gas extraction, selected States: proportionate mortality ratios and 95% confidence intervals for ICD classified causes of death; adjusted for age and race. Total deaths = 13,840

Cause of death (ICD-9 code)	No.	PMR	95% CI
Infectious and parasitic diseases (001-139)	186	66	57, 76
Non-A, non-B viral hepatitis (0704-0709)	10	277	133, 509
Malignant neoplasms (140-208)	3,331	100	97, 103
Malignant neoplasm, trachea, bronchus, and lung (162)	1,242	109	104, 115
Diseases of the heart (390-398, 402, 404-429)	5,038	102	100, 104
Ischemic heart disease (410-414)	3,635	103	101, 106
Acute myocardial infarction (410)	1,954	104	100, 108
Other ischemic heart disease (411-414)	1,681	102	98, 107
External causes of injury and poisoning (E8000-E999)	1,225	119	115, 124

Source: National Occupational Mortality Surveillance (NOMS) database.

Table 2-8.—Female workers age 18 and older with usual industry on death certificate listed as petroleum and natural gas extraction, selected States: proportionate mortality ratios and 95% confidence intervals for ICD classified causes of death; adjusted for age and race. Total deaths = 806

Cause of death (ICD-9 code)	No.	PMR	95% CI
Malignant neoplasms (140-208)	238	109	96, 124
External causes of injury and poisoning (E800-E999)	47	121	89, 161

Source: National Occupational Mortality Surveillance (NOMS) database.

CHAPTER 3. EMPLOYMENT AND ACTIVE MINING OPERATIONS: MSHA DATA

This chapter presents MSHA data on mine employment and active mining operations during 1986-1995. Figures 3-1 through 3-10 show, for each commodity, the location of mine operations in 1995, and employee hours and active mining operations by year during 1986-1995 for mine operators.

For coal and nonmetal operators, the number of active mining operations and the number of employee hours decreased over the 10-year period. For metal operators, the number of active operations decreased, while the number of employee hours increased. For stone and sand and gravel operators, the number of active operations and the number of employee hours remained about the same.

Figures 3-11 and 3-12 show that over the 10-year period, there was an increase in the proportion of hours worked by contractors in coal mining, while the overall employment decreased. For metal, nonmetal, stone, and sand and gravel combined, the proportion of contractor hours increased, with overall employment also increasing.

Table 3-1 shows the distribution of hours worked during 1986-1995 by commodity and type of operation. For coal, the majority of hours worked were in underground mines. For metal, nonmetal, and stone, the largest number of hours worked were in mills and preparation plants. For sand and gravel, all work hours other than office were in surface mines.

Table 3-1.—Number and percent of employee hours (in millions) by commodity and type of operation for operators, 1986-1995.

Type of operation	Coal		Metal		Nonmetal		Stone		Sand and gravel	
	Hours in millions	(%)	Hours in millions	(%)	Hours in millions	(%)	Hours in millions	(%)	Hours in millions	(%)
Underground mines										
Underground operations	1,210.50	(46.0)	127.85	(13.2)	70.44	(11.2)	30.83	(2.0)	NA	NA
Surface operations	124.10	(4.7)	33.70	(3.4)	12.82	(2.0)	8.04	(<1.0)	NA	NA
Surface mines										
Strip	846.59	(32.2)	307.01	(31.8)	121.39	(19.3)	572.40	(37.0)	490.11	(72.2)
Auger	6.54	(<1.0)	NA	NA	NA	NA	NA	NA	NA	NA
Culm bank	6.58	(<1.0)	NA	NA	NA	NA	NA	NA	NA	NA
Dredge	1.05	(<1.0)	8.79	(<1.0)	1.71	(<1.0)	3.05	(<1.0)	93.02	(13.7)
Other surface	NA	NA	2.95	(<1.0)	.02	(<1.0)	NA	NA	NA	NA
Shops	20.72	(1.0)	8.30	(<1.0)	.14	(<1.0)	4.35	(<1.0)	NA	NA
Mills/preparation plants	283.60	(10.8)	370.48	(38.4)	337.93	(53.7)	720.39	(46.6)	NA	NA
Office	130.18	(4.9)	106.65	(11.0)	84.91	(13.5)	206.38	(13.4)	95.24	(14.0)
Total	2,629.86	(100.0)	965.77	(100.0)	629.35	(100.0)	1,545.40	(100.0)	678.37	(100.0)

NA - Not applicable; operation does not exist for this commodity, or breakdown of hours is unavailable.

Source: Mine Safety and Health Administration data.

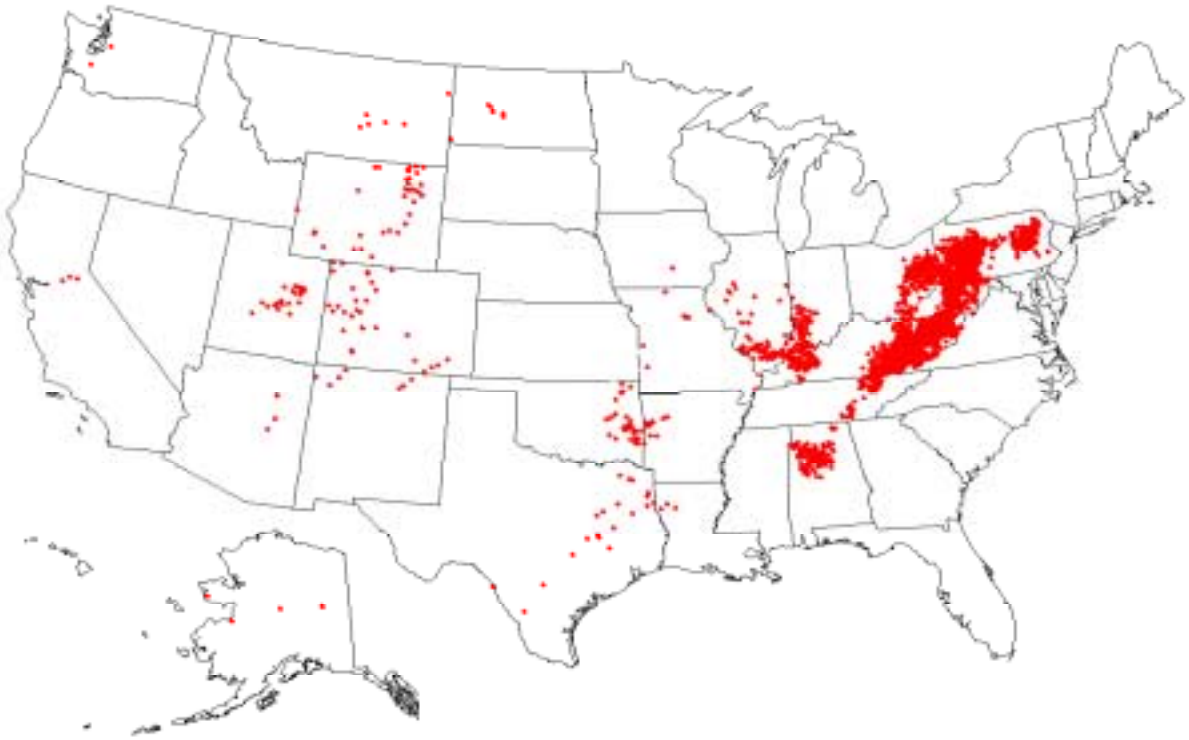


Figure 3-1.—Locations of active mining operations, coal industry, 1995. (Source: MSHA)

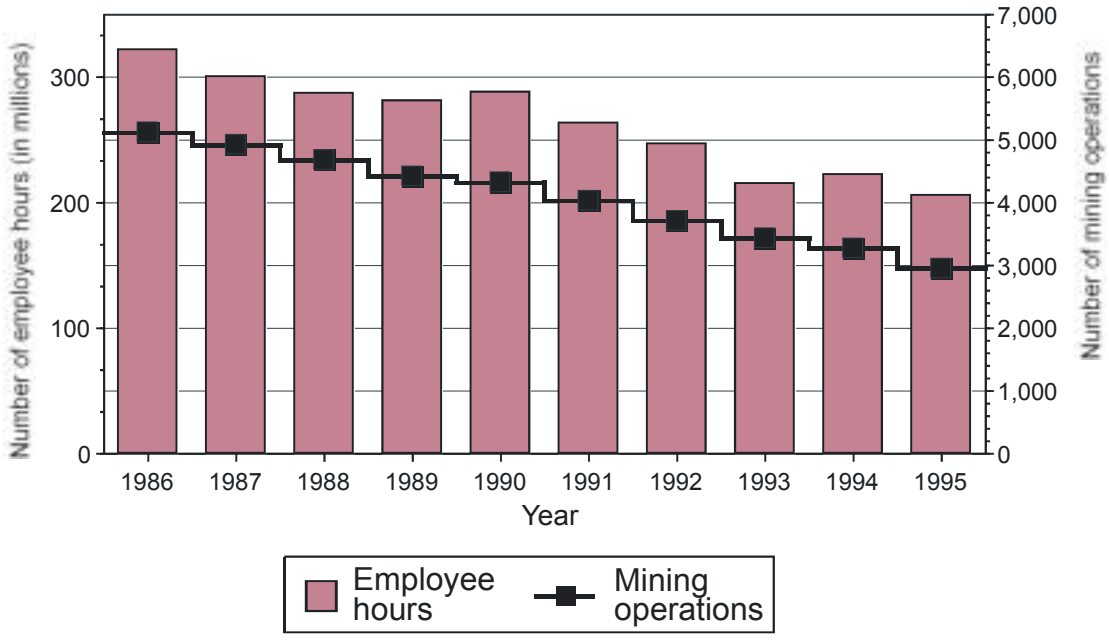


Figure 3-2.—Coal operators: number of employee hours in millions and number of active mining operations by year, 1986-1995. (Source: MSHA)

Figure 3-3.—Locations of active metal mining operations, metal industry, 1995. (Source: MSHA)

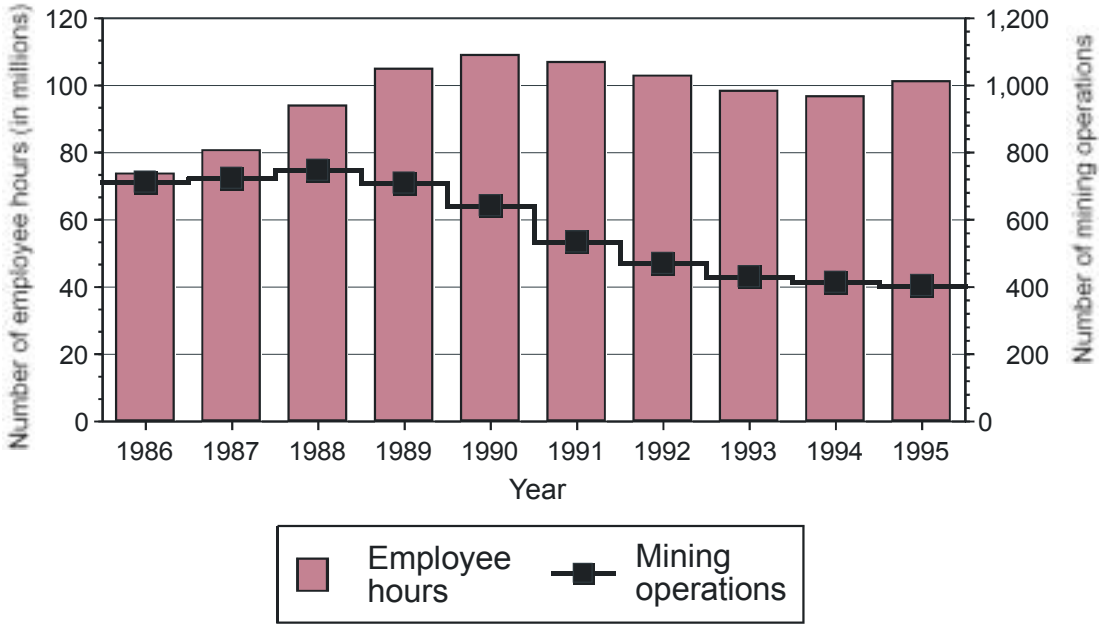


Figure 3-4.—Metal operators: number of employee hours in millions and number of active mining operators by year, 1986-1995. (Source: MSHA)

Figure 3-5.—Locations of active mining operations, nonmetal industry, 1995. (Source: MSHA)

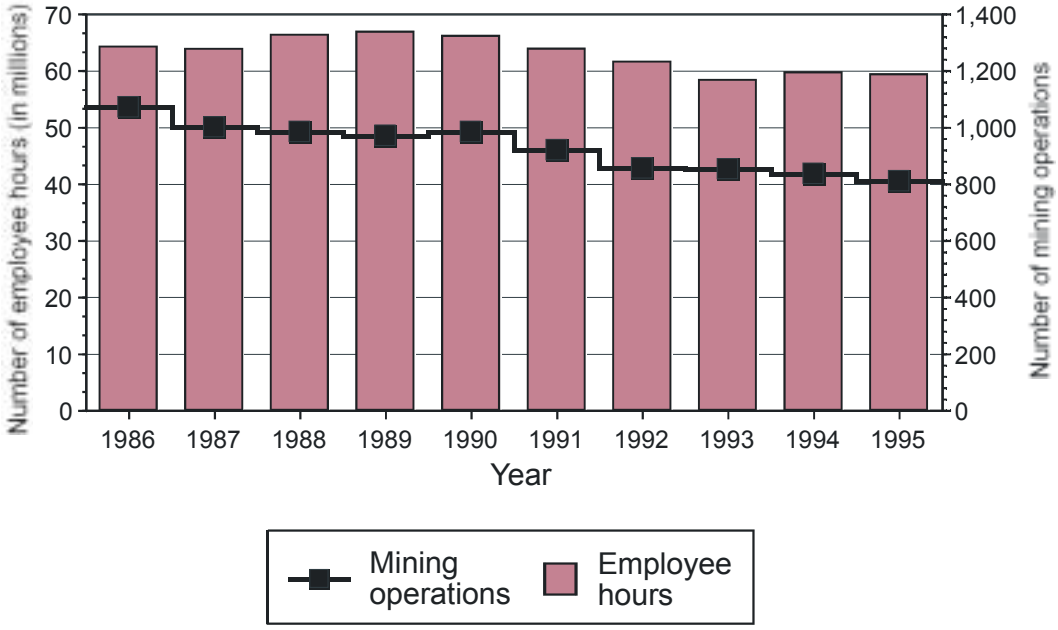


Figure 3-6.—Nonmetal operators: number of employee hours in millions and number of active mining operations by year, 1986-1995. (Source: MSHA)

Figure 3-7.—Locations of active mining operations, stone industry, 1995. (Source: MSHA)

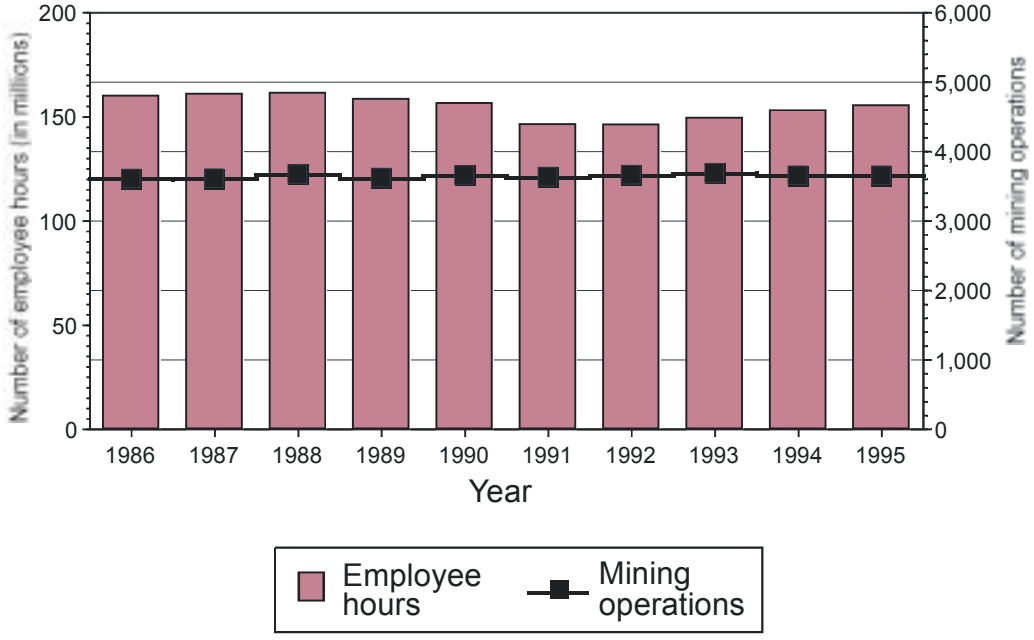


Figure 3-8.—Stone operators: number of employee hours in millions and number of active mining operations by year, 1986-1995. (Source: MSHA)

Figure 3-9.—Locations of active mining operations, sand and gravel industry, 1995. (Source: MSHA)

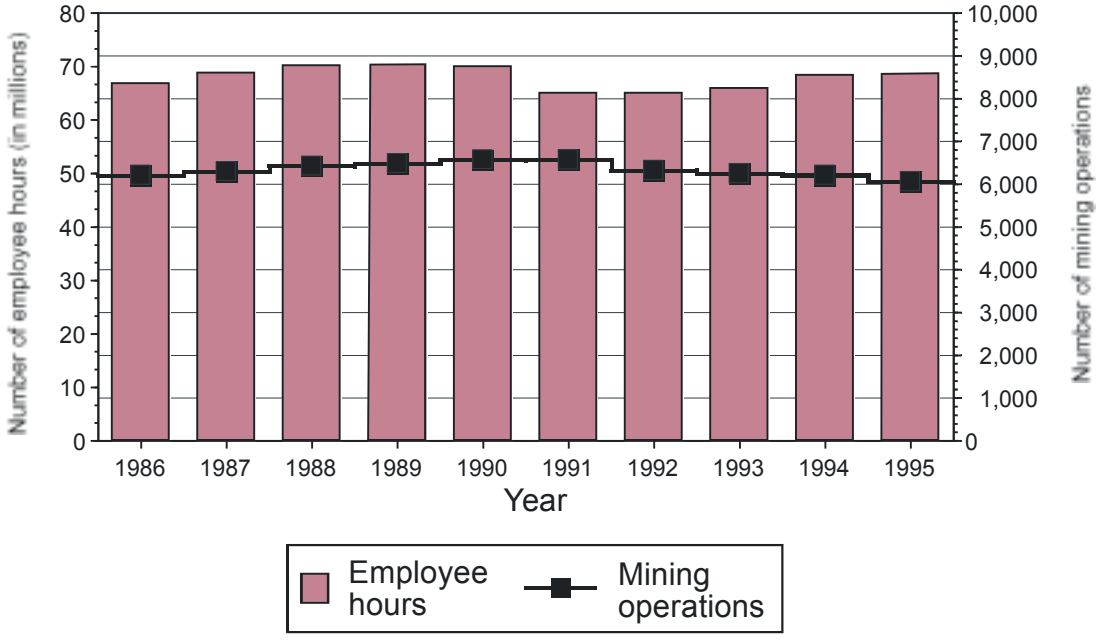


Figure 3-10.—Sand and gravel operators: number of employee hours in millions and number of active mining operations by year, 1986-1995. (Source: MSHA)

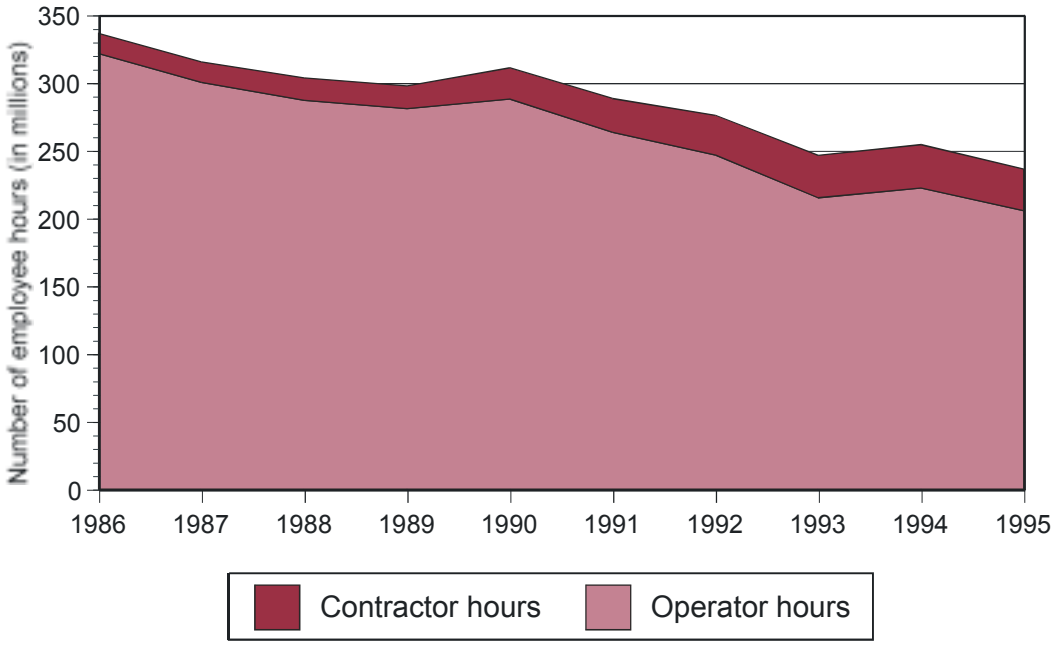


Figure 3-11.—Coal industry: number of employee hours (in millions) for operators and contractors by year. (Source: MSHA)

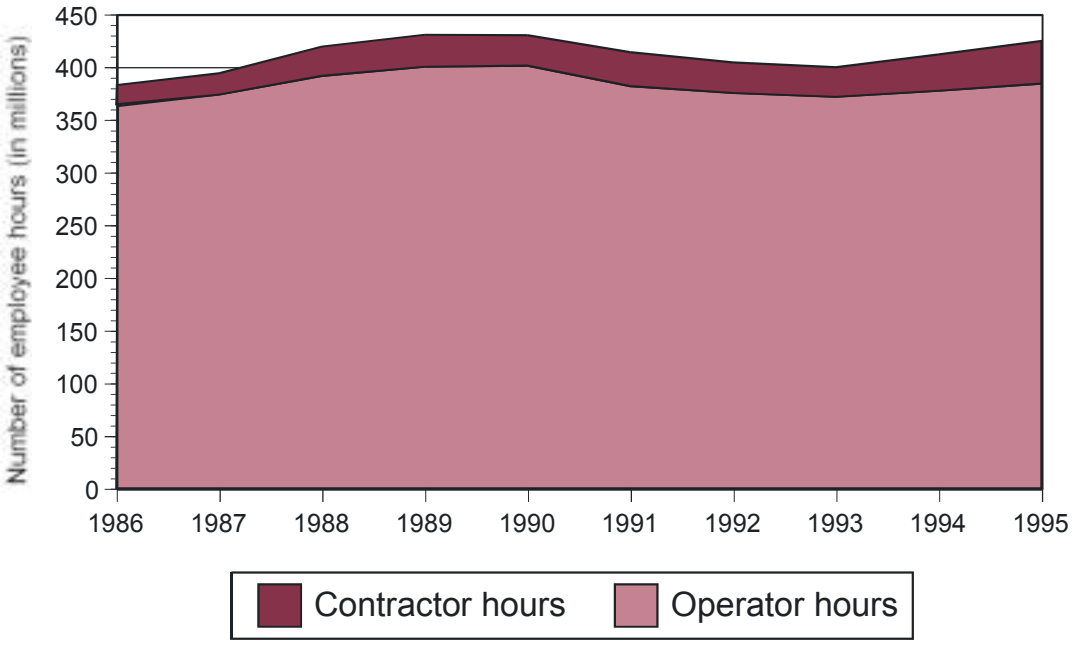


Figure 3-12.—Metal, nonmetal, stone, and sand and gravel industries: number of employee hours (in millions) for operators and contractors by year, 1986-1995. (Source: MSHA)

CHAPTER 4. FATAL AND NONFATAL INJURIES: MSHA DATA

This chapter presents an overview of fatal and nonfatal injuries reported to MSHA during 1986-1995. Reportable injuries follow the criteria for reporting specified in 30 CFR 50. These criteria are listed in appendix A. The data used for these analyses came from the MSHA accident, injury, and illness data closeout files for the years 1986-1995. The MSHA data are described in appendix A and methods used in data analysis in appendix B. *There may be slight discrepancies between the figures presented here and other presentations of MSHA data for the following reasons: (1) injuries to nonemployees have been excluded from analysis; and (2) injuries identified by MSHA after the files were closed out are not included.*

Within the MSHA data, there are differences in reporting requirements for operators and contractors. Contractors are required to report only those injuries that occur during certain categories of work (described in appendix A). For this reason, *data on injuries among employees of operators and contractors in the MSHA database should not be considered directly comparable.*

As discussed in the "Introduction," the MSHA data on fatal injuries differ from the CFOI data (chapter 1) because of varying definitions used for the mining industry. As compared to the CFOI data, MSHA data exclude injuries that occurred off of mine property and include injuries occurring at mills and processing plants on mine property.

Tables 4-1 through 4-9 and figure 4-1 provide comparisons of injury frequencies and rates among the commodities. These comparisons are followed by sections 4A through 4E, which provide more detailed tables and figures for each commodity separately. The method used to calculate injury rates is described in appendix B. *Since denominator data for occupations (job titles) were available for 1986 only, estimates of rates by occupation for the entire 10-year period are based on extrapolation from 1986 data. For this reason, estimates of injury by occupation should be interpreted with caution.*

Fatal Injuries

A total of 1,078 fatal on-the-job injuries were reported to MSHA during the 10-year period 1986- 1995. The average annual fatal injury rate for all commodities combined during this period was 30.9 per 100,000 full-time equivalent workers. Mine operators accounted for 908 (84%) of the fatalities and had an average annual fatal injury rate of 28.2 per 100,000. While mine contractors comprised only 16% (n = 170) of the total number of fatalities, their average annual fatal injury rate was 2.3 times higher than that of mine operators (65.0 per 100,000).

Table 4-1 presents the number and rates of fatal injuries by commodity for operators and contractors. Contractors in metal, nonmetal, stone, and sand and gravel are grouped together, since MSHA data on employment were not available for rate calculations for these commodities separately. The highest average annual fatality rate for the period, 66.5 per 100,000, occurred among metal and nonmetallic mineral mining contractors, followed closely by coal contractors (63.1 per 100,000). Among mine operators, the highest average annual fatal injury rate was in coal (38.9 per 100,000); the lowest was in nonmetal (14.3 per 100,000).

Table 4-2 shows the average annual fatal injury rate by type of operation for each commodity for mine operators only. Of commodities with underground mines, all except stone had higher fatality rates at underground than at surface operations of these mines. The highest fatality rate for any operation occurred in surface operations at underground stone mines (124.5 fatal injuries per 100,000 workers). Stone had the second highest fatality rate for underground operations at underground mines (77.9 per 100,000). The highest rate for underground operations at underground mines occurred in metal (87.6 per 100,000).

Table 4-3 shows the number and rate of fatal injuries by U.S. Bureau of the Census occupational groups (described in appendix D) for the 10 occupation-commodity groups with the highest fatal injury rates. These data should be interpreted with caution because the denominator used in calculating the rates was based on an extrapolation from data for the year 1986 only, as described in appendix B. Extractive occupations are represented in this group for three commodities: coal, metal, and sand and gravel. Construction trades are included for coal, sand and gravel, and nonmetal.

The distribution of fatal injuries by commodity and work activity for mine operators is presented in table 4-4. A description of the work activity categories is in appendix C. Overall, the leading work activity at the time of injury was using or operating tools and machinery (26.4%) followed by constructing, repairing, and cleaning (24.0%), vehicular operations (18.8%), and materials handling (12.6%). The distribution varied by commodity. The largest percentage of fatal injuries occurred while operating tools and machinery in both coal and stone; during vehicular operations in metal; and during constructing, repairing, and cleaning activities in nonmetal and sand and gravel.

Table 4-5 shows the distribution of fatal injuries by commodity and MSHA accident classification for mine operators. A description of the MSHA accident classifications appears in appendix E. The largest proportion of injuries overall occurred during powered haulage (28.5%). The

leading MSHA classifications varied by commodity: fall of ground was responsible for the largest proportion of injuries in coal and nonmetal, while powered haulage was the leading MSHA classification for metal, stone, and sand and gravel.

Nonfatal Injuries

Among the 267,232 nonfatal injuries reported to MSHA during 1986-1995, mine operators accounted for 95% (253,536) of the total. In contrast to the rates for fatal injuries, mine operators had higher nonfatal injury rates than contractors (7.9 per 100 full-time workers for operators compared to 5.2 per 100 for contractors). The largest number of injuries (131,144) and the highest injury rate (49.1 per 100) occurred among coal operators (table 4-6).

Table 4-7 shows the distribution and average annual rate of nonfatal injuries by commodity and subunit for mine operators. In coal, 75% of all nonfatal injuries occurred at underground mines; 69% of all nonfatal injuries occurred at underground locations of underground mines. The injury rates incurred at surface locations of underground mines were higher than those for underground locations in the commodities of nonmetal and stone; however, these results must be interpreted with caution due to the small percentage of total employment represented by surface locations of underground mines in these two commodities. Of surface mines, 83% of all injuries reported in sand and gravel occurred at strip mines; this compares to coal (16%), metal (26%), nonmetal (18%), and stone (40%). The highest injury rates reported at strip mines occurred in stone and sand and gravel (7.7 and 6.6 per 100 workers, respectively). An additional 17% of injuries in sand and gravel were reported in dredging operations. Preparation plants and mills accounted for a significant proportion of the injuries in the commodities of metal (41%), nonmetal (63%), and stone (56%). Preparation plants comprised about 8% of all nonfatal injuries in coal.

Figure 4-1 shows the nonfatal injury rates over the 10-year period by commodity sector for mine operators. All five commodity sectors show similar patterns when injury rates are examined by year, with the nonfatal injury rates increasing sharply from 1986 to 1988 (or 1989), then declining for the remainder of the period. This spike in injury rates seen during 1988 and 1989 was probably due to clarification of reporting requirements by MSHA, which resulted in improved reporting of injuries by mine operators.

Of all nonfatal injuries to mine operators, 61% resulted in time lost from work. By commodity sector, coal had the largest proportion of injuries that resulted in days lost from work (73%). Fifty-seven percent of all injuries in sand and gravel resulted in days lost, followed by stone (48%), nonmetal (42%), and metal (42%). The mean number of days lost in the commodity of coal was 27 days, followed by metal (15 days), sand and gravel (13 days), nonmetal (12 days), and stone (12 days).

For sprains and strains, 76% of all injuries involved time lost from work compared to 51% of the injuries classified as nonsprains. Sprains and strains and lacerations were the two most common types of injury in all five commodity sectors. Contusions and fractures were the third and fourth most frequent, although the rank order varied among the commodity sectors. Table 4-8 shows the percentage of injuries and mean days lost by type of injury and commodity for the four most common types of injuries.

Table 4-9 shows the percentage of injuries and mean days lost by work activity and commodity for the four most common types of work activity. Overall, handling materials (30%) was the most common activity being performed at the time of injury, followed by using or operating tools or machinery (26%), constructing, repairing, and cleaning tasks (18%), and vehicular and transportation operations (13%).

Figures 4-2 and 4-3 show the body parts most commonly injured for injuries classified as strains and nonstrains among employees of mine operators in all commodities. The back was the body part most frequently affected by strain injuries (49%). For nonstrain injuries, the fingers were the most frequently affected body part, accounting for 23% of all injuries.

During the 10-year period, the distribution of workforce demographics (e.g., age and work experience) of injured workers varied by commodity sector. In coal, the average age and total mining experience of the injured workers steadily increased, while years of experience at current mine decreased. The number of years at current job remained relatively steady over the 10-year period. In the other four commodity sectors, the work experience indicators all remained relatively constant over the 10-year period. The average age of injured workers increased slightly, but less than the increase seen in coal.

Sections 4A through 4E are separate presentations of injury data for each commodity. Additional information not discussed here is provided in these sections, including a breakdown, within each MSHA classification, of the event and source resulting in injury. However, event and source are not provided for injuries due to fall of ground, since both event and source were falling rock for over 90% of these injuries.

Table 4-1.—Mine operators and contractors: number and average annual rate of fatal injuries (per 100,000 full-time workers) by commodity, 1986-1995.

Employer type and commodity	Number	(%)	Rate
Operators			
Coal	511	(47.4)	38.9
Metal	106	(9.8)	22.0
Nonmetal	45	(4.2)	14.3
Stone	157	(14.6)	20.3
Sand and gravel	89	(8.3)	26.2
Contractors			
Coal	74	(6.9)	63.1
Metal, nonmetal, stone, and sand and gravel	96	(8.9)	66.5
Total	1,078	(100.0)	30.9

Source: Mine Safety and Health Administration data.

Table 4-2.—Mine operators: number and average annual rate of fatal injuries (per 1000,000 full-time workers) by commodity and subunit, 1986-1995.

Subunit	Coal		Metal		Nonmetal		Stone		Sand and gravel	
	No.	Rate	No.	Rate	No.	Rate	No.	Rate	No.	Rate
Underground mines										
Underground	337	55.7	56	87.6	16	45.4	12	77.9	NA	NA
Surface	31	50.0	5	29.7	0	*	5	124.5	NA	NA
Surface mines										
Strip	99	23.4	31	20.2	17	28.0	99	34.6	67	27.3
Other surface	3	42.4	0	*	0	*	0	*	22	47.3
Independent shops/yards	2	*	1	*	0	*	0	*	NA	NA
Mill/preparation plant	39	27.5	13	7.0	12	7.1	41	11.4	NA	NA
Office	0	*	0	*	0	*	0	*	0	*
Total	511	38.9	106	22.0	45	14.3	157	20.3	89	26.2

*Rate not calculated because there were fewer than 3 fatalities.
NA - Not applicable; subunit does not exist for this commodity; or injuries and employment hours were not reported separately for the subunit.

Source: Mine Safety and Health Administration data.

Table 4-3.—Mine operators: number and average annual rate of fatal injuries (per 100,000 full-time workers) for the 10 occupation-commodity groups with the highest fatal injury rates.

Occupational group and commodity	Number of fatalities	Average annual rate per 100,000
Construction trades, sand and gravel	3	307.7
Extractive occupations, coal	196	85.1
Extractive occupations, metal	44	75.5
Protective service, coal	4	69.8
Precision production, stone	7	59.9
Construction trades, coal	94	55.9
Extractive occupations, sand and gravel	5	51.3
Construction trades, nonmetal	3	50.5
Professional specialty, coal	9	47.8
Helpers and laborers, sand and gravel	12	45.1

Source: Mine Safety and Health Administration data.

Table 4-4.—Mine operators: number and percent of fatal injuries by commodity and work activity, 1986-1995.

Work activity	Coal		Metal		Nonmetal		Stone		Sand and gravel		All operators	
	No.	(%)	No.	(%)	No.	(%)	No.	(%)	No.	(%)	No.	(%)
Using or operating tools or machinery	141	(27.6)	20	(18.9)	6	(13.3)	47	(29.9)	26	(29.2)	282	(26.4)
Constructing, repairing, cleaning	121	(23.7)	21	(19.8)	14	(31.1)	33	(21.0)	29	(32.6)	256	(24.0)
Vehicle/transportation operations	97	(19.0)	26	(24.5)	5	(11.1)	32	(20.4)	11	(12.4)	202	(18.8)
Materials handling	56	(11.0)	16	(15.1)	10	(22.2)	17	(10.8)	15	(16.9)	139	(12.6)
All other	96	(18.8)	23	(21.7)	10	(22.2)	28	(17.8)	8	(9.0)	199	(18.2)
Total	511	(100.0)	106	(100.0)	45	(100.0)	157	(100.0)	89	(100.0)	1,078	(100.0)

Source: Mine Safety and Health Administration data.

Table 4-5.—Mine operators: number and percent of fatal injuries by MSHA accident classification and commodity, 1986-1995.

MSHA accident classification	Coal		Metal		Nonmetal		Stone		Sand and gravel		All operators	
	No.	(%)	No.	(%)	No.	(%)	No.	(%)	No.	(%)	No.	(%)
Powered haulage	118	(23.1)	33	(31.1)	11	(24.4)	61	(38.9)	36	(40.5)	259	(28.5)
Fall of ground	162	(31.7)	18	(17.0)	13	(28.9)	13	(8.3)	1	(1.0)	207	(22.8)
Machinery	85	(16.6)	10	(9.4)	7	(15.6)	25	(15.9)	17	(19.1)	144	(15.9)
Electrical	42	(8.2)	9	(8.4)	5	(11.1)	12	(7.6)	17	(19.1)	86	(9.5)
All other	104	(20.4)	36	(34.0)	9	(20.0)	46	(29.2)	18	(20.2)	212	(23.3)
Total	511	(100.0)	106	(100.0)	45	(100.0)	157	(100.0)	89	(100.0)	908	(100.0)

Source: Mine Safety and Health Administration data.

Table 4-6.—Mine operators and contractors: number and average annual rate of nonfatal injuries (per 100 full-time workers) by commodity for mine operators and contractors, 1986-1995.

Employer type and commodity	Number	(%)	Rate
Operators			
Coal	131,144	(49.1)	10.0
Metal	31,494	(11.8)	6.5
Nonmetal	17,133	(6.4)	5.4
Stone	54,359	(20.3)	7.0
Sand and gravel	19,406	(7.3)	5.7
Contractors			
Coal	5,472	(2.0)	4.7
Metal, nonmetal, stone, and sand and gravel	8,224	(3.1)	5.7
Total	267,232	(100.0)	7.7

Source: Mine Safety and Health Administration data.

Table 4-7.—Mine operators: number and average annual rate of nonfatal injuries (per 100 full-time workers) by commodity and subunit, 1986-1995.

Subunit	Coal		Metal		Nonmetal		Stone		Sand and gravel	
Underground mines	No.	Rate	No.	Rate	No.	Rate	No.	Rate	No.	Rate
Underground	91,011	15.0	8,177	12.8	2,575	7.3	1,173	7.6	NA	NA
Surface	6,784	10.9	1,293	7.7	566	8.8	450	11.2	NA	NA
Surface mines										
Strip	21,388	5.1	8,179	5.3	3,043	5.0	21,982	7.7	16,045	6.6
Other surface	571	8.1	488	8.3	69	8.0	93	6.1	3,252	7.0
Independent shops/yards	870	8.4	276	6.6	6	8.6	168	7.7	NA	NA
Mill/preparation plant	10,234	7.2	12,921	7.0	10,770	6.4	30,223	8.4	NA	NA
Office	286	0.4	160	0.3	104	0.2	270	0.3	109	0.2
Total	131,144	10.0	31,494	6.5	17,133	5.4	54,359	7.0	19,406	5.7

NA - Not applicable.

Source: Mine Safety and Health Administration data.

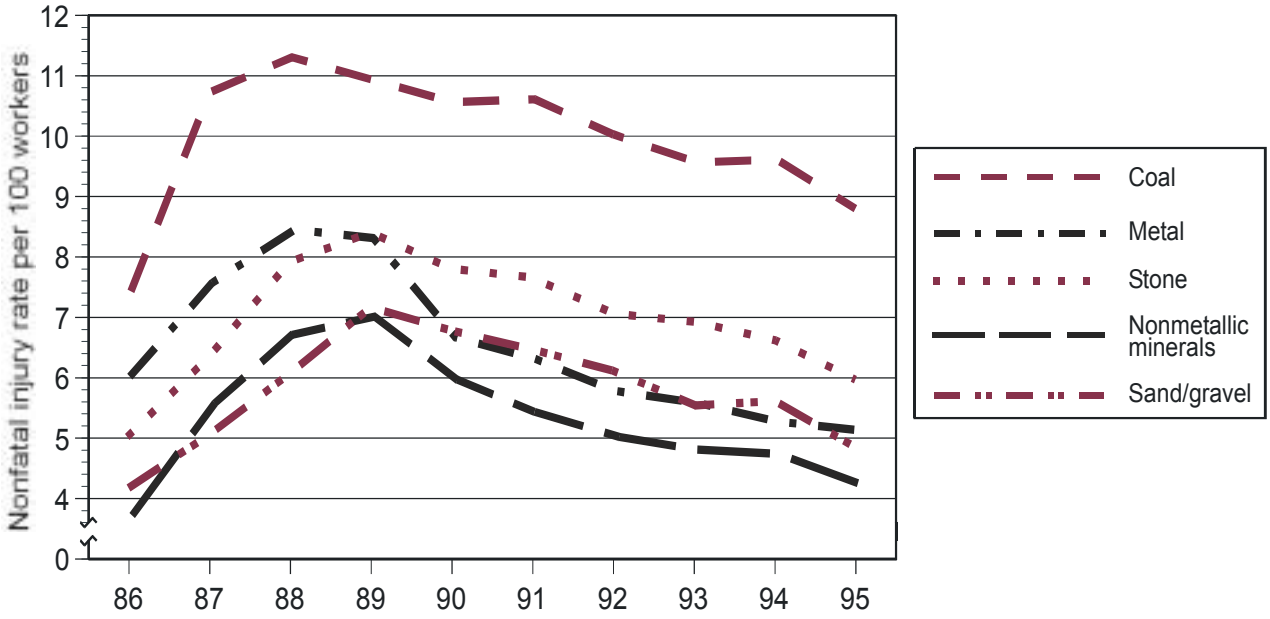


Figure 4.1—Mine operators: rate of nonfatal injury (per 100 full-time workers) by commodity and year, 1986-1995. (Source: MSHA)

Table 4-8.—Mine operators: percent of injuries and mean days lost work for the 4 leading types of injury by commodity.

Nature of injury	Coal (131,144 injuries)		Metal (31,494 injuries)		Nonmetal (17,133 injuries)		Stone (54,359 injuries)		Sand and gravel (19,406 injuries)	
	% of injuries	Mean days lost	% of injuries	Mean days lost	% of injuries	Mean days lost	% of injuries	Mean days lost	% of injuries	Mean days lost
Sprains/strains	40.4	35	34.2	22	36.1	17	32.7	16	29.7	16
Lacerations	16.4	5	23.4	2	19.9	2	19.4	3	21.2	3
Contusions	12.2	19	7.3	12	8.8	7	9.1	8	9.1	9
Fractures	10.3	37	11.4	23	7.9	23	9.3	24	9.2	25
All other	20.7	26	23.7	14	27.3	11	29.5	12	30.8	13
Total	100.0	27	100.0	15	100.0	12	100.0	12	100.0	13

Source: Mine Safety and Health Administration data.

Table 4-9.—Mine operators: percent of injuries and mean days lost work for the 4 leading work activities by commodity.

Work activity	Coal (131,144 injuries)		Metal (31,494 injuries)		Nonmetal (17,133 injuries)		Stone (54,359 injuries)		Sand and gravel (19,406 injuries)	
	% of injuries	Mean days lost	% of injuries	Mean days lost	% of injuries	Mean days lost	% of injuries	Mean days lost	% of injuries	Mean days lost
Handling materials	30.9	29	29.0	15	34.9	13	28.5	12	26.4	13
Using or operating tools or machinery	25.1	20	27.7	10	23.3	8	27.6	9	27.4	9
Constructing, repairing, cleaning	16.0	24	18.7	13	17.9	10	20.9	12	23.3	13
Vehicle / transportation operations	14.5	31	11.3	22	10.2	17	10.8	17	7.6	17
All other	13.5	31	13.3	20	13.7	16	12.2	16	15.3	17
Total	100.0	27	100.0	15	100.0	12	100.0	12	100.0	13

Source: Mine Safety and Health Administration data.

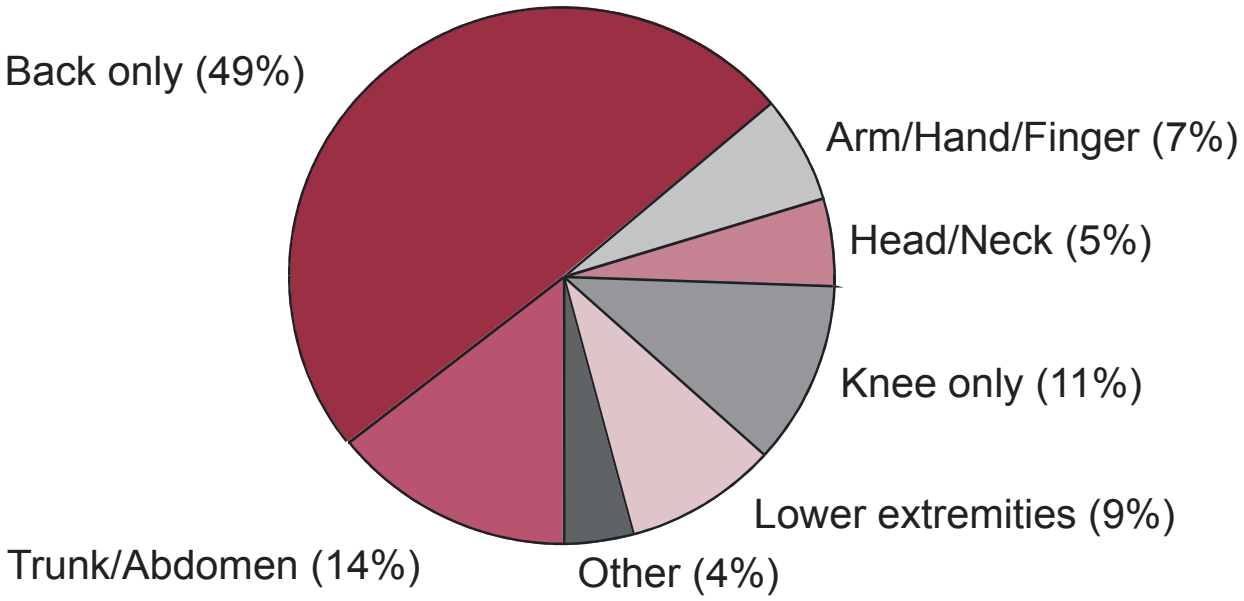


Figure 4-2.—Body part affected for strain injuries, all commodities combined, 1986-1995. (Source: MSHA)

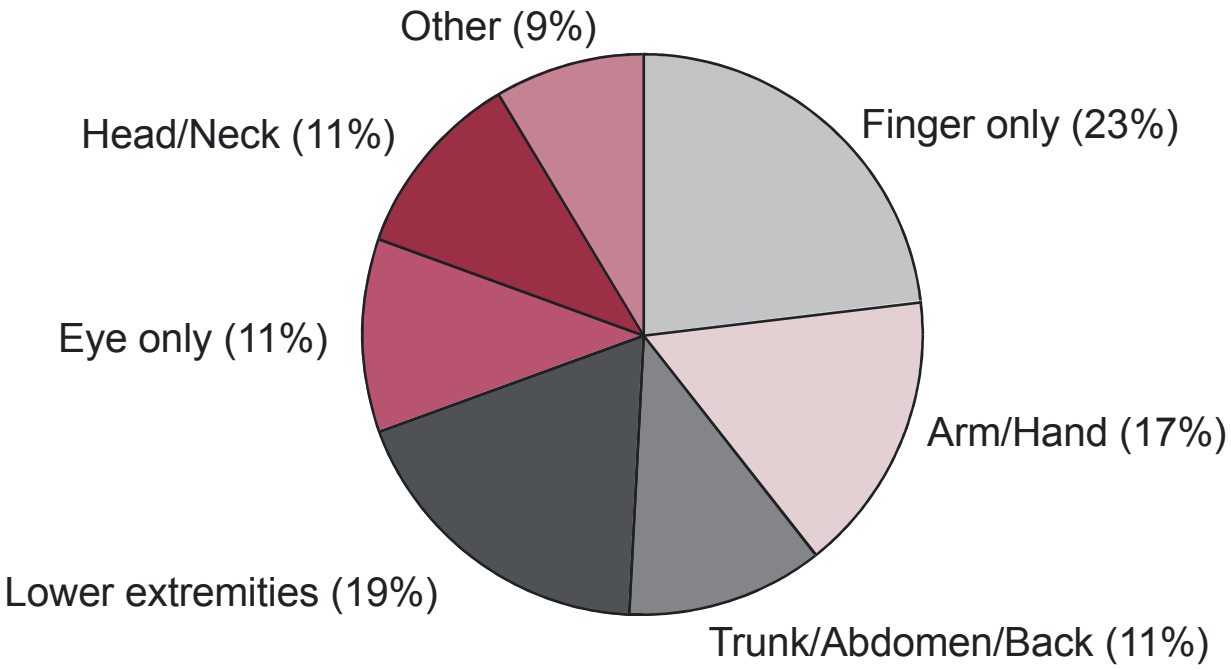


Figure 4-3.—Body part affected for nonstrain injuries, all commodities combined, 1986-1995. (Source: MSHA)

4A. INJURIES IN COAL MINING

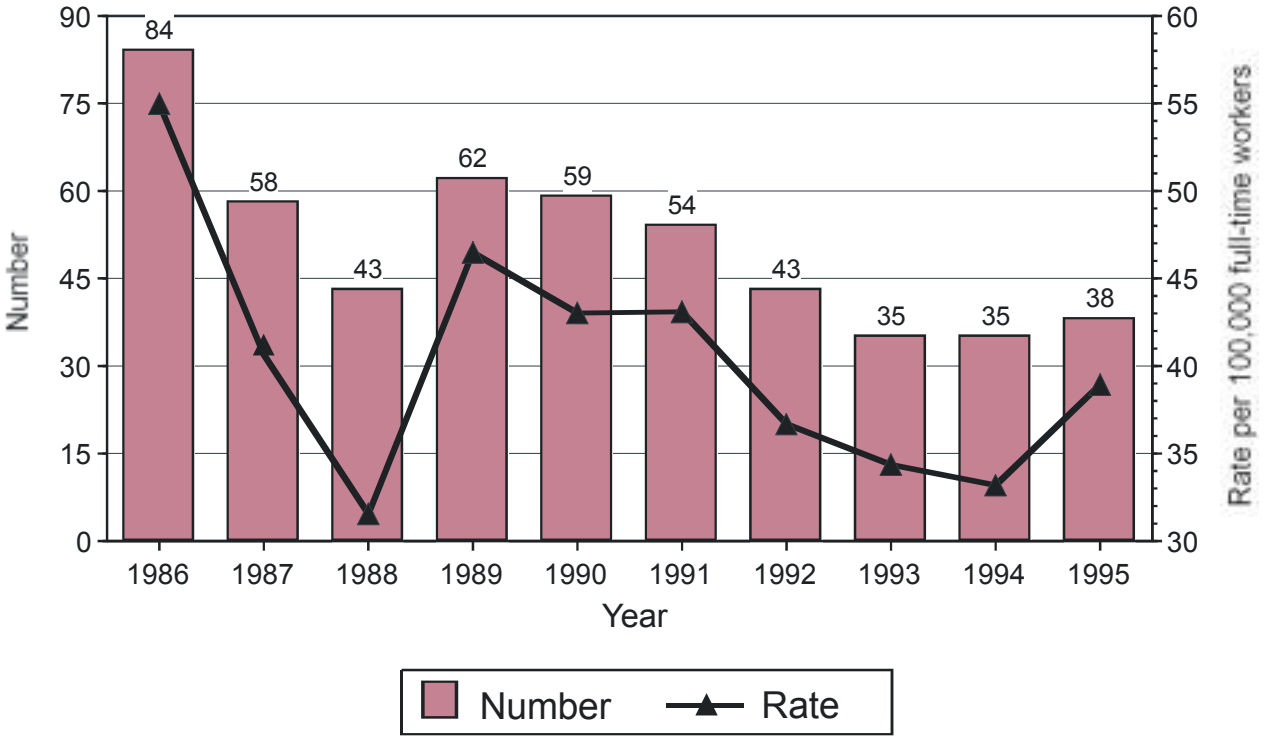


Figure 4A-1.—Coal operators: number and rate (per 100,000 workers) of fatal injuries by year, 1986-1995. (Source: MSHA data)

Table 4A-1.—Coal operators: number and average annual rate (per 100,000) workers of fatal injuries by subunit, 1986-1995.

Mining operation	Number, 1986-1995	Average annual rate per 100,000 full-time workers
Underground mines:		
Underground operations	337	55.68
Surface operations	31	49.96
Surface mines:		
Strip	99	23.39
Auger	1	*
Culm Bank	2	*
Dredge	0	*
Independent shops/yards	2	*
Preparation Plants	39	27.5
Office	0	*
Total	511	38.86

*** Rate not calculated because there were fewer than 3 fatalities**

Source: Mine Safety and Health Administration data.

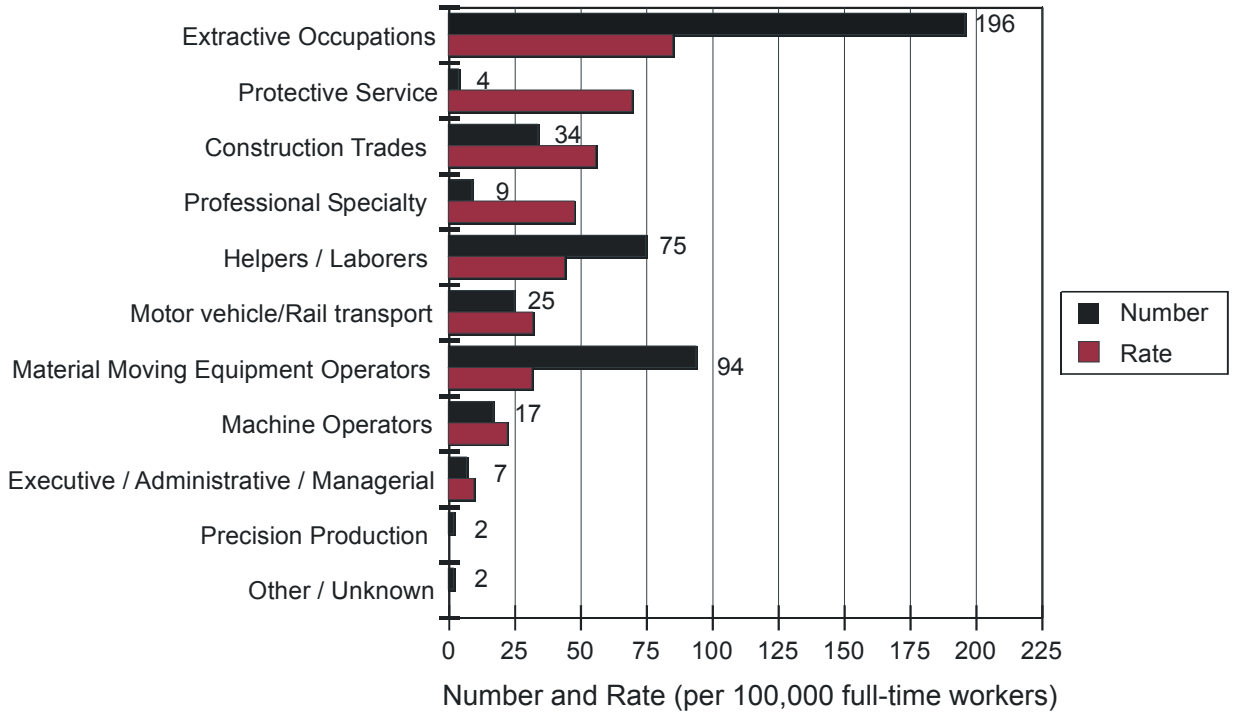


Figure 4A-2.—Coal operators: number and rate (per 100,000 workers) of fatal injuries by U.S. Bureau of the Census Occupation Division, 1986-1995. (Source: MSHA data)

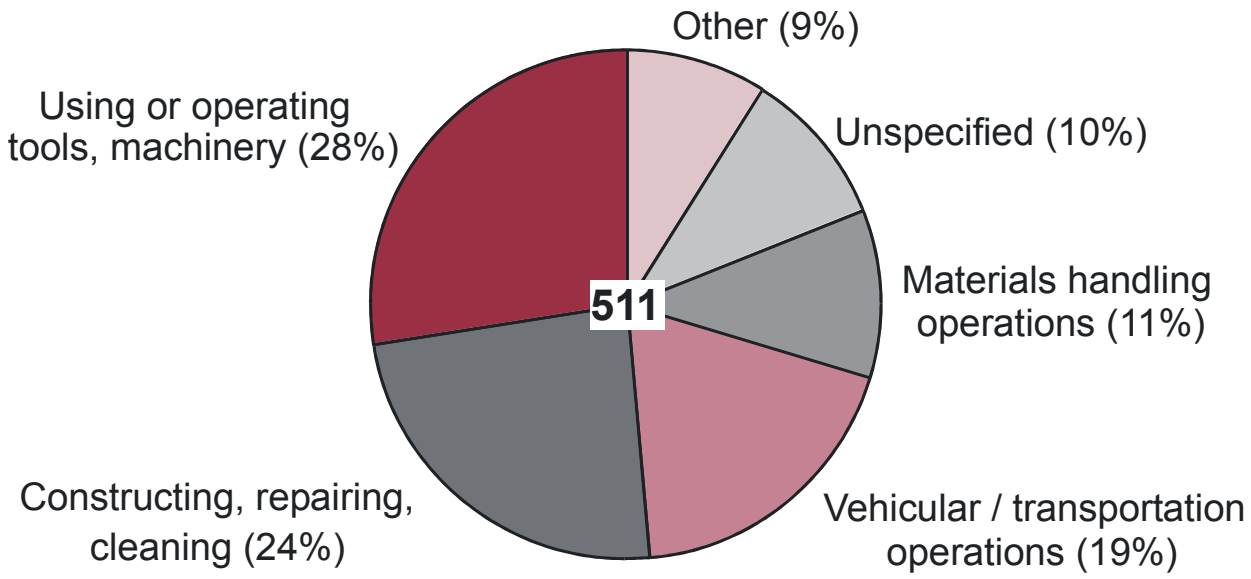


Figure 4A-3.—Coal operators: percent of fatal injuries by work activity, 1986-1995. (Source: MSHA data)

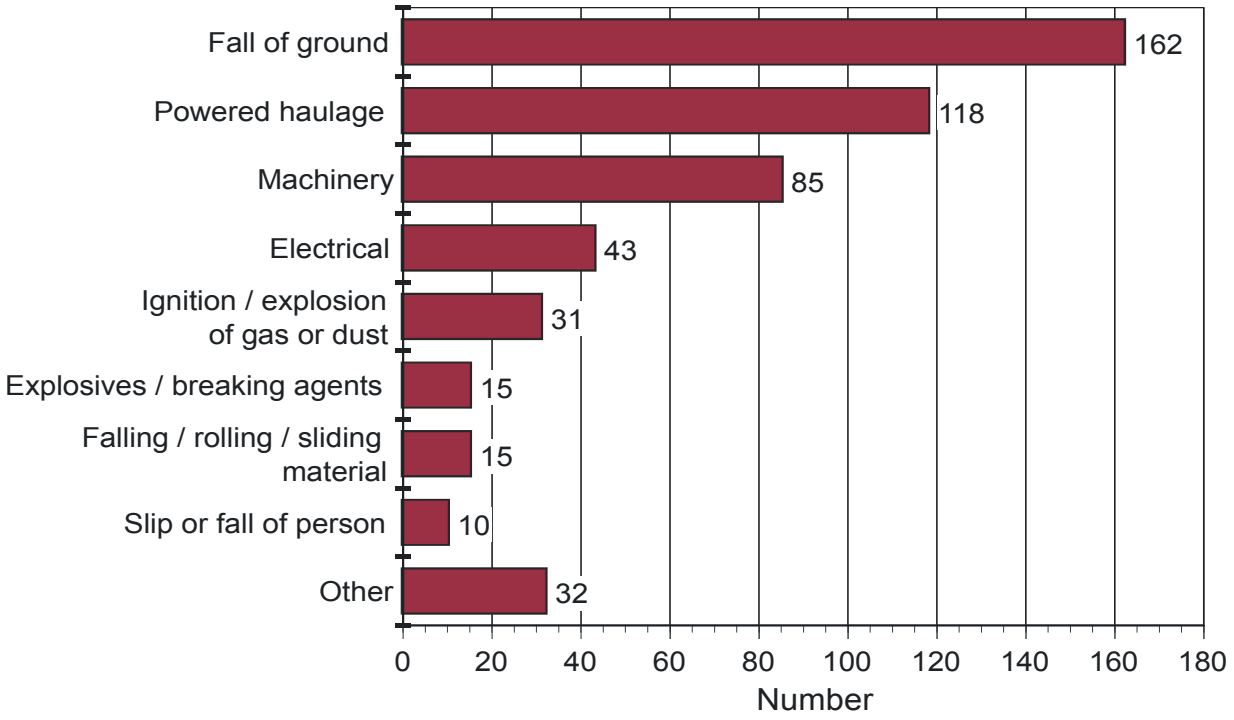


Figure 4A-4.—Coal operators: number of fatal injuries by MSHA accident classification, 1986-1995. (Source: MSHA data)

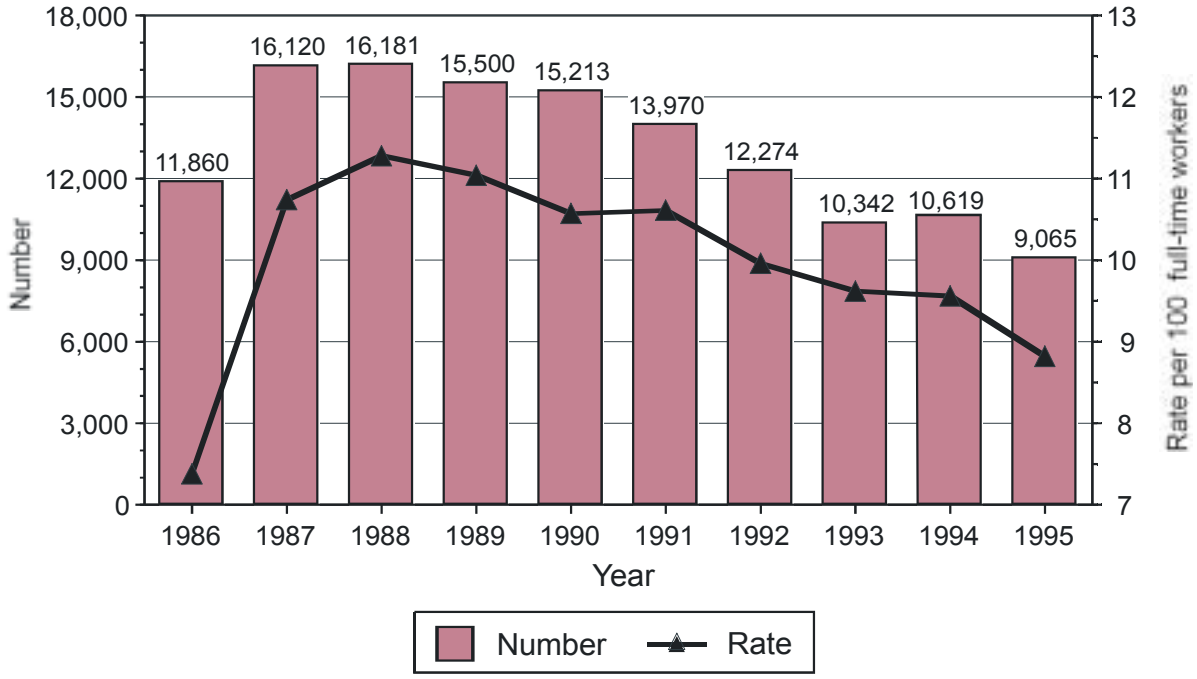


Figure 4A-5.—Coal operators: number and rate (per 100 workers) of nonfatal injuries by year, 1986-1995. (Source: MSHA data)

Table 4A-2.—Coal operators: number and average annual rate (per 100 workers) of nonfatal injuries by subunit, 1986-1995.

Mining operation	Number, 1986-1995	Average annual rate per 100 full-time workers
Underground mines:		
Underground operations	91,011	15.04
Surface operations	6,784	10.93
Surface mines:		
Strip	21,388	5.05
Auger	266	8.14
Culm Bank	286	8.7
Dredge	19	3.62
Independent shops/yards	870	8.4
Preparation Plant	10,234	7.22
Office	286	0.44
Total	131,144	9.97

Source: Mine Safety and Health Administration data.

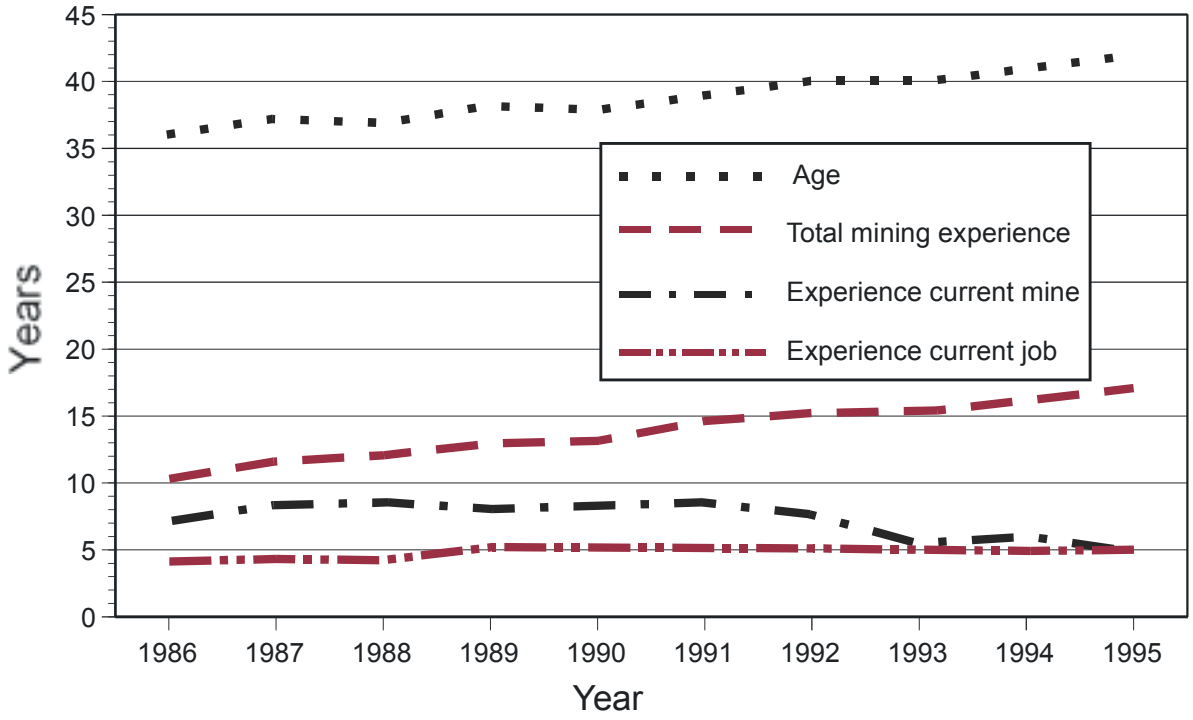


Figure 4A-6.—Coal operators: median values for age, total mining experience in current mine, and experience in current job for workers with nonfatal injuries by year, 1986-1995. (Source: MSHA data)

Table 4A-3.—Coal operators: nonfatal injuries, 1986-1995, by nature of injury. Number of cases, percentage of cases with one or more lost workdays, mean days lost work per case, total days work lost for all cases, and statutory days charged for all cases.

Nature of injury	Number of cases	Lost workday cases (%)	Mean days lost work	Total days lost	Total statutory days
Sprains and strains	52,939	87.0	35.31	1,869,202	59,874
Fracture	13,487	71.8	36.57	493,066	43,175
Contusions	16,010	81.3	18.90	302,523	10,970
Lacerations	21,543	33.6	5.36	115,546	4,245
Hernia	1,117	84.2	31.90	35,635	45,450
Crushing	1,499	71.8	20.32	30,421	5,550
Amputation or enucleation	665	75.3	44.14	29,352	325,173
Dislocation	600	80.0	39.80	23,879	350
Burn, heat	1,351	64.8	13.43	18,115	0
Electric shock	247	82.2	54.74	13,520	0
Joint, tendon, or muscle inflammation or irritation	485	78.6	26.94	13,065	0
Noncontact electric arc burn	983	73.6	10.02	9,854	0
Abrasions	1,139	61.7	6.74	7,675	0
Brain concussion	185	88.1	36.05	6,633	6,000
Electrical burn	195	76.4	19.50	3,802	50
Burn, chemical	701	56.5	4.71	3,305	0
Dust in eyes	1,559	41.2	1.59	2,479	0
Poisoning	244	50.4	2.74	669	0
Other specified causes	1,255	75.3	27.28	34,237	5,400
Multiple injuries, unspecified	9,093	75.5	29.77	270,626	69,480
Other unspecified injuries	5,847	81.6	36.70	214,558	9,000
Total	131,144	73.2	26.28	3,498,162	584,717

Source: Mine Safety and Health Administration data.

Table 4A-4.—Coal operators: nonfatal injuries, 1986-1995, by work activity. Number of cases, percentage of cases with one or more lost workdays, mean days lost work per case, total days work lost for all cases, and statutory days charged for all cases.

Work activity	Number of cases	Lost workday cases (%)	Mean days work lost	Total days lost	Total statutory days
Materials handling	40,469	77.3	29.25	1,183,702	163,034
Using or operating tools or machinery	32,899	64.0	20.49	673,893	134,133
Vehicular and transportation operations	19,000	80.4	30.58	580,959	95,945
Constructing, repairing, or cleaning	20,963	68.8	24.22	507,737	131,235
Bodily movement	12,373	78.4	30.00	371,211	22,065
Other	4,295	74.4	29.16	125,235	27,555
Unspecified	1,145	88.5	48.41	55,425	10,750
Total	131,144	73.2	26.68	3,498,162	584,717

Source: Mine Safety and Health Administration data.

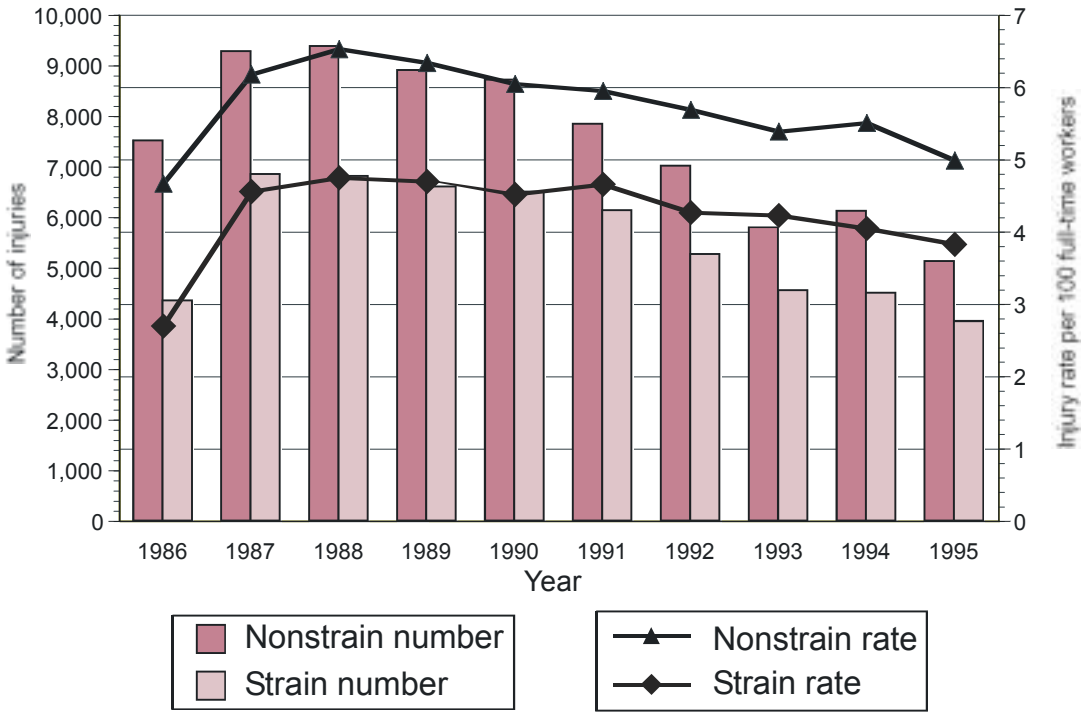


Figure 4A-7.—Coal operators: nonfatal injuries, 1986-1995. Number and rate (per 100 workers) of strain and nonstrain injuries by year. (Source: MSHA data)

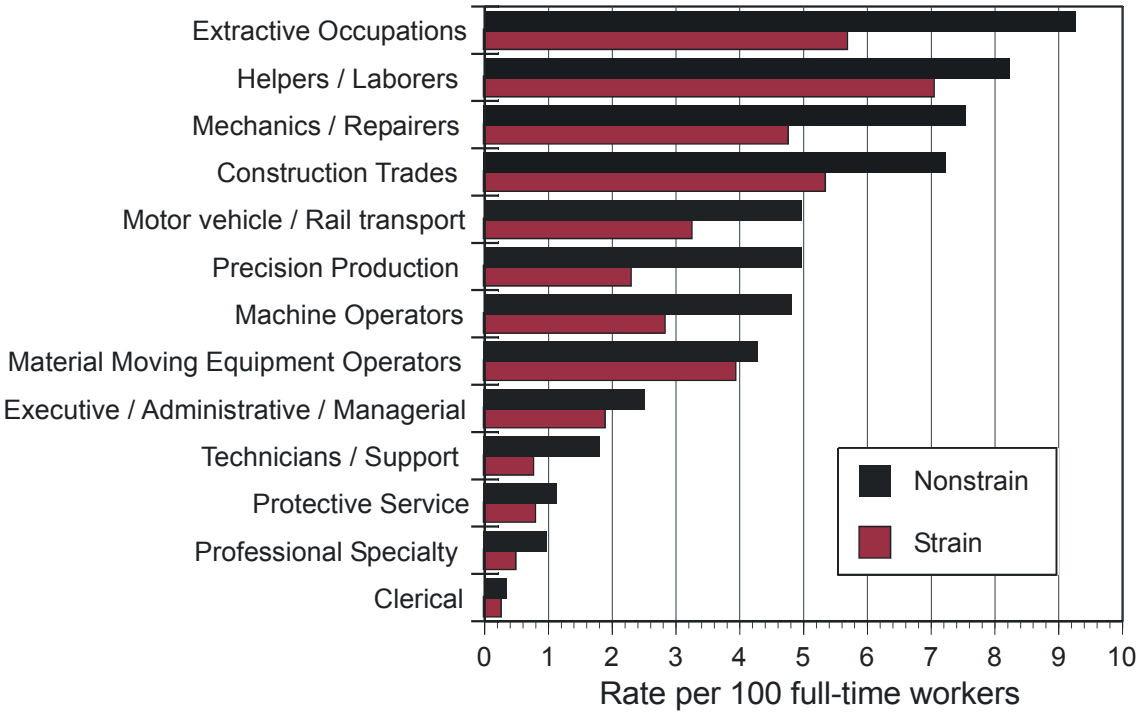


Figure 4A-8.—Coal operators: nonfatal injuries, 1986-1995. Rate (per 100 workers) of strain and nonstrain injuries by U.S. Bureau of the Census Occupation Division. (Data on occupations were missing for 3,726 out of 131,144 cases (1.8%).) (Source: MSHA data)

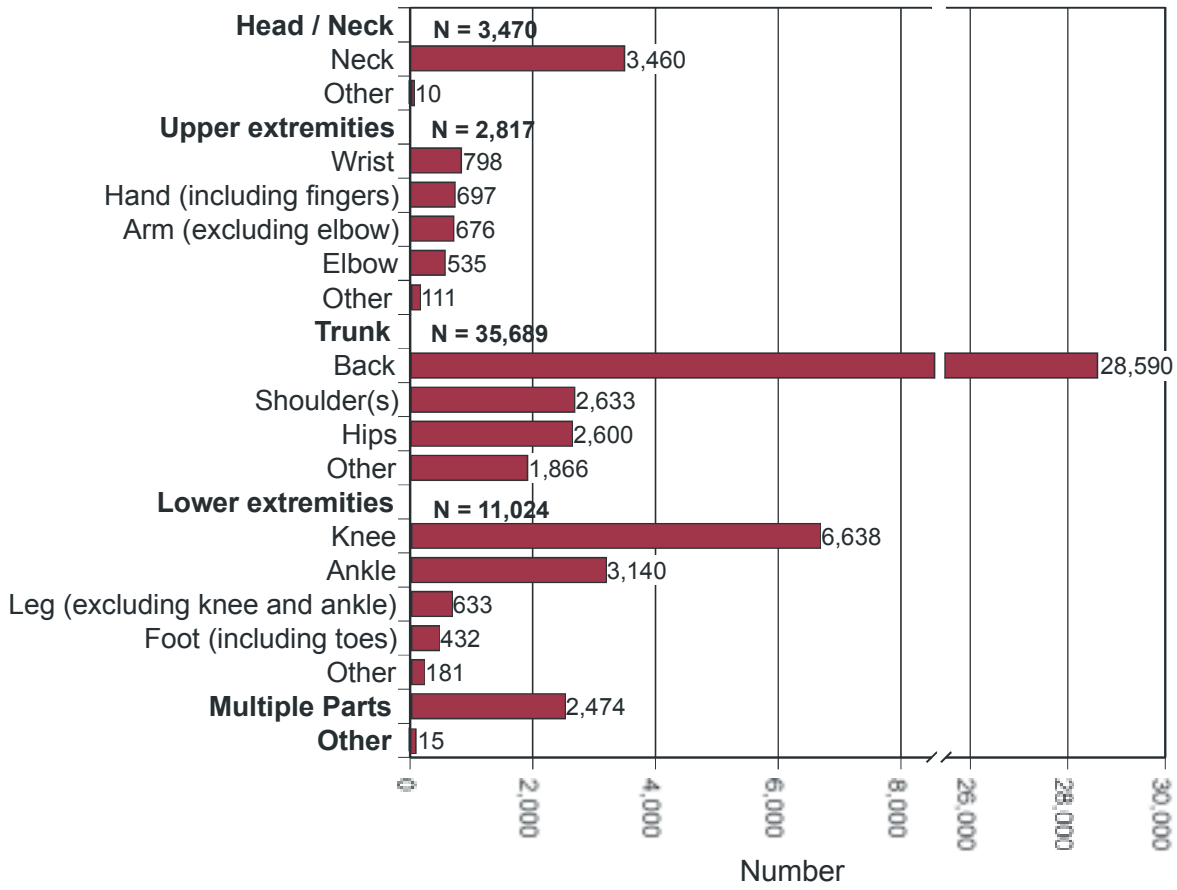


Figure 4A-9.—Coal operators: number of (nonfatal) strain injuries by body part injured, 1986-1995. (Source: MSHA data)

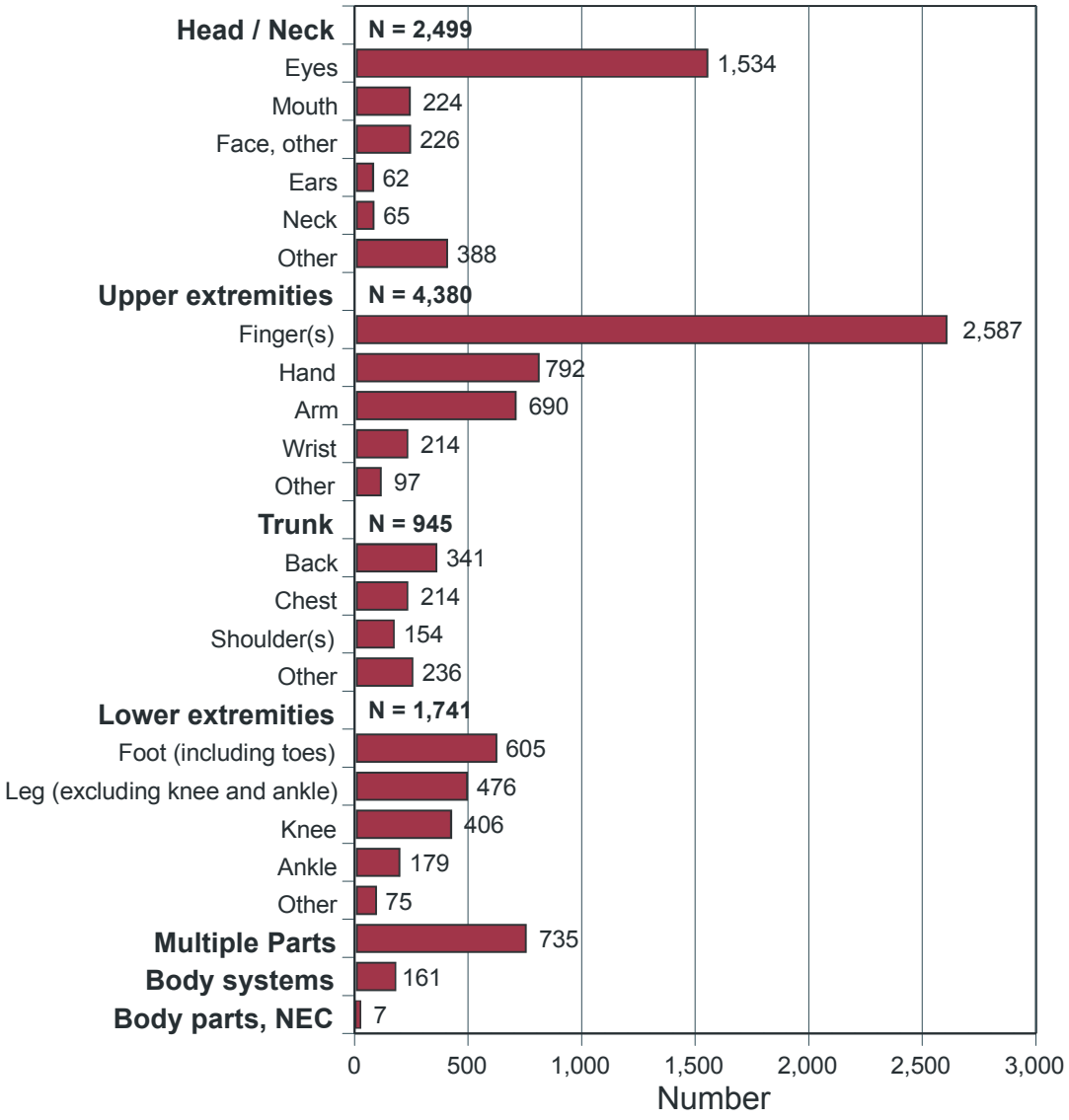


Figure 4A-10.—Coal operators: number of (nonfatal) nonstrain injuries by body part injured, 1986-1995. (Source: MSHA data)

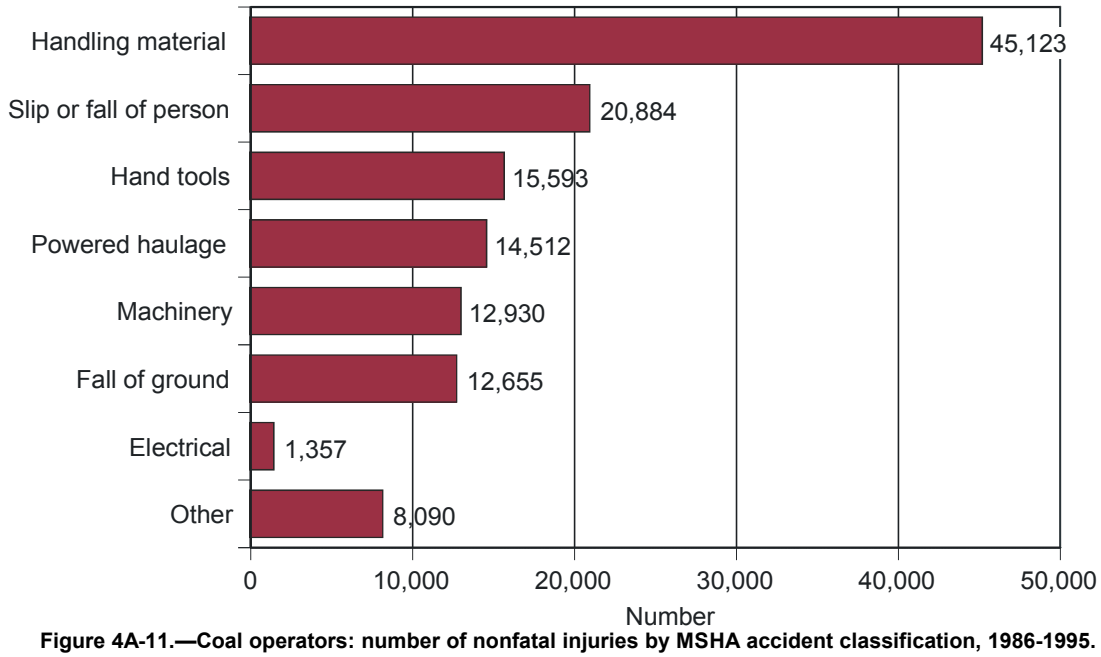


Figure 4A-11.—Coal operators: number of nonfatal injuries by MSHA accident classification, 1986-1995. (Source: MSHA data)

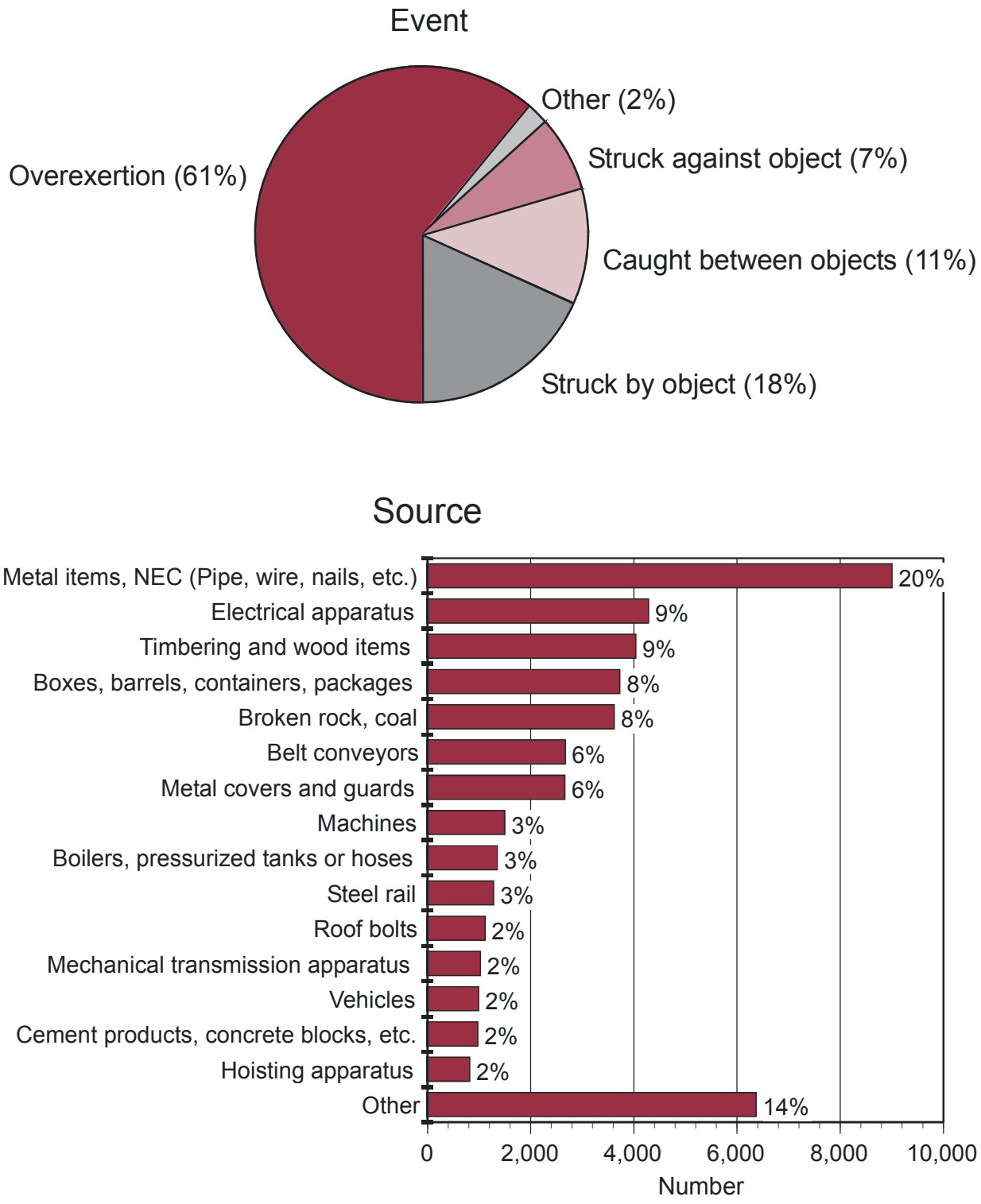


Figure 4A-12.—Coal operators: nonfatal material handling injuries, 1986-1995. Percent of injuries by event resulting in injury and by source of injury (n = 45,123). (Source: MSHA data)

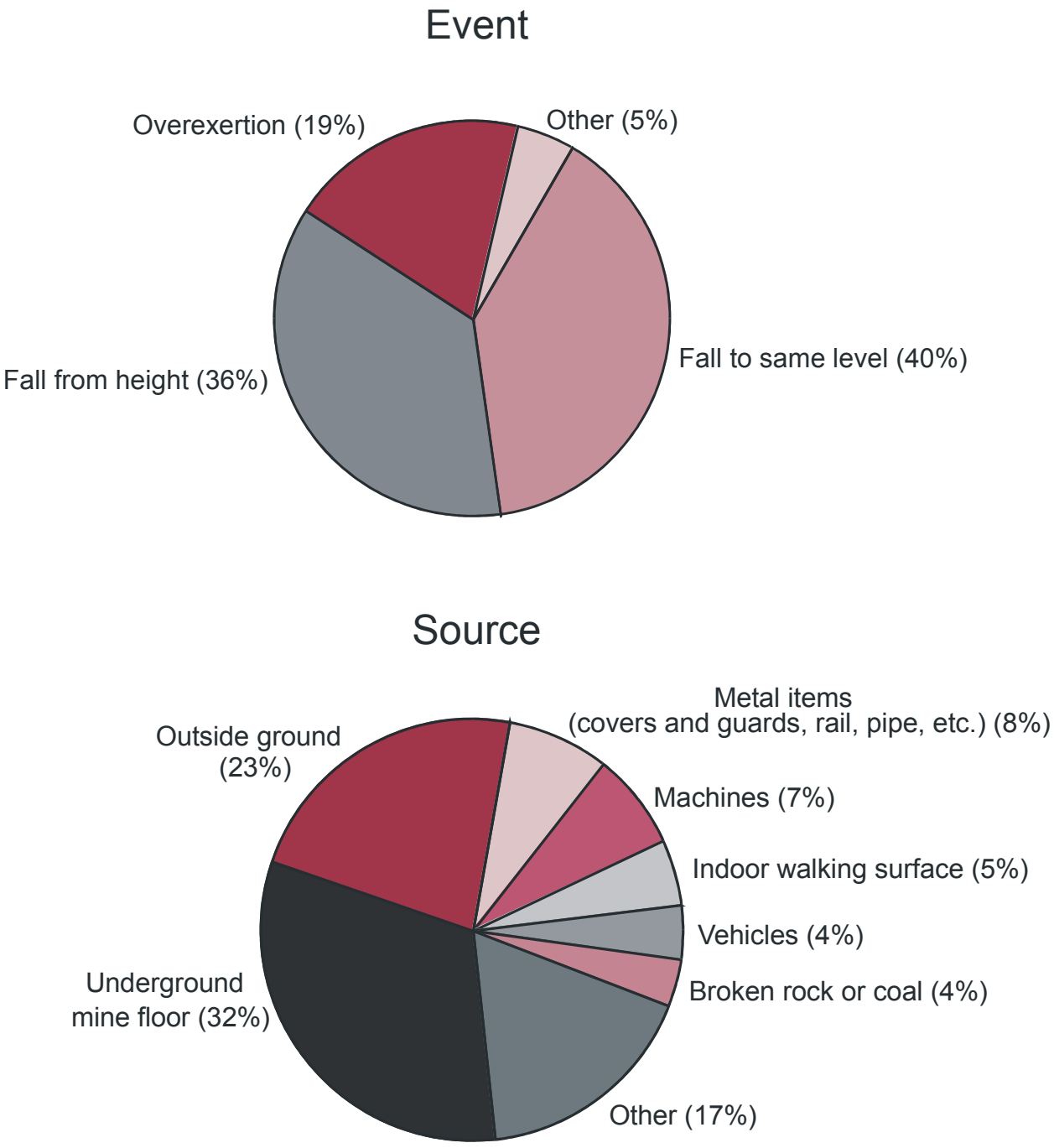


Figure 4A-13.—Coal operators: nonfatal fall injuries, 1986-1995. Percent of injuries by event resulting in injury and by source of injury (n = 20,884). (Source: MSHA data)

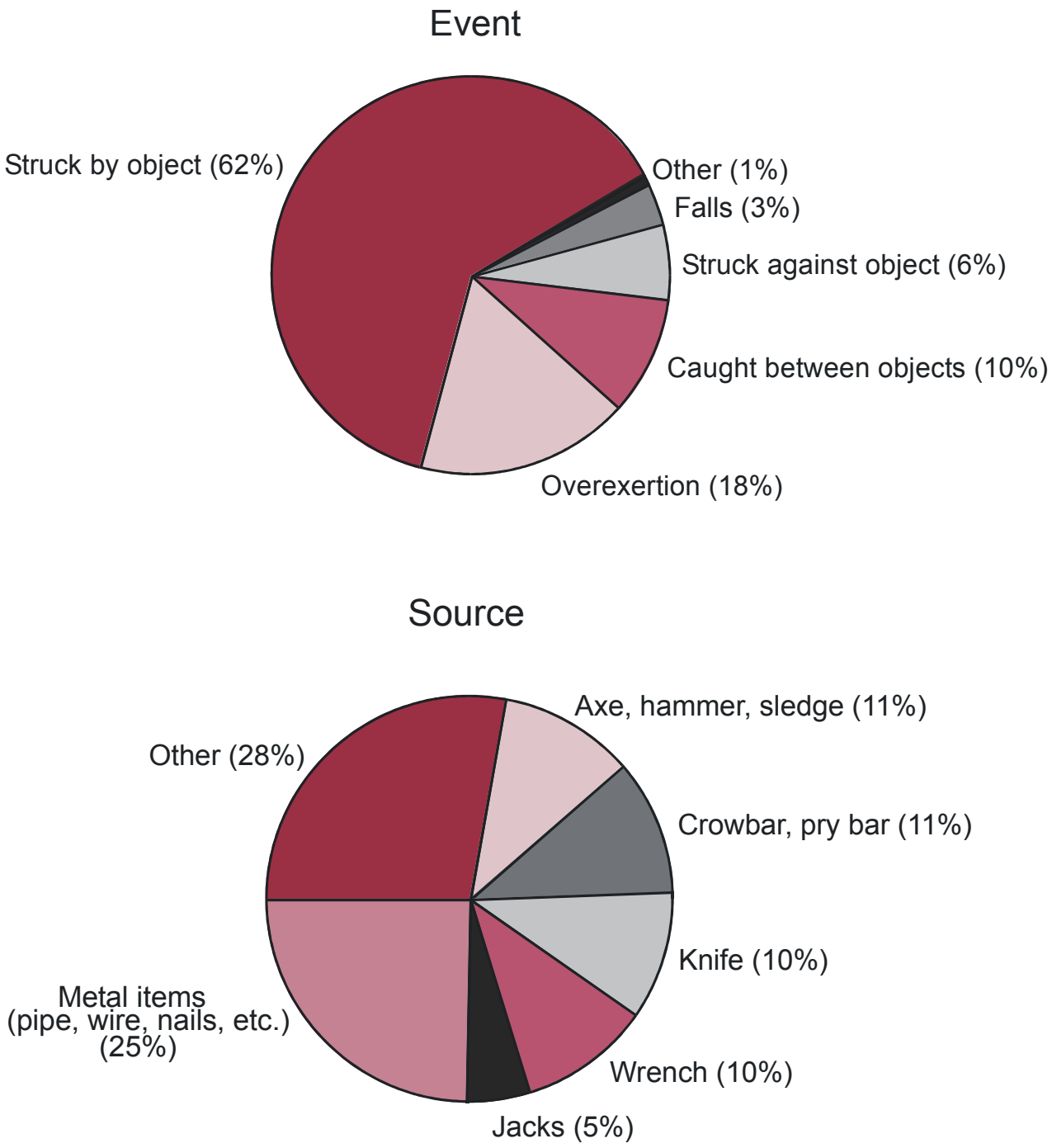


Figure 4A-14.—Coal operators: nonfatal hand tool injuries, 1986-1995. Percent of injuries by event resulting in injury and by source of injury (n = 15,593). (Source: MSHA data)

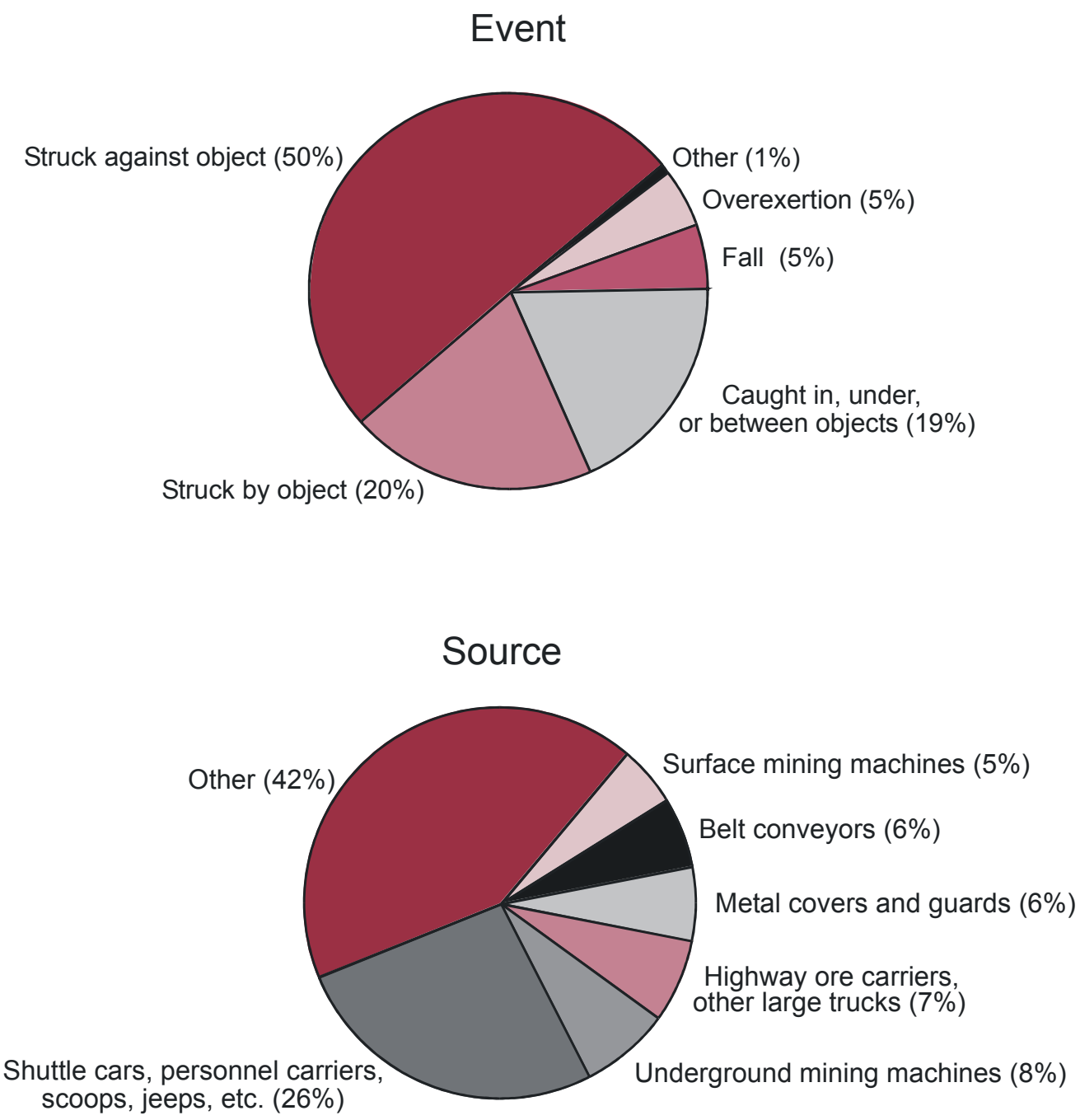


Figure 4A-15.—Coal operators: nonfatal powered haulage injuries, 1986-1995. Percent of injuries by event resulting in injury and by source of injury (n = 14,512), (Source: MSHA data)

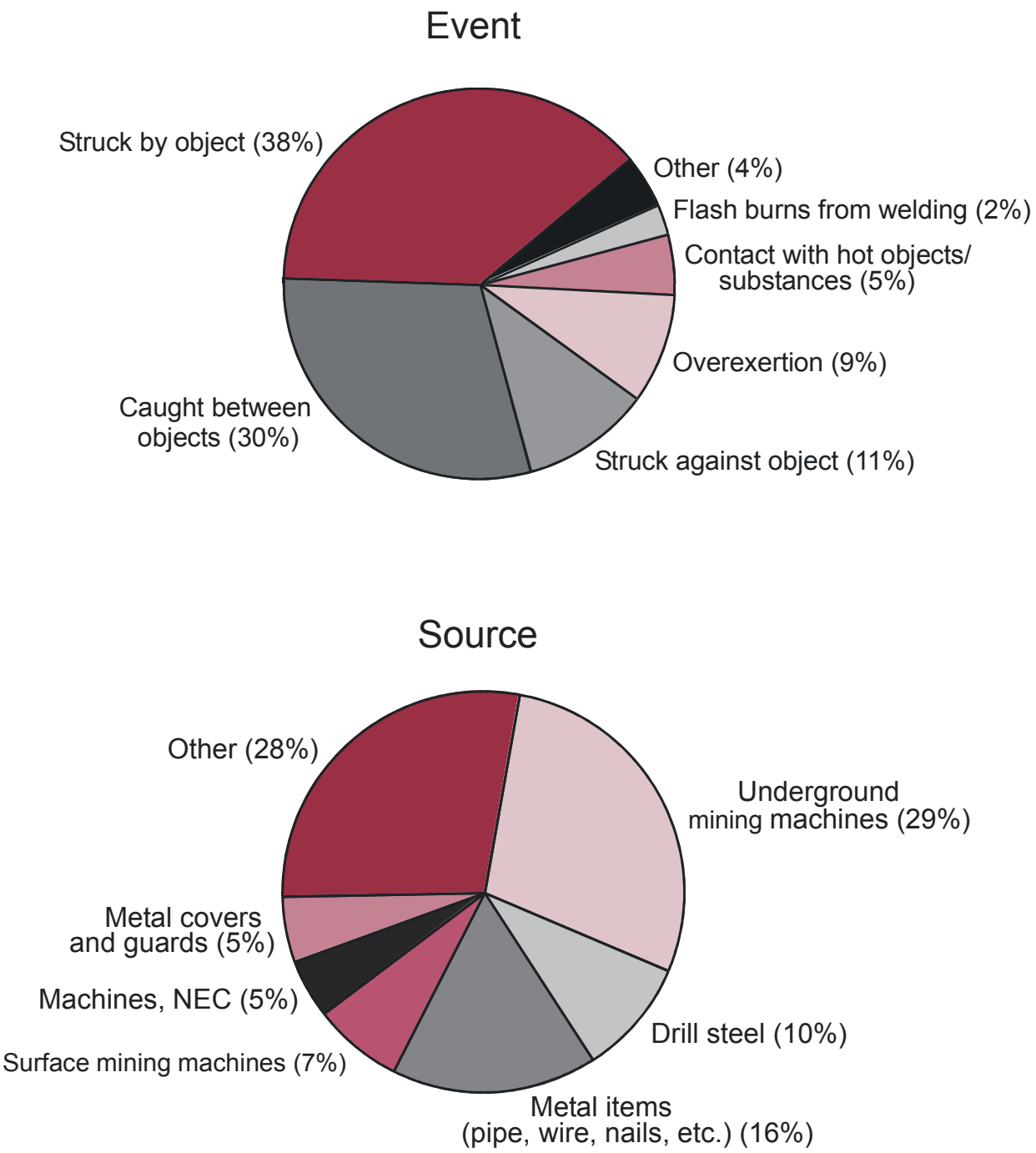


Figure 4A-16.—Coal operators: nonfatal machine injuries, 1986-1995. Percent of injuries by event resulting in injury and by source of injury (n = 12,930). (Source: MSHA data)

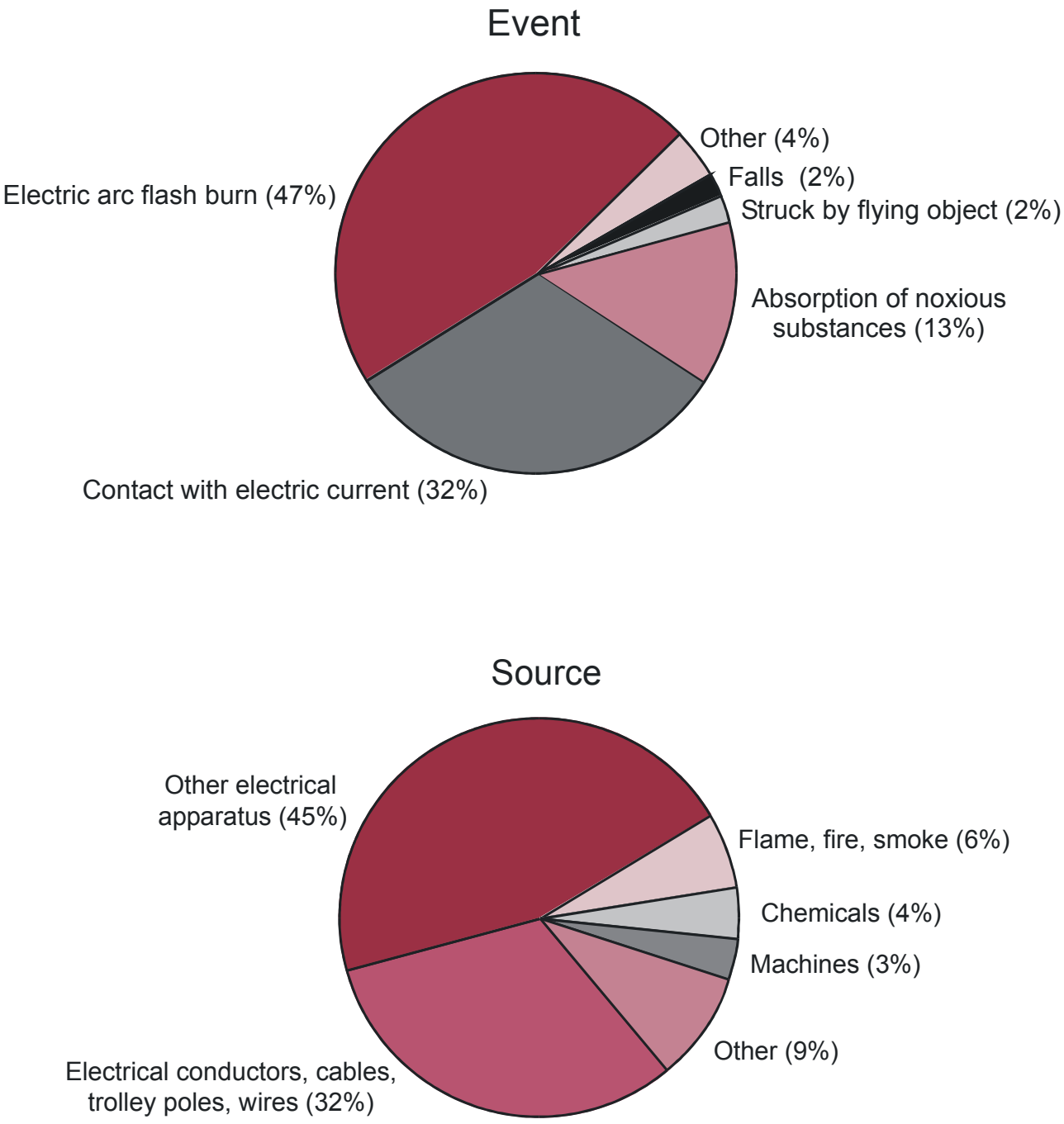


Figure 4A-17.—Coal operators: nonfatal electrical injuries, 1986-1995. Percent of injuries by event resulting in injury and by source of injury (n = 1,357). (Source: MSHA data)

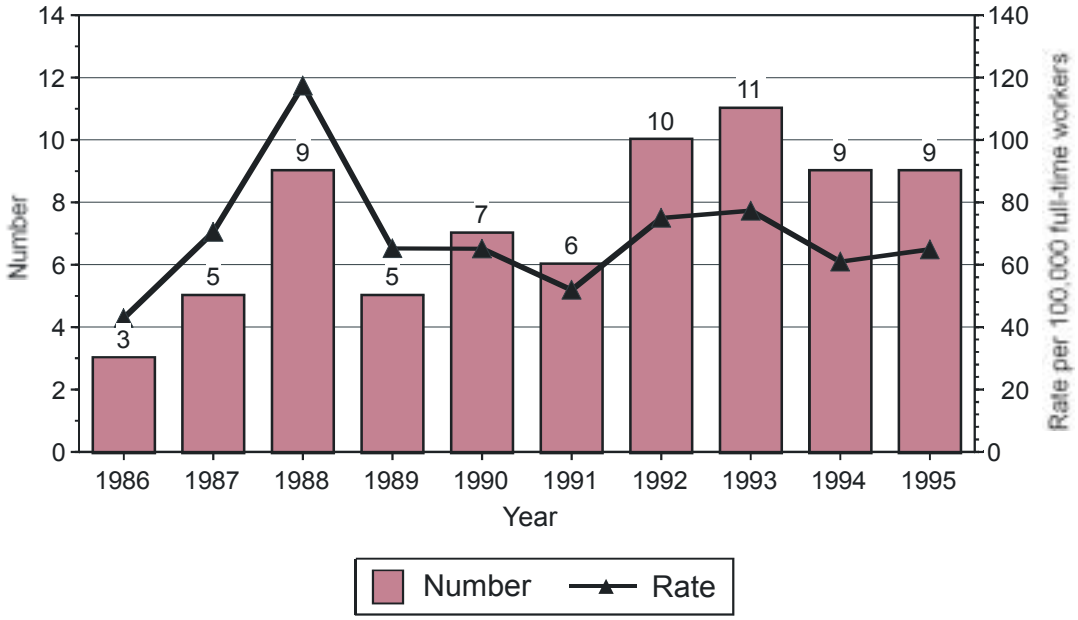


Figure 4A-18.—Coal contractors: number and rate of fatal injuries (per 1000,000 workers) by year. (Source: MSHA data)

Table 4A-5.—Coal contractors: number and average annual rate (per 100,00 workers) of fatal injuries by subunit, 1986-1995.

Mining operation	Number, 1986-1995	Average annual rate per 100,000 full-time workers
Underground mines:		
Underground operations	2	*
Surface operations	13	68.3
Surface mines:		
Strip	36	64.4
Auger	4	396.7
Culm Bank	1	*
Dredge	0	*
Independent shops/yards	1	*
Preparation Plants	17	75.87
Office	0	*
Total	74	63.1

*** Rate not calculated because there were fewer than 3 fatalities**

Source: Mine Safety and Health Administration data.

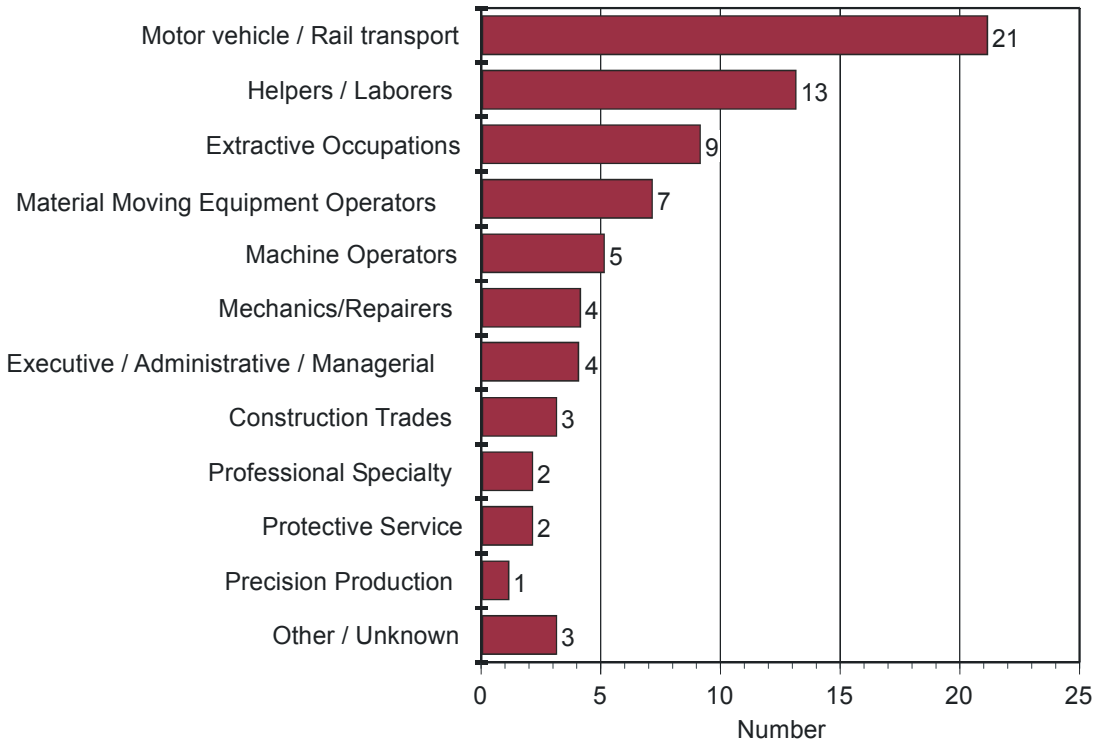


Figure 4A-19.—Coal contractors: number of fatal injuries by U.S. Bureau of the Census Occupation Division, 1986-1995. (Source: MSHA data)

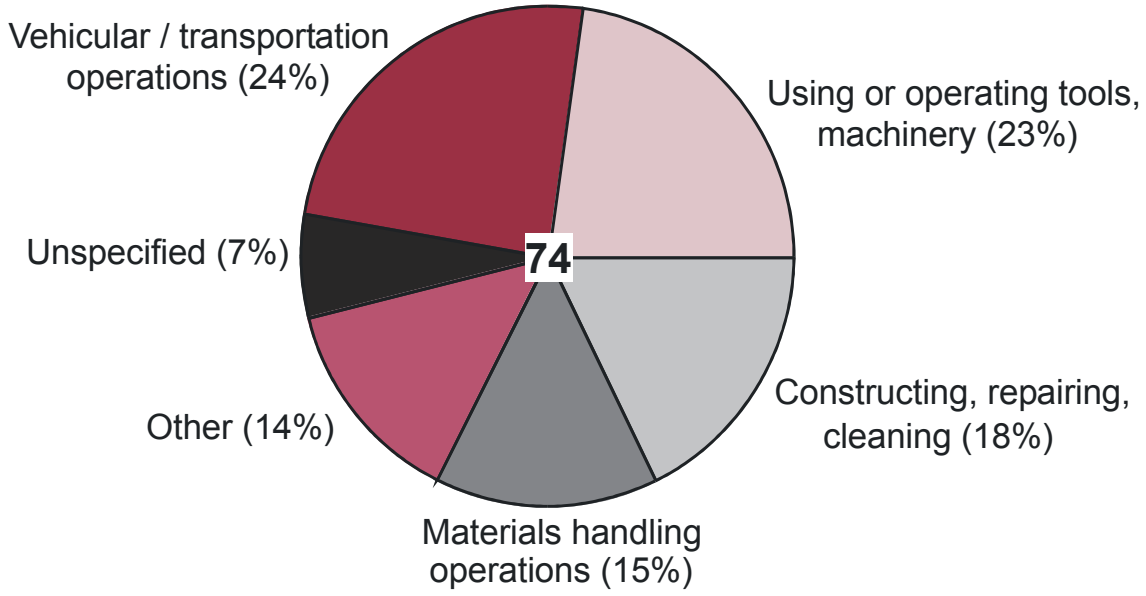


Figure 4A-20.—Coal contractors: percent of fatal injuries by work activity, 1986-1995. (Source: MSHA data)

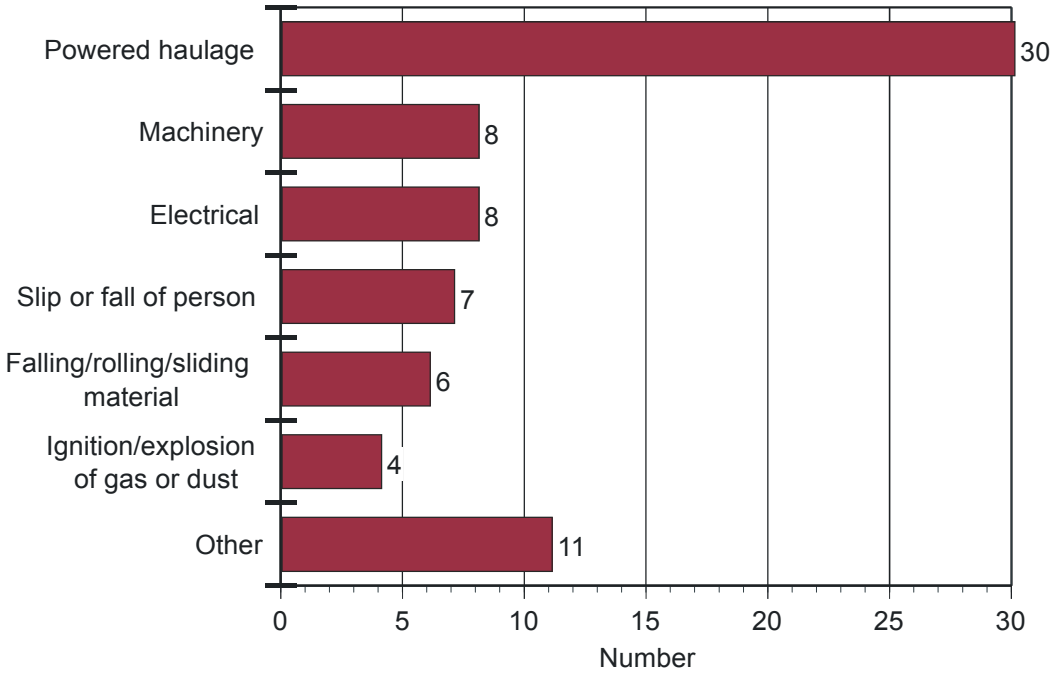


Figure 4A-21.—Coal contractors: number of fatal injuries by MSHA accident classification, 1986-1995. (Source: MSHA data)

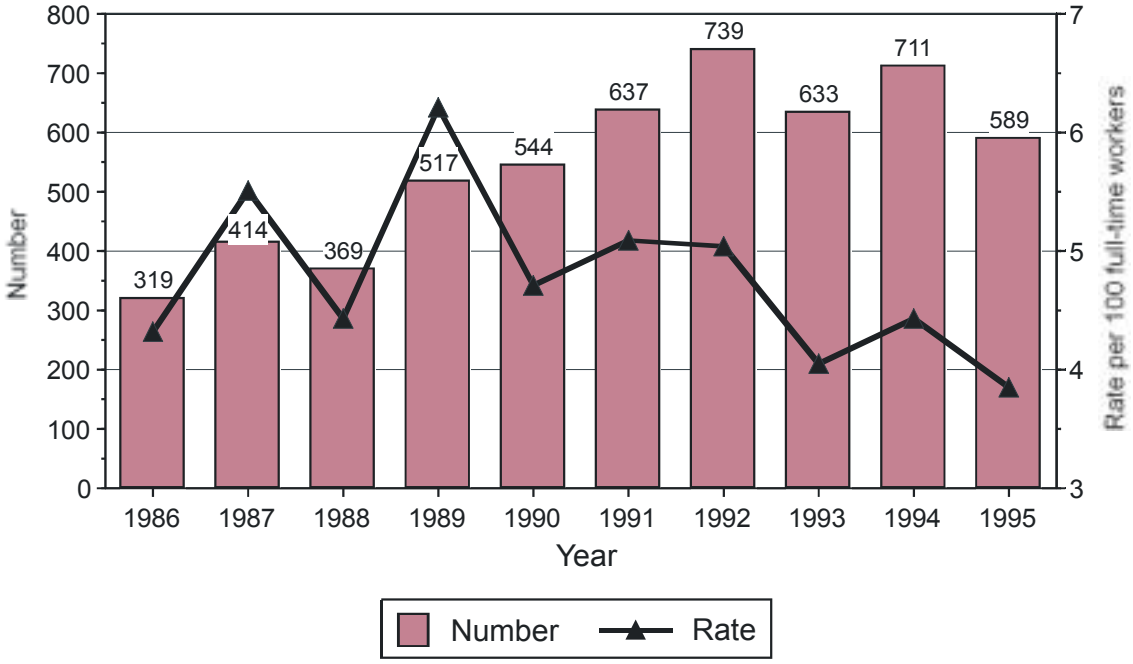


Figure 4A-22.—Coal contractors: number and rate (per 100 workes) of nonfatal injuries by year. (Source: MSHA data)

Table 4A-6.—Coal contractors: number and average annual rate (per 100 workers) of nonfatal injuries by subunit, 1986-1995.

Mining operation	Number, 1986 -1995	Average annual rate per 100 full-time workers
Underground mines:		
Underground operations	1,375	15.87
Surface operations	623	3.27
Surface mines:		
Strip	1,911	3.42
Auger	75	7.44
Culm Bank	10	1.69
Dredge	2	1.22
Independent shops/yards	26	17.55
Preparation Plant	1,379	6.15
Office	71	0.76
Total	5,472	4.67

Source: Mine Safety and Health Administration data.

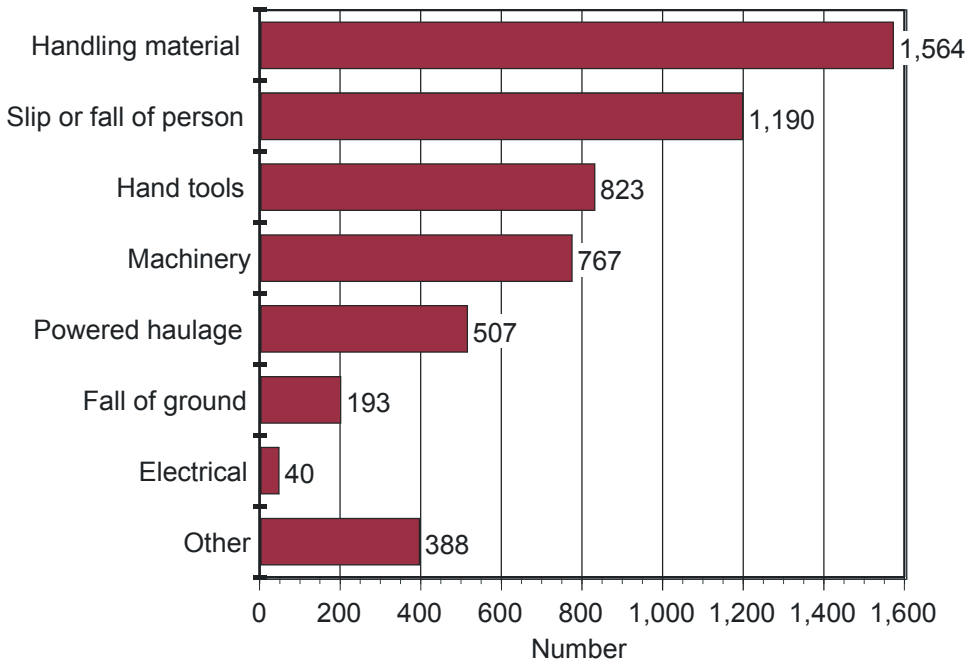


Figure 4A-23.—Coal contractors: number of nonfatal injuries by MSHA accident classification, 1986-1995. (Source: MSHA data)

4B. INJURIES IN METAL MINING

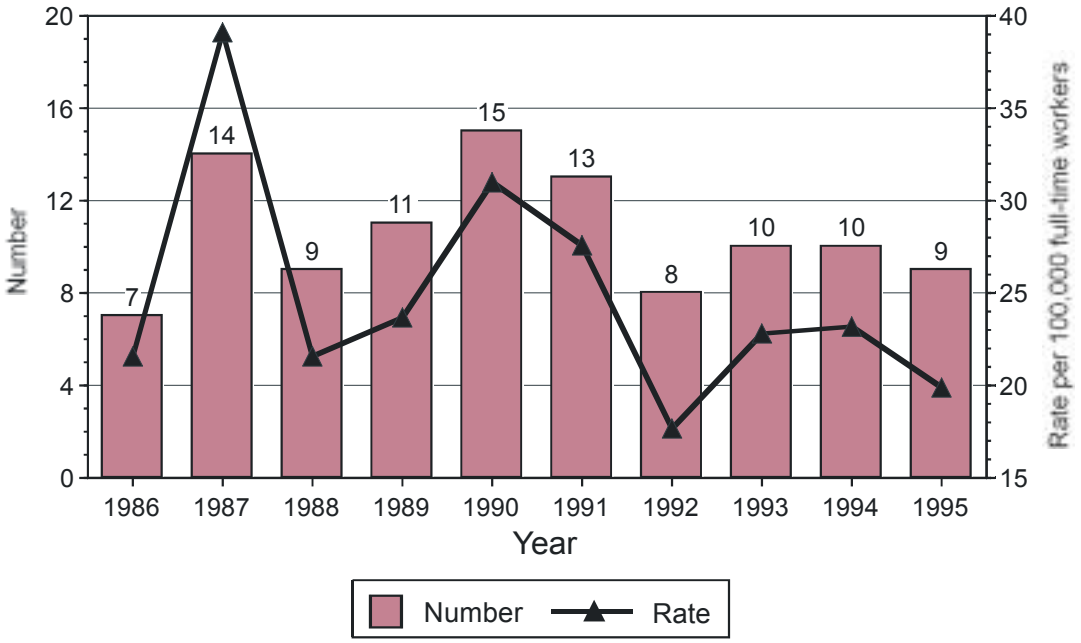


Figure 4B-1.—Metal operators: number and rate (per 100,000 workers) of fatal injuries by year, 1986-1995. (Source: MSHA data)

Table 4B-1.—Metal operators: number and average annual rate (per 100,000 workers) of fatal injuries by subunit, 1986-1995.

Mining operation	Number, 1986-1995	Average annual rate per 100,000 full-time workers
Underground mines:		
Underground operations	56	87.6
Surface operations	5	29.7
Surface mines:		
Strip	31	20.2
Dredge	0	*
Other surface mining	0	*
Independent shops/yards	1	*
Mill	13	7
Office	0	*
Total	106	22

*** Rate not calculated because there were fewer than 3 fatalities**

Source: Mine Safety and Health Administration data.

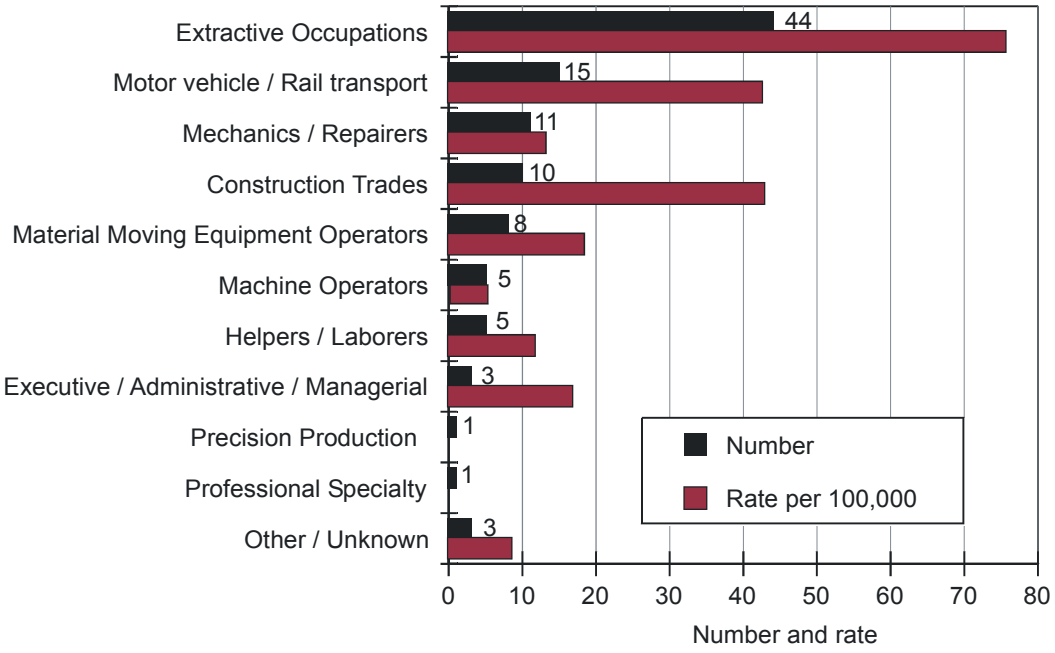


Figure 4B-2.—Metal operators: number and rate (per 100,000 workers) of fatal injuries by U.S. Bureau of the Census Occupation Division, 1996-1995. (Source: MSHA data)

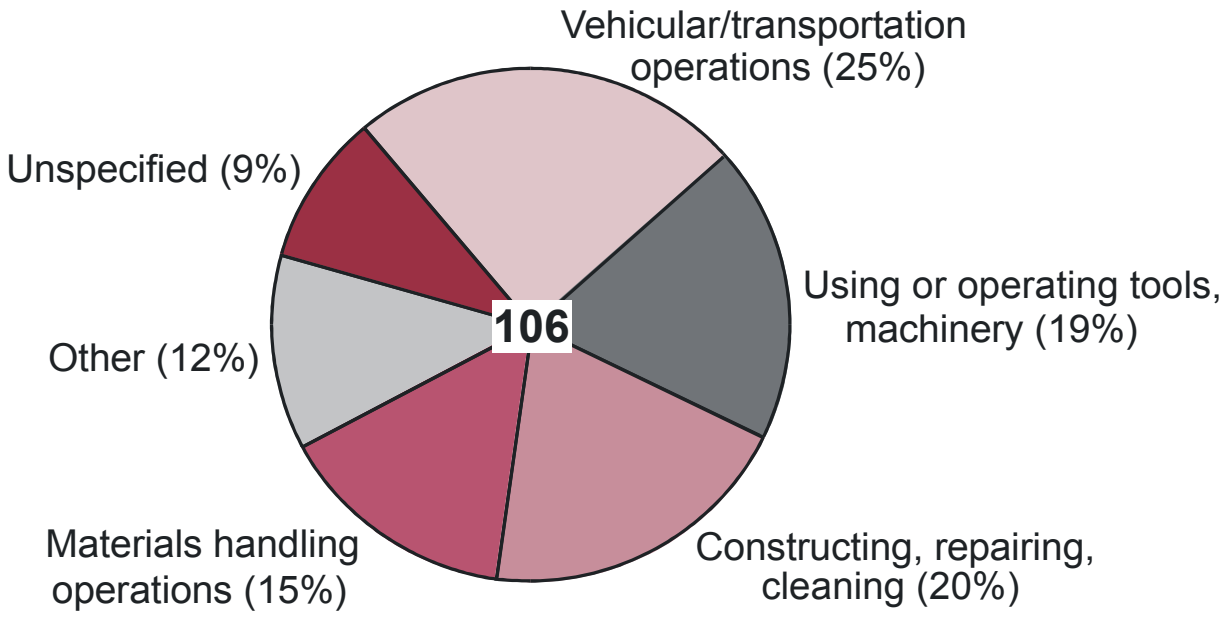


Figure 4B-3.—Metal operators: number of fatal injuries by work activity, 1986-1995. (Source: MSHA data)

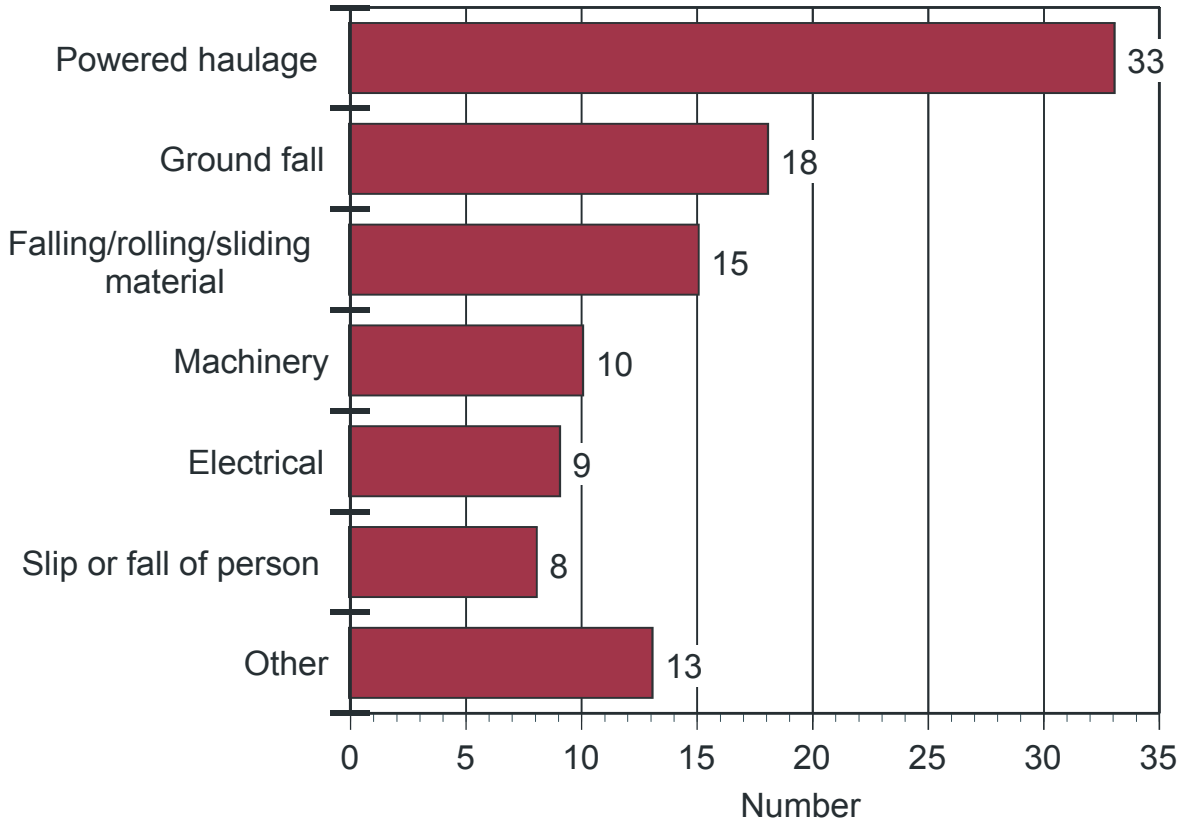


Figure 4B-4.—Metal operators: number of fatal injuries by MSHA accident classification, 1986-1995. (Source: MSHA data)

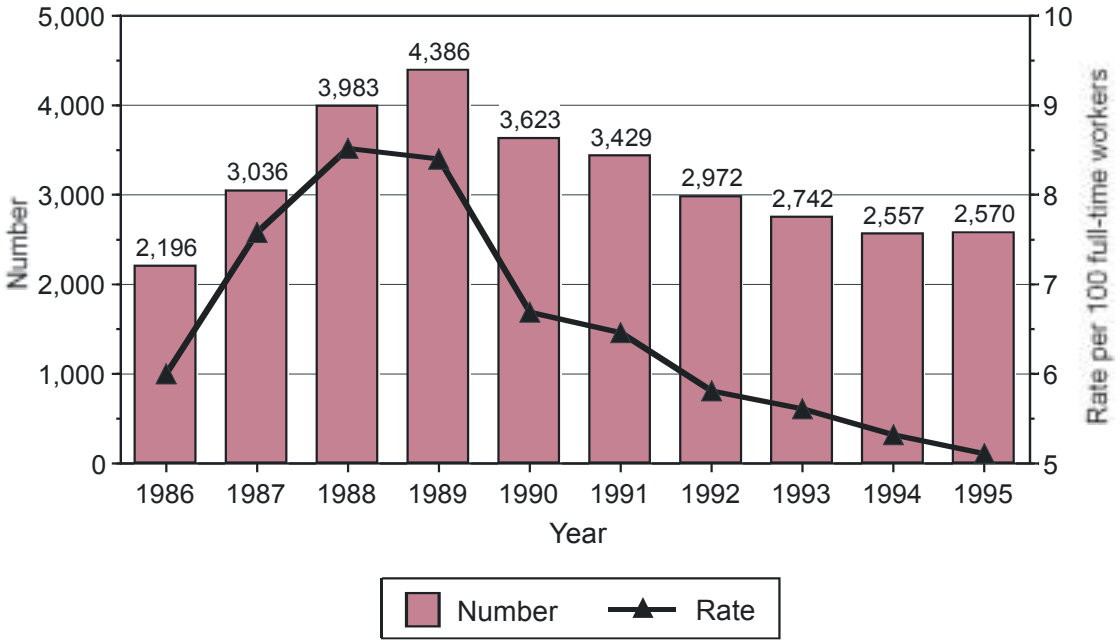


Figure 4B-5.—Metal operators: number and rate (per 100 workers) of nonfatal injuries by year, 1986-1995. (Source: MSHA data)

Table 4B-2.—Metal operators: number and average annual rate (per 100 workers) of nonfatal injuries by subunit, 1986-1995.

Mining operation	Number, 1986-1995	Average annual rate per 100 full-time workers
Underground mines:		
Underground operations	8,177	12.79
Surface operations	1,293	7.67
Surface mines:		
Strip	8,179	5.33
Dredge	417	9.49
Other surface mining	71	9.67
Independent shops/yards	276	6.61
Mill	12,921	6.98
Office	160	0.3
Total	31,494	6.52

Source: Mine Safety and Health Administration data.

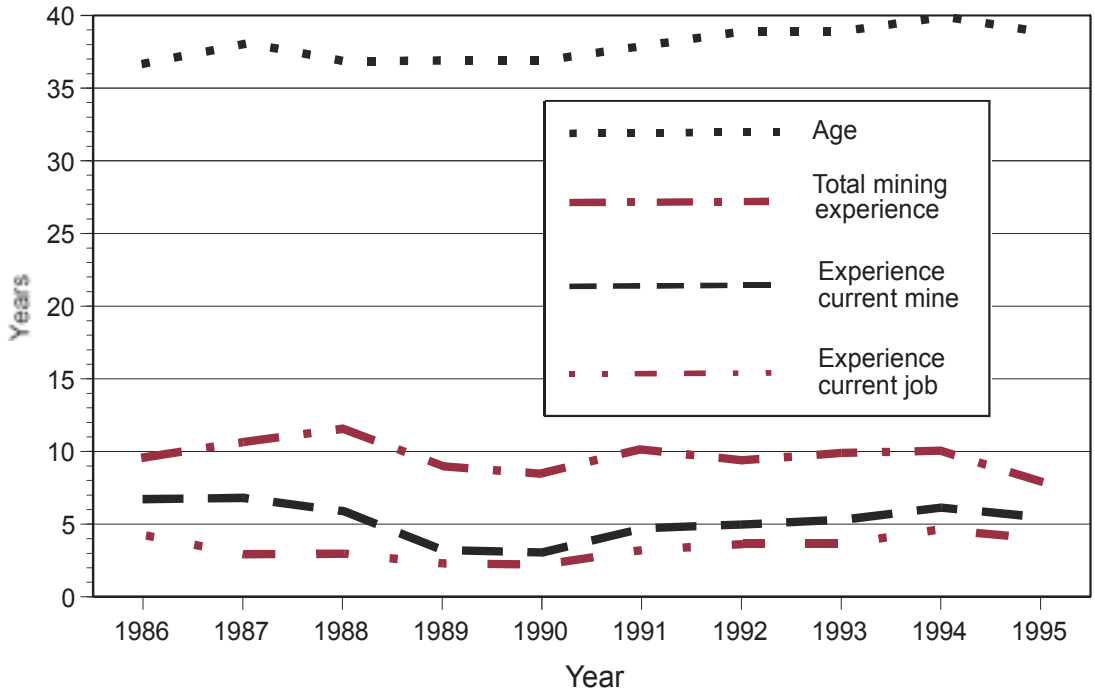


Figure 4B-6.—Metal operators: median values for age, total mining experience, experience in current mine, and experience in current job for workers with nonfatal injuries by year, 1986-1995. (Source: MSHA data)

Table 4B-3.—Metal operators: nonfatal injuries, 1986-1995, by nature of injury. Number of cases, percentage of cases with one or more lost workdays, mean days lost work per case, total days work lost for all cases, and statutory days charged for all cases.

Nature of injury	Number of cases	Lost workday cases (%)	Mean days lost work	Total days lost	Total statutory days
Sprains and strains	10,761	59.0	21.81	234,696	17,540
Fracture	3,605	43.5	22.86	82,399	15,912
Contusions	2,306	50.4	11.67	26,908	0
Lacerations	7,371	12.8	2.05	15,111	1,870
Hernia	366	82.5	26.12	9,560	13,600
Amputation or enucleation	191	66.5	30.75	5,874	74,025
Dislocation	194	54.6	27.72	5,377	950
Joint, tendon, or muscle inflammation or irritation	247	50.6	21.51	5,313	0
Burn, heat	671	33.2	6.94	4,657	450
Crushing	260	40.0	12.32	3,204	6,950
Burn, chemical	733	32.7	4.32	3,165	0
Noncontact electric arc burn	216	42.1	5.46	1,179	0
Brain concussion	63	79.4	15.59	982	0
Poisoning	166	41.6	4.75	788	0
Abrasions	417	33.3	1.88	784	0
Electrical burn	21	57.1	21.29	447	0
Dust in eyes	705	14.5	0.57	401	0
Electric shock	29	58.6	29.00	269	0
Other specified causes	405	48.9	12.68	5,137	6,943
Multiple injuries, unspecified	2,239	50.0	14.79	44,193	16,785
Other unspecified injuries	528	57.8	22.41	11,835	75
Total	31,494	42.4	14.68	462,279	155,100

Source: Mine Safety and Health Administration data.

Table 4B-4.—Metal operators: nonfatal injuries, 1986-1995, by work activity. Number of cases, percentage of cases with one or more lost workdays, mean days lost work per case, total days work lost for all cases, and statutory days charged for all cases.

Work activity	Number of cases	Lost workday cases (%)	Mean days lost work	Total days lost	Total statutory days
Materials handling	9,148	44.9	14.68	134,332	48,010
Using or operating tools or machinery	8,724	32.8	10.32	90,071	32,535
Constructing, repairing or cleaning	5,894	38.7	13.36	78,767	35,735
Vehicular and transportation operations	3,565	55.6	21.86	77,935	7,570
Bodily movement	3,020	50.6	18.85	56,914	6,360
Other	830	47.1	16.71	13,871	20,690
Unspecified	313	62.6	33.19	10,389	4,200
Total	31,494	42.4	14.68	462,279	155,100

Source: Mine Safety and Health Administration data.

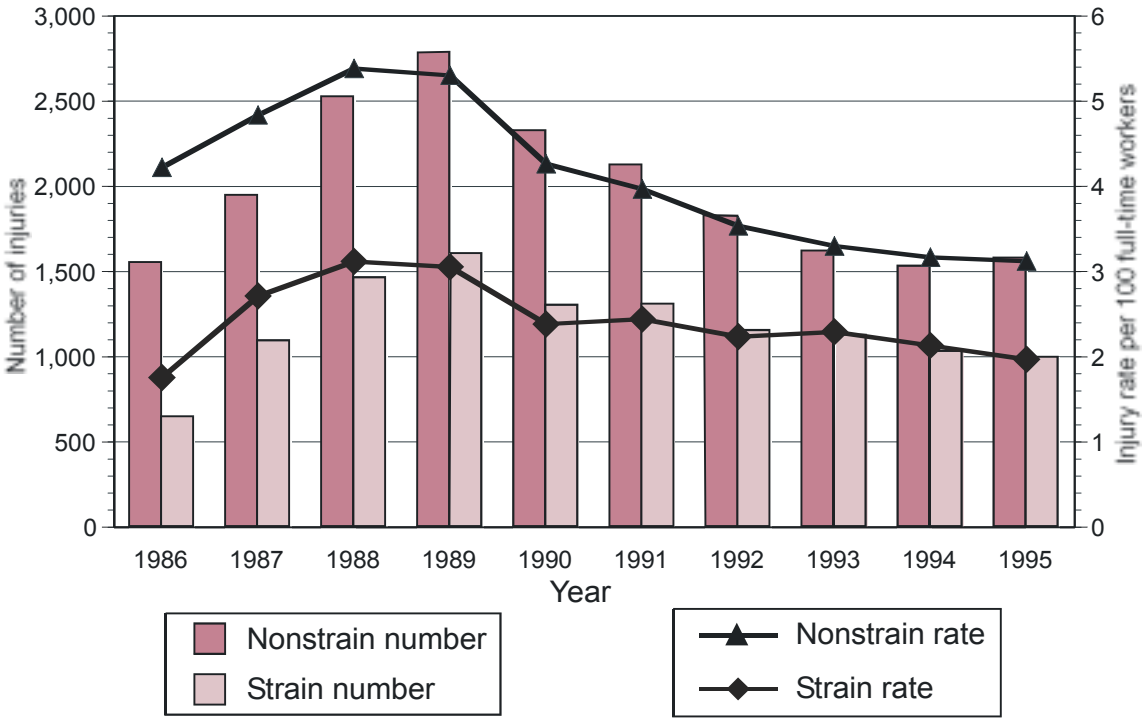


Figure 4B-7.—Metal operators: nonfatal injuries 1986-1995. Number and rate (per 100 workers) of strain and nonstrain injuries by year, 1986-1995. (Source: MSHA data)

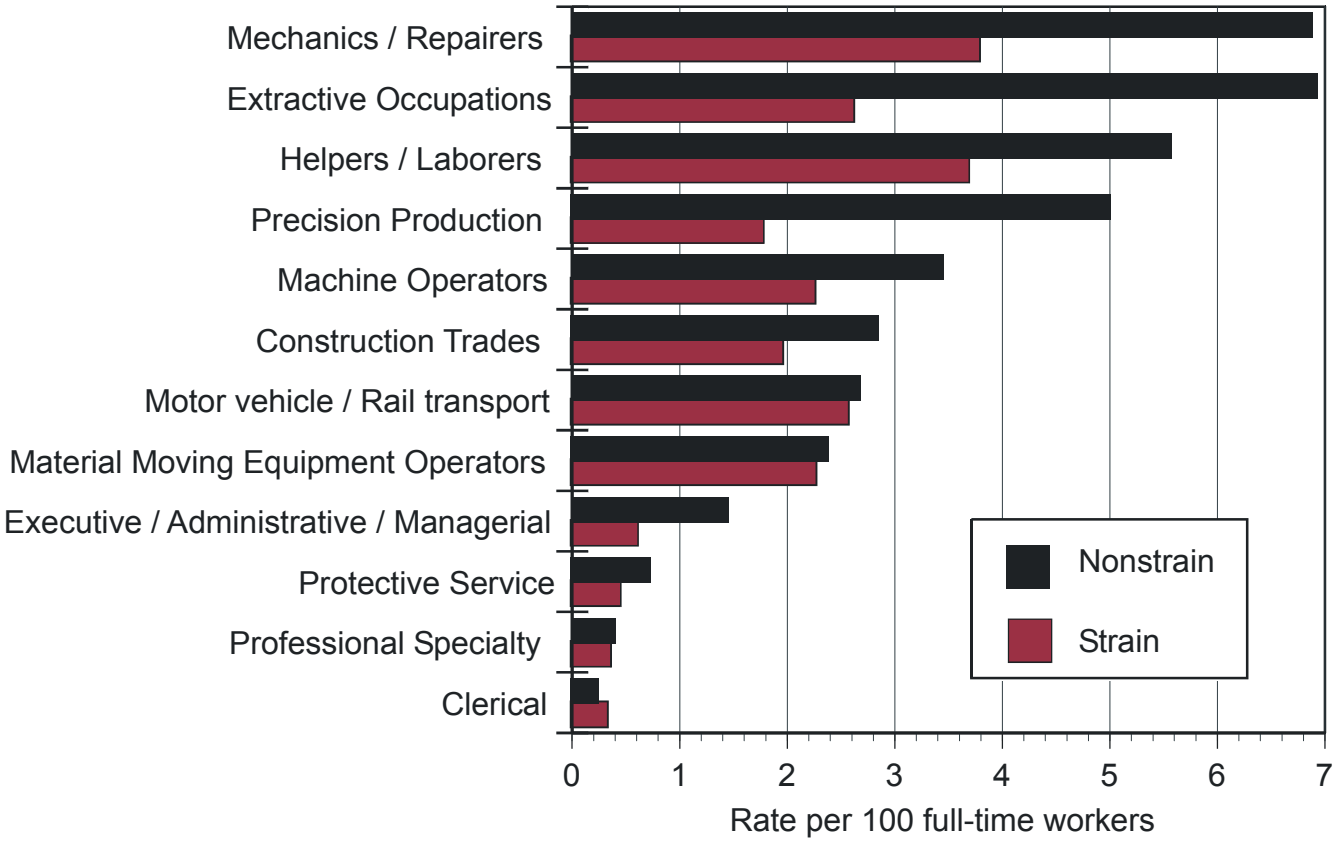


Figure 4B-8.—Metal operators: nonfatal injuries 1986-1995. Number and rate (per 100 workers) of strain and nonstrain injuries by U.S. Bureau of the Census Occupation Division, 1986-1995. (Data on occupations were missing for 915 out of 31,492 cases (2.9%).) (Source: MSHA data)

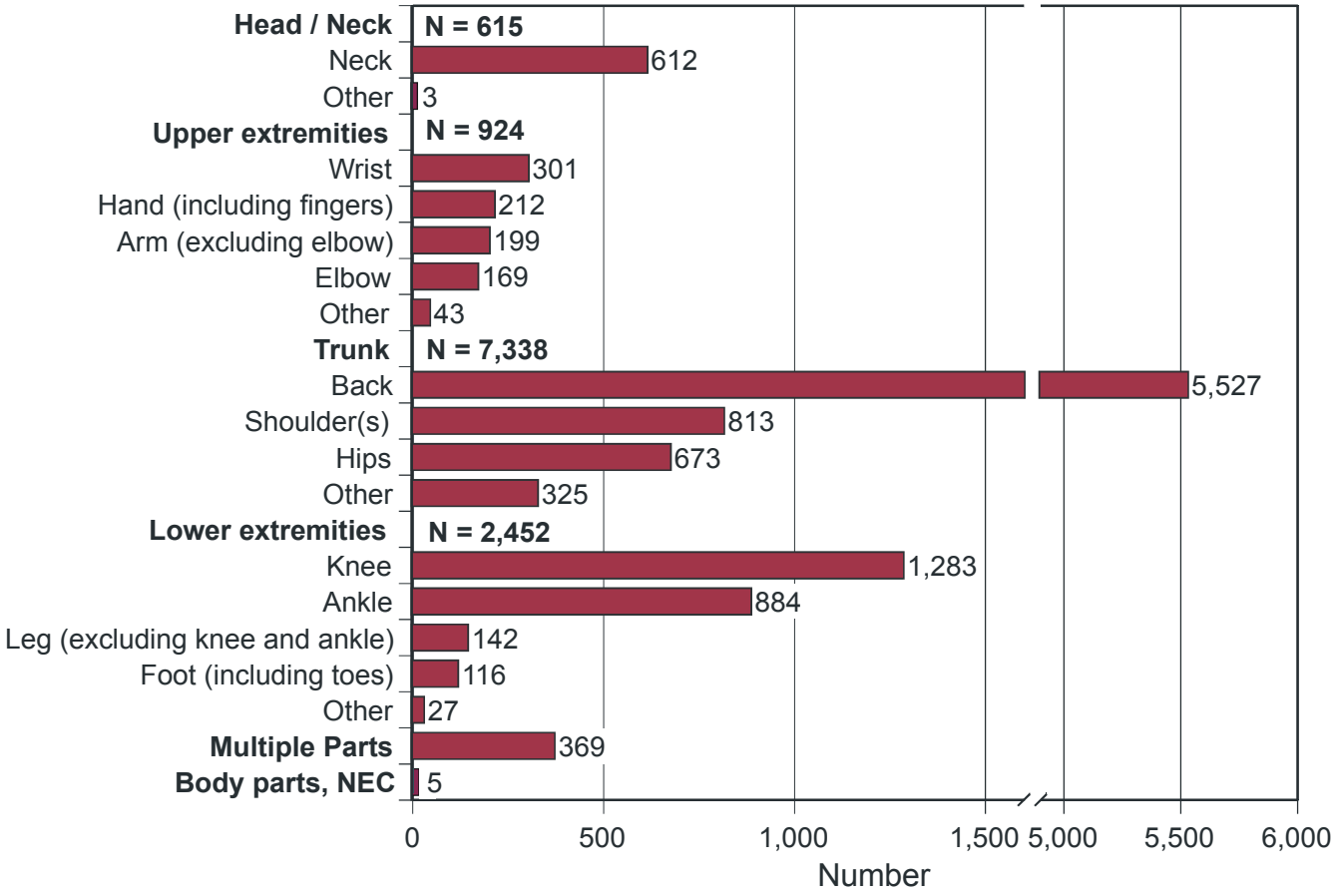


Figure 4B-9.—Metal operators: number of (nonfatal) strain injuries by body part injured, 1986-1995. (Source: MSHA data)

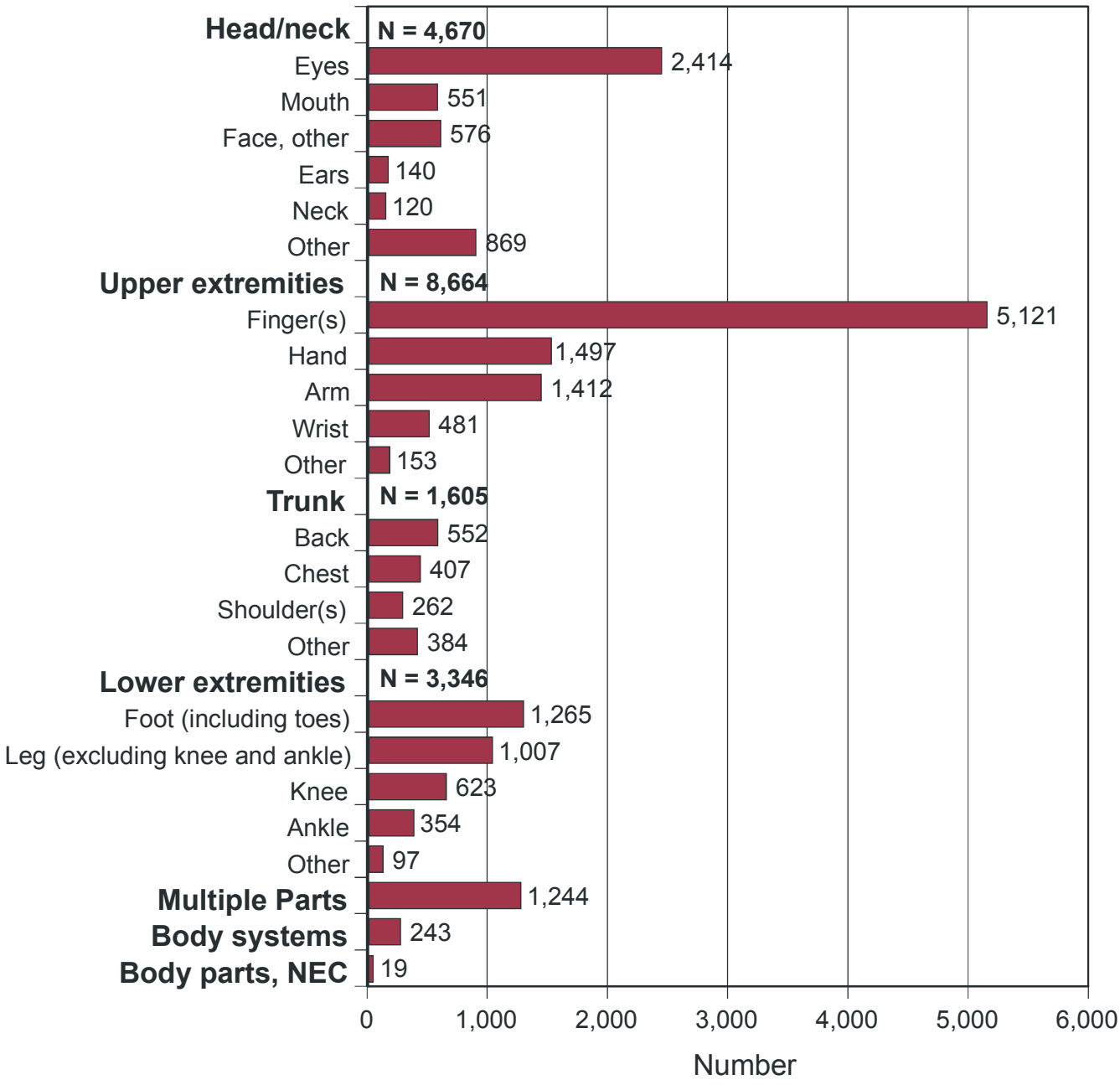


Figure 4B-10.—Metal operators: number of (nonfatal) nonstrain injuries by body part injured, 1986-1995. (Source: MSHA data)

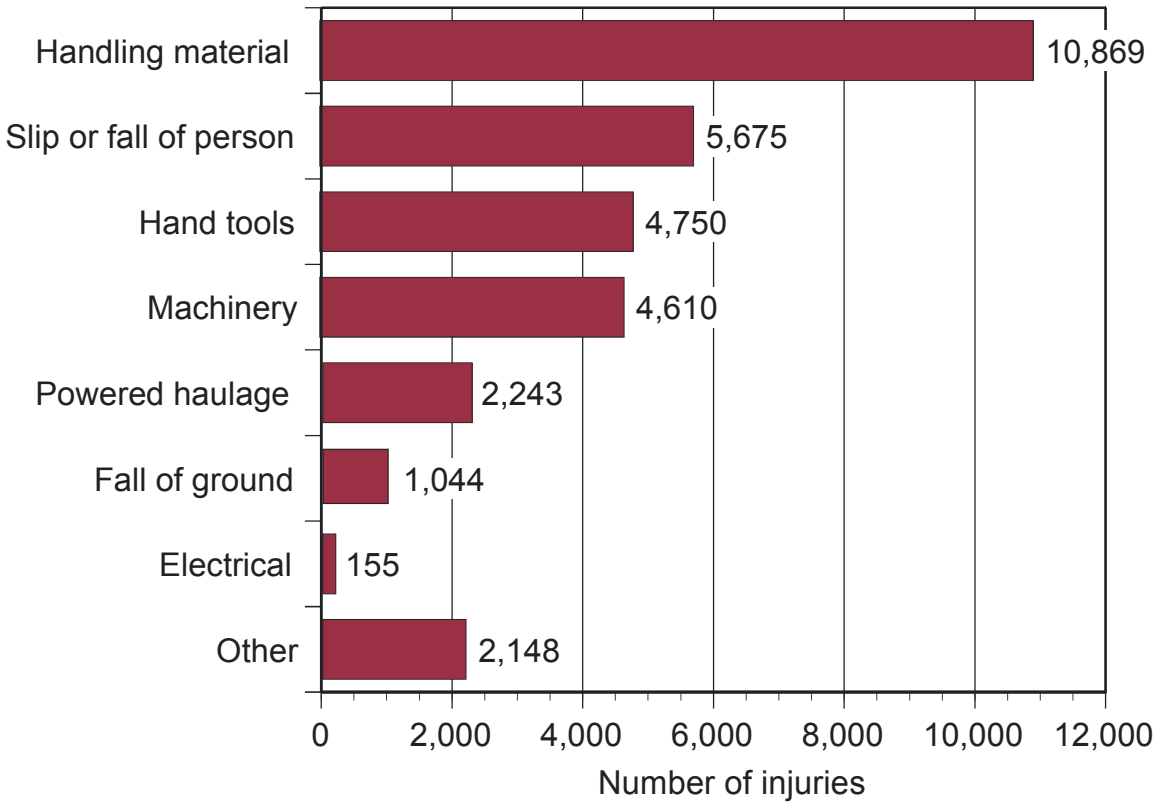
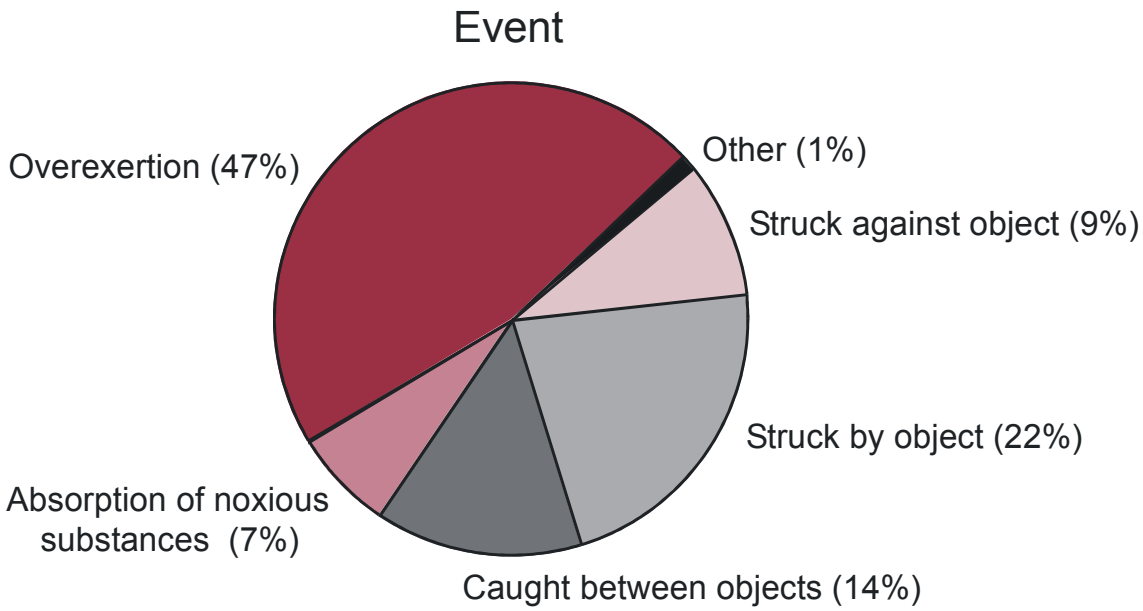


Figure 4B-11.—Metal operators: number of nonfatal injuries by MSHA accident classification, 1986-1995. (Source: MSHA data)



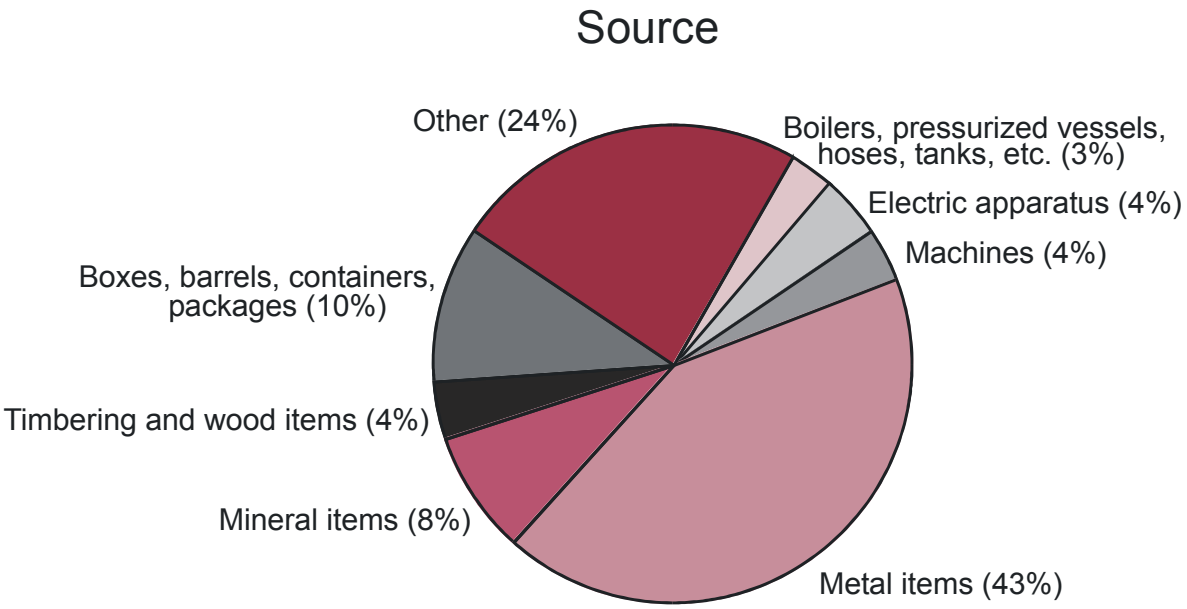


Figure 4B-12.—Metal operators: nonfatal material handling injuries, 1986-1995. Percent of injuries by event resulting in injury and by source of injury (n = 10,869). (Source: MSHA data)

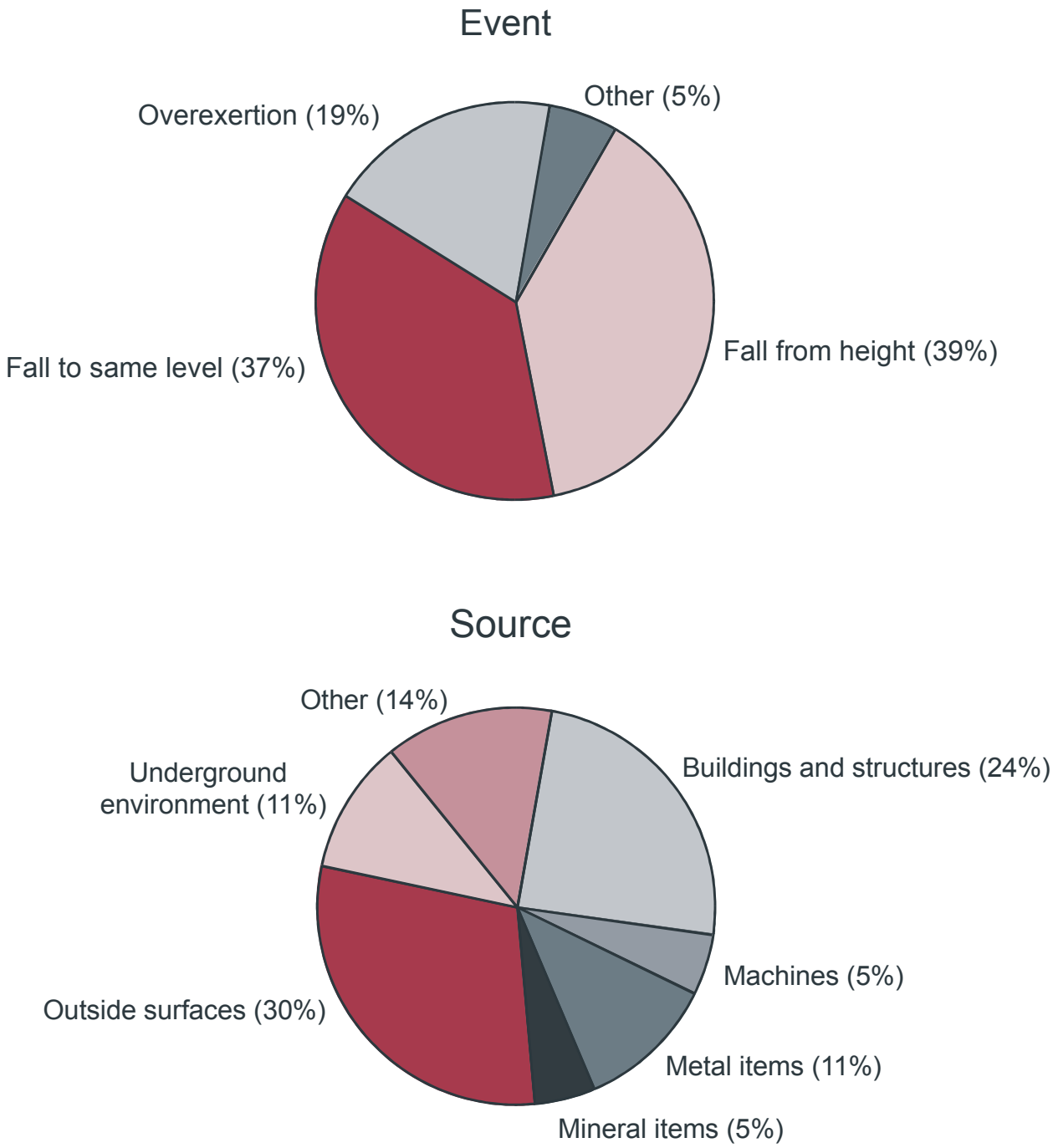


Figure 4B-13.—Metal operators: nonfatal fall injuries, 1986-1995. Percent of injuries by event resulting in injury and by source of injury (n = 5,675). (Source: MSHA data)

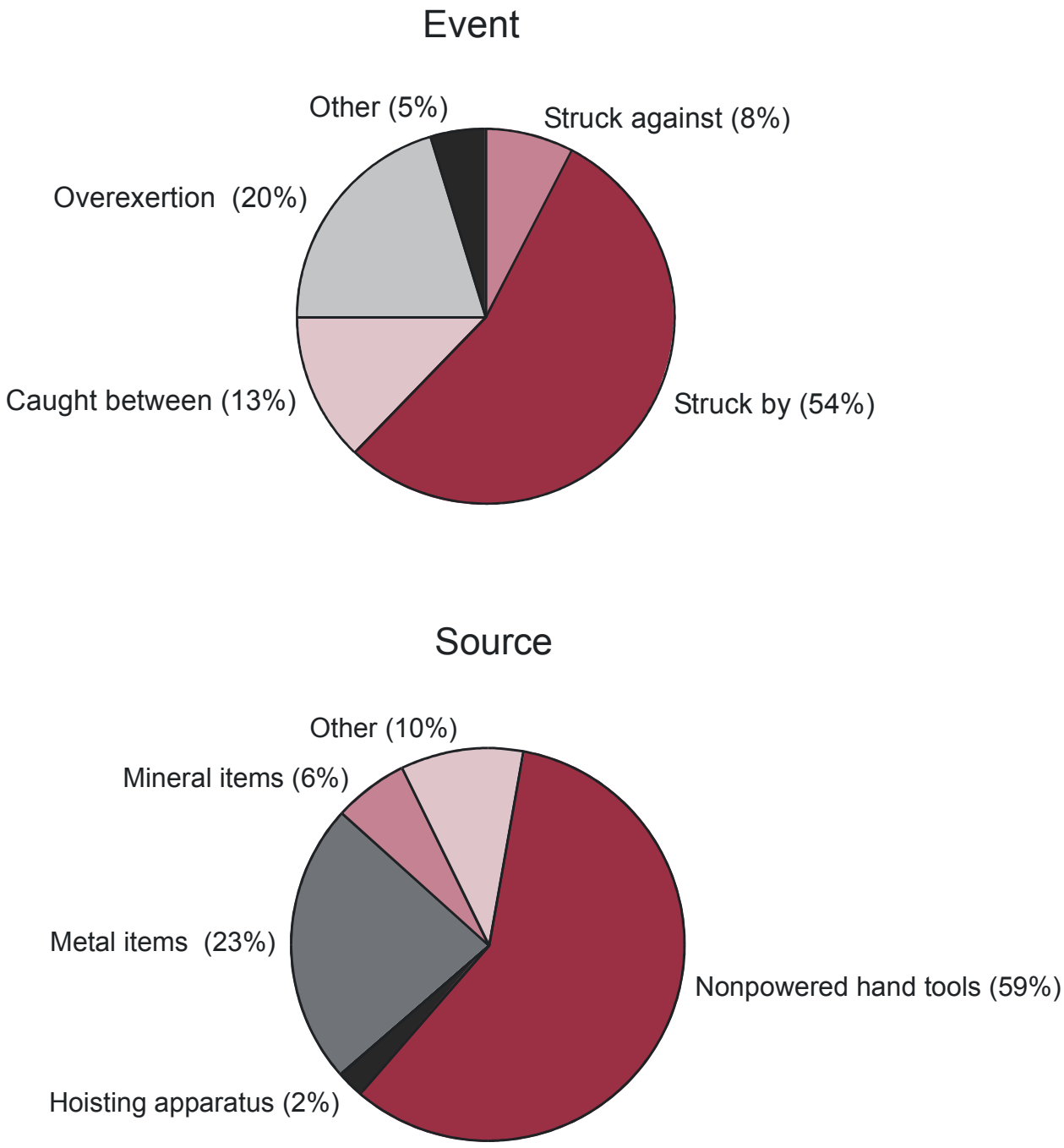


Figure 4B-14.—Metal operators: nonfatal hand tool injuries, 1986-1995. Percent of injuries by event resulting in injury and by source of injury (n = 4,750). (Source: MSHA data)

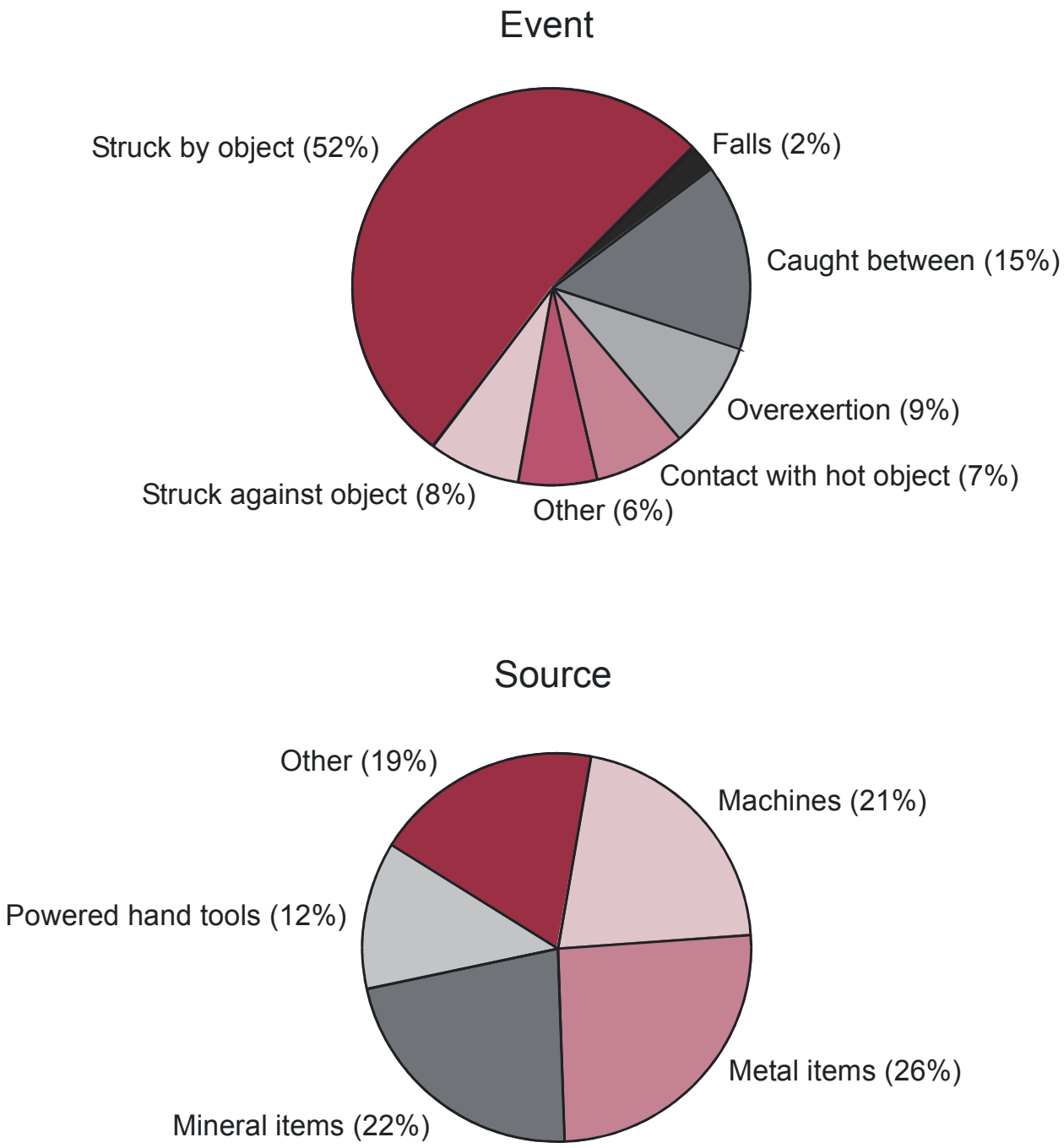


Figure 4B-15.—Metal operators: nonfatal machine injuries, 1986-1995. Percent of injuries by event resulting in injury and by source of injury (n = 4,610). (Source: MSHA data)

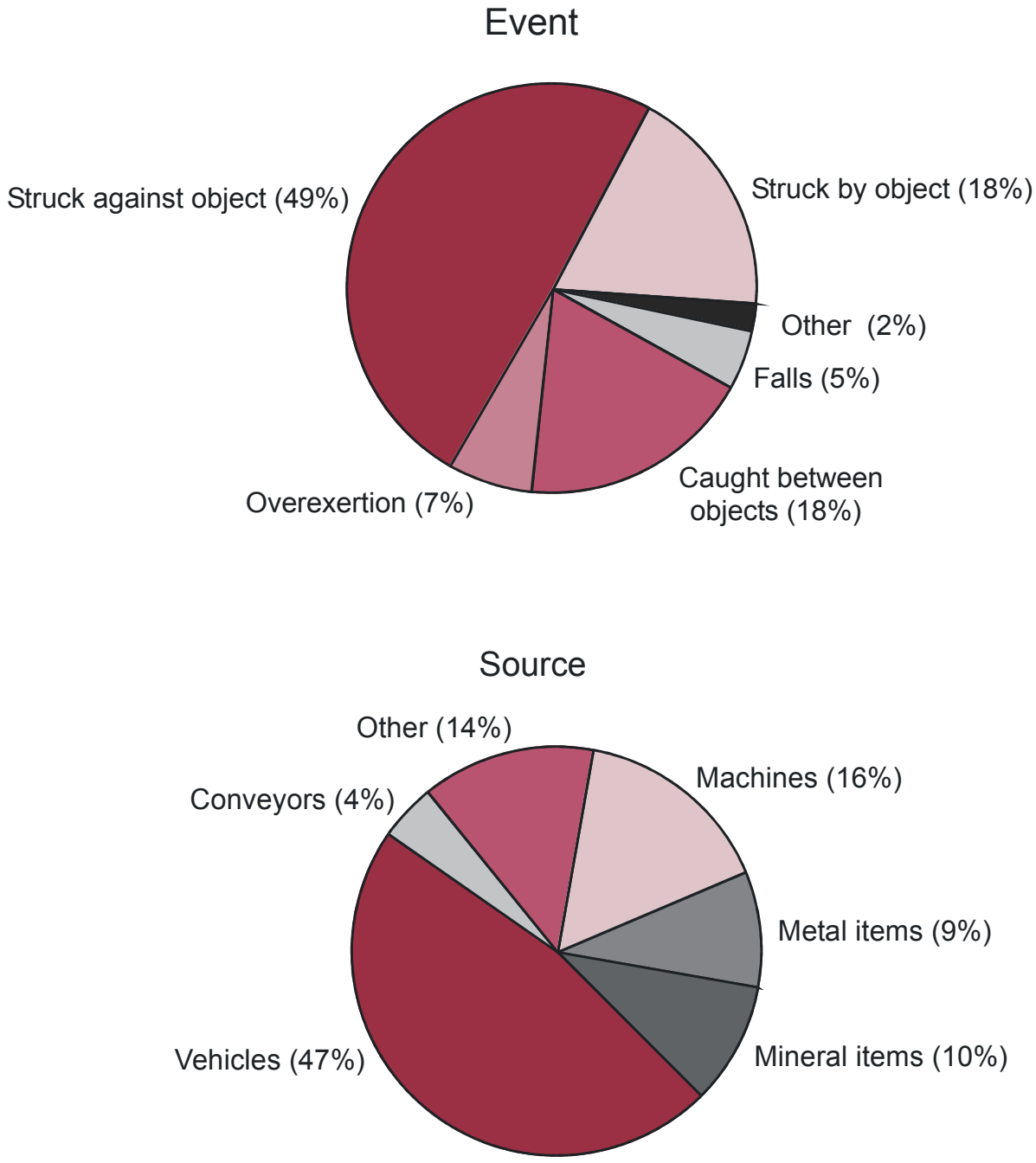
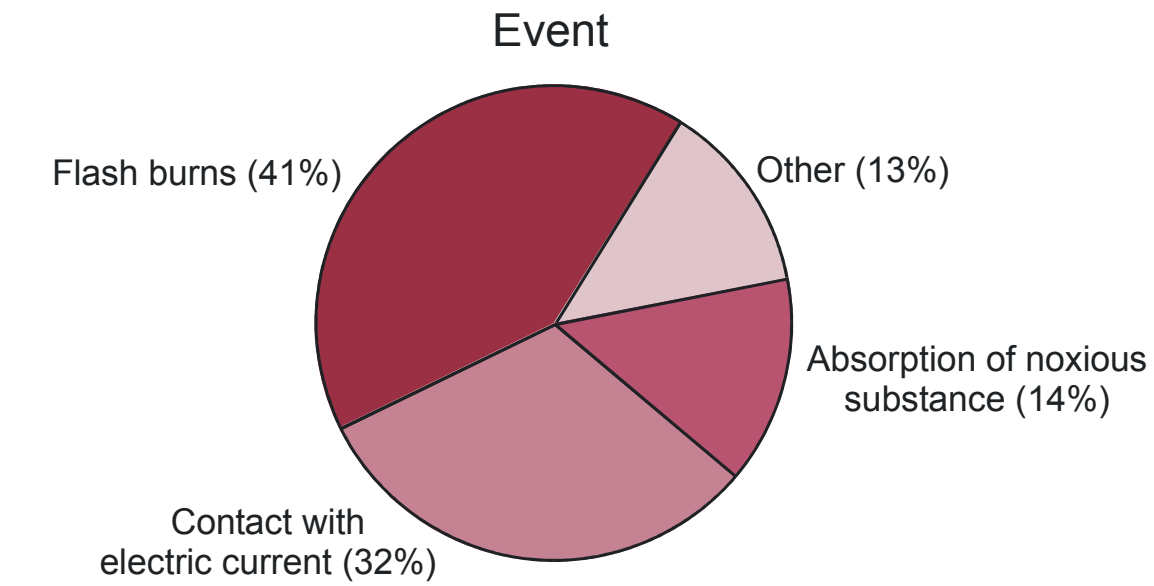


Figure 4B-16.—Metal operators: nonfatal powered haulage injuries, 1986-1995. Percent of injuries by event resulting in injury and by source of injury (n = 2,243). (Source: MSHA data)



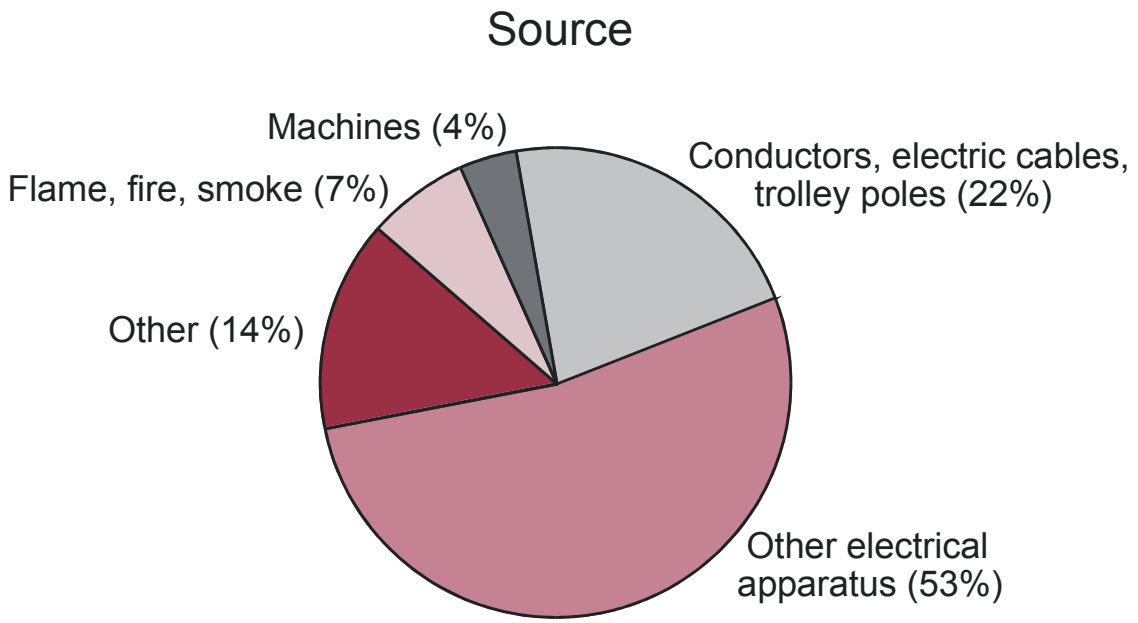


Figure 4B-17.—Metal operators: nonfatal electrical injuries, 1986-1995. Percent of injuries by event resulting in injury and by source of injury (n = 155). (Source: MSHA data)

4C. INJURIES IN NONMETAL MINING

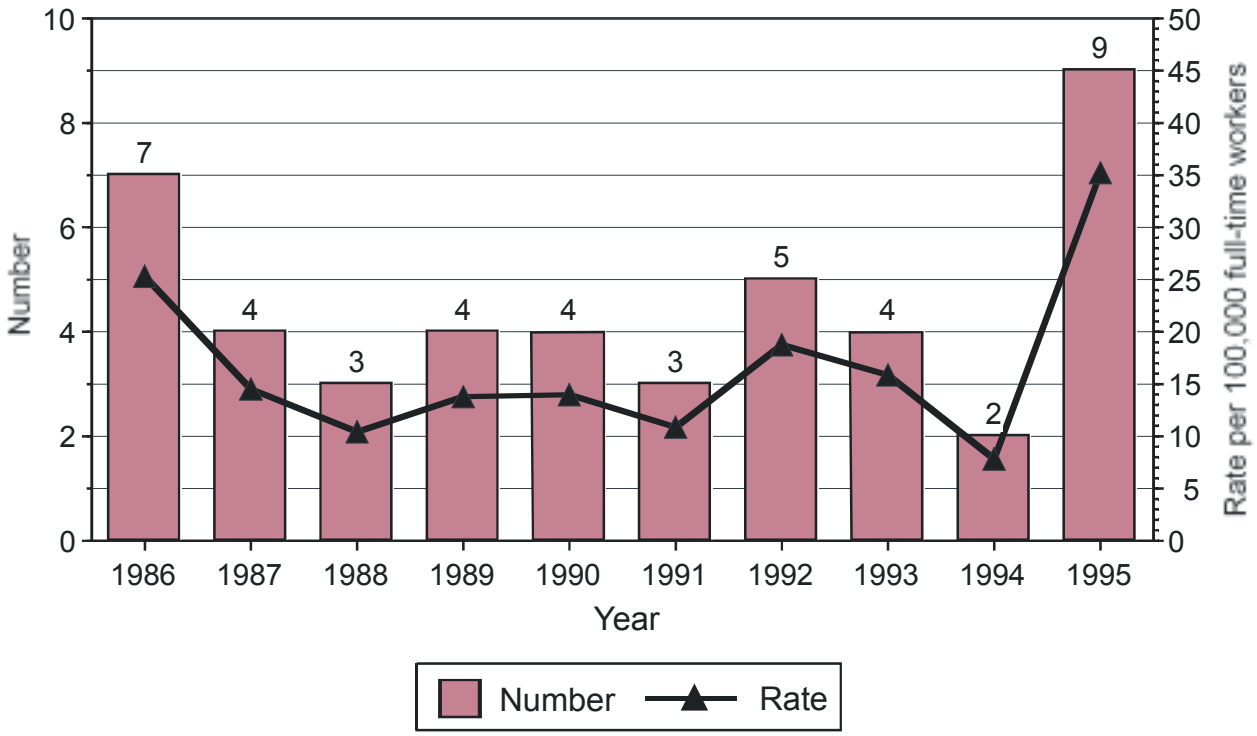


Figure 4C-1.—Nonmetal operators: number and rate (per 100,000 workers) of fatal injuries by year, 1986-1995. (Source: MSHA data)

Table 4C-1.—Nonmetal operators: number and average annual rate (per 100,000 workers) of fatal injuries by subunit, 1986-1995.

Mining operation	Number, 1986-1995	Average annual rate per 100,000 full-time workers
Underground mines:		
Underground operations	16	45.4
Surface operations	0	*
Surface mines:		
Strip	17	28
Dredge	0	*
Other surface mining	0	*
Independent shops/yards	0	0
Mill	12	7.1
Office	0	*
Total	45	14.3

*** Rate not calculated because there were fewer than 3 fatalities**

Source: Mine Safety and Health Administration data.

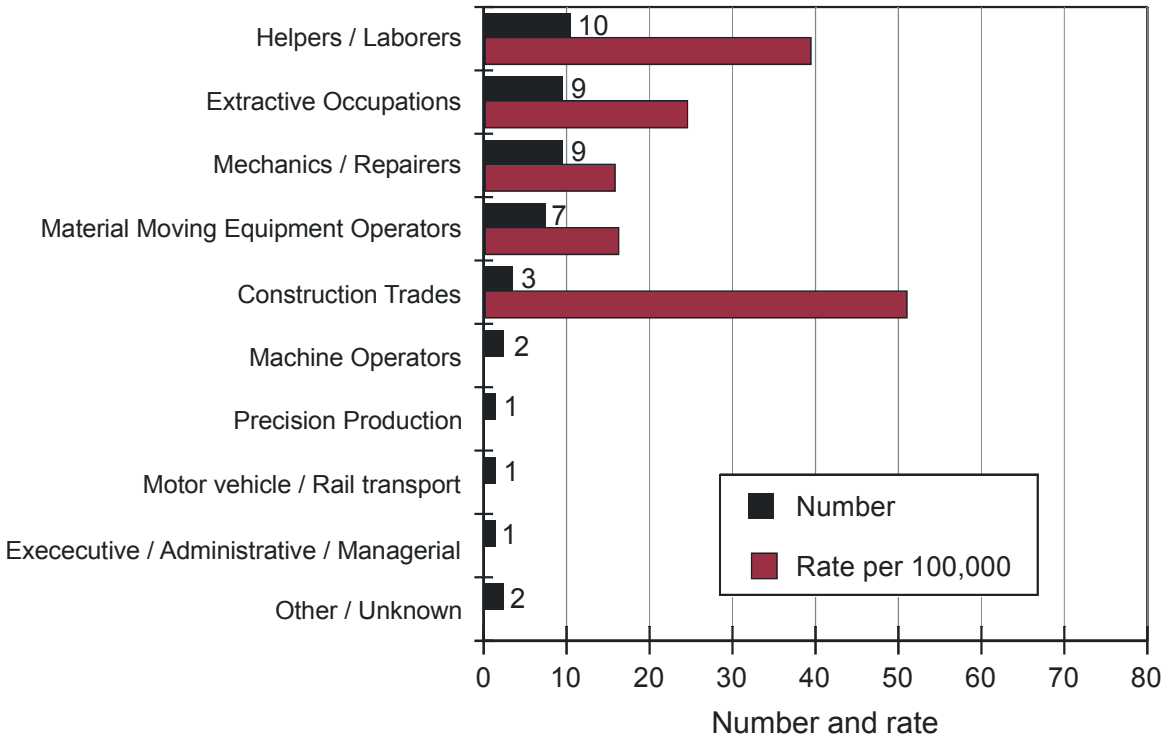


Figure 4C-2.—Nonmetal operators: number and rate (per 100,000 workers) of fatal injuries by U.S. Bureau of the Census Occupation Division, 1986-1995. (Source: MSHA data)

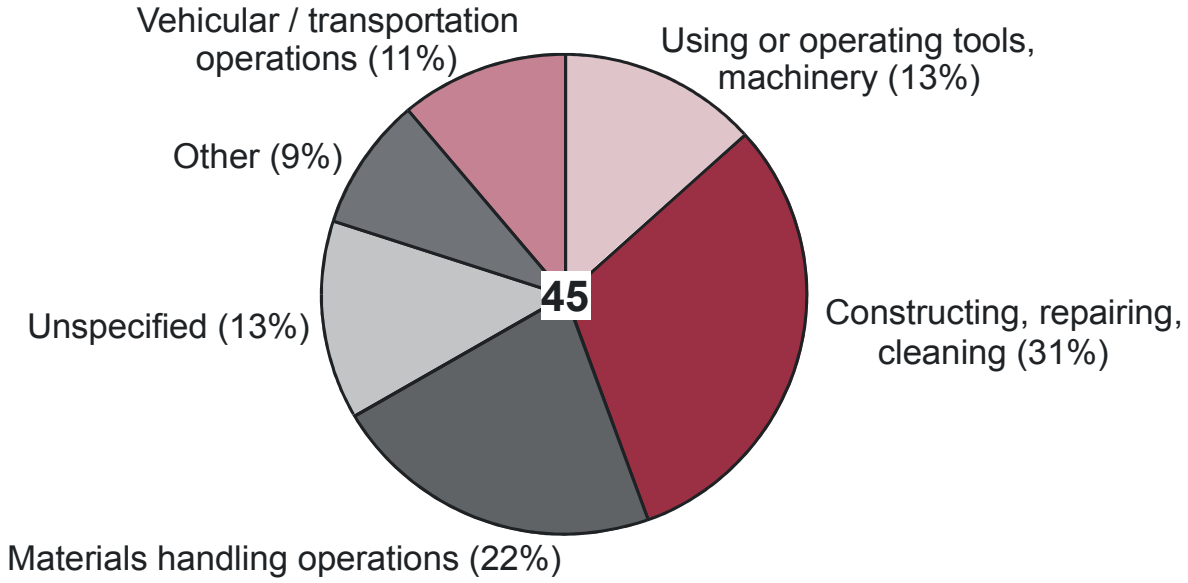


Figure 4C-3.—Nonmetal operators: percent of fatal injuries by work activity, 1986-1995. (Source: MSHA data)

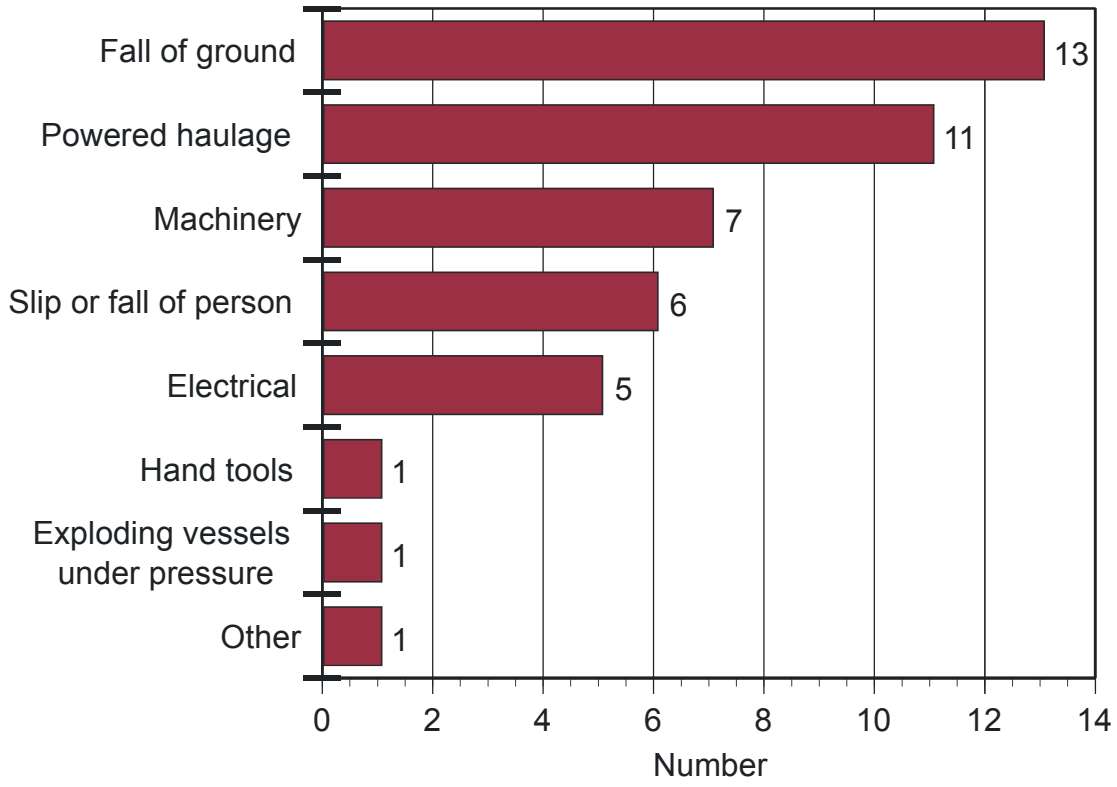


Figure 4C-4.—Nonmetal operators: number of fatal injuries by MSHA accident classification, 1986-1995. (Source: MSHA data)

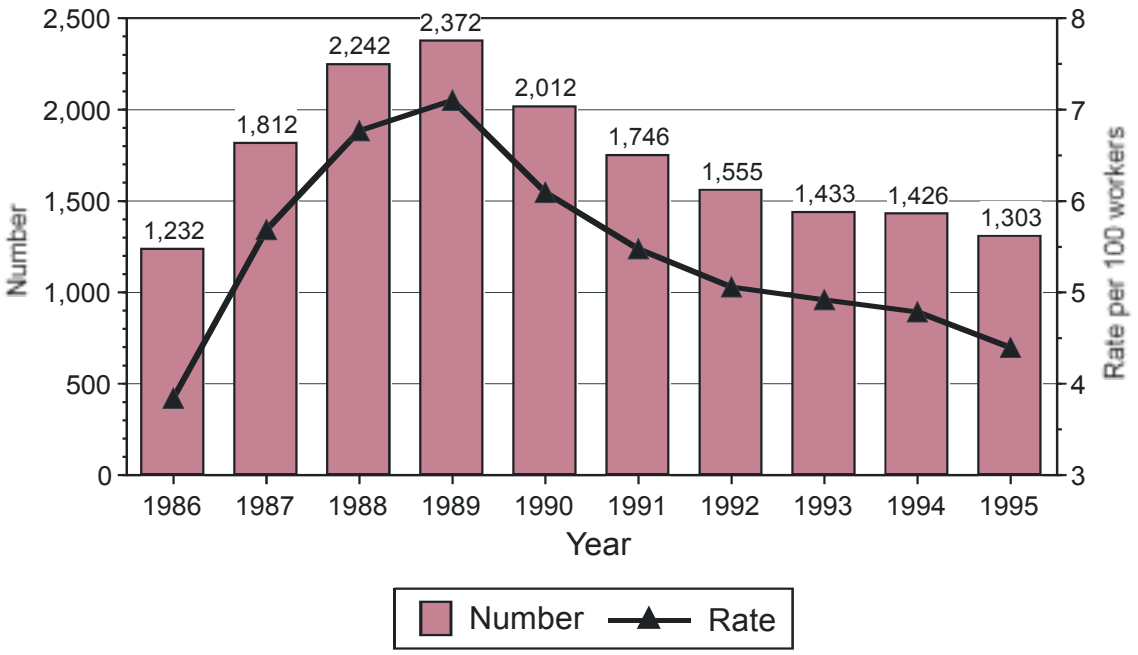


Figure 4C-5.—Nonmetal operators: number and rate (per 100,000 workers) of nonfatal injuries by year, 1986-1995. (Source: MSHA data)

Table 4C-2.—Nonmetal operators: number and average annual rate (per 100 workers) of nonfatal injuries by subunit, 1986-1995.

Mining operation	Number, 1986-1995	Average annual rate per 100 full-time workers
Underground mines:		
Underground operations	2,575	7.31
Surface operations	566	8.83
Surface mines:		
Strip	3,043	5.01
Dredge	68	7.99
Other surface mining	1	*
Independent shops/yards	6	8.57
Mill	10,770	6.37
Office	104	0.24
Total	17,133	5.44

* Rate not calculated because there were fewer than 3 nonfatal injuries

Source: Mine Safety and Health Administration data.

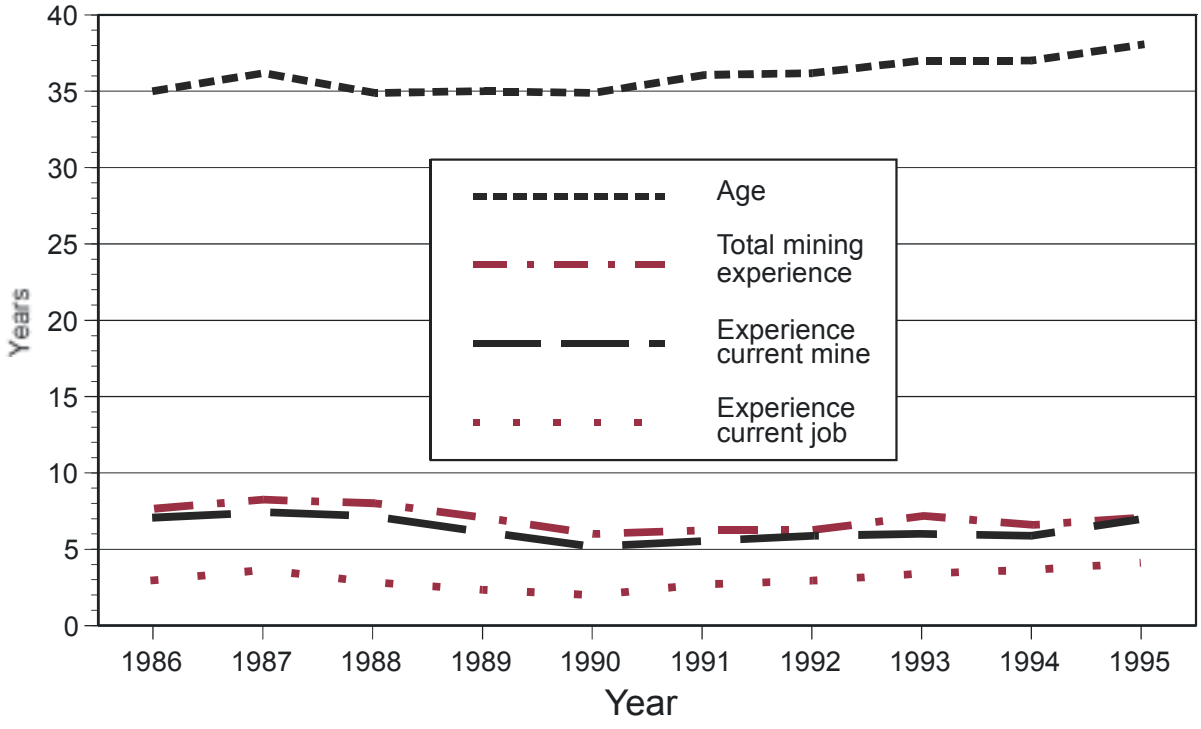


Figure 4C-6.—Nonmetal operators: median values for age, total mining experience, experience in current mine, and experience in current job for workers with nonfatal injuries by year, 1986-1995. (Source: MSHA data)

Table 4C-3.—Nonmetal opertors: Nonfatal injuries, 1986-1995, by nature of injury. Number of cases, percentage of cases with one or more lost workdays, mean days lost work per case, total days work lost for all cases, and statutory days charged for all cases.

Nature of injury	Number of cases	Lost workday cases (%)	Mean days lost work	Total days lost	Total statutory days
Sprains and strains	6,191	56.2	17.02	105,359	9,520
Fracture	1,362	44.5	22.55	30,713	7,090
Contusions	1,505	42.3	7.38	11,110	0
Lacerations	3,417	14.6	1.90	6,494	350
Hernia	154	78.6	25.71	3,959	6,250
Burn, heat	409	35.9	8.52	3,485	0
Amputation or enucleation	117	53.8	28.58	3,344	63,242
Crushing	211	36.0	8.86	1,870	1,800
Dislocation	96	46.9	17.65	1,694	0
Joint, tendon, or muscle inflammation or irritation	165	40.0	9.76	1,611	50
Burn, chemical	239	29.3	2.77	663	0
Electric shock	32	56.3	19.41	621	0
Noncontact electric arc burn	142	45.1	3.95	561	0
Abrasions	240	27.5	1.36	327	0
Poisoning	103	31.1	3.10	319	0
Dust in eyes	597	23.6	0.53	318	0
Electrical burn	16	43.8	19.25	308	0
Brain concussion	20	70.0	7.65	153	0
Other specified causes	274	40.5	10.17	2,786	6,300
Multiple injuries, unspecified	1,237	44.1	14.77	18,270	19,090
Other unspecified injuries	606	63.5	19.35	11,729	0

Source: Mine Safety and Health Administration data.

Table 4C-4.—Nonmetal operators: nonfatal injuries, 1986-1995, by work activity. Number of cases, percentage of cases with one or more lost workdays, mean days lost work per case, total days lost for all cases, and statutory days charged for all cases.

Work activity	Number of cases	Lost workday cases (%)	Mean days lost work	Total days lost	Total statutory days
Materials handling	5,972	46.1	12.58	75,098	14,726
Using or operating tools or machinery	3,984	31.5	8.28	32,997	32,325
Constructing, repairing, or cleaning	3,066	36.5	10.34	31,707	44,691
Vehicular and transportation operations	1,748	51.8	16.56	28,952	15,320
Bodily movement	1,821	49.3	14.89	27,116	1,880
Other	391	44.5	15.24	5,958	4,700
Unspecified	151	61.6	25.60	3,866	50
Total	17,133	42.0	12.01	205,694	113,692

Source: Mine Safety and Health Administration data.

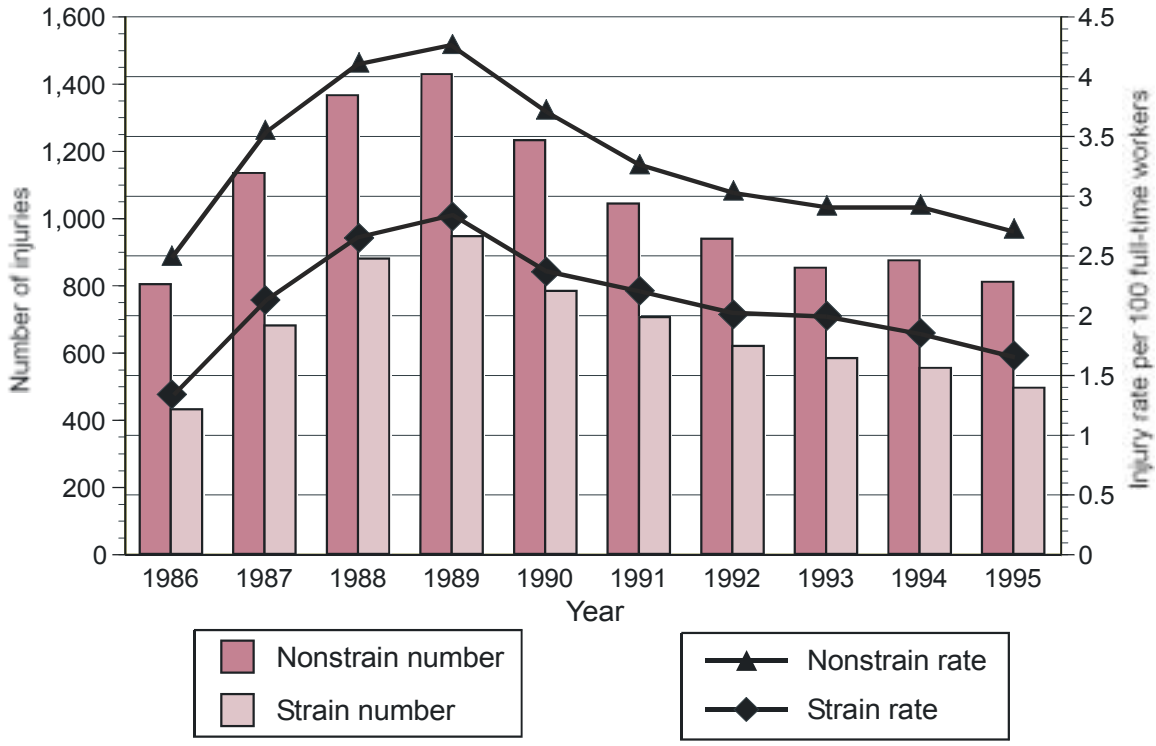


Figure 4C-7.—Nonmetal operators: nonfatal injuries 1986-1995. Number and rate (per 100 workers) of strain and nonstrain injuries by year, 1986-1995. (Source: MSHA data)

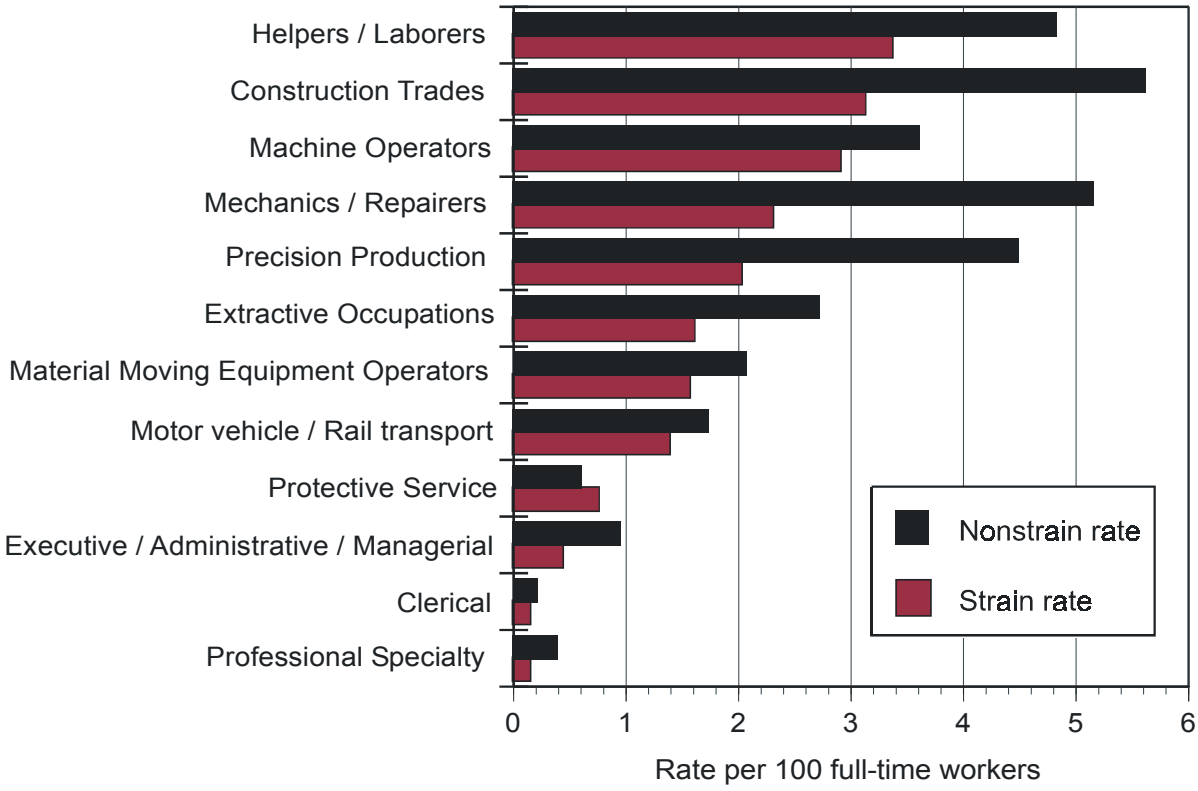


Figure 4C-8.—Nonmetal operators: nonfatal injuries, 1986-1995. Rate (per 100 workers) of strain and nonstrain injuries by U.S. Bureau of the Census Occupation Division, 1986-1995. (Data on occupations were missing for 500 out of 17,133 cases (2.9%).) (Source: MSHA data)

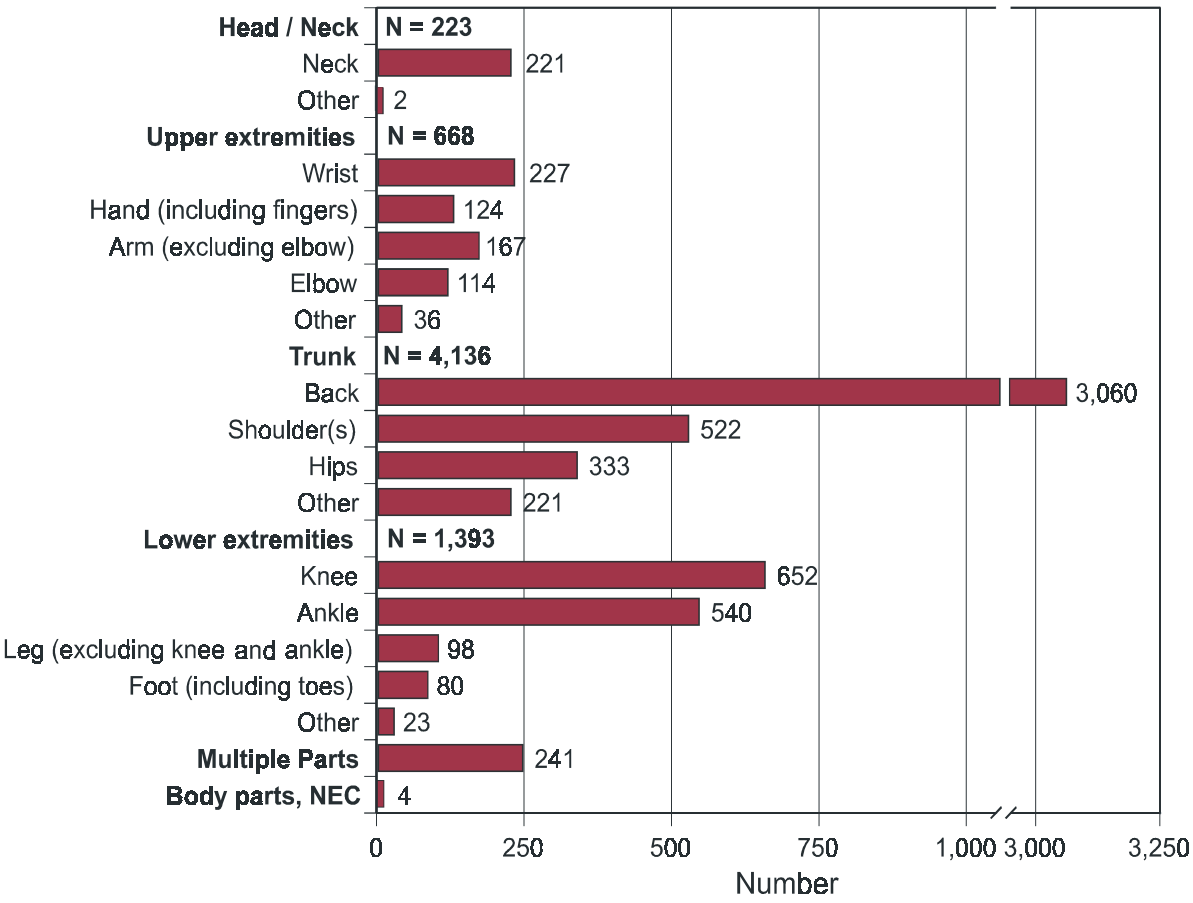


Figure 4C-9.—Nonmetal operators: number of (nonfatal) strain injuries by body part injured, 1986-1995. (Source: MSHA data)

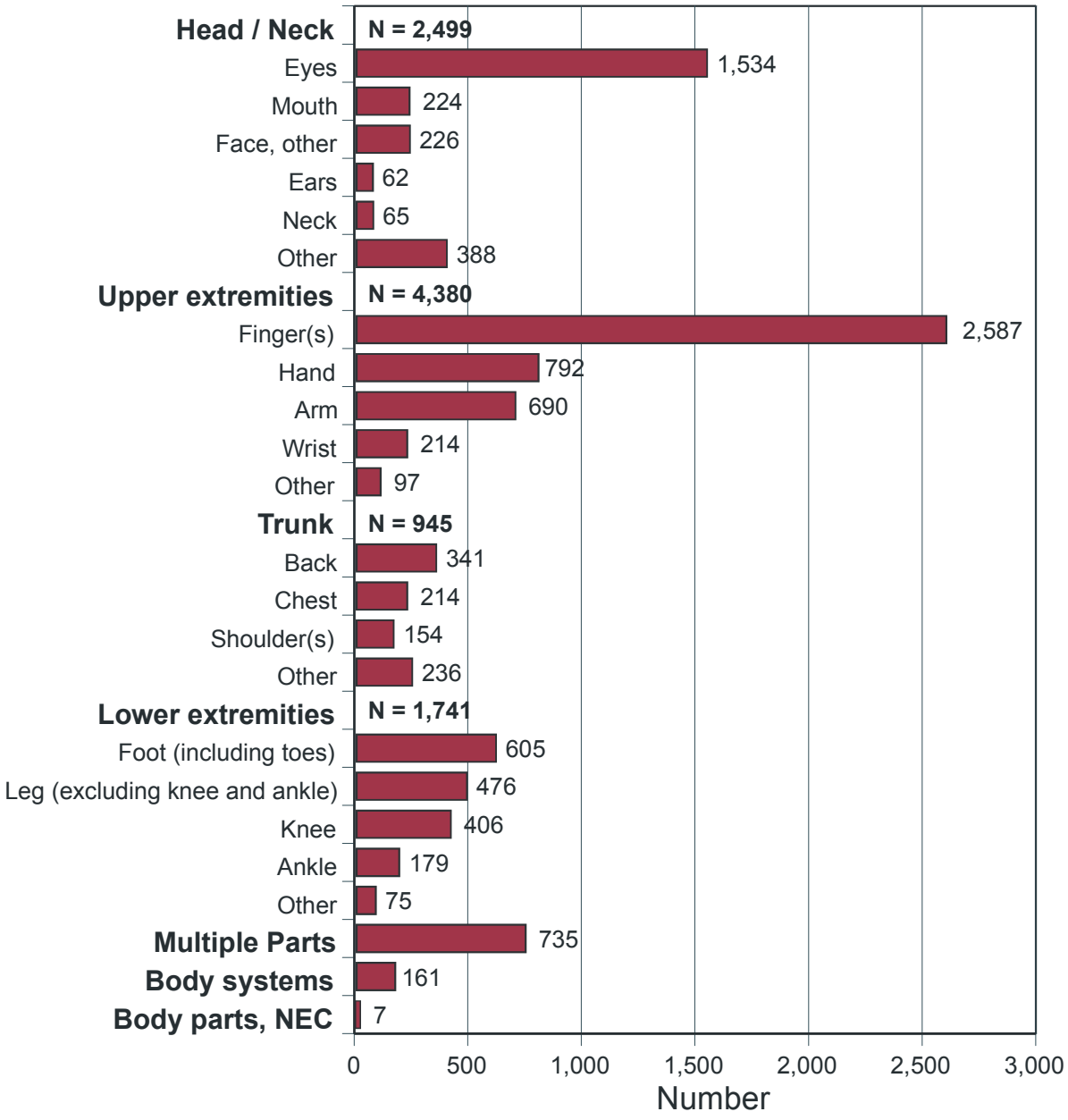


Figure 4C-10.—Nonmetal operators: number of (nonfatal) nonstrain injuries by body part injured, 1986-1995. (Source: MSHA data)

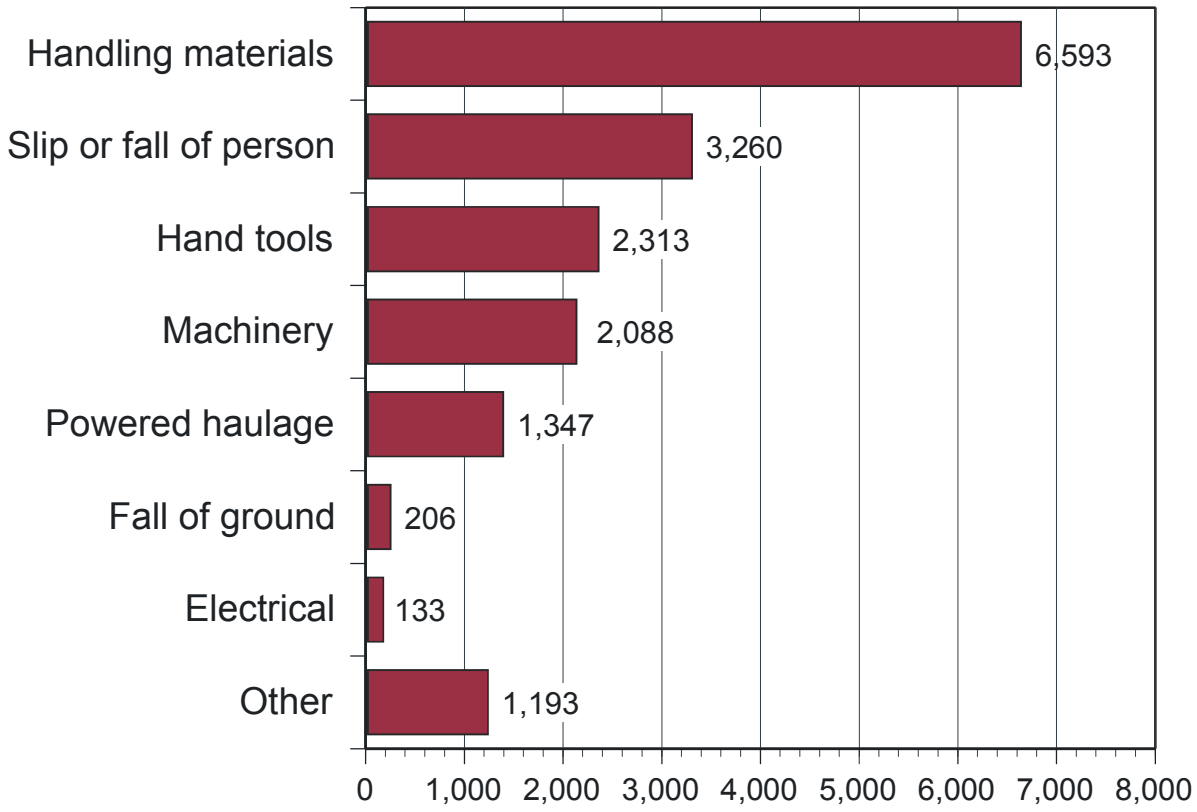


Figure 4C-11.—Nonmetal operators: number of nonfatal injuries by MSHA accident classification, 1986-1995. (Source: MSHA data)

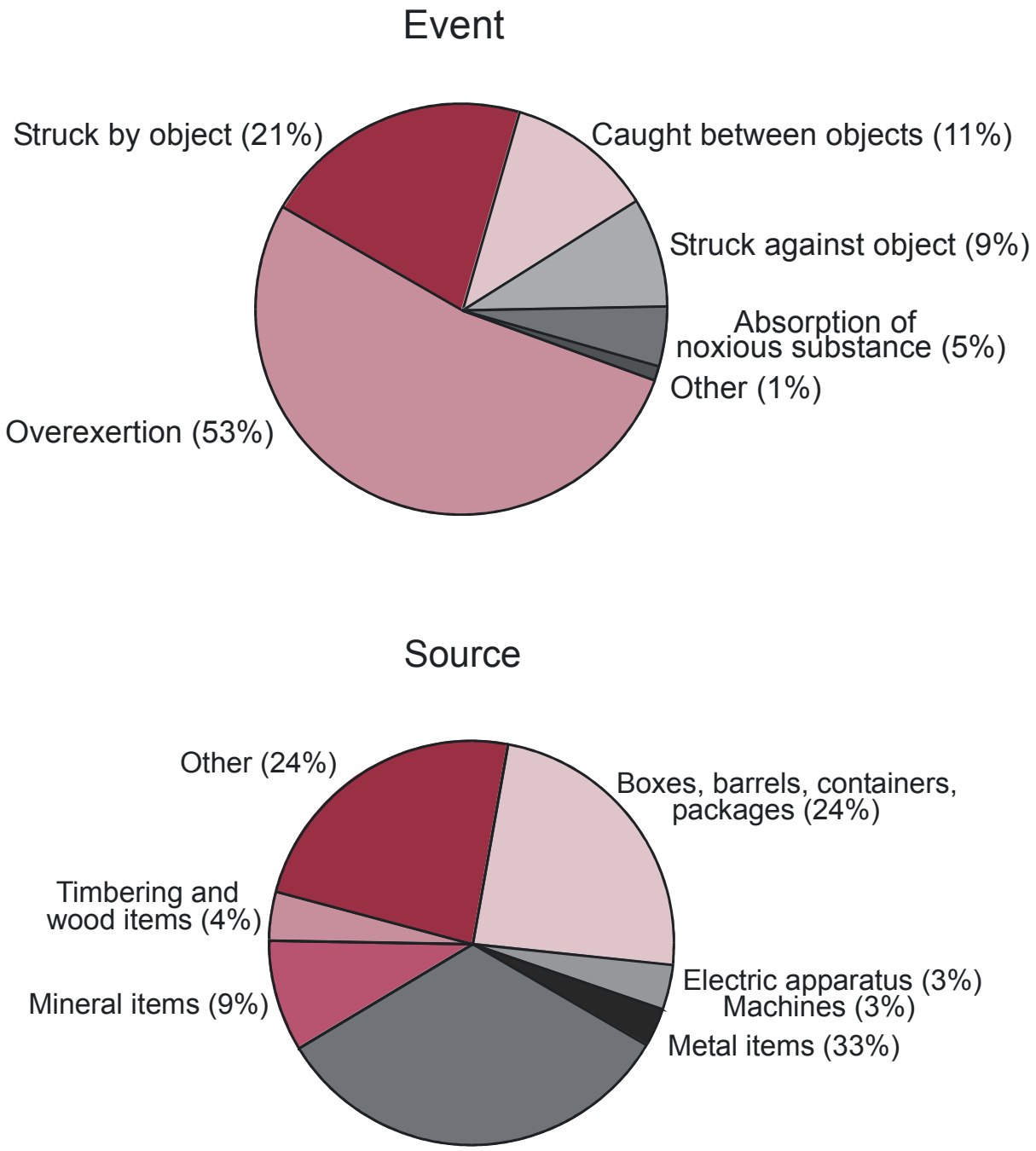


Figure 4C-12.—Nonmetal operators: nonfatal material handling injuries, 1986-1995. Percent of injuries by event resulting in injury and by source of injury (n = 6,593). (Source: MSHA data)

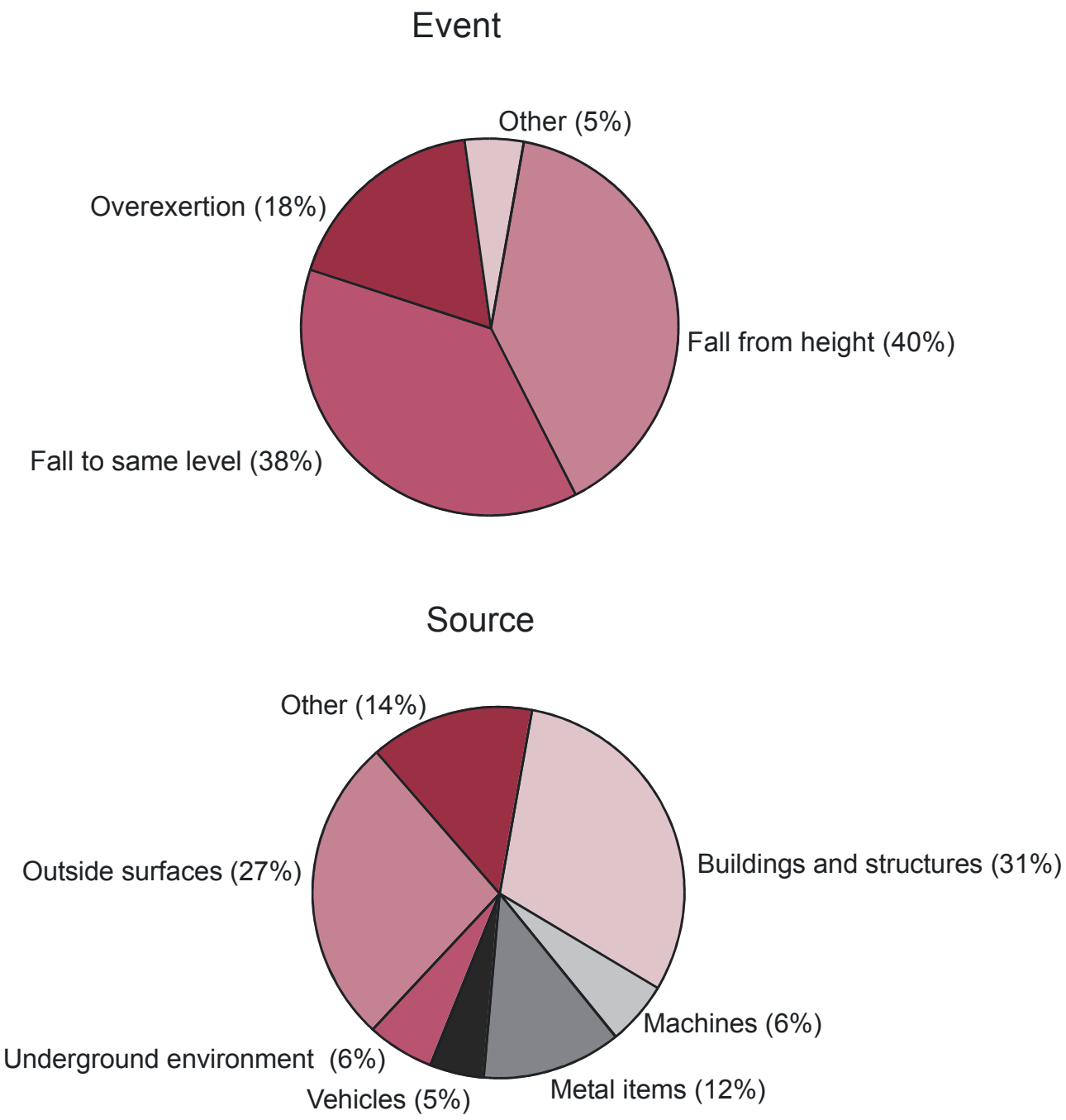


Figure 4C-13.—Nonmetal operators: nonfatal fall injuries, 1986-1995. Percent of injuries by event resulting in injury and by source of injury (n = 3,260). (Source: MSHA data)

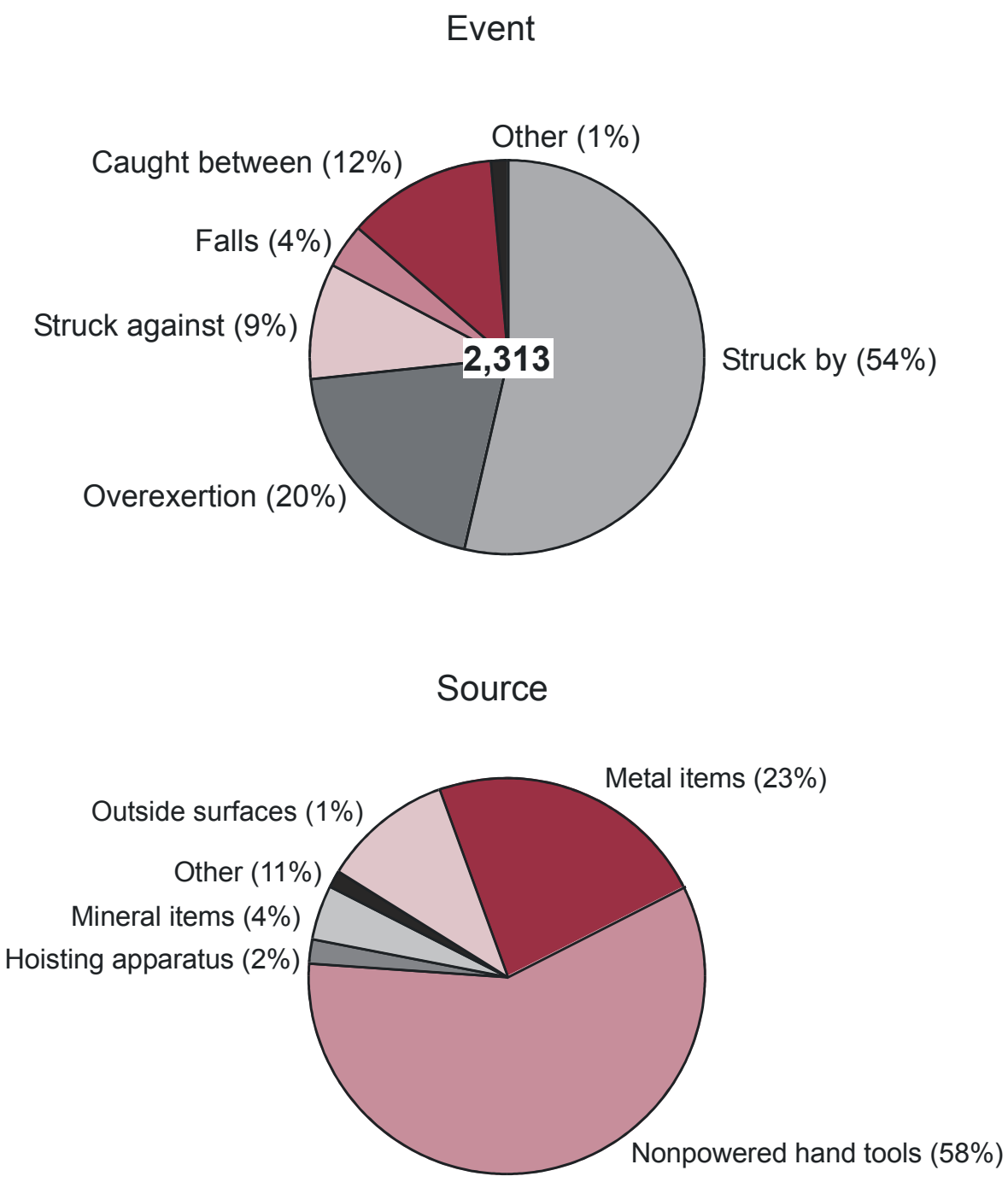


Figure 4C-14.—Nonmetal operators: nonfatal hand tool injuries, 1986-1995. Percent of injuries by event resulting in injury and by source of injury (n = 2,313). (Source: MSHA data)

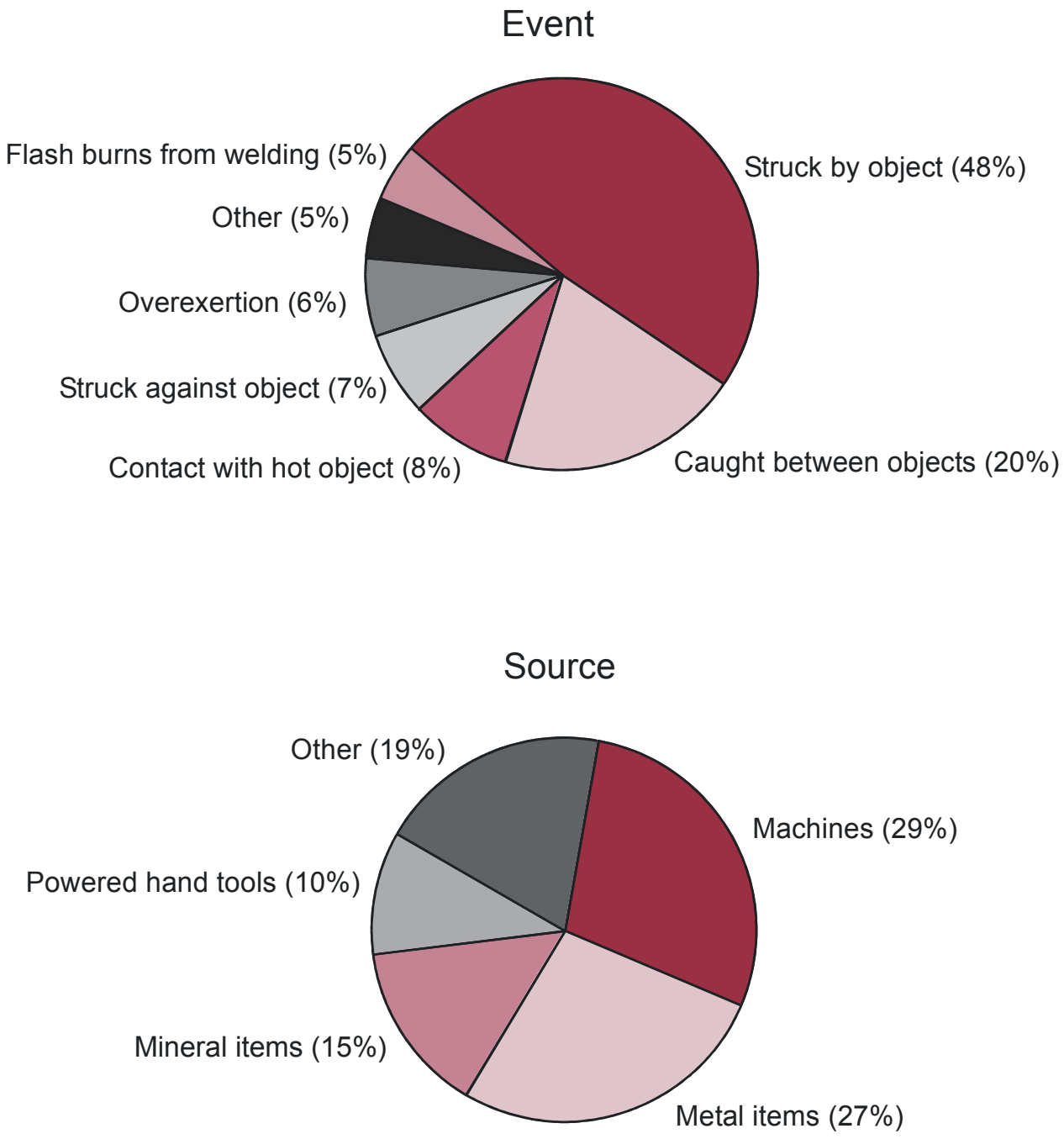


Figure 4C-15.—Nonmetal operators: nonfatal machine injuries, 1986-1995. Percent of injuries by event resulting in injury and by source of injury (n = 2,088). (Source: MSHA data)

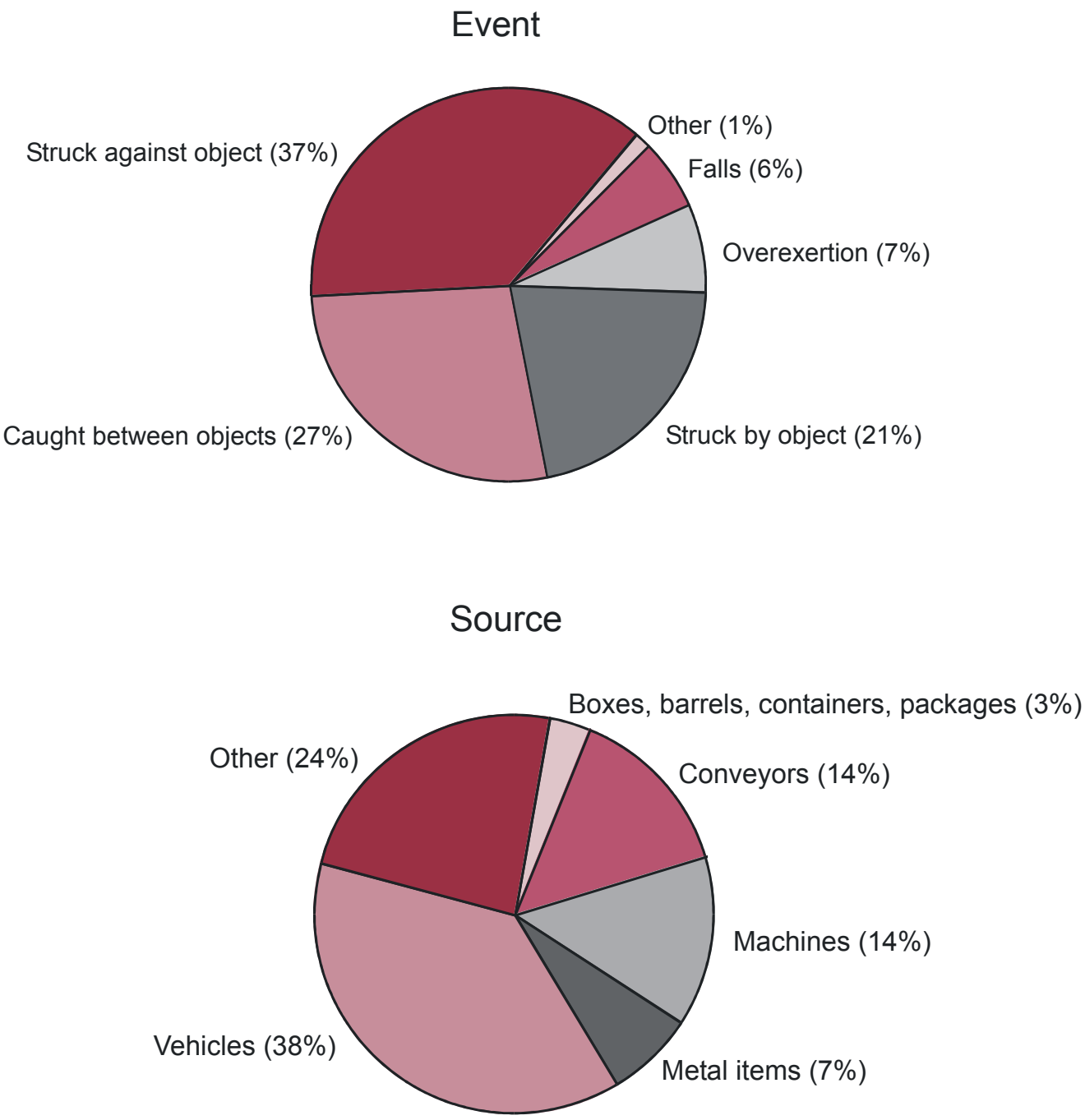


Figure 4C-16.—Nonmetal operators: nonfatal powered haulage injuries, 1986-1995. Percent of injuries by event resulting in injury and by source of injury (n = 1,347). (Source: MSHA data)

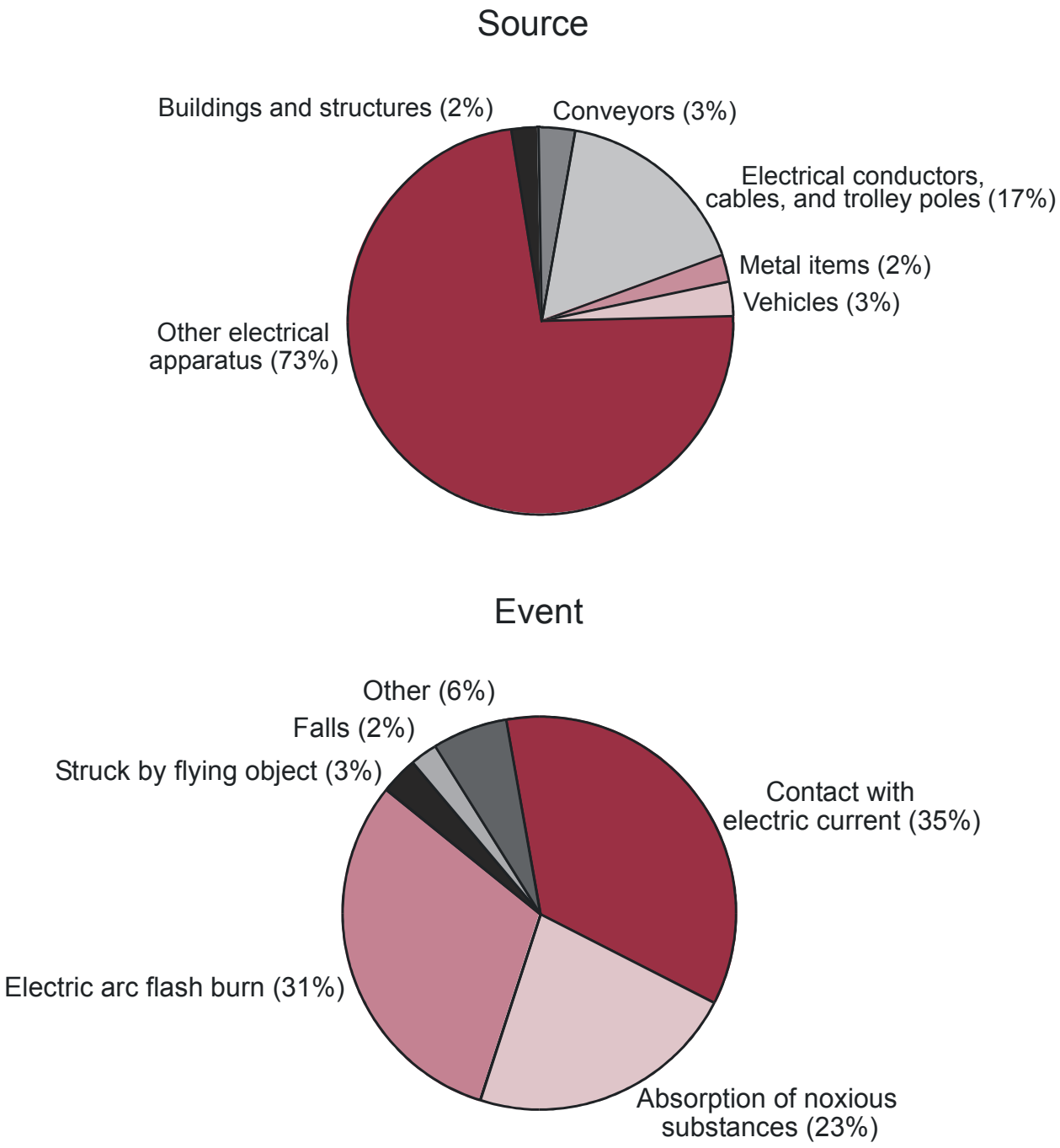


Figure 4C-17.—Nonmetal operators: nonfatal electrical injuries, 1986-1995. Percent of injuries by event resulting in injury and by source of injury (n = 133). (Source: MSHA data)

4D. INJURIES IN STONE MINING

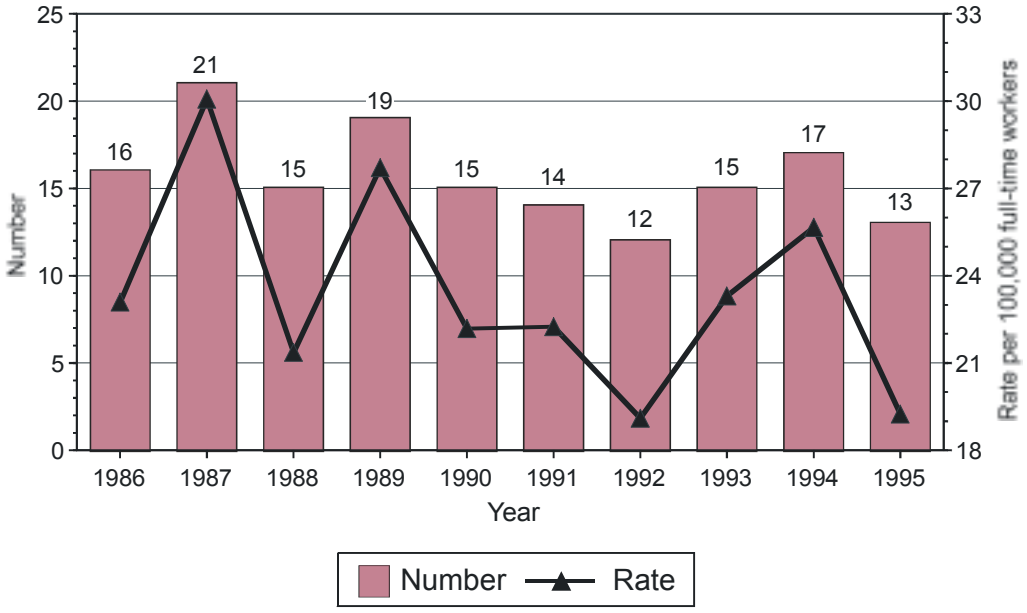


Figure 4D-1.—Stone operators: number and rate (per 100,000 workers) of fatal injuries by year, 1986-1995. (Source: MSHA data)

Table 4D-1.—Stone operators: number and average annual rate (per 100,000 workers) of fatal injuries by subunit, 1986-1995.

Mining operation	Number, 1986-1995	Average annual rate per 100,000 full-time workers
Underground mines:		
Underground operations	12	77.9
Surface operations	5	124.5
Surface mines:		
Strip	99	34.6
Dredge	0	*
Independent shops/yards	0	*
Mill	41	11.4
Office	0	*
Total	157	20.3

*** Rate not calculated because there were fewer than 3 fatalities**

Source: Mine Safety and Health Administration data.

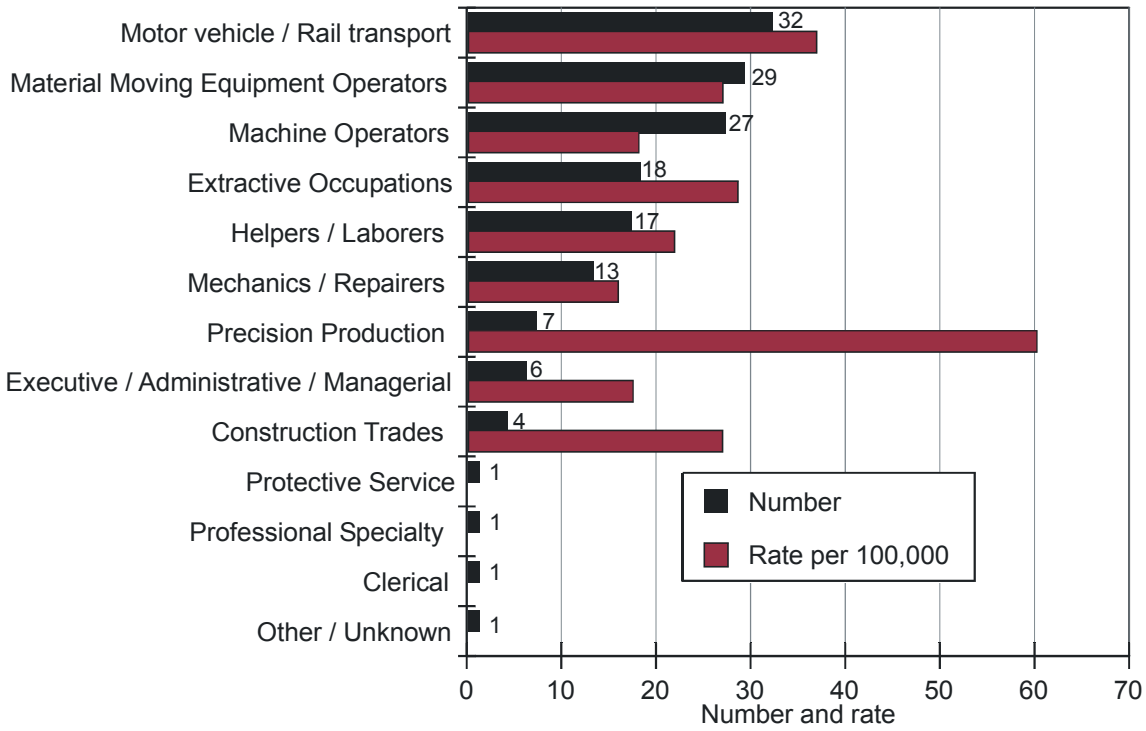


Figure 4D-2.—Stone operators: number and rate (per 100,000 workers) of fatal injuries by U.S. Bureau of the Census Occupation Division, 1986-1995. (Source: MSHA data)

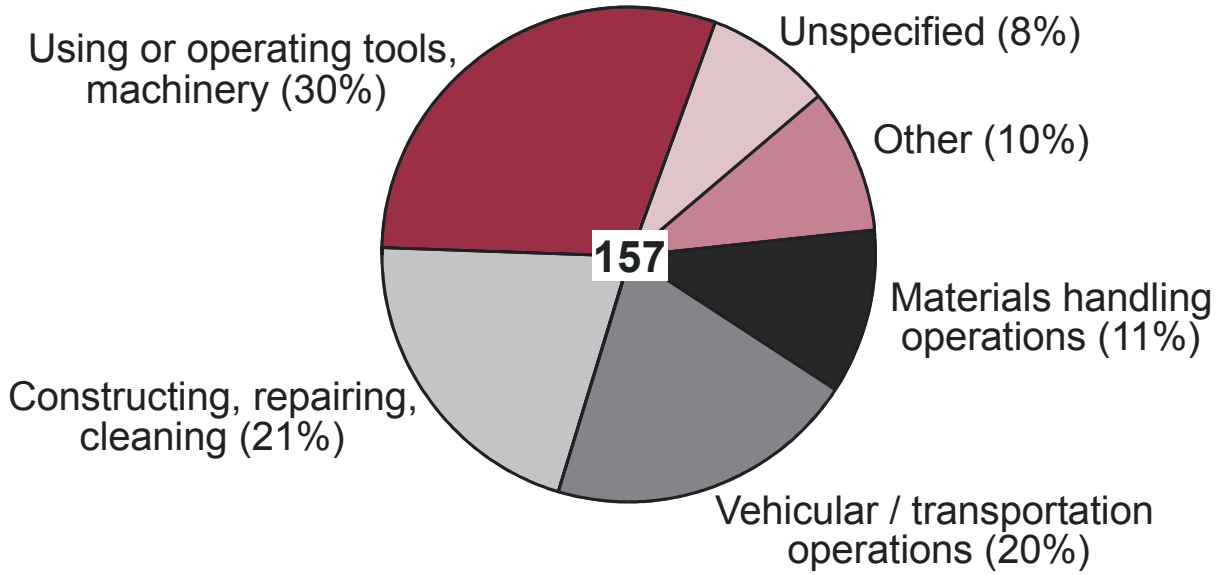


Figure 4D-3.—Stone operators: number of fatal injuries by work activity, 1986-1995. (Source: MSHA data)

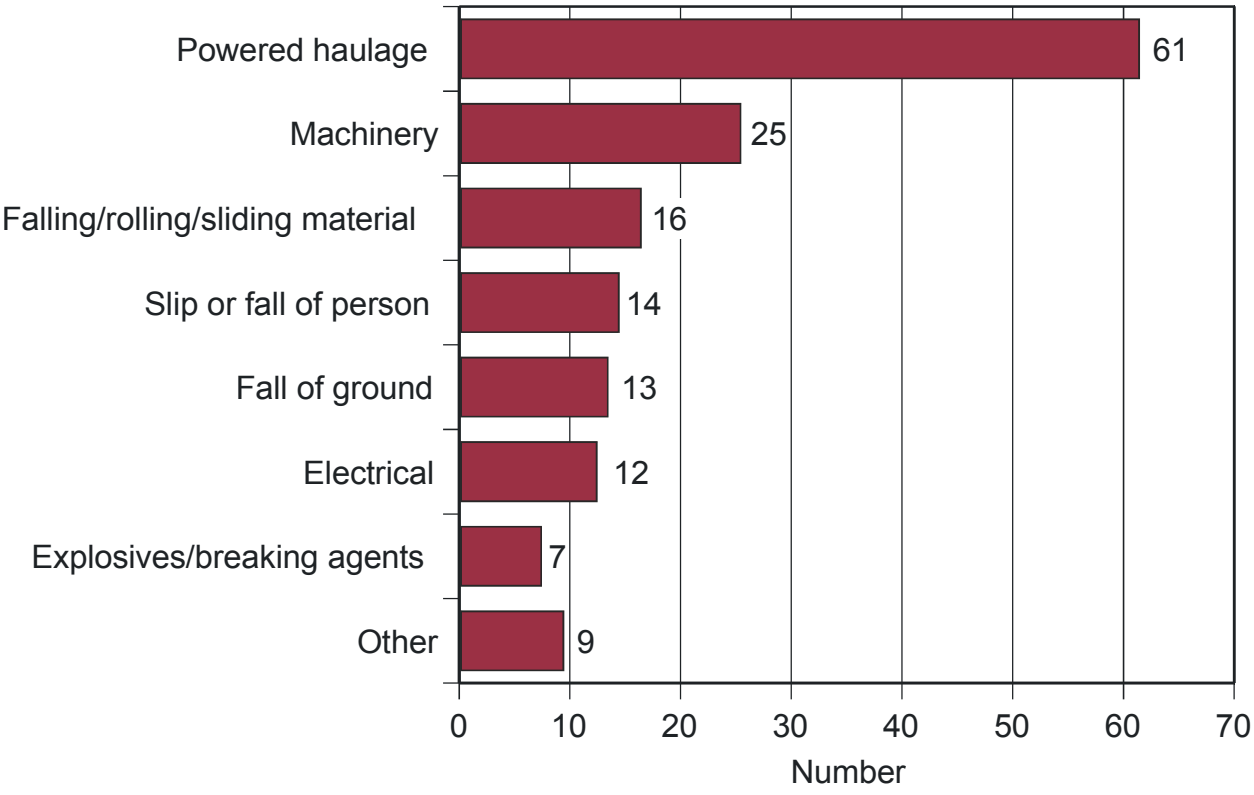


Figure 4D-4.—Stone operators: number of fatal injuries by MSHA accident classification, 1986-1995. (Source: MSHA data)

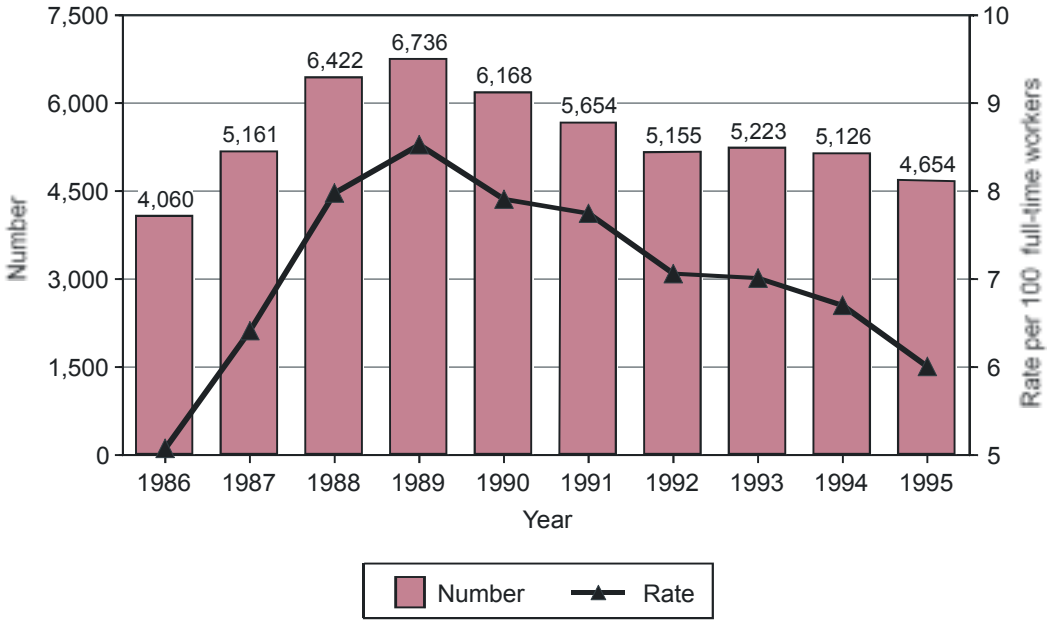


Figure 4D-5.—Stone operators: number and rate (per 100 workers) of nonfatal injuries by year, 1986-1995. (Source: MSHA data)

Table 4D-2.—Stone operators: number and average annual rate (per 100 workers) of nonfatal injuries by subunit, 1986-1995.

Mining operation	Number, 1986-1995	Average annual rate per 100 full-time workers
Underground mines:		
Underground operations	1,173	7.61
Surface operations	450	11.2
Surface mines:		
Strip	21,982	7.68
Dredge	93	6.11
Independent shops/yards	168	7.72
Mill	30,223	8.39
Office	270	0.26
Total	54,359	7.03

Source: Mine Safety and Health Administration data.

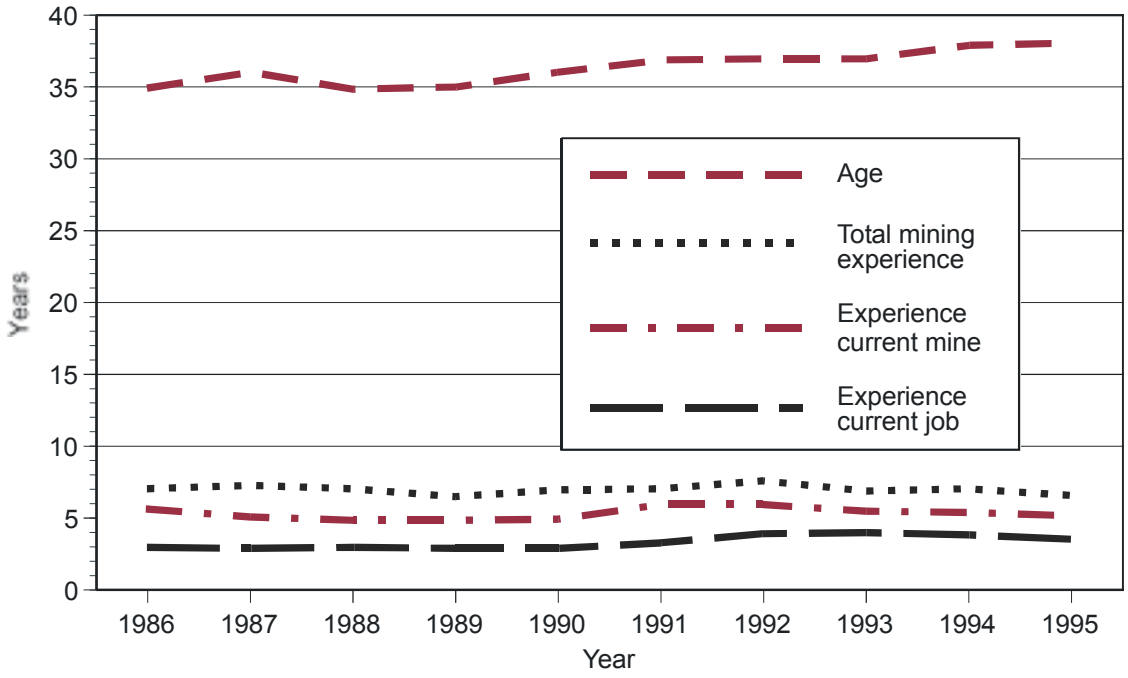


Figure 4D-6.—Stone operators: median values for age, total mining experience, experience in current mine, and experience in current job for workers with nonfatal injuries by year, 1986-1995. (Source: MSHA data)

Table 4D-3.—Stone operators: nonfatal injuries, 1986-1995, by nature of injury. Number of cases, percentage of cases with one or more lost workdays, mean days lost work per case, total days work lost for all cases, and statutory days charged for all cases.

Nature of injury	Number of cases	Lost workday cases (%)	Mean days lost work	Total days lost	Total statutory days
Sprains and strains	17,793	62.0	16.19	288,117	19,890
Fracture	5,080	53.9	23.51	119,430	44,276
Contusions	4,956	51.3	8.09	40,087	1,470
Lacerations	10,552	21.3	2.78	29,257	4,410
Hernia	564	78.2	27.25	15,367	22,050
Burn, heat	1,619	43.2	8.62	13,950	13,500
Amputation, enucleation	326	60.7	30.72	10,016	189,483
Crushing	955	42.0	8.77	8,375	3,950
Dislocation	296	64.2	21.65	6,407	0
Joint, tendon, or muscle inflammation or irritation	418	40.2	9.61	4,015	0
Burn, chemical	1,132	40.2	3.30	3,740	5,400
Noncontact electric arc burn	560	53.2	4.61	2,583	1,800
Abrasions	833	33.9	2.78	2,317	0
Electrical burn	57	61.4	21.79	1,242	0
Dust in eyes	1,616	21.7	0.66	1,073	0
Electric shock	72	63.9	14.22	1,024	0
Poisoning	217	41.5	4.36	946	0
Brain concussion	81	82.7	11.38	922	0
Other specified causes	938	46.6	10.92	10,243	1,800
Multiple injuries, unspecified	3,944	53.6	16.98	66,966	13,650
Other unspecified injuries	2,350	63.0	17.56	41,269	2,820
Total	54,359	48.4	12.28	667,346	324,499

Source: Mine Safety and Health Administration data.

Table 4D-4.—Stone operators: nonfatal injuries, 1986-1995, by work activity. Number of cases, percentage of cases with one or more lost workdays, mean days lost work per case, total days work lost for all cases, and statutory days charged for all cases.

Work activity	Number of cases	Lost workday cases (%)	Mean days lost work	Total days lost	Total statutory days
Materials handling	15,502	51.5	12.25	189,919	80,678
Constructing, repairing, or cleaning	11,347	44.1	12.03	136,518	98,815
Using or operating tools or machinery	15,021	39.9	8.75	131,505	81,181
Vehicular and transportation operations	5,876	61.7	17.35	101,949	45,020
Bodily movement	4,983	55.1	14.99	74,695	7,350
Other	1,229	55.8	18.47	22,696	10,605
Unspecified	401	66.6	25.10	10,064	850
Total	54,359	48.4	12.28	667,346	324,499

Source: Mine Safety and Health Administration data.

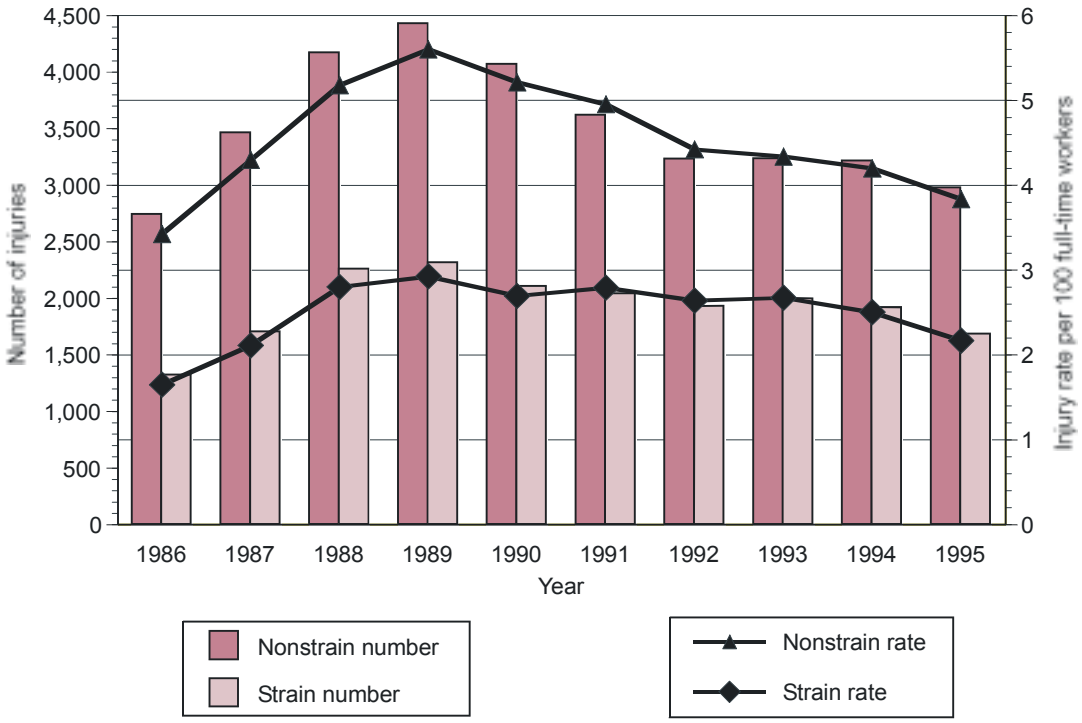


Figure 4D-7.—Stone operators: nonfatal injuries 1986-1995. Number and rate (per 100 workers) of strain and nonstrain injuries by year, 1986-1995. (Source: MSHA data)

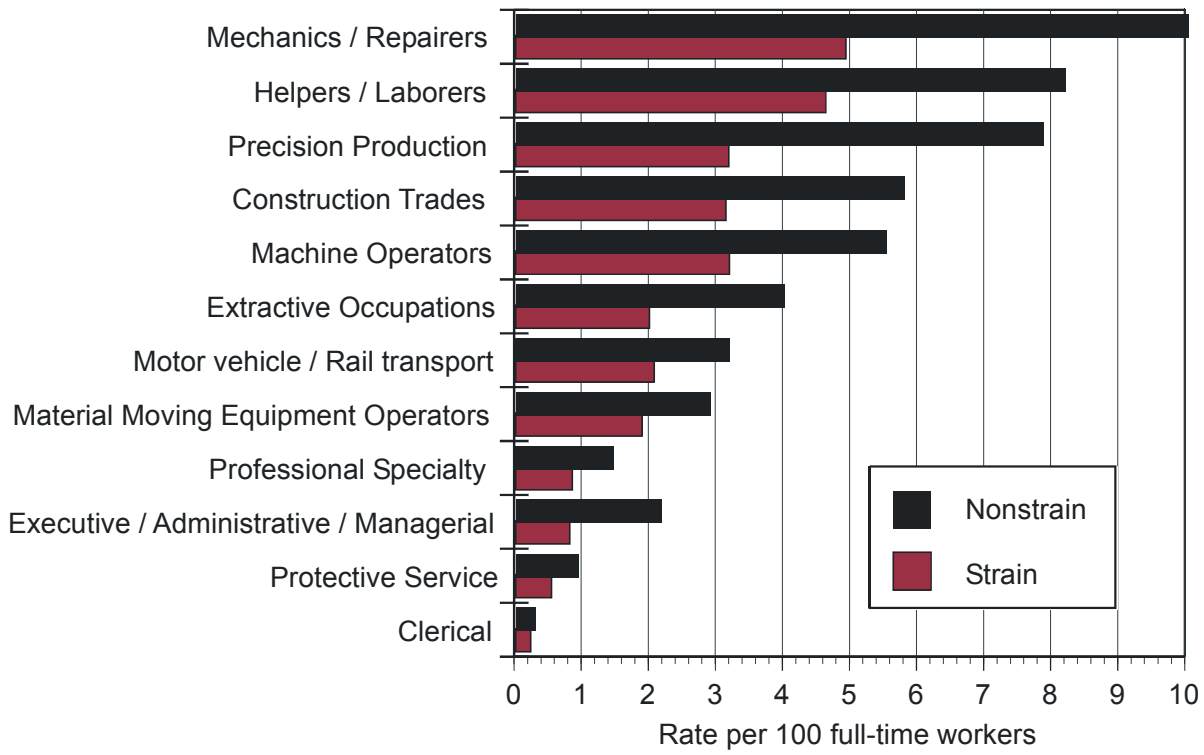


Figure 4D-8.—Stone operators: nonfatal injuries, 1986-1995. Rate (per 100 workers) of strain and nonstrain injuries by U.S. Bureau of the Census Occupation Division, 1986-1995. (Data on occupations were missing for 1,237 out of 54,360 cases (2.3%).) (Source: MSHA data)

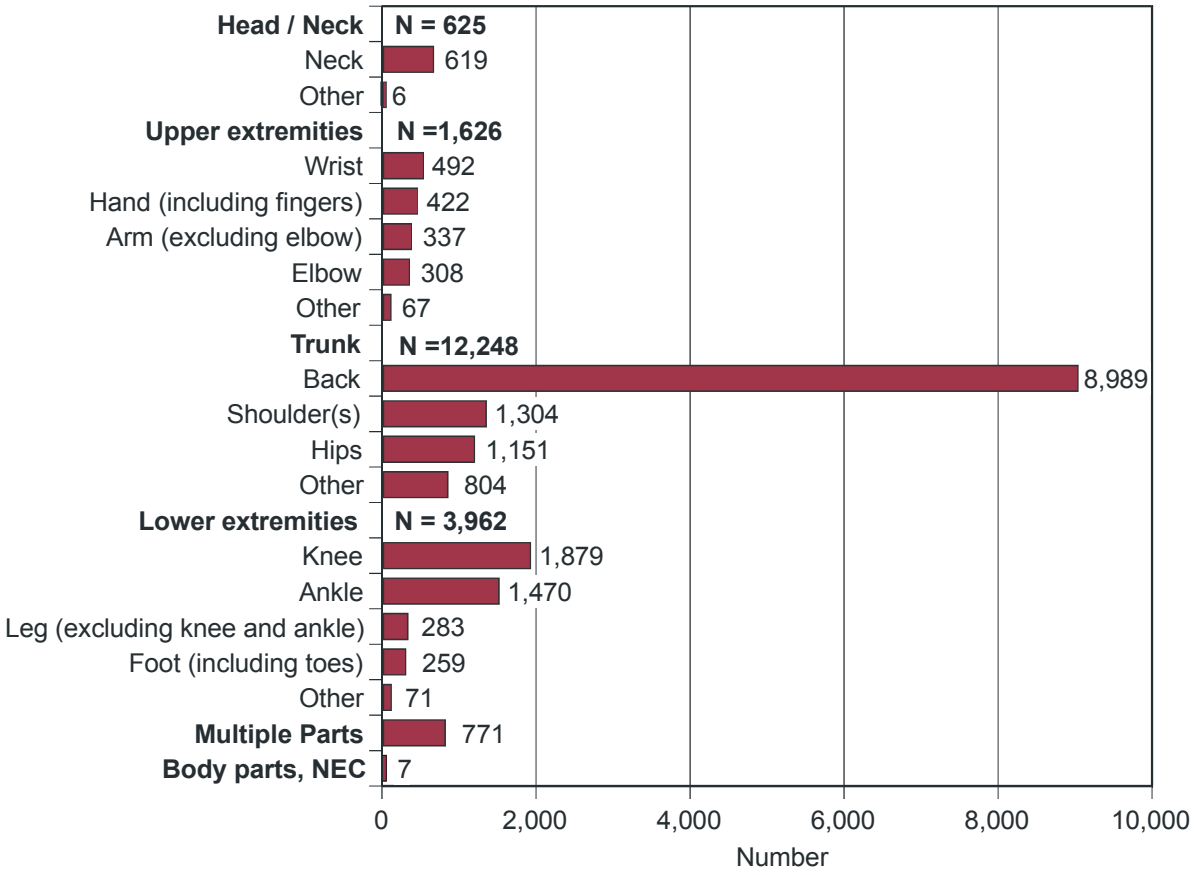


Figure 4D-9.—Stone operators: number of (nonfatal) strain injuries by body part injured, 1986-1995. (Source: MSHA data)

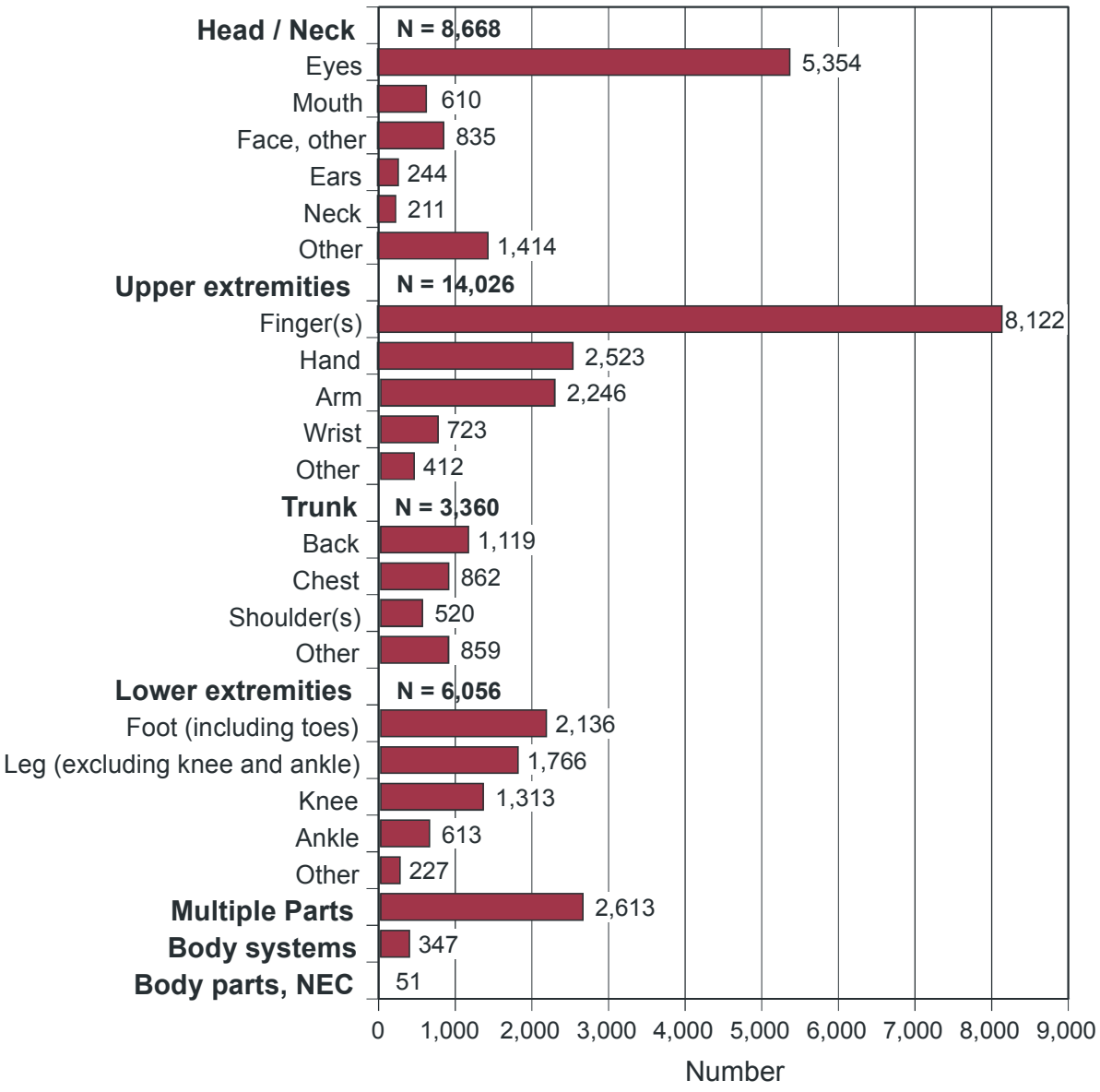


Figure 4D-10.—Stone operators: number of (nonfatal) nonstrain injuries by body part injured, 1986-1995. (Source: MSHA data)

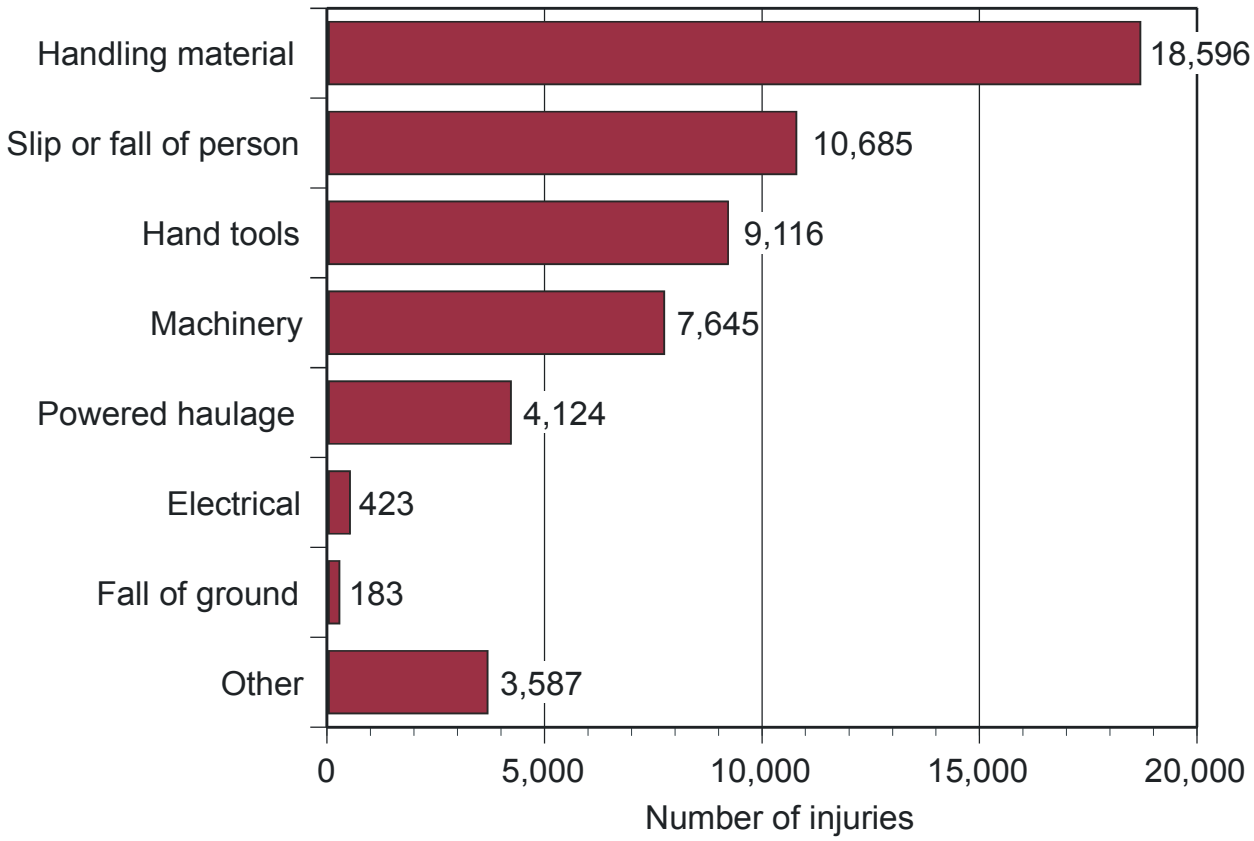


Figure 4D-11.—Stone operators: number of nonfatal injuries by MSHA accident classification, 1986-1995. (Source: MSHA data)

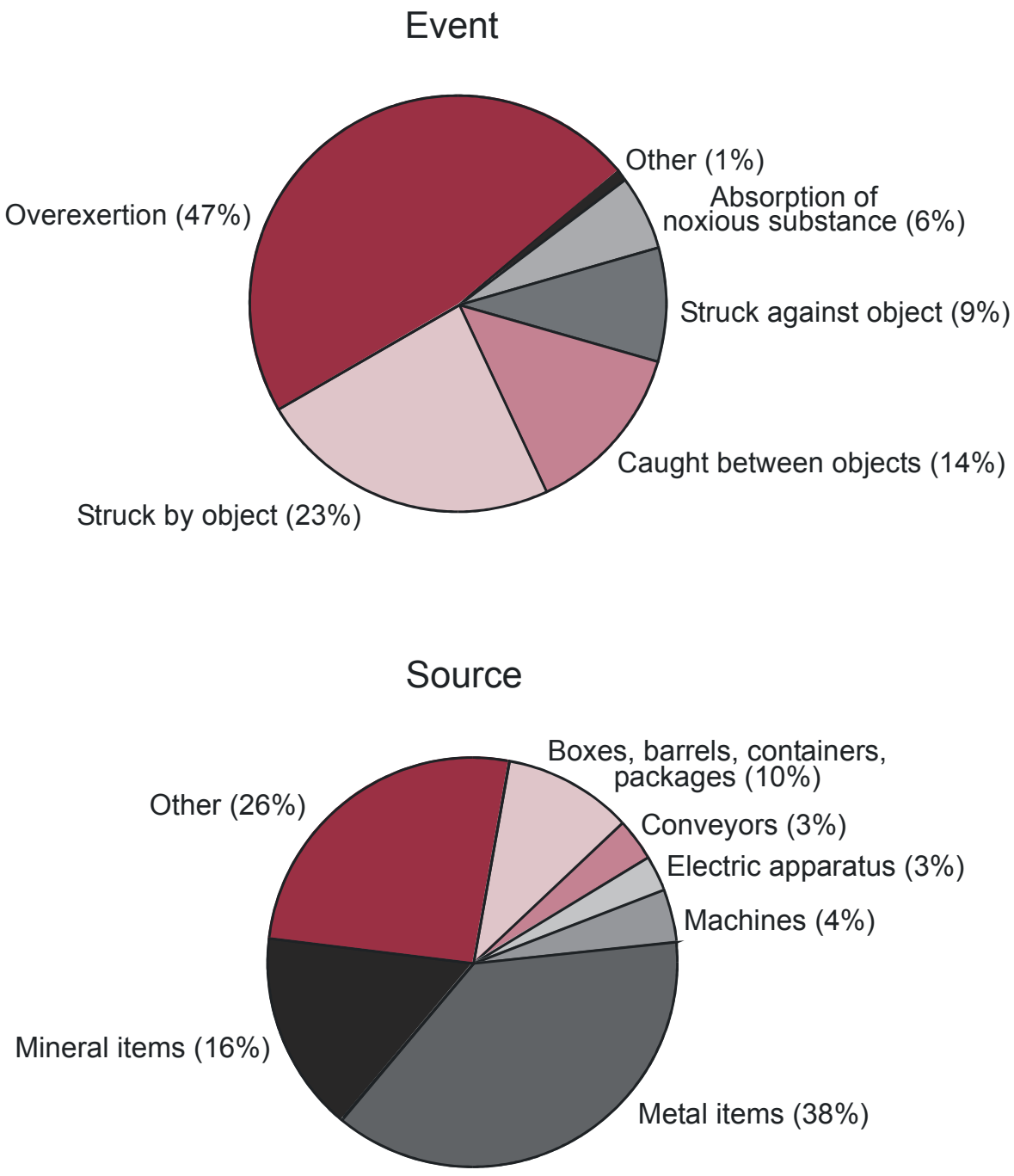


Figure 4D-12.—Stone operators: nonfatal material handling injuries, 1986-1995. Percent of injuries by event resulting in injury and by source of injury (n = 18,596). (Source: MSHA data)

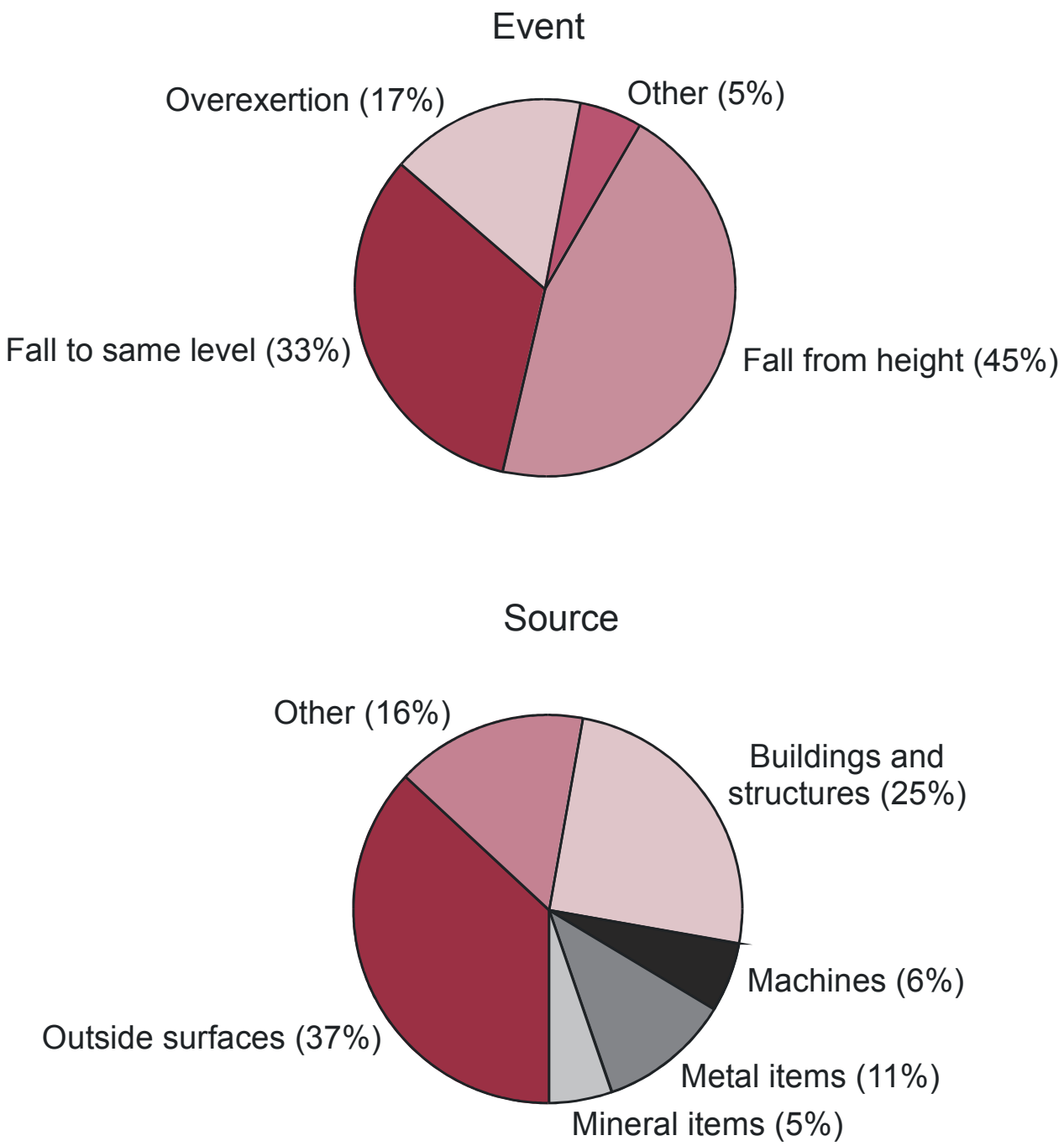


Figure 4D-13.—Stone operators: nonfatal fall injuries, 1986-1995. Percent of injuries by event resulting in injury and by source of injury (n = 10,685). (Source: MSHA data)

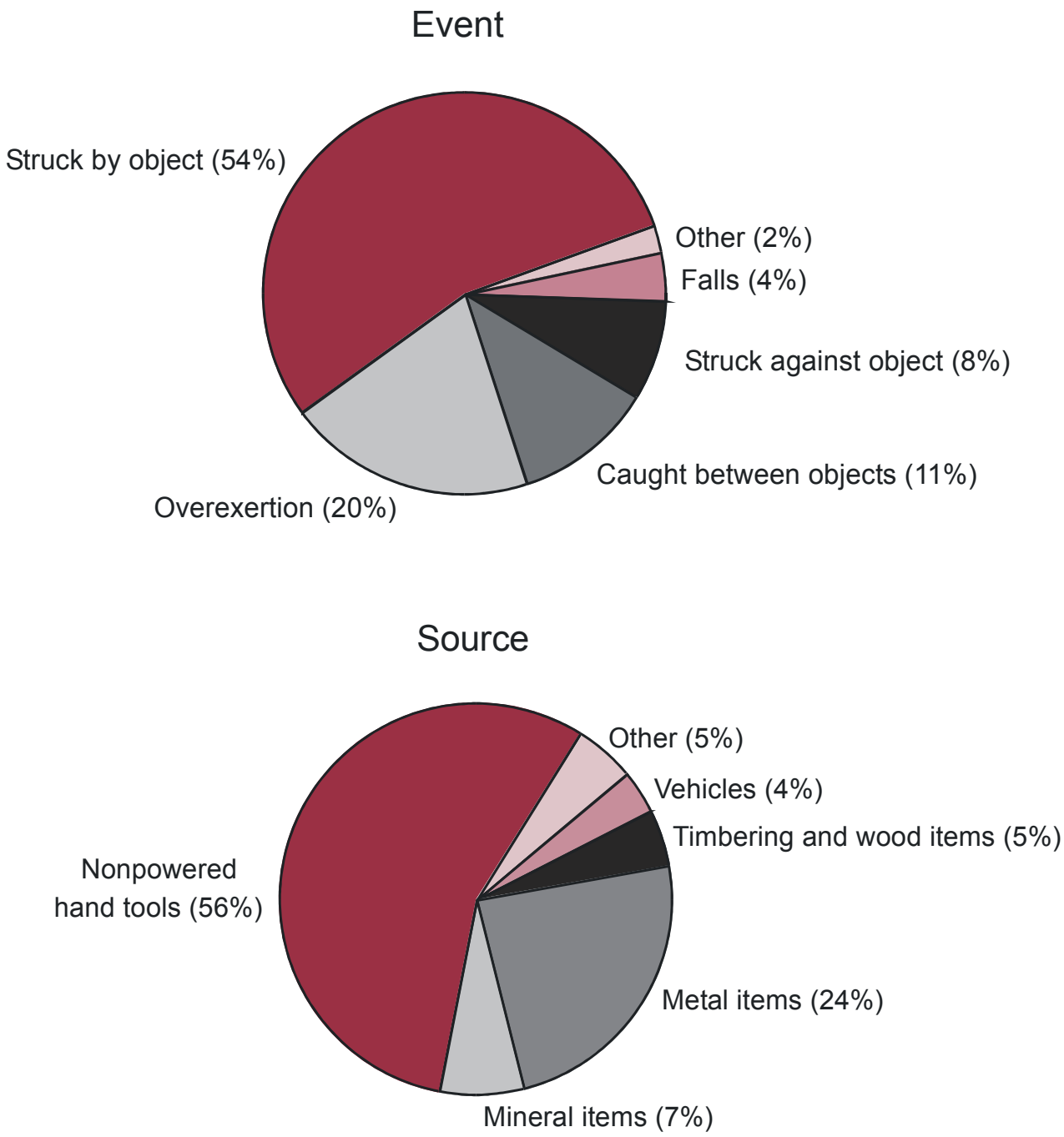


Figure 4D-14.—Stone operators: nonfatal hand tool injuries, 1986-1995. Percent of injuries by event resulting in injury and by source of injury (n = 9, 116). (Source: MSHA data)

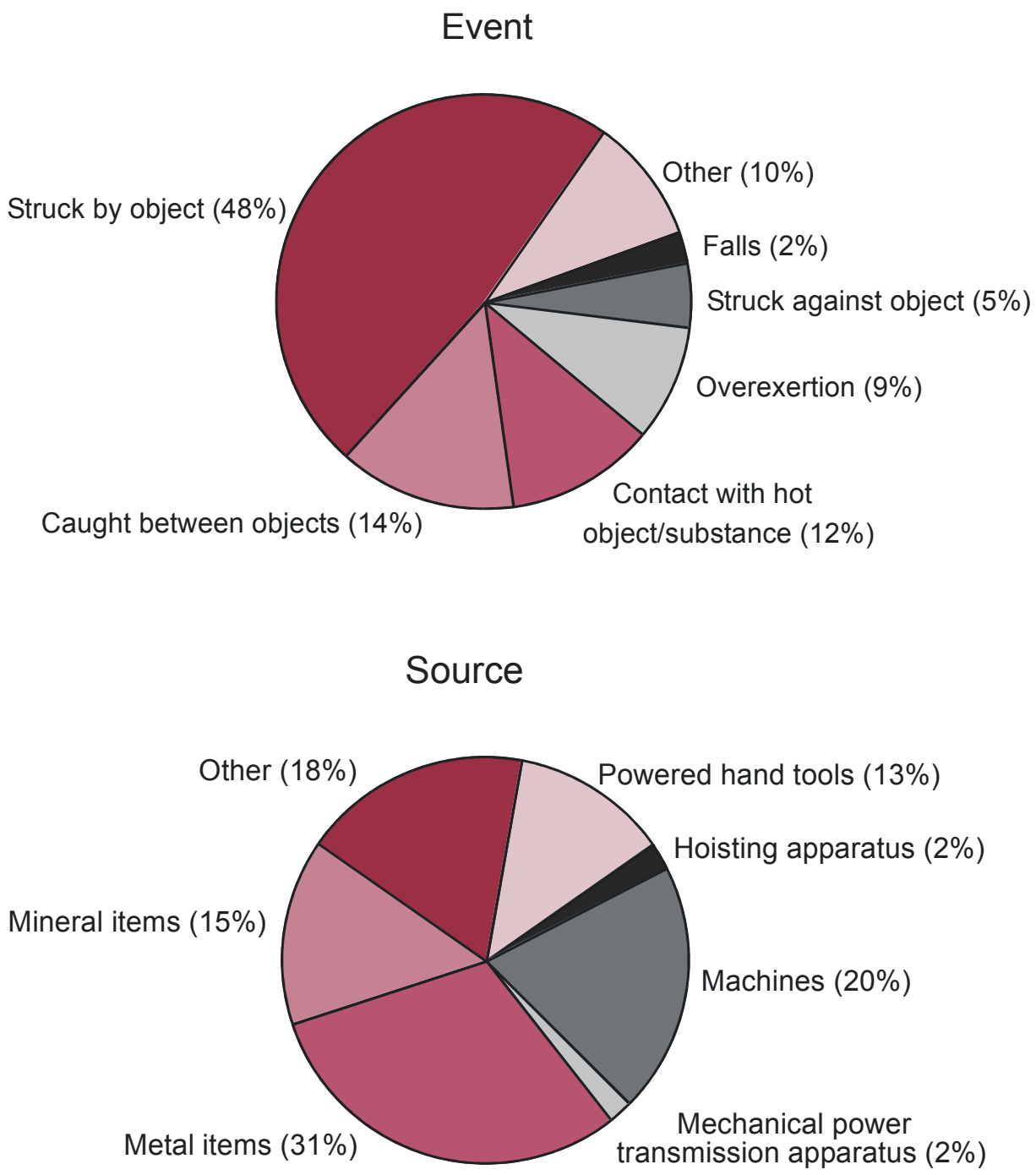


Figure 4D-15.—Stone operators: nonfatal machine injuries, 1986-1995. Percent of injuries by event resulting in injury and by source of injury (n = 7,645). (Source: MSHA data)

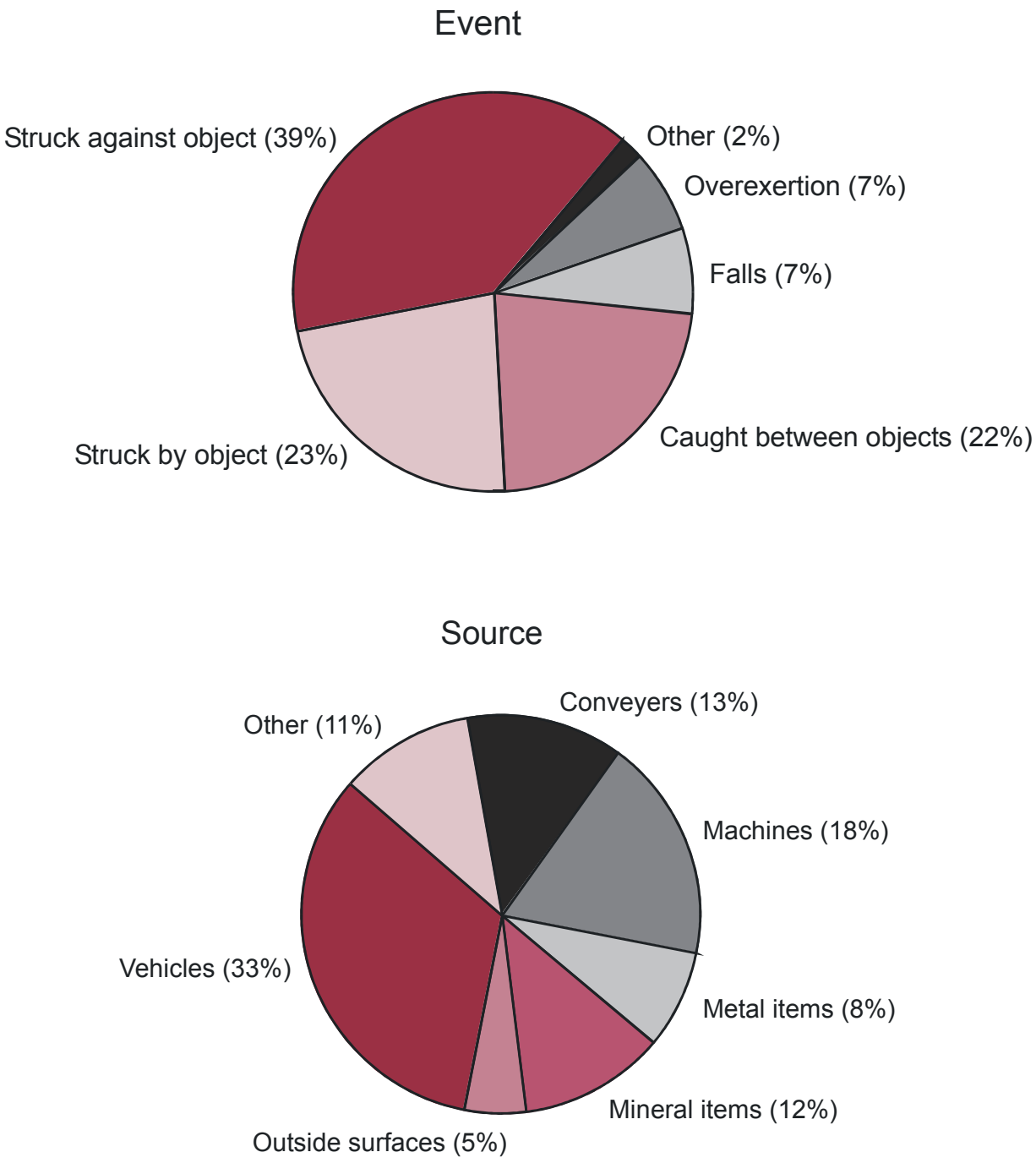


Figure 4D-16.—Stone operators: nonfatal powered haulage injuries, 1986-1995. Percent of injuries by event resulting in injury and by source of injury (n = 4,124). (Source: MSHA data)

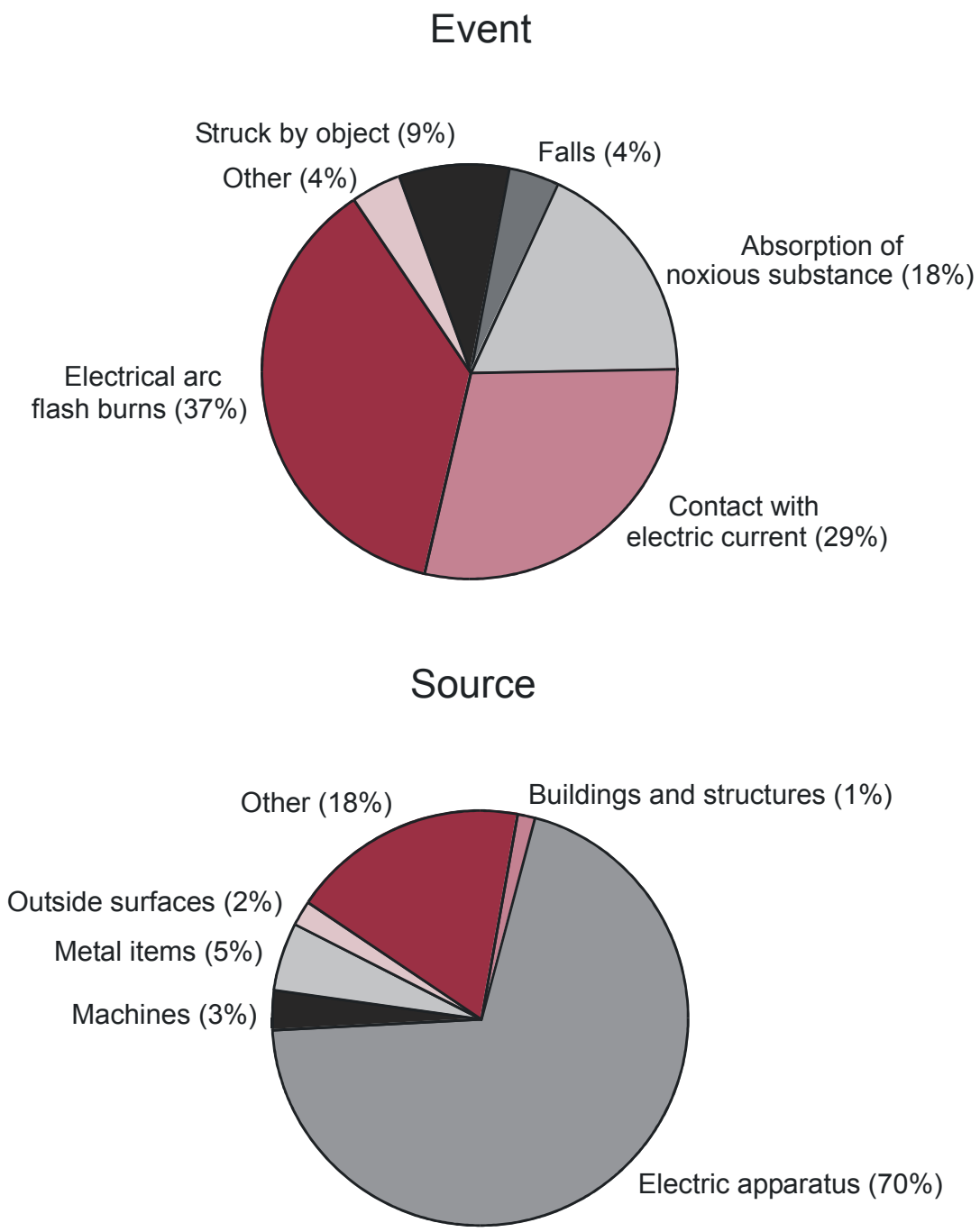


Figure 4D-17.—Stone operators: nonfatal electrical injuries, 1986-1995. Percent of injuries by event resulting in injury and by source of injury (n = 423). (Source: MSHA data)

4E. INJURIES IN SAND AND GRAVEL MINING

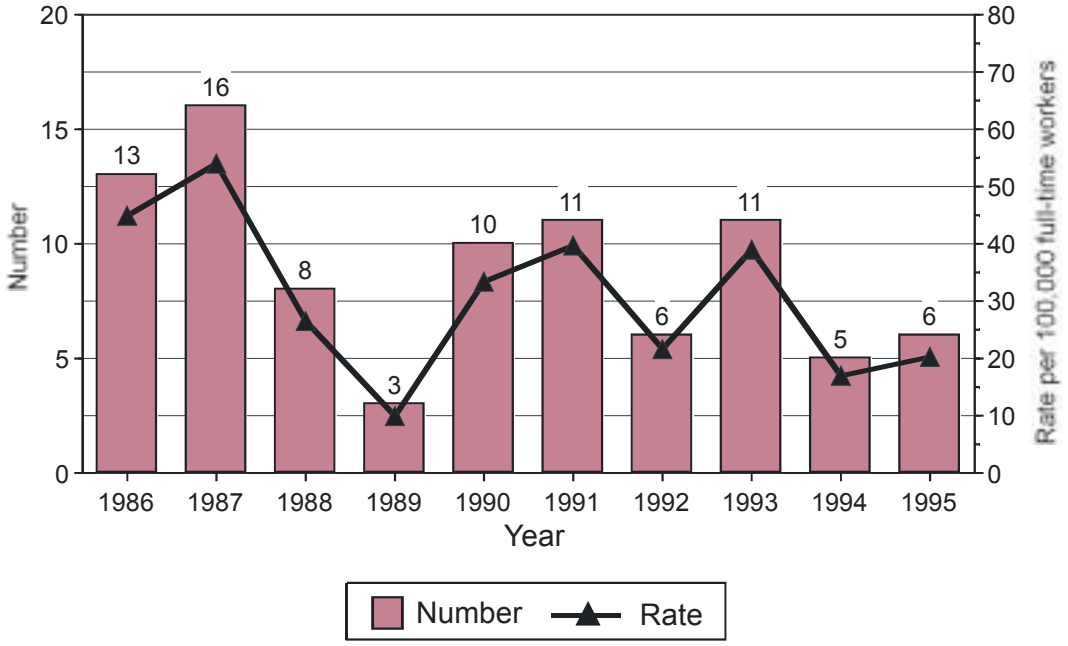


Figure 4E-1.—Sand and gravel operators: number and rate (per 100,000 workers) of fatal injuries by year, 1986-1995. (Source: MSHA data)

Table 4E-1.—Sand and gravel operators: number and average annual rate (per 100,000 workers) of fatal injuries by subunit, 1986-1995.

Mining operation	Number, 1986-1995	Average annual rate per 100,000 full-time workers
Surface mines:		
Strip	**67**	**27.3**
Dredge	**22**	**47.3**
Office	**0**	*
Total	**89**	**26.2**

*** Rate not calculated because there were fewer than 3 fatalities**

Source: Mine Safety and Health Administration data.

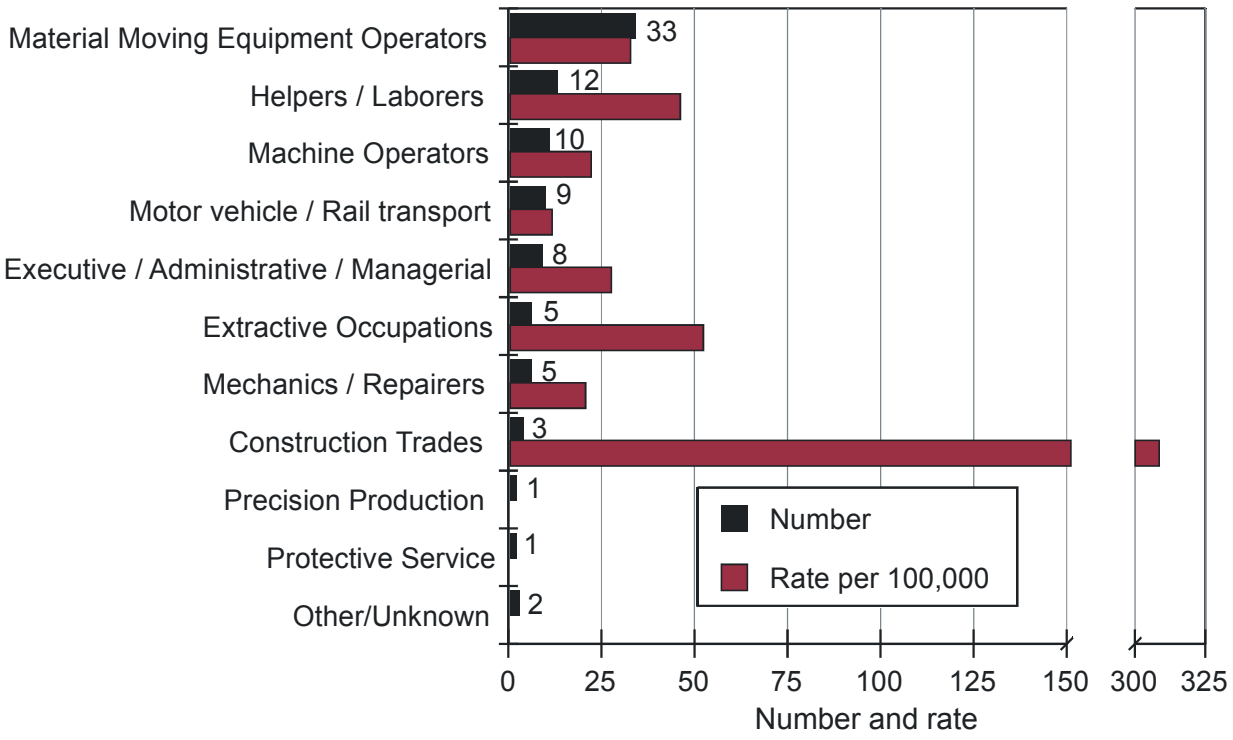


Figure 4E-2.—Sand and gravel operators: number and rate (per 100,000 workers) of fatal injuries by U.S. Bureau of the Census Occupation Division, 1986-1995. (Source: MSHA data)

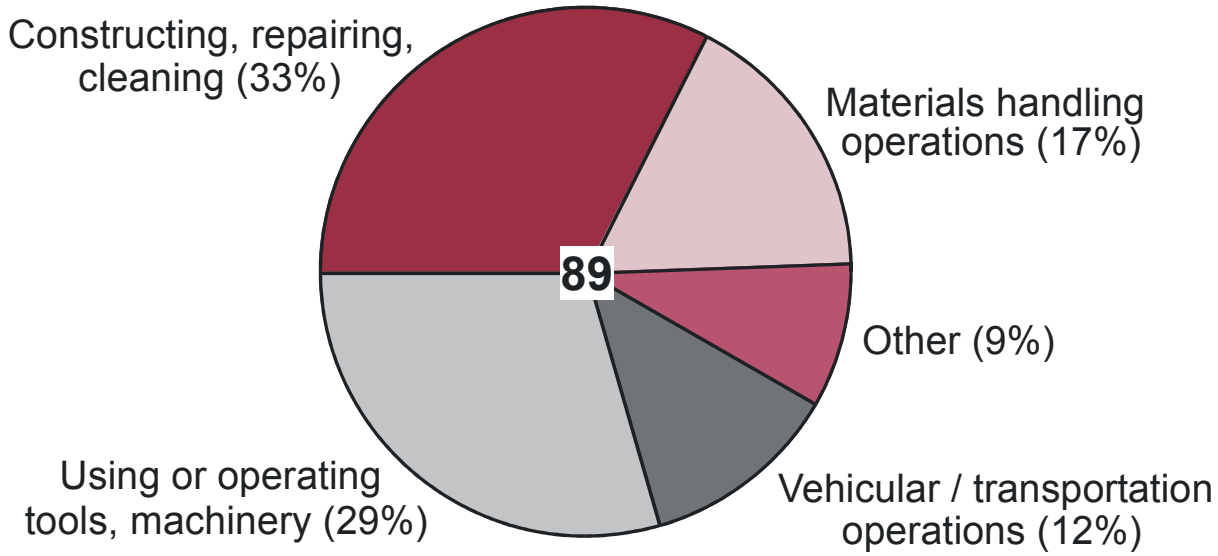


Figure 4E-3.—Sand and gravel operators: number of fatal injuries by work activity, 1986-1995. (Source: MSHA data)

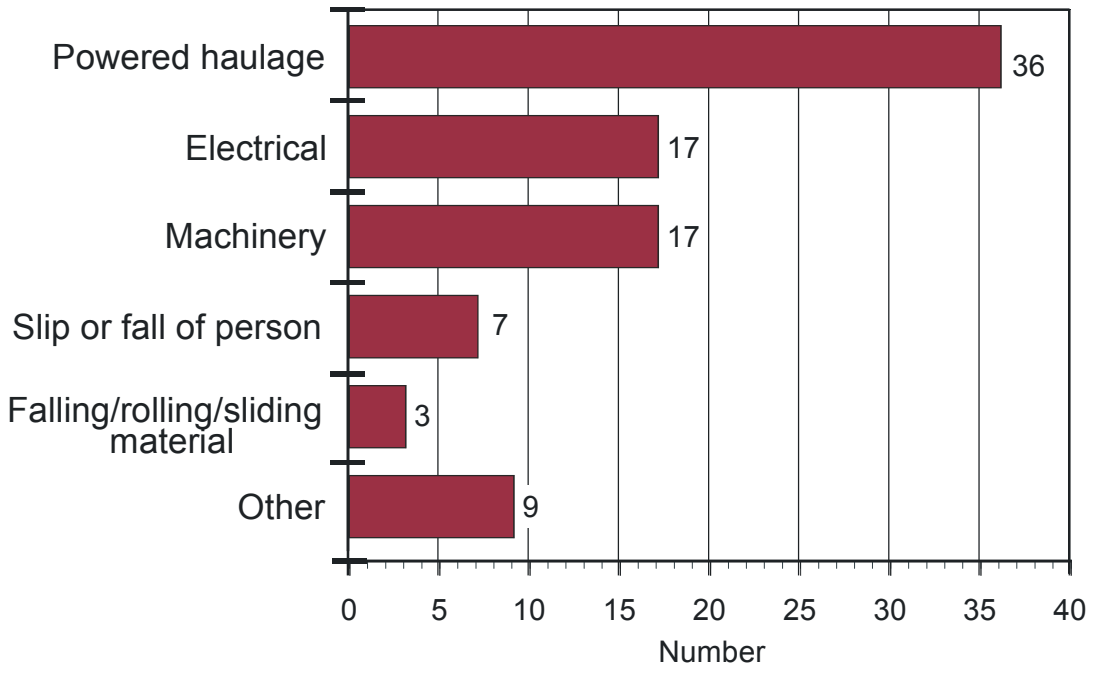


Figure 4E-4.—Sand and gravel operators: number of fatal injuries by MSHA accident classification, 1986-1995. (Source: MSHA data)

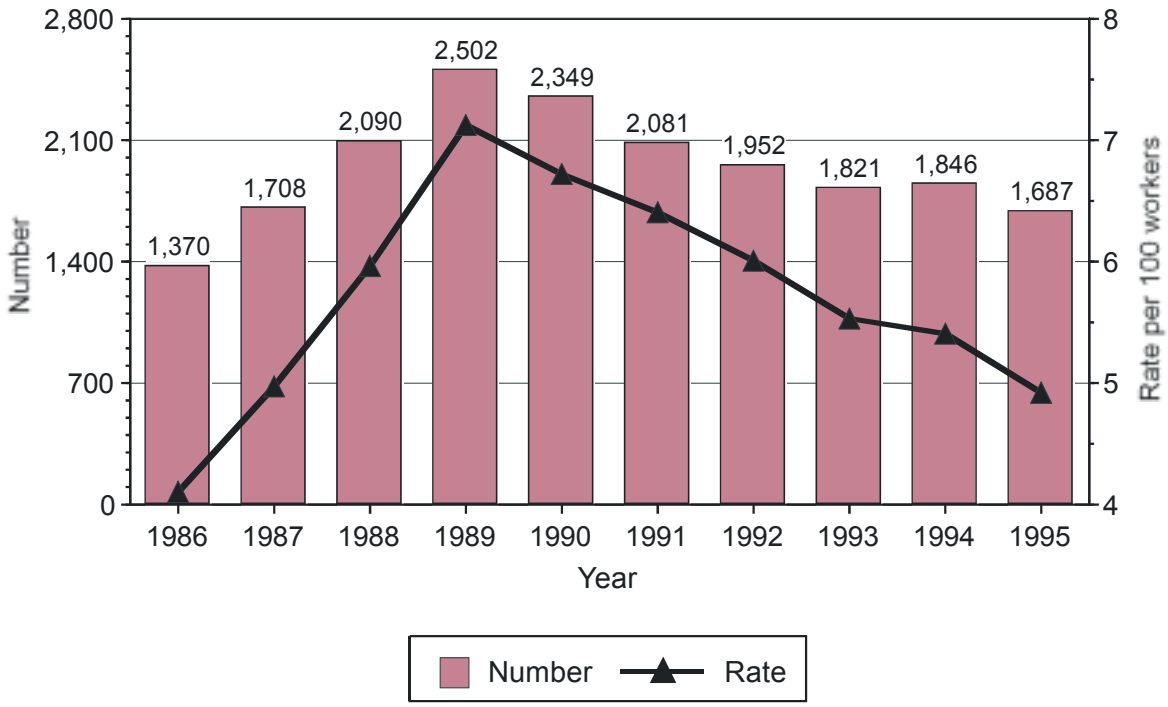


Figure 4E-5.—Sand and gravel operators: number and rate (per 100 workers) of nonfatal injuries by year, 1986-1995. (Source: MSHA data)

Table 4E-2.—Sand and gravel operators: number and average annual rate (100 workers) of nonfatal injuries by subunit, 1986-1995.

Mining operation	Number, 1986-1995	Average annual rate per 100 full-time workers
Surface mines:		
Strip	16,045	6.55
Dredge	3,252	6.99
Office	109	0.23
Total	19,406	5.72

Source: Mine Safety and Health Administration data.

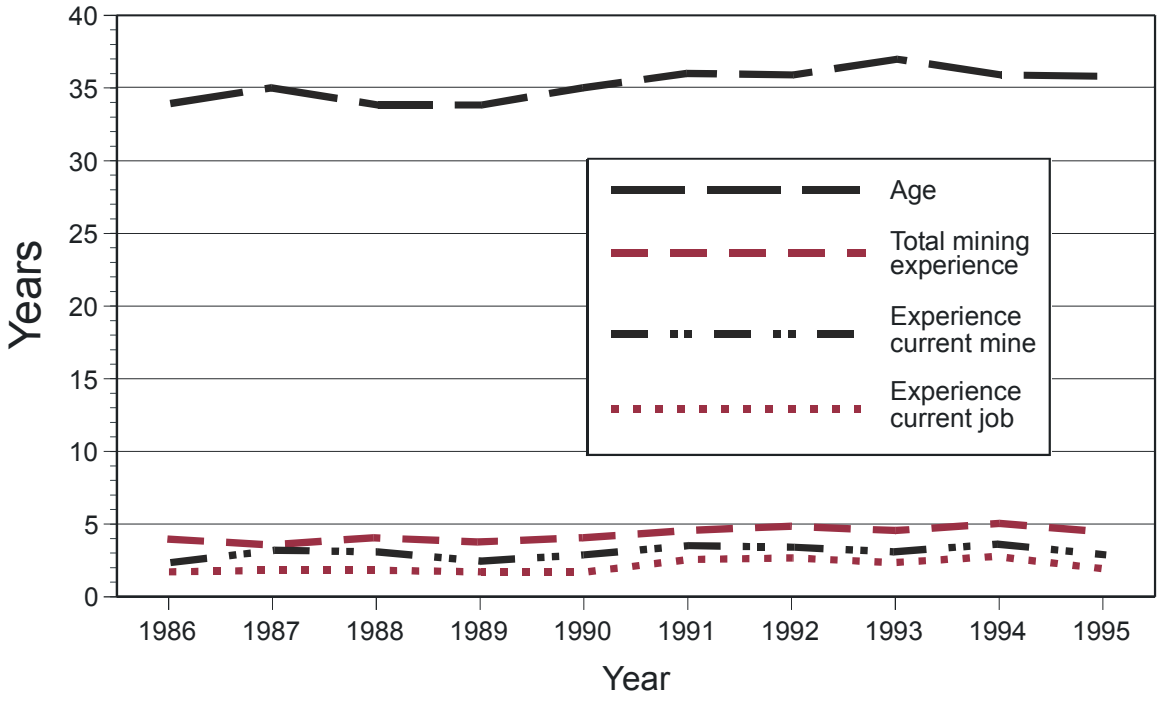


Figure 4E-6.—Sand and gravel operators: median values for age, total mining experience, experience in current mine, and experience in current job for workers with nonfatal injuries by year, 1986-1995. (Source: MSHA data)

Table 4E-3.—Sand and gravel operators: nonfatal injuries, 1986-1995, by nature of injury. Number of cases, percentage of cases with one or more lost workays, mean days lost work per case, total days work lost for all cases, and statutory days charged for all cases.

Nature of injury	Number of cases	Lost workday cases (%)	Mean days lost work	Total days lost	Total statutory days
Sprains and strains	5,768	71.2	16.08	92,773	7,920
Fracture	1,793	65.1	24.62	44,138	6,600
Contusions	1,775	59.5	8.53	15,135	1,200
Lacerations	4,111	29.9	3.47	14,269	4,018
Amputation, enucleation	173	59.0	23.85	4,126	154,590
Hernia	183	68.9	20.63	3,776	7,700
Crushing	378	48.4	9.84	3,720	3,270
Burn, heat	492	48.2	5.65	2,780	0
Joint, tendon, or muscle inflammation or irritation	111	55.0	17.66	1,960	0
Dislocation	114	62.3	17.11	1,951	6,000
Electric shock	38	76.3	34.11	1,296	6,000
Noncontact electric arc burn	311	60.8	3.77	1,171	0
Dust in eyes	586	29.9	1.23	723	0
Brain concussion	47	87.2	14.55	684	0
Abrasions	252	42.1	1.95	491	0
Electrical burn	23	69.6	18.70	430	0
Burn, chemical	127	55.1	3.02	383	0
Poisoning	141	40.4	2.15	303	0
Other specified causes	300	58.7	12.65	3,795	5,400
Multiple injuries, unspecified	1,539	67.6	20.83	32,043	22,530
Other unspecified injuries	1,144	65.1	18.08	20,679	5,650
Total	19,406	56.6	12.71	246,626	230,878

Source: Mine Safety and Health Administration data.

Table 4E-4.—Sand and gravel operators: nonfatal injuries, 1986-1995, by work activity. Number of cases, percentage of cases with one or more lost workdays, mean days lost work per case, total days work lost for all cases, and statutory days charged for all cases.

Work activity	Number of cases	Lost workday cases (%)	Mean days lost work	Total days lost	Total statutory days
Materials handling	5,115	60.2	12.51	63,967	52,815
Constructing, repairing, or cleaning	4,518	54.2	13.23	59,754	98,590
Using or operating tools or machinery	5,313	46.6	9.04	48,033	42,000
Vehicular and transportation operations	2,412	68.5	16.91	40,798	18,578
Bodily movement	1,477	65.9	16.42	24,256	8,840
Other	417	61.9	16.43	6,851	9,855
Unspecified	154	59.7	19.27	2,967	200
Total	19,406	56.6	12.71	246,626	230,878

Source: Mine Safety and Health Administration data.

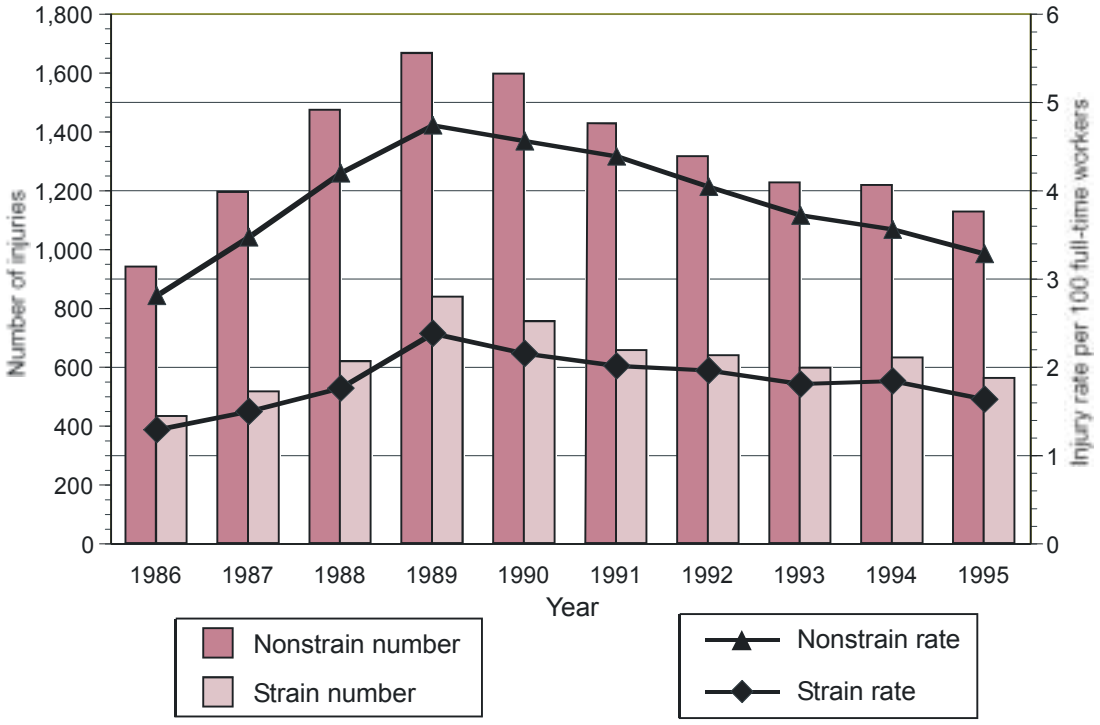


Figure 4E-7.—Sand and gravel operators: nonfatal injuries 1986-1995. Number and rate (per 100 workers) of strain and nonstrain injuries by year, 1986-1995. (Source: MSHA data)

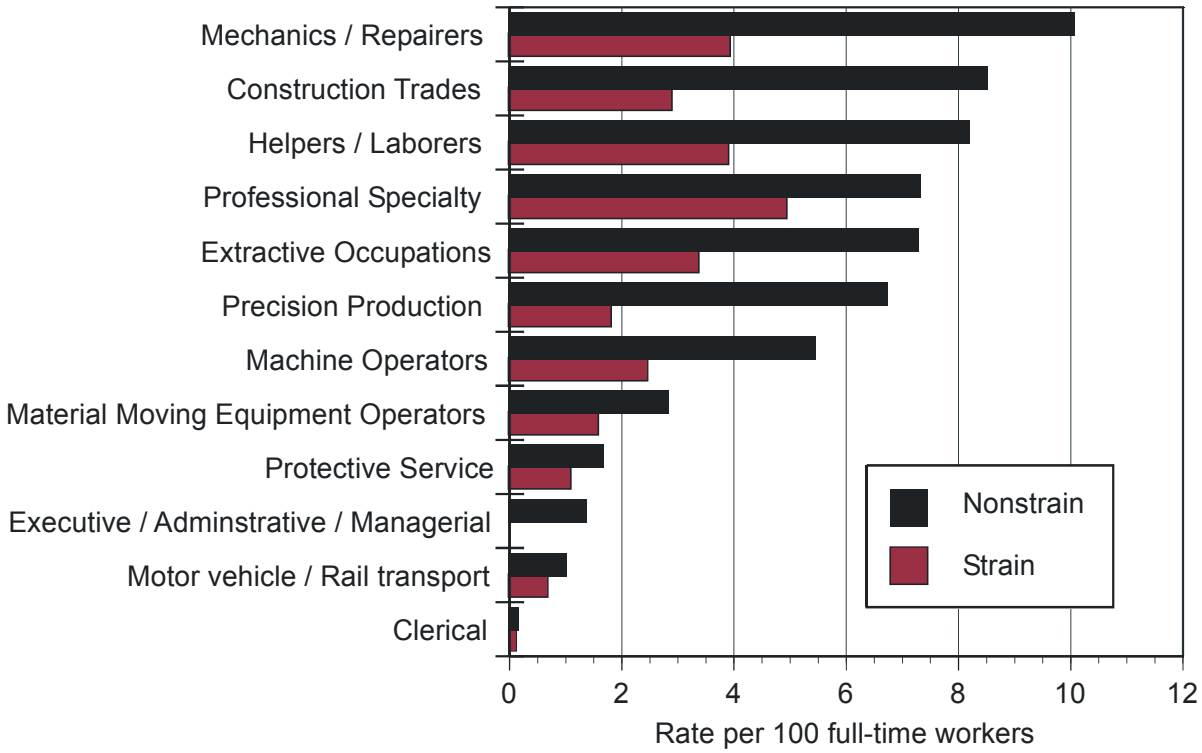


Figure 4E-8.—Sand and gravel operators: nonfatal injuries, 1986-1995. Rate (per 100 workers) of strain and nonstrain injuries by U.S. Bureau of the Census Occupation Division, 1986-1995. (Data on occupations were missing for 610 out of 19,406 cases (3.1%).) (Source: MSHA data)

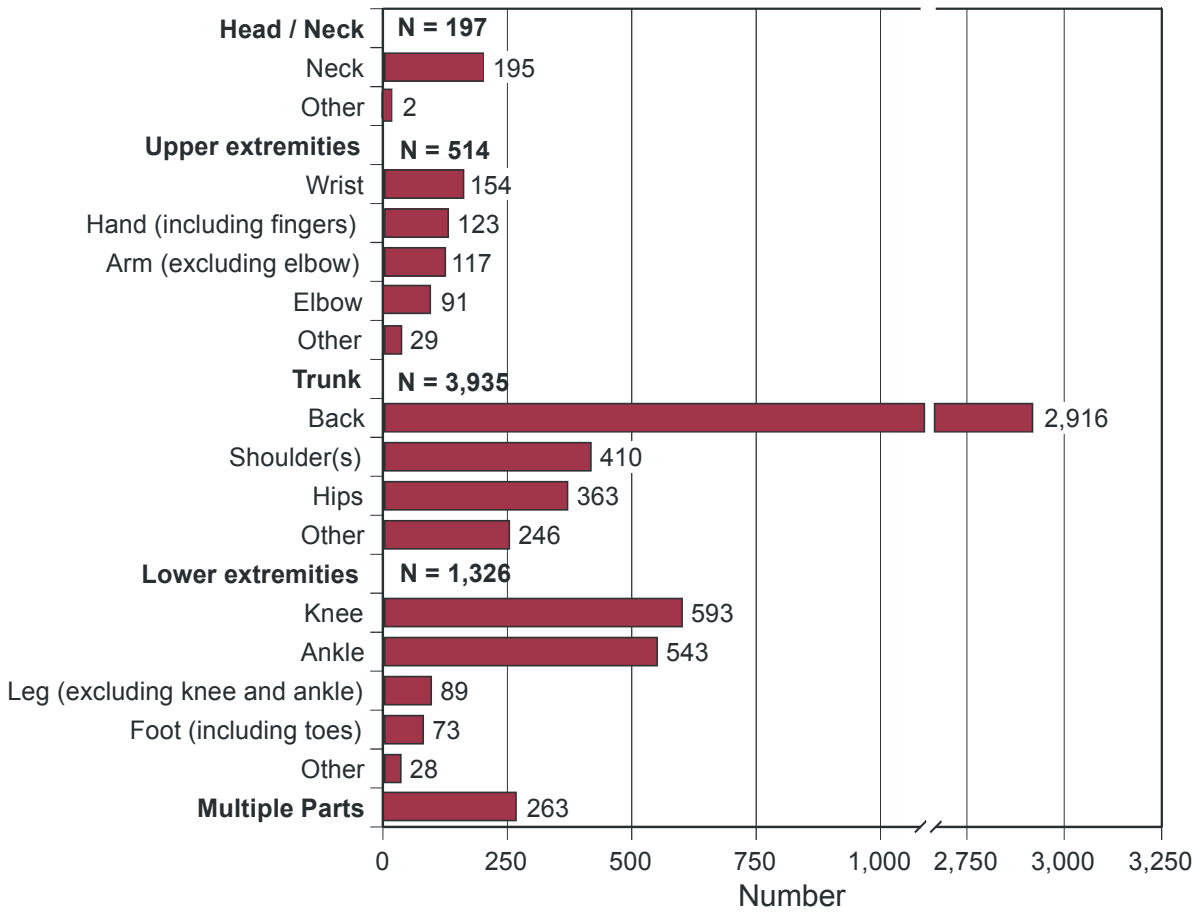


Figure 4E-9.—Sand and gravel operators: number of (nonfatal) strain injuries by body part injured, 1986-1995. (Source: MSHA data)

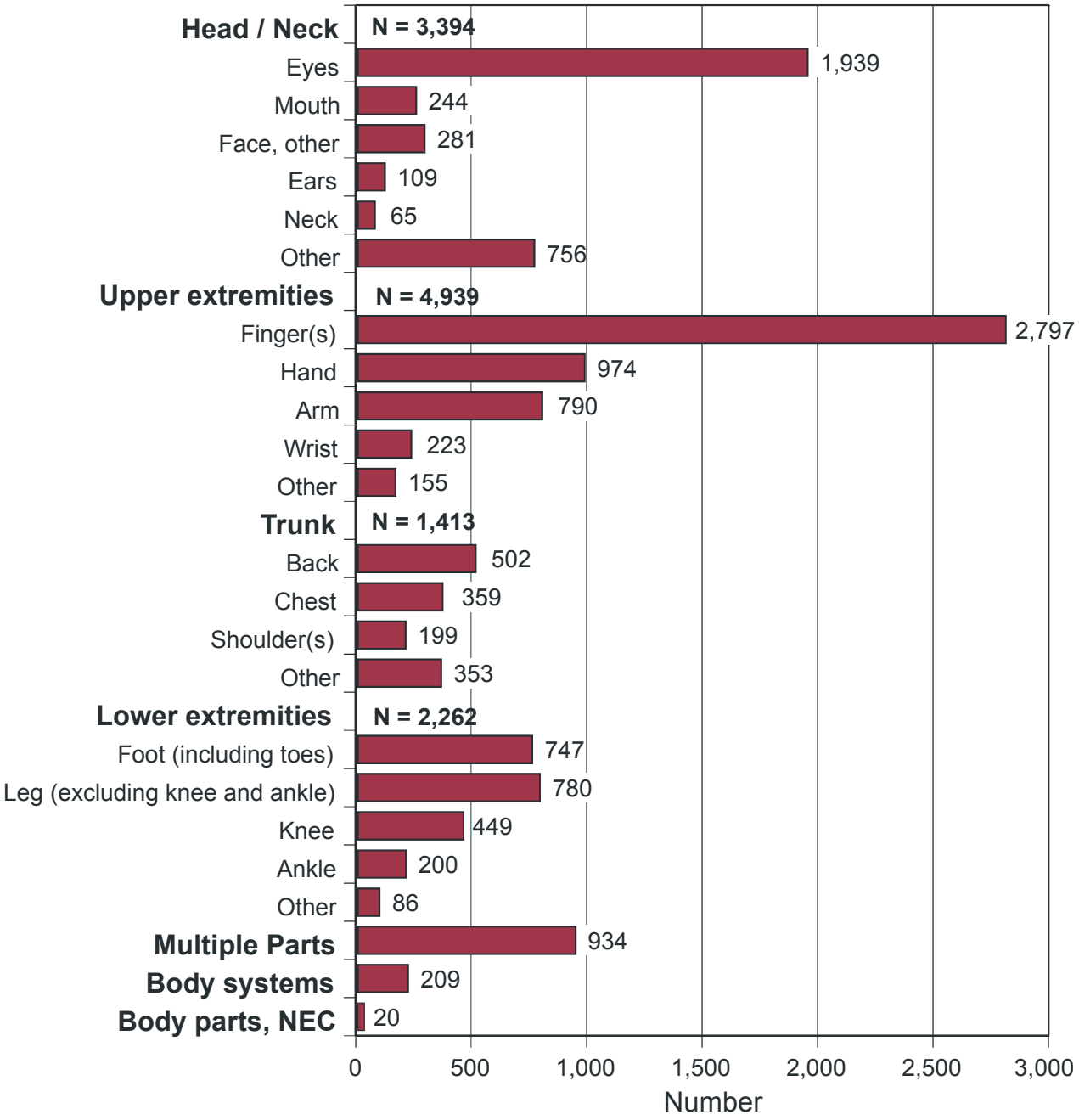


Figure 4E-10.—Sand and gravel operators: number of (nonfatal) nonstrain injuries by body part injured, 1986-1995. (Source: MSHA data)

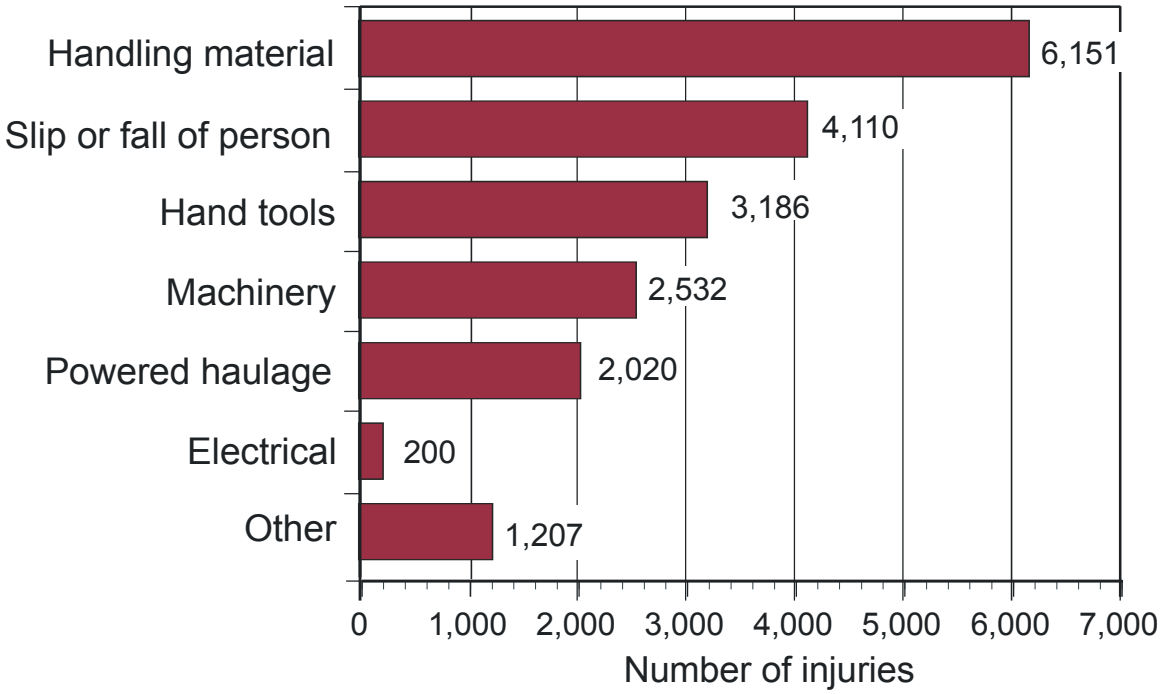


Figure 4E-11.—Sand and gravel operators: number of nonfatal injuries by MSHA accident classification, 1986-1995. (Source: MSHA data)

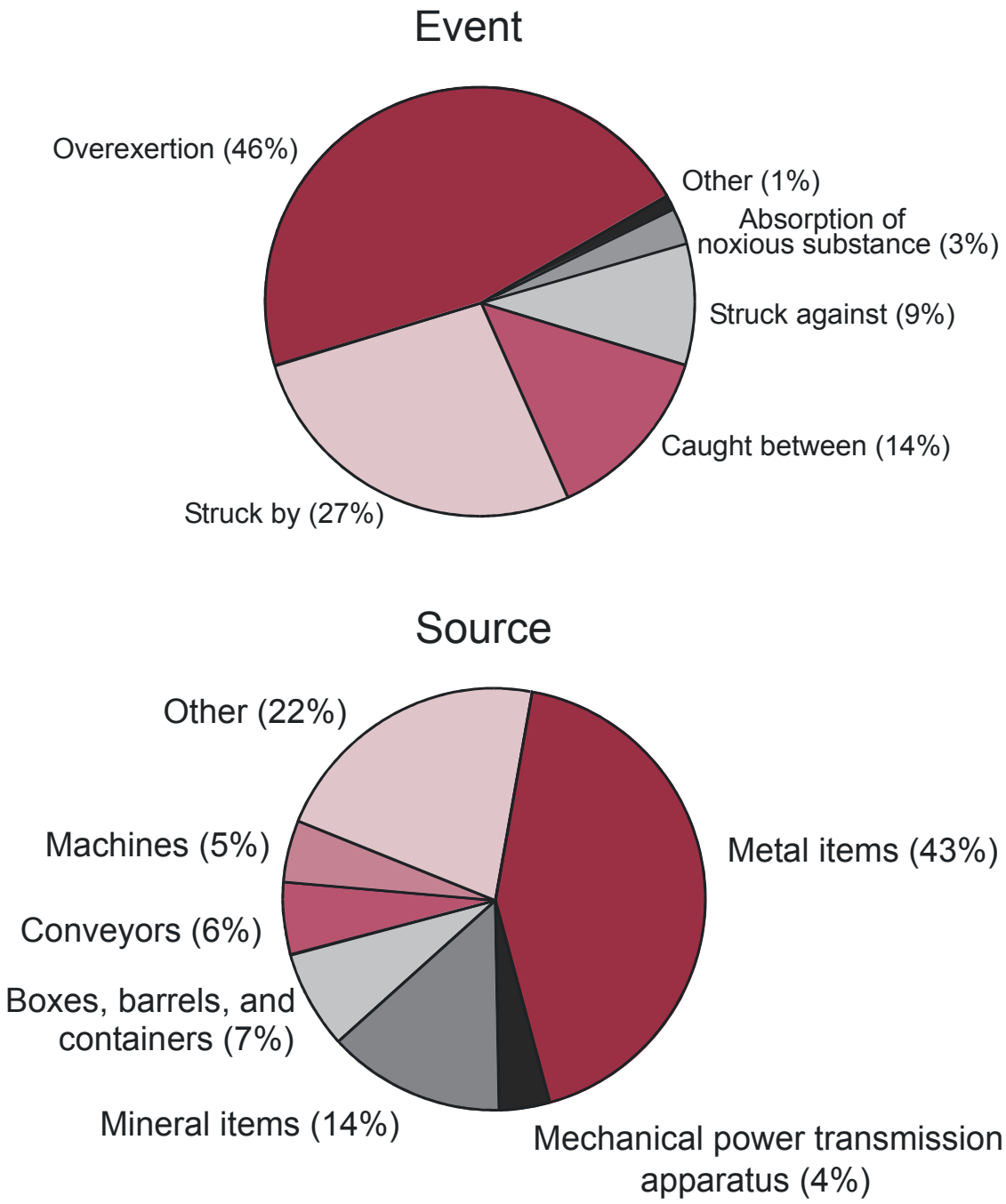


Figure 4E-12.—Sand gravel operators: nonfatal material handling injuries, 1986-1995. Percent of injuries by event resulting in injury and by source of injury (n = 6,151). (Source: MSHA data)

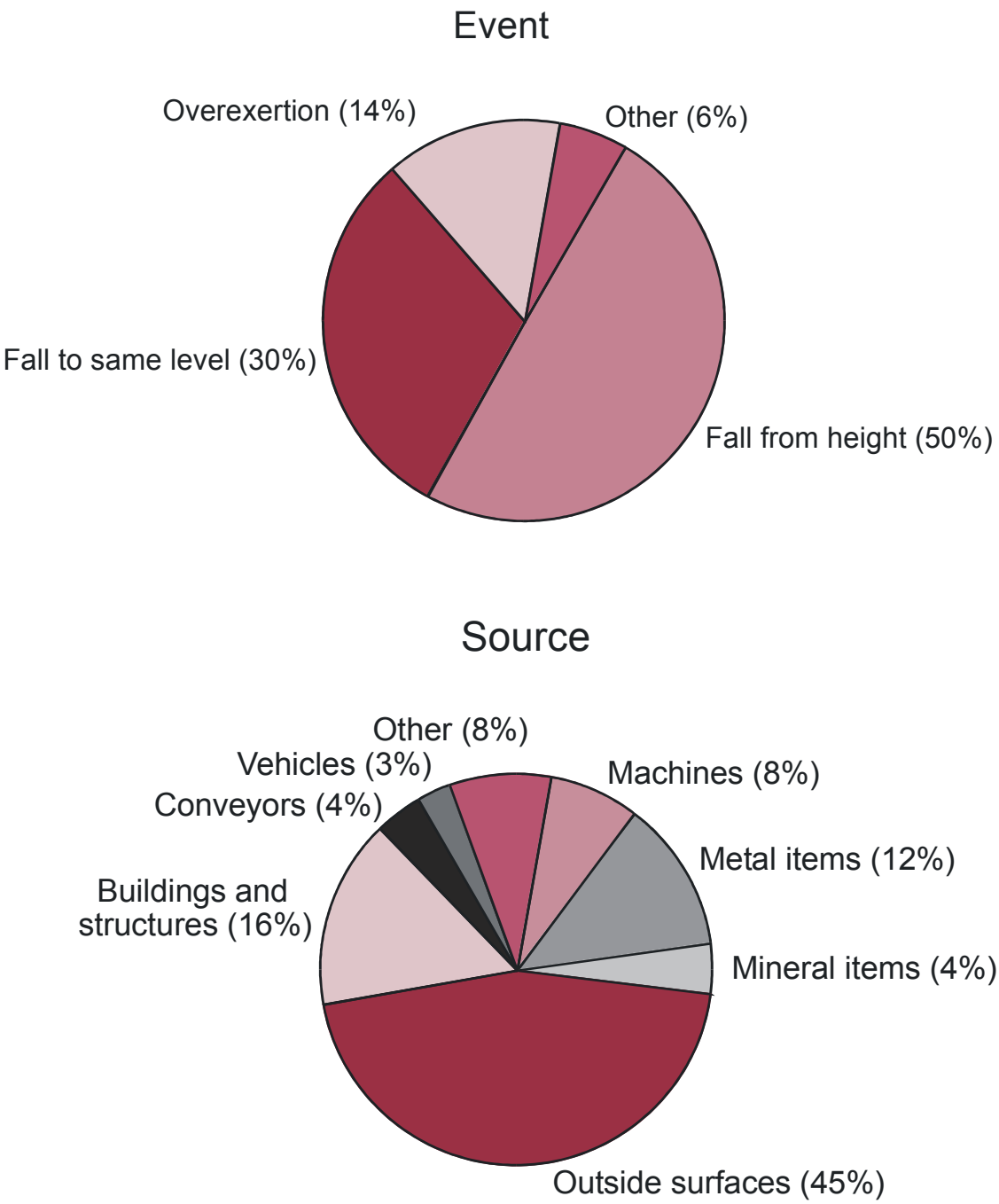


Figure 4E-13.—Sand and gravel operators: nonfatal fall injuries, 1986-1995. Percent of injuries by event resulting in injury and by source of injury (n = 4,110). (Source: MSHA data)

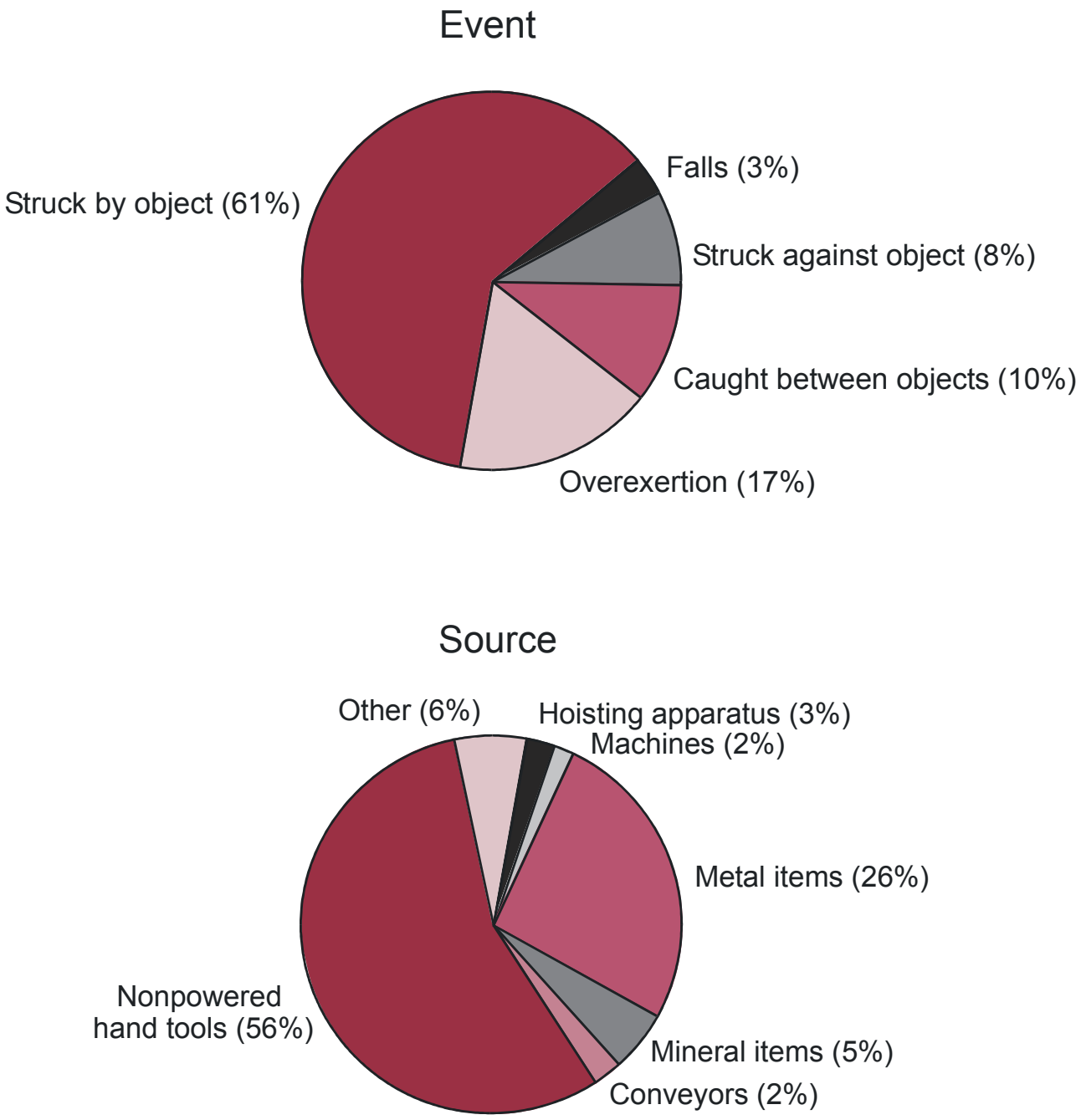


Figure 4E-14.—Sand and gravel operators: nonfatal hand tool injuries, 1986-1995. Percent of injuries by event resulting in injury and by source of injury (n = 3,186). (Source: MSHA data)

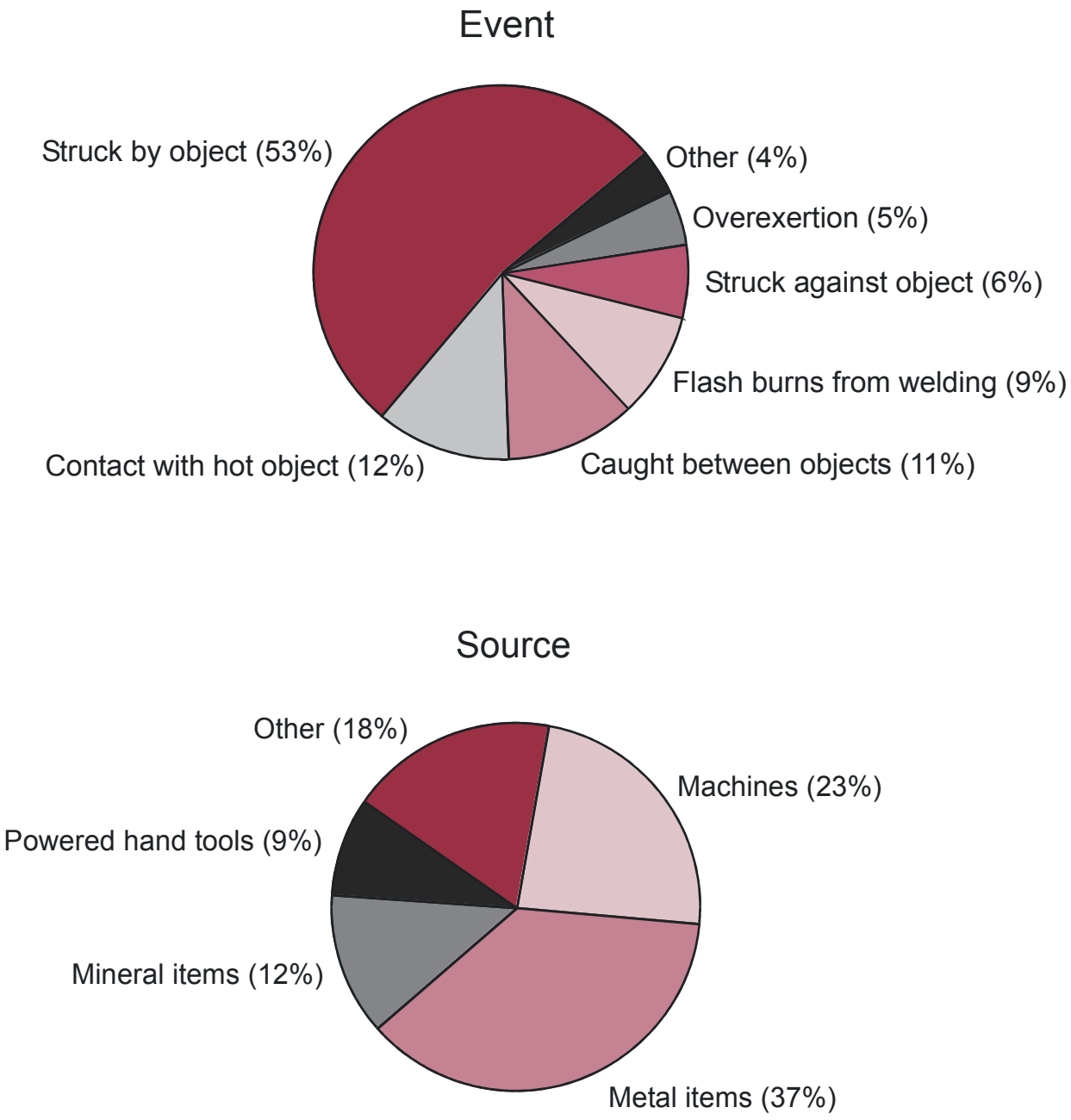
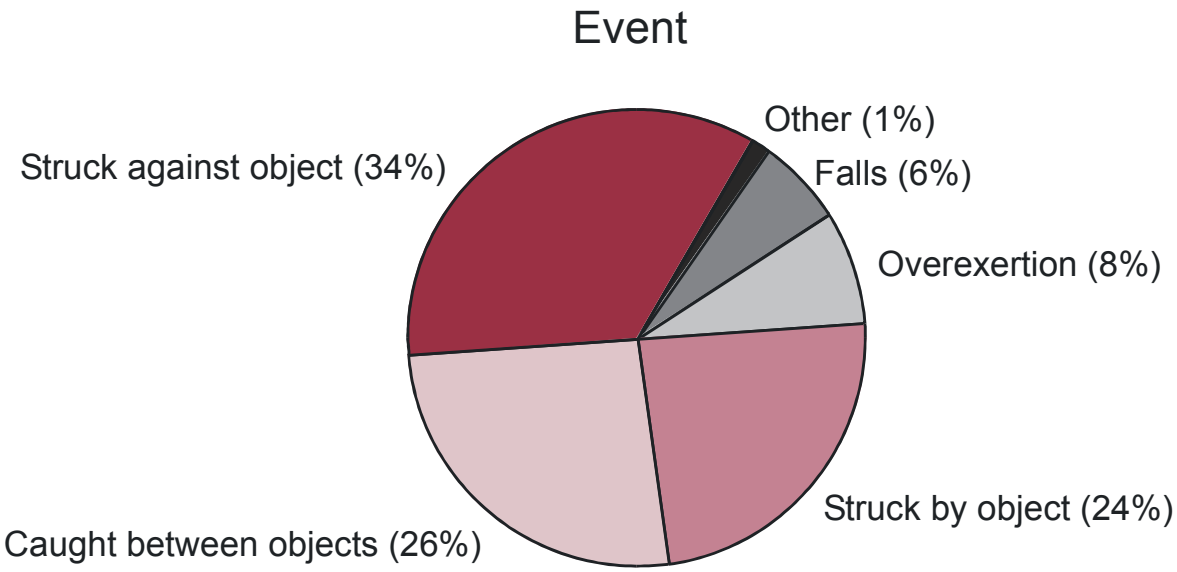


Figure 4E-15.—Sand and gravel operators: nonfatal machine injuries, 1986-1995. Percent of injuries by event resulting in injury and by source of injury (n = 2,532). (Source: MSHA data)



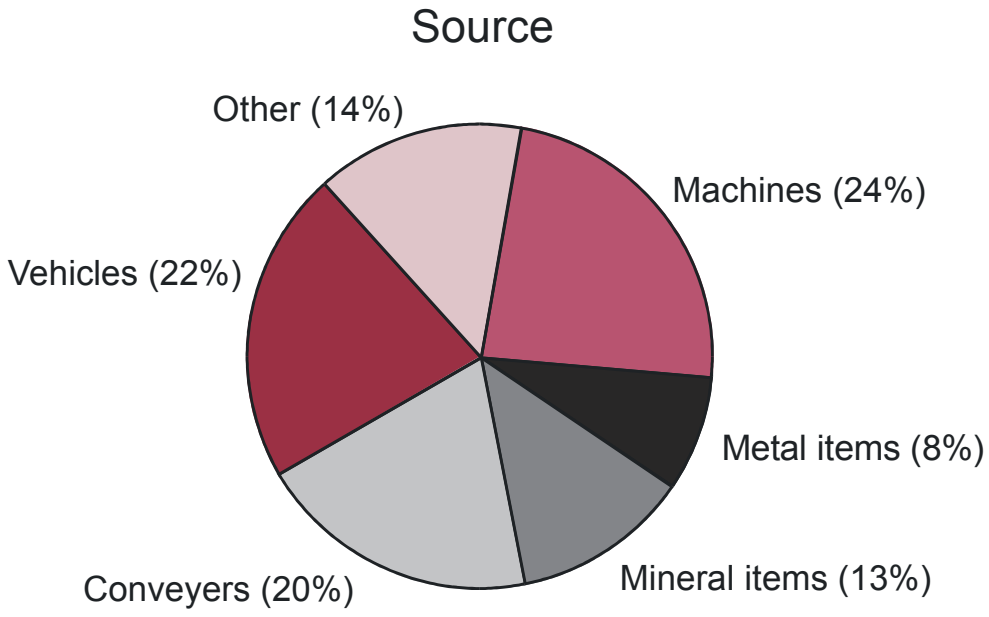


Figure 4E-16.—Sand and gravel operators: nonfatal powered haulage injuries, 1986-1995. Percent of injuries by event resulting in injury and by source of injury (n = 2,020). (Source: MSHA data)

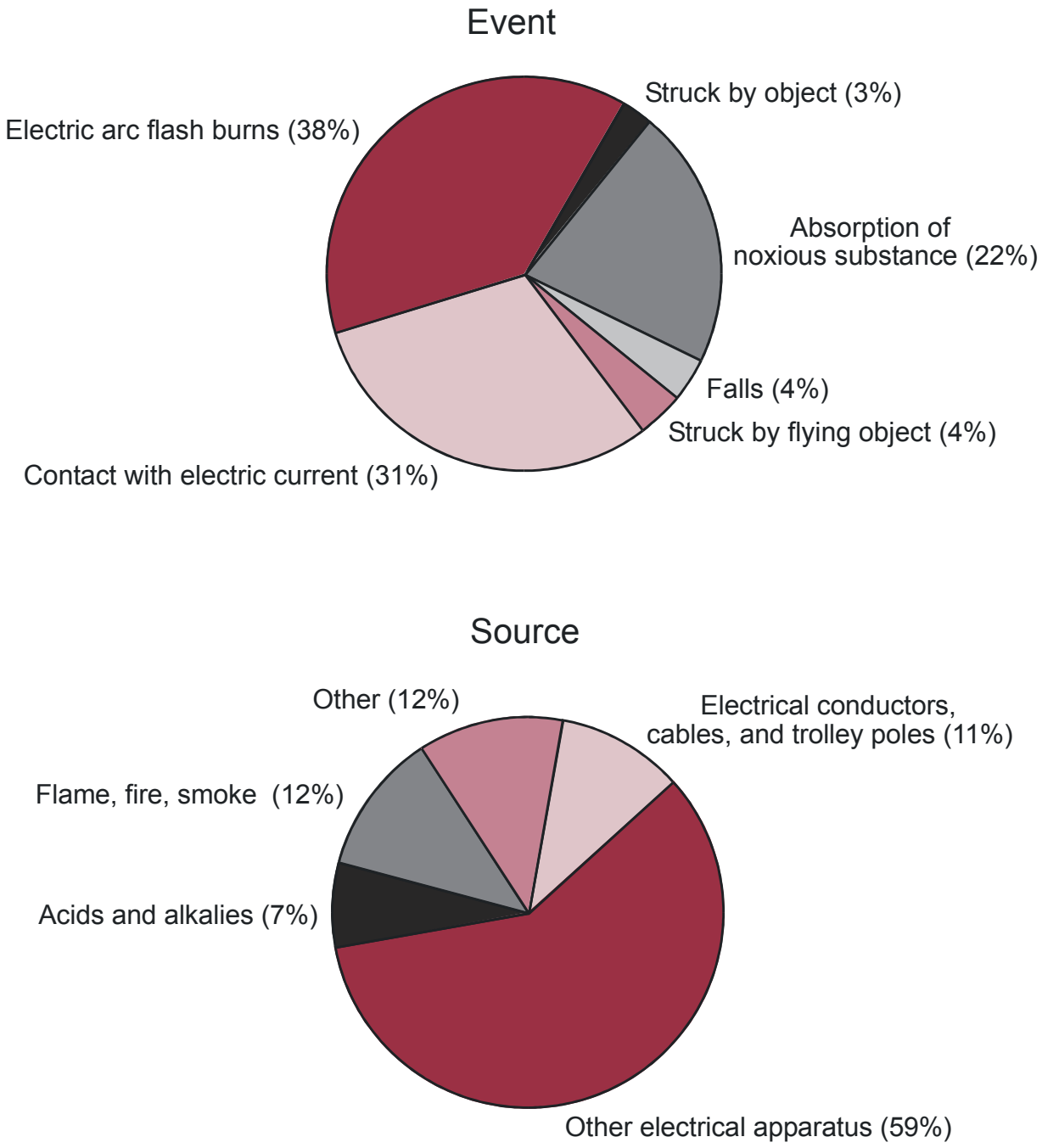


Figure 4E-17.—Sand and gravel operators: nonfatal electrical injuries, 1986-1995. Percent of injuries by event resulting in injury and by source of injury (n = 200). (Source: MSHA data)

CHAPTER 5. OCCUPATIONAL ILLNESSES

Occupational illnesses are more difficult to identify than on-the-job injuries. Many illnesses related to occupational exposures may not be diagnosed until years after exposure; by that time, exposed workers may have changed jobs or left the workforce. Other approaches to identifying occupationally related illness are analysis of death certificate data (see chapter 2) and medical examination studies of workers known to have high exposures to hazardous agents.

Figures 5-1, 5-3, 5-4, 5-6, 5-8, and 5-10 show, for each commodity, the percent of illness conditions reported to MSHA by nature of condition. Heart attacks that occurred on the job are reported without regard to work-relatedness. Figures 5-2, 5-5, 5-7, 5-9, and 5-11 show rates by year during 1986-1995 for selected conditions. *Since there are many limitations on the accuracy of illness reporting, the frequencies and rates shown here should not be considered directly comparable across commodities.*

Figure 5-12 shows estimates for hearing loss by age among coal miners compared to a nonoccupationally noise-exposed population. These data come from a study by Franks [1996] of a group of audiograms obtained on coal miners by a commercial company. Using the NIOSH definition of hearing impairment, i.e., an average hearing threshold level for both ears that exceeds 25 dB at frequencies of 1,000, 2,000, 3,000 and 4,000 Hz, the figure shows that by age 30, more than 10% of miners suffer hearing impairment; by age 50, 90% of miners have hearing impairment. In contrast, only 10% of the nonoccupationally noise-exposed population suffer hearing impairment at age 51, and 50% of the nonoccupationally exposed population have hearing impairment at age 69.

Figure 5-13 shows a similar analysis of commercial audiograms on male metal/nonmetal miners [Franks 1997]. At age 20, approximately 2% have hearing impairment using the NIOSH definition of hearing impairment described above. This increases to 7% at age 30, 25% at age 40, and 49% at age 50. In contrast, only 9% of the nonoccupationally noise-exposed comparison population have hearing impairment at age 50. Franks' analysis showed a different pattern for female metal/nonmetal miners; they developed hearing loss at the same rate as would be expected for a non-noise-exposed female population.

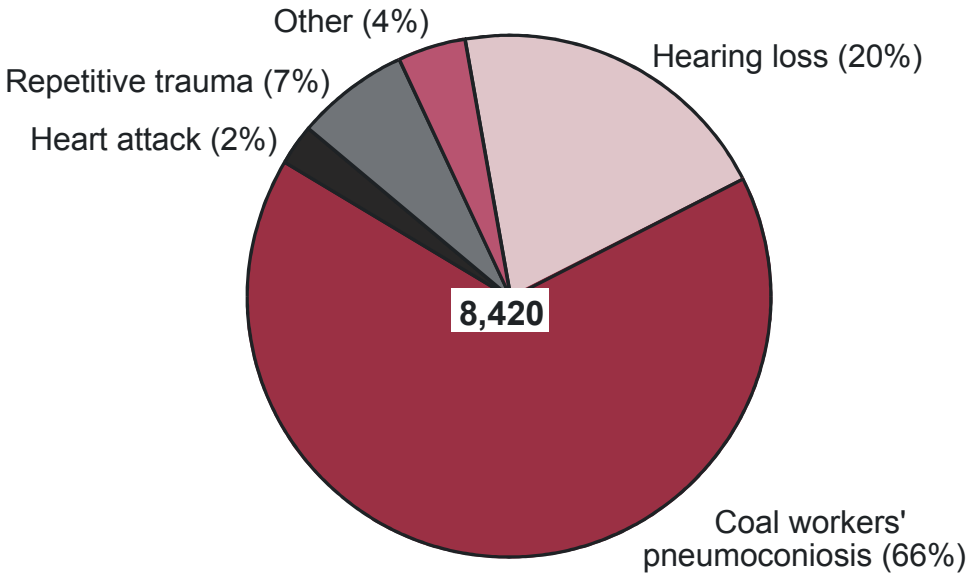


Figure 5-1.—Coal operators: percent of illness conditions reported by nature of condition, 1986-1995. (Source: MSHA data)

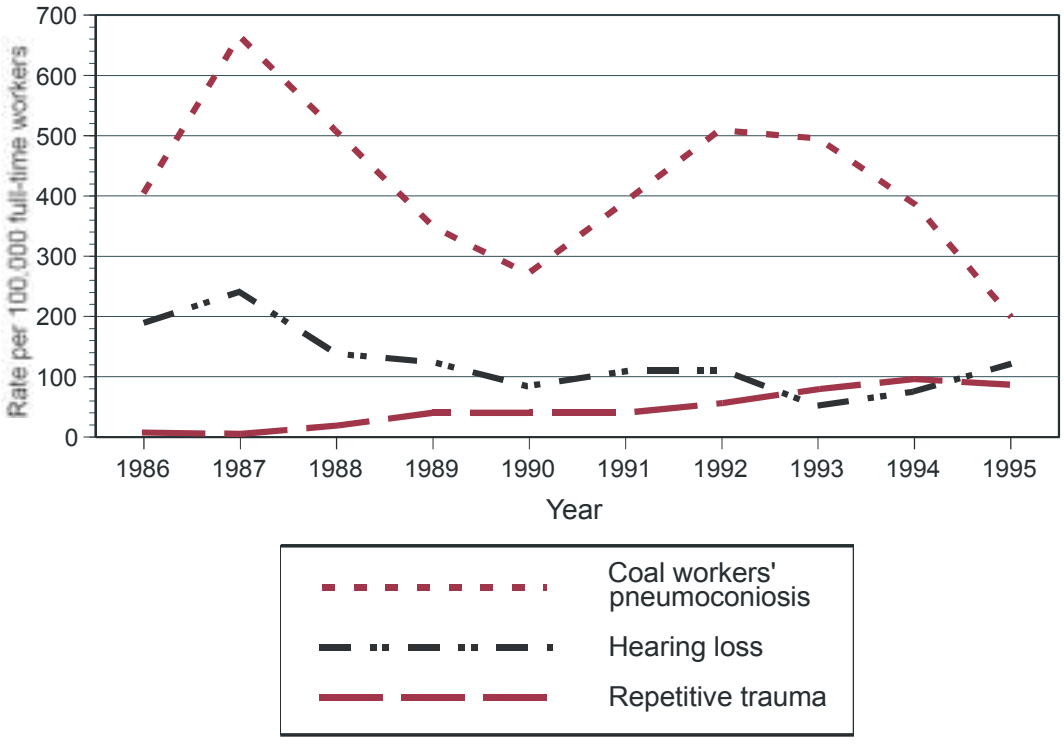


Figure 5-2.—Coal operators: rate of illness conditions reported (per 100,000 workers) for selected conditions by year, 1986-1995. (Source: MSHA data)

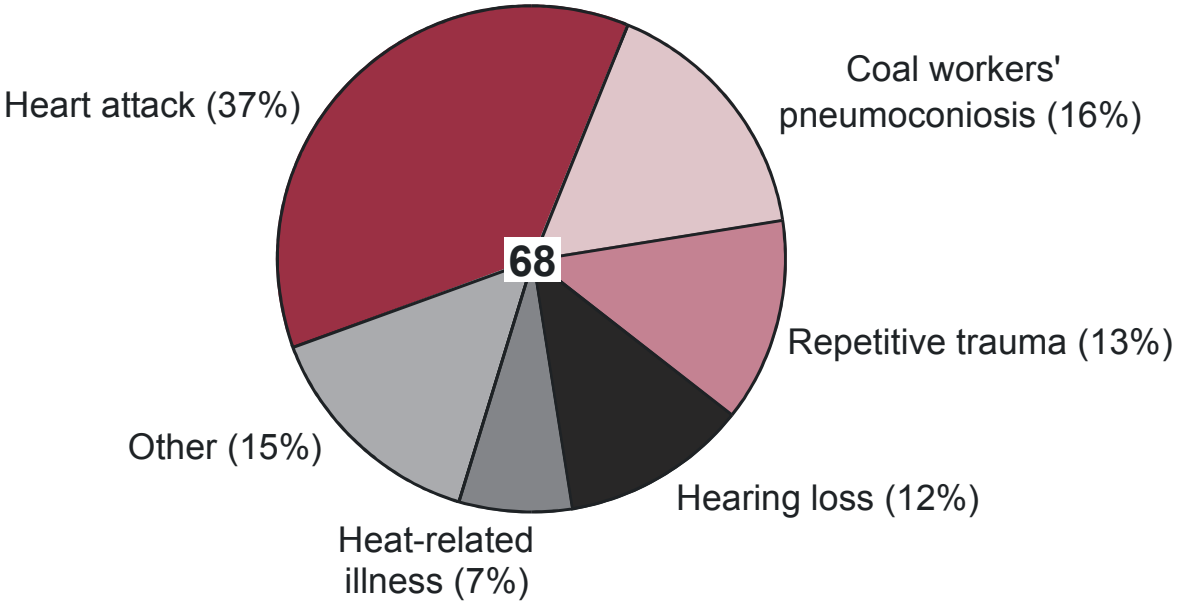


Figure 5-3.—Coal contractors: percent of illness conditions reported by nature of condition, 1986-1995. (Source: MSHA data)

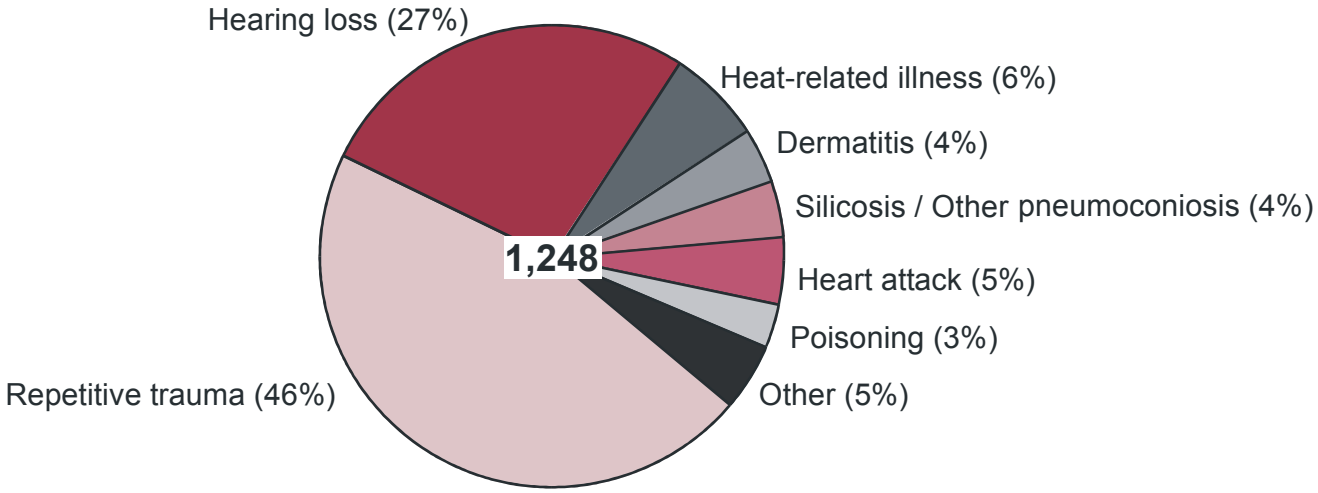


Figure 5-4.—Metal operators: percent of illness conditions reported by nature of condition, 1986-1995. (Source: MSHA data)

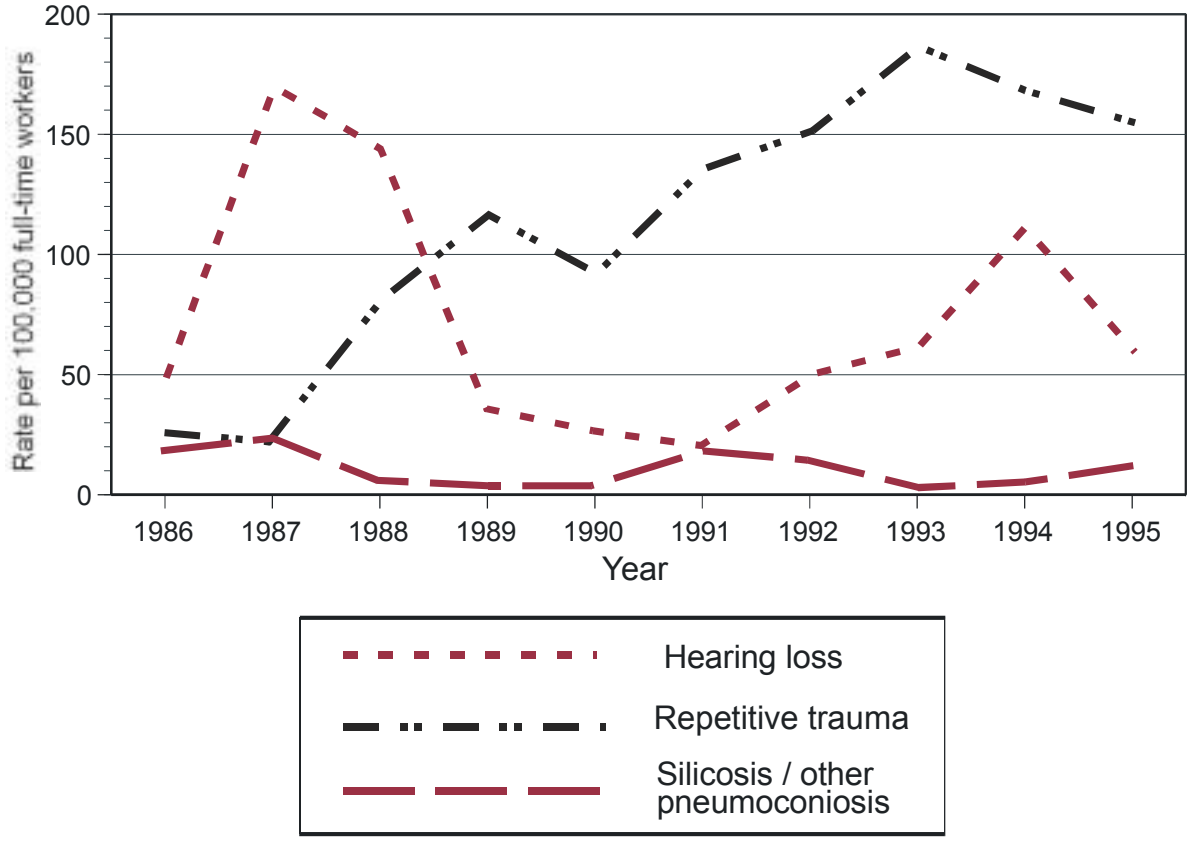


Figure 5-5.—Metal operators: rates of illness conditions reported (per 100,000 workers) for selected conditions by year, 1986-1995. (Source: MSHA data)

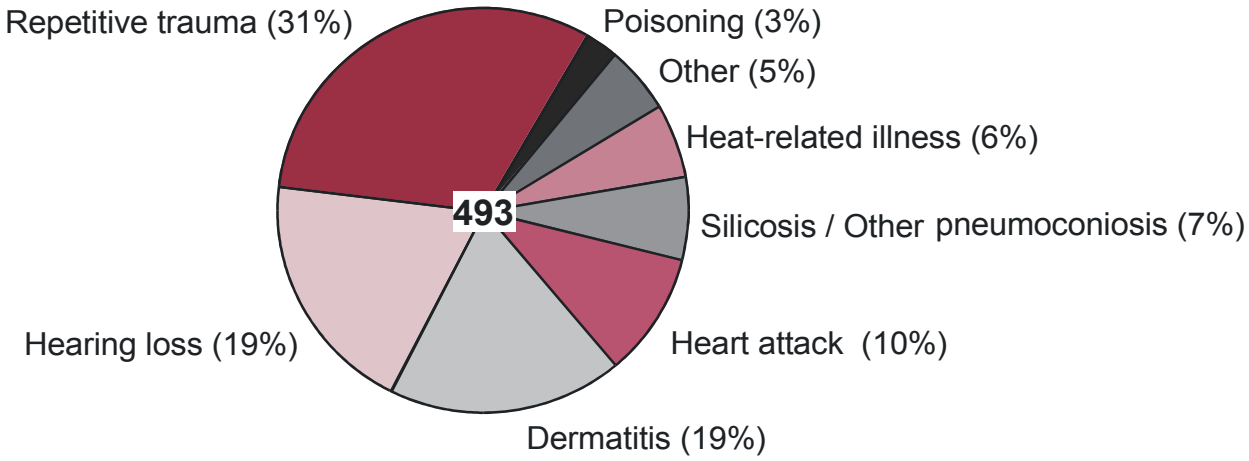


Figure 5-6.—Nonmetal operators: percent of illness conditions reported by nature of condition, 1986-1995. (Source: MSHA data)

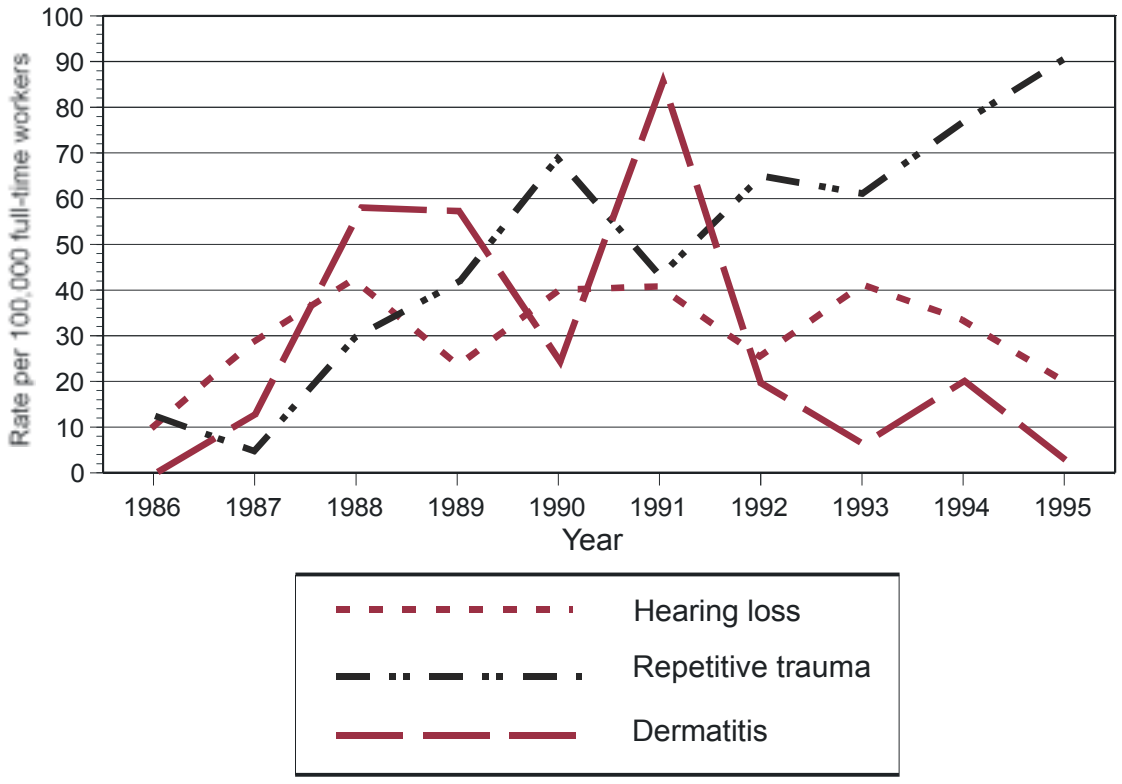


Figure 5-7.—Nonmetal operators: rates of illness conditions reported (per 100,000 workers) for selected conditions by year, 1986-1995. (Source: MSHA data)

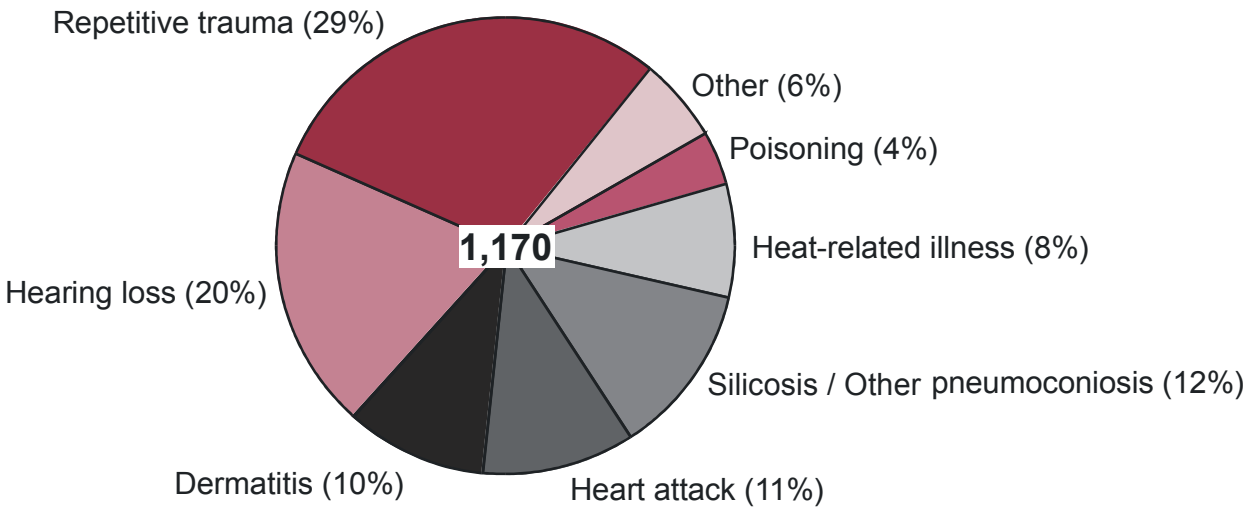


Figure 5-8.—Stone operators: percent of illness conditions reported by nature of condition, 1986-1995. (Source: MSHA data)

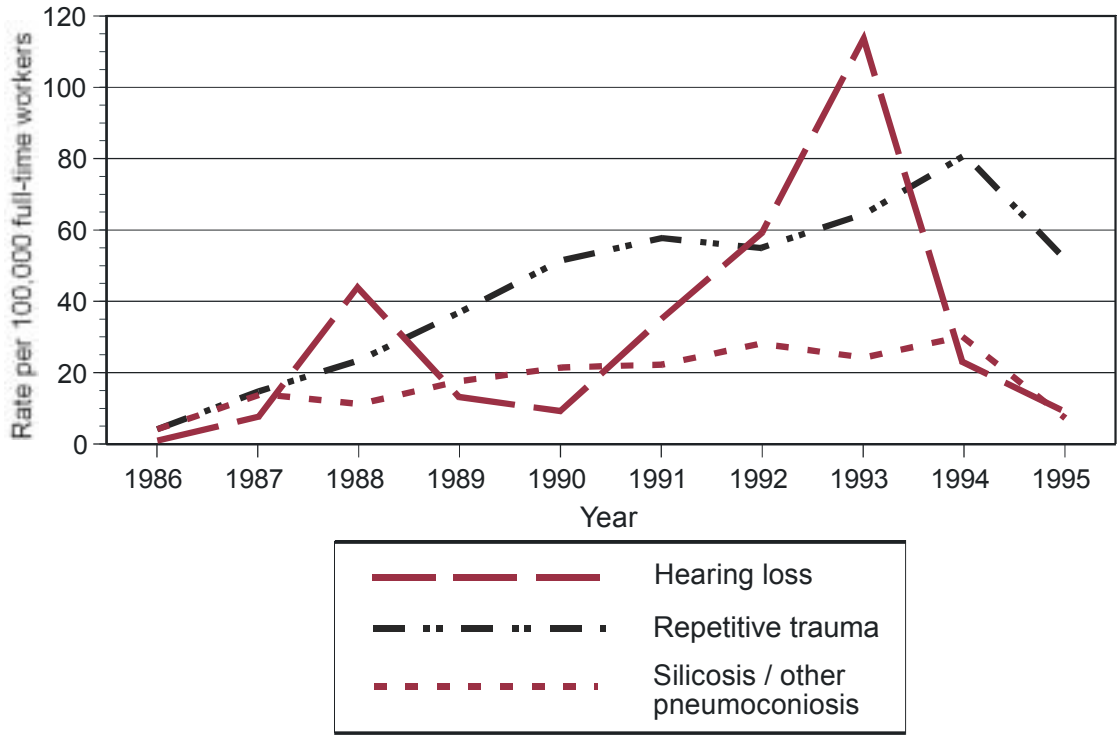


Figure 5-9.—Stone operators: rates of illness conditions reported (per 100,000 workers) for selected conditions by year, 1986-1995. (Source: MSHA data)

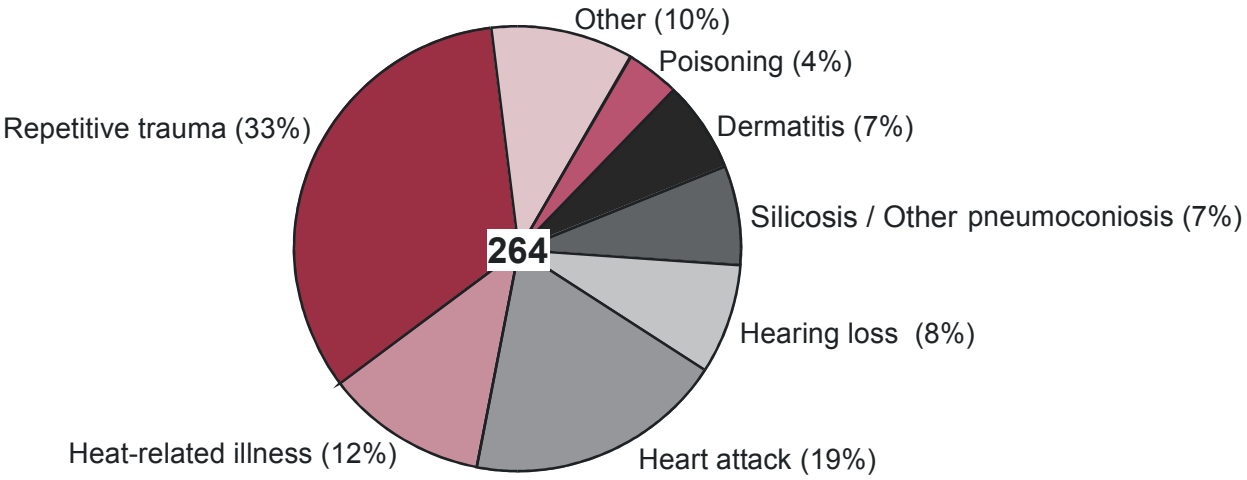


Figure 5-10.—Sand and gravel operators: percent of illness conditions reported by nature of condition, 1986-1995. (Source: MSHA data)

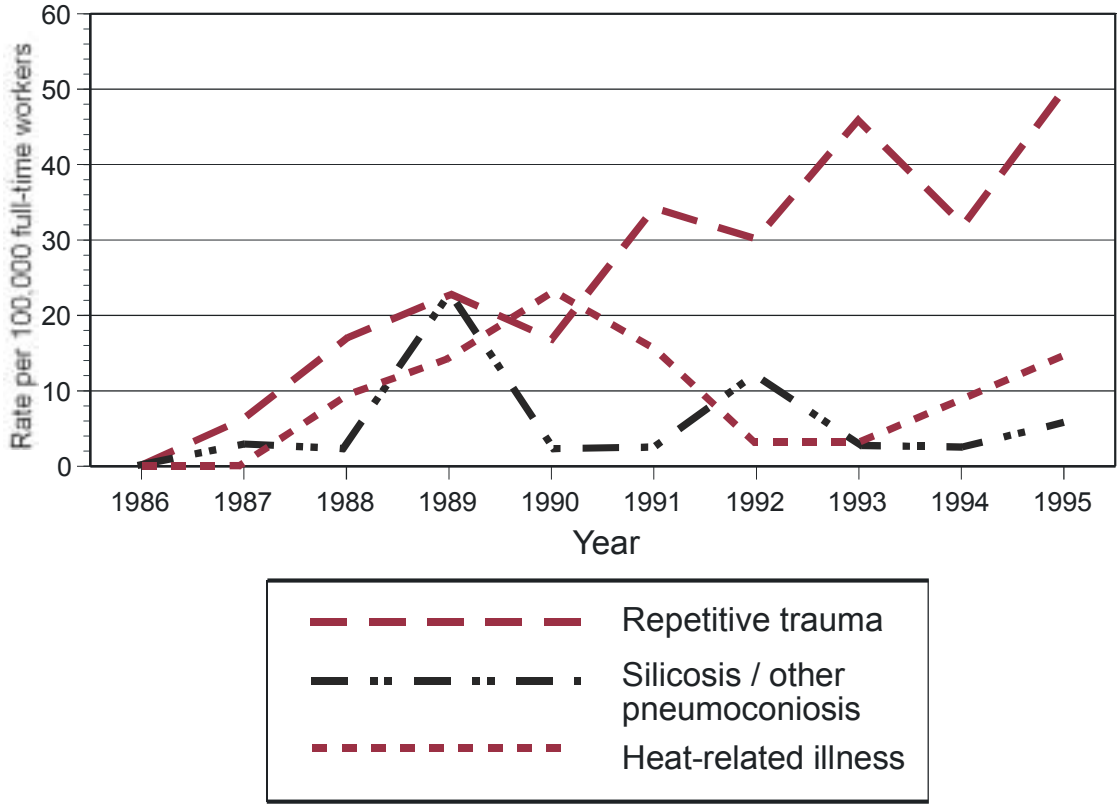


Figure 5-11.—Sand and gravel operators: rates of illness conditions reported (per 100,000 workers) for selected conditions by year, 1986-1995. (Source: MSHA data)

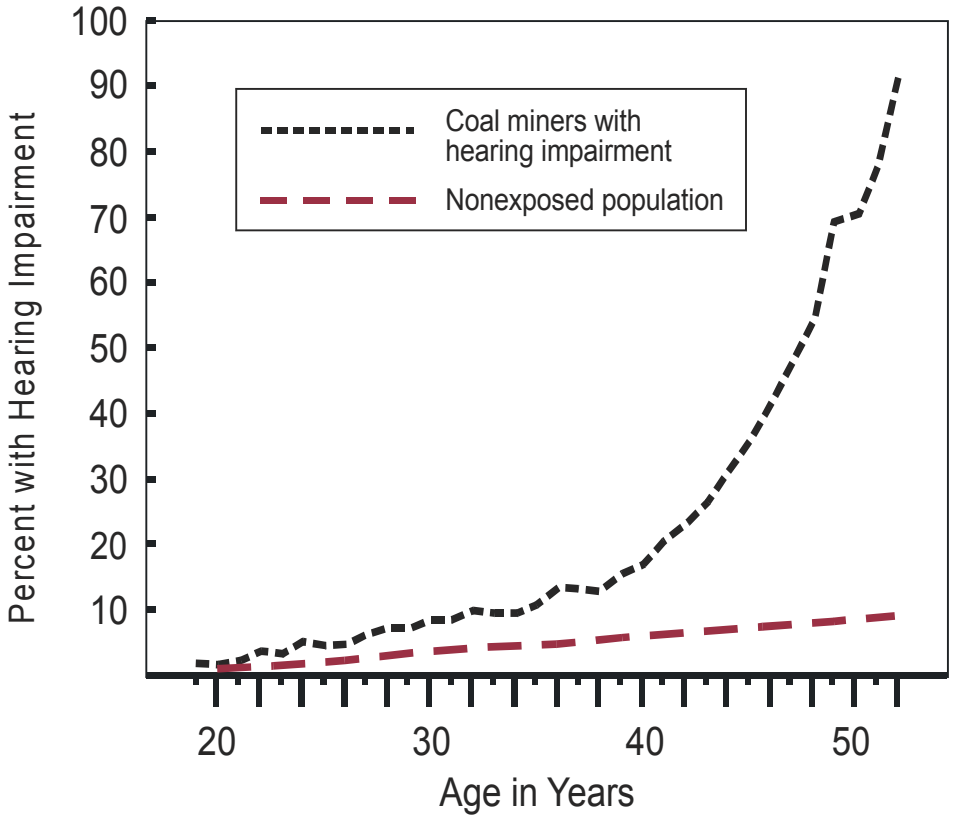


Figure 5-12.—Percent of coal miners with NIOSH-defined hearing impairment by age compared to the percent of the nonoccupationally noise-exposed population having hearing impairment as calculated from ISO-1999. (Source: Franks [1996])

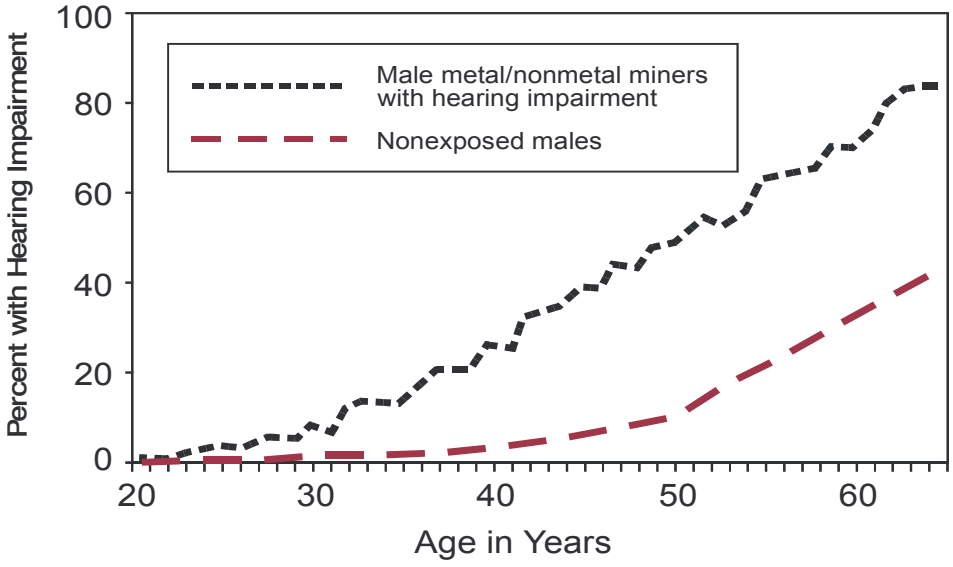


Figure 5-13.—Percent of male metal/nonmetal miners with NIOSH-defined hearing impairment by age compared to the percent of the nonoccupationally noise-exposed male population having hearing impairment as calculated from ISO-1999. (Source: Franks [1997])

CHAPTER 6. OCCUPATIONAL EXPOSURES

This chapter presents data on occupational exposures from several sources. Data from compliance samples obtained by MSHA inspectors are presented in table 6-1 for coal mine dust and silica dust, and in tables 6-2 through 6-6 for metal fumes. Since these samples were taken for compliance monitoring rather than as part of a survey of the industry, it is difficult to predict how well they indicate actual exposures for all mining operations.

In the coal industry, 7.8% of all respirable dust samples during 1986-1995 were above the permissible exposure limit (PEL). Of silica dust samples obtained during the 10-year period, 23.7% were above the PEL in coal, 16% in metal, 10.8% in nonmetal, 9.1% in stone, and 7.6% in sand and gravel. Of metal fume samples, silver samples showed the largest percentage above the PEL—approximately 48% of samples in both metal and nonmetal.

Tables 6-7 and 6-8 present data on noise exposures from the MSHA "dual threshold" survey, which was published in the *Federal Register* [61 Fed. Reg. 66347 (1996)] as part of a proposed rule change for occupational noise exposure in mining. This study examined a group of samples obtained during 1991-1995 and compared the percent of samples that were above two separate specified limits. The first limit was the current noise standard, a time-weighted average of 90 dBA, calculated to include only exposures at 90 dBA and above. The second limit was a time-weighted average of 85 dBA, calculated to include exposures at 80 dBA and above.

Tables 6-8 and 6-9 refer to musculoskeletal overload conditions examined in the National Occupational Health Survey of Mining (NOHSM) [NIOSH 1996]. Table 6-8 shows the operational definitions for each condition; table 6-9 shows the percentage of the workforce potentially exposed, by commodity. Across all commodities, a large proportion of workers were exposed to musculoskeletal overloads due to positioning of the neck and back; positioning and motion of the forearms, arms, and shoulders; heavy lifting; and positioning and movement of the lower limbs.

The recorded overloads were defined in the survey and did not exceed any NIOSH, MSHA, or OSHA guidelines for musculoskeletal overloads. Further information on this survey appears in appendix A.

Table 6-1.—Dust samples, 1986-1995. Number of samples, number and percent under permissible exposure limit (PEL), number and percent 1-2 times PEL, and number and percent 2 or more times PEL.

Sample type	Total samples	Samples under PEL		Samples > PEL and <2 × PEL		Samples >2 × PEL	
		No.	%	No.	%	No.	%
Coal respirable dust	194,682	179,584	92.2	11,751	6.0	3,347	1.7
Coal silica dust	49,044	37,434	76.3	7,213	14.7	4,397	9.0
Metal silica dust	9,044	7,593	84.0	873	9.7	578	6.4
Nonmetal silica dust	10,347	9,230	89.2	668	6.4	449	4.3
Stone silica dust	45,608	41,453	90.9	2,435	5.3	1,720	3.7
Sand and gravel silica dust	34,924	32,275	92.4	1,487	4.3	1,162	3.3

Source: Mine Safety and Health Administration data.

Table 6-2.—Metal industry: metal fume samples, 1986-1995. Number of samples, number and percent under permissible exposure limit (PEL), number and percent 1-2 times PEL, and number and percent 2 or more times PEL.

Fume type	Total samples	Samples < PEL		Samples > PEL and < 2 × PEL		Samples > 2 × PEL	
		Number	Percent			Number	Percent
Aluminum oxide	778	776	99.7	0	0.0	2	0.3
Arsenic	379	379	100.0	0	0.0	0	0.0
Beryllium	465	464	99.8	1	0.2	0	0.0
Cadmium oxide	495	494	99.8	0	0.0	1	0.2
Chromic acid/chromate	444	419	94.4	15	3.4	10	2.3
Cobalt	483	481	99.6	0	0.0	2	0.4
Copper	858	812	94.6	16	1.9	30	3.5
Fluoride	4	4	100.0	0	0.0	0	0.0
Iron oxide	1,038	1,008	97.1	13	1.3	17	1.6
Lead	797	757	95.0	22	2.8	18	2.3
Magnesium oxide	743	743	100.0	0	0.0	0	0.0
Manganese	793	793	100.0	0	0.0	0	0.0
Mercury	156	137	87.8	10	6.4	9	5.7
Molybdenum	453	452	99.8	1	0.2	0	0.0
Nickel	559	559	100.0	0	0.0	0	0.0
Silver	248	129	52.0	25	10.1	94	37.9
Titanium dioxide	602	601	99.8	1	0.2	0	0.0
Vanadium	512	511	99.8	1	0.2	0	0.0
Zinc oxide	698	697	99.9	1	0.1	0	0.0

Source: Mine Safety and Health Administration data.

Table 6-3.—Nonmetal industry: metal fume samples, 1986-1995. Number of samples, number and percent under permissible exposure limit (PEL), number and percent 1-2 times PEL, and number and percent 2 or more times PEL.

Fume type	Total	Samples < PEL		Samples > PEL and < 2 × PEL		Samples > 2 × PEL	
		Number	Percent	Number	Percent	Number	Percent
Aluminum oxide	2,460	2,454	99.8	2	0.1	4	0.2
Arsenic	1,309	1,309	100.0	0	0.0	0	0.0
Beryllium	1,550	1,547	99.8	3	0.2	0	0.0
Cadmium oxide	1,513	1,512	99.9	1	0.1	0	0.0
Chromic acid/chromate	1,467	1,297	88.4	65	4.4	105	7.2
Cobalt	1,609	1,607	99.9	2	0.1	0	0.0
Copper	2,453	2,378	96.9	29	1.2	46	1.9
Iron oxide	3,220	3,148	97.8	39	1.2	33	1.0
Lead	1,941	1,898	97.8	25	1.3	18	0.9
Magnesium oxide	2,555	2,555	100.0	0	0.0	0	0.0
Manganese	2,824	2,761	97.8	40	1.4	23	0.8
Mercury	113	94	83.2	10	8.8	9	8.0
Molybdenum	1,532	1,531	99.9	1	0.1	0	0.0
Nickel	1974	1,967	99.6	4	0.2	3	0.2
Silver	249	130	52.2	25	10.0	94	37.8
Tin oxide	3	3	100.0	0	0.0	0	0.0
Titanium dioxide	2,182	2,181	100.0	1	0.0	0	0.0
Vanadium	1,593	1,590	99.8	3	0.2	0	0.0
Zinc oxide	2,099	2,097	99.9	2	0.1	0	0.0

Source: Mine Safety and Health Administration data.

Table 6-4.—Stone industry: metal fume samples, 1986-1995. Number of samples, number and percent under permissible exposure limit (PEL), number and percent 1-2 times PEL, and number and percent 2 or more times PEL.

Fume type	Total samples	Samples < PEL		Samples > PEL and < 2 × PEL		Samples > 2 × PEL	
		Number	Percent	Number	Percent	Number	Percent
Aluminum oxide	1,164	1,162	99.8	1	0.1	1	0.1
Arsenic	538	538	100.0	0	0.0	0	0.0
Beryllium	666	666	100.0	0	0.0	0	0.0
Cadmium oxide	619	619	100.0	0	0.0	0	0.0
Chromic acid/chromate	795	667	83.9	44	5.5	84	10.6
Cobalt	704	704	100.0	0	0.0	0	0.0
Copper	1,065	1,044	98.0	9	0.8	12	1.1
Iron oxide	1,512	1,478	97.8	20	1.3	14	0.9
Lead	708	705	99.6	3	0.4	0	0.0
Magnesium oxide	1,254	1,254	100.0	0	0.0	0	0.0
Manganese	1,424	1,367	96.0	37	2.6	20	1.4
Mercury	6	6	100.0	0	0.0	0	0.0
Molybdenum	664	663	99.8	1	0.2	0	0.0
Nickel	967	961	99.4	3	0.3	3	0.3
Silver	1	1	100.0	0	0.0	0	0.0
Tin oxide	3	3	100.0	0	0.0	0	0.0
Titanium dioxide	1,085	1,084	99.9	1	0.1	0	0.0
Vanadium	688	686	99.7	2	0.3	0	0.0
Zinc oxide	950	948	99.8	2	0.2	0	0.0

Source: Mine Safety and Health Administration data.

Table 6-5.—Sand and gravel industry: metal fume samples, 1986-1995. Number of samples, number and percent under permissile exposure limit (PEL), number and percent 1-2 times PEL, and number and percent 2 or more times PEL.

Fume type	Total samples	Samples < PEL		Samples > PEL and < 2 × PEL		Samples > 2 × PEL	
		Number	Percent			Number	Percent
Aluminum	346	346	100.0	0	0.0	0	0.0
Arsenic	240	240	100.0	0	0.0	0	0.0
Beryllium	254	252	99.2	2	0.8	0	0.0
Cadmium oxide	250	250	100.0	0	0.0	0	0.0
Chromic acid/chromate	144	136	94.4	3	2.1	5	3.5
Cobalt	264	264	100.0	0	0.0	0	0.0
Copper	325	322	99.1	2	0.6	1	0.3
Iron oxide	432	427	98.8	3	0.7	2	0.5
Lead	271	271	100.0	0	0.0	0	0.0
Magnesium oxide	338	338	100.0	0	0.0	0	0.0
Manganese	387	386	99.7	1	0.3	0	0.0
Mercury	2	2	100.0	0	0.0	0	0.0
Molybdenum	247	247	100.0	0	0.0	0	0.0
Nickel	280	280	100.0	0	0.0	0	0.0
Titanium dioxide	321	321	100.0	0	0.0	0	0.0
Vanadium	250	250	100.0	0	0.0	0	0.0
Zinc oxide	303	303	100.0	0	0.0	0	0.0

Source: Mine Safety and Health Administration data.

Table 6-6.—Coal industry: MSHA "dual-threshold" study, 1991-1995. Number of samples by occupation, percent of samples over 90 dBA based on 90-dBA threshold for time-weighted average, and percent of samples over 85 dBA based on 80-dBA threshold for time-weighted average.

Occupation	Number of samples	% of samples over 90 dBA with time-weighted average based on 90-dBA threshold	% of samples over 85 dBA with time-weighted average based on 80-dBA threshold
Continuous miner helper	68	33.8	88.2
Continuous miner operator	262	49.6	96.2
Roof bolter operator (single)	234	21.8	85.5
Roof bolter operator (twin)	92	31.5	98.9
Shuttle car operator	260	13.5	78.5
Scoop car operator	94	18.1	74.5
Cutting machine operator	22	36.4	63.6
Headgate operator	20	40.0	100.0
Longwall operator	34	70.6	100.0
Jack setter (longwall)	25	32.0	68.0
Cleaning plant operator	107	36.4	77.6
Bulldozer operator	225	48.9	94.2
Front-end loader operator	244	16.0	76.6
Highwall drill operator	83	21.7	77.1
Refuse/backfill truck driver	162	13.6	78.4
Coal truck driver	28	17.9	64.3

Table 6-7.—Metal/nonmetal industry: MSHA "dual-threshold" study, 1991-1994. Number of samples by occupation, percent of samples over 90 dBA based on 90-dBA threshold for time-weighted average, and percent of samples over 85 dBA based on 80-dBA threshold for time-weighted average.

Occupation	Number of samples	% of samples over 90 dBA with time-weighted average based on 90-dBA threshold	% of samples over 85 dBA with time-weighted average based on 80-dBA threshold
Front-end loader operator	12,812	12.9	67.7
Truck driver	6,216	13.1	73.7
Crusher operator	5,357	19.9	65.1
Bulldozer operator	1,440	50.7	86.5
Bagger	1,308	10.2	65.0
Sizing/washing plant operator	1,246	13.2	59.7
Dredge/barge attendant	1,124	27.2	78.7
Clean-up person	927	19.3	71.3
Dry screen operator	871	11.7	57.6
Utility worker	846	12.4	60.6
Mechanic	761	3.8	43.9
Supervisors/administrators	730	9.0	32.2
Laborer	642	17.1	65.7
Dragline operator	583	34.0	82.5
Backhoe operator	546	8.4	52.6
Dryer/kiln operator	517	10.5	55.5
Rotary drill operator (electric/hydraulic)	543	39.6	83.1
Rotary drill operator (pneumatic)	489	64.4	89.0

Table 6-8.—Operational definitions for musculoskeletal overload conditions in the National Occupational Health Survey of Mining (NOHSM).

Awkward lifting	Lifting above head level, or lifting while twisting, or lifting while reaching excessively.
Heavy lifting	Lifting greater than 50 lb unaided.
Frequent lifting	Lifting an object heavier than 25 lb, 5 or more times per minute.
Fingers and hands	Forceful finger actions (except grasping with the whole hand), grasping with wet or poorly fitting gloves, tool handles that end in the central part of the palm.
Wrist movement	Forceful movements or finger manipulations with wrist bent, using repeated wrist motions, or clothes-wringing motion.
Forearms, arms, and shoulders	Elbows unsupported and/or abducted, or forearms resting on sharp edges, or working with hands above the shoulders, or tossing motions at extremes of range of motion.
Neck and/or back	Bent forward, or bent to the side, or hyperextended, or twisted neck and back.
Lower limb movement	Kneeling, or squatting (bearing the body weight on the knee, flexed to an acute angle), or crawling on hands and knees.
Sitting	Sitting in a cramped position, or with feet dangling, or without low back support, or in a seat tilted forward or to one side.
Standing	Standing without movement for 4 or more min or operating foot pedals while standing, or standing in a restricted space for 2 hr or more without sitting or leaning.
Prone or supine	Lying flat on back, or lying on abdomen, or lying on one side supported by one hip and one shoulder or elbow.

Table 6-9.—Percent of workers potentially exposed to musculoskeletal overload conditions by condition and commodity, National Occupational Health Survey of Mining (NOHSM), 1984-1989.

	Percentage of workforce potentially exposed				
Musculoskeletal overload condition	Coal	Metal	Nonmetal	Stone	Sand and Gravel
Awkward lifting	22	29	16	17	19
Heavy lifting	41	37	24	30	21
Frequent lifting	9	3	8	8	5
Fingers and hands	24	35	24	14	12
Wrist movement	21	29	16	12	11
Forearms, arms, and shoulders	44	39	30	25	23
Neck and/or back	42	50	35	34	30
Lower limb movement	31	26	15	16	13
Sitting	19	10	8	9	11
Standing	<1	2	3	1	4
Prone or supine	10	5	5	4	3

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APPENDIX A. SOURCES OF DATA

National Occupational Mortality Surveillance (NOMS) System

The National Occupational Mortality Surveillance (NOMS) System was developed by NIOSH in collaboration with the National Center for Health Statistics and the National Cancer Institute. NOMS is based on mortality data from the National Vital Statistics system, with the addition of occupation and industry information coded by selected State health departments. The NOMS data include all conditions listed on the death certificate, both underlying and contributing, for each decedent. Additional data include age, race, sex, State, and county of residence at the time of death.

The number of States included in NOMS varies by year. A total of 28 States have contributed data since 1979. The States included in the analyses presented in this report and the years for which those States provided data are: Alaska (1987-88), Colorado (1985-1993), Georgia (1985-1993), Hawaii (1993), Idaho (1988-1993), Indiana (1986-1993), Kansas (1985-1993), Kentucky (1985-1993), Maine (1985-1993), Missouri (1985-1986), Nebraska (1985), Nevada (1985-1993), New Hampshire (1985-1993), New Jersey (1988-1993), New Mexico (1986-1993), New York (1985-1987; New York City excluded in 1985) North Carolina (1987-1993), Ohio (1985-1993), Oklahoma (1985-1993), Pennsylvania (1985-1991), Rhode Island (1985-1993), South Carolina (1985-1993), Tennessee (1985-1988), Utah (1985-1993), Vermont (1986-1993), Washington (1990-1992), West Virginia (1988-1993), and Wisconsin (1985-1993).

Census of Fatal Occupational Injuries (CFOI)

The Census of Fatal Occupational Injuries (CFOI) was developed by the U.S. Bureau of Labor Statistics (BLS) to compile comprehensive and timely information on fatal work injuries occurring in the 50 States and the District of Columbia. Because no single source of information is capable of identifying all fatalities that occur at work, the CFOI system cross-references nearly 25 different sources of information to compile a complete roster. These sources include (but are not limited to) death certificates, workers' compensation files, motor vehicle reports, the news media, and data collected by State and Federal agencies such as the Occupational Safety and Health Administration, the Mine Safety and Health Administration, and the Employment Standards Administration. To ensure an accurate count of fatal occupational injuries, the program requires that for each case, the injury's work-relatedness be substantiated by at least two independent sources, or a source document and a followup questionnaire.

Data collection is a cooperative process between BLS and the States. The States are responsible for data collection and coding, while BLS concatenates the national database and provides for additional verification of fatality reports that have only one source of information. A work-related case in CFOI is required to meet the following criteria: "The dece-dent must have been employed (working for pay, compensa-tion, or profit or in the family business) at the time of the event and engaged in a legal work activity or present at the site of the incident as a job requirement" [U.S. Bureau of Labor Statistics 1995]. Fatalities that resulted from motor vehicle crashes while driving as part of work and from violent acts at work such as homicide and suicide are included in the data.

Current Population Survey (CPS)

The Current Population Survey (CPS) is a monthly survey of approximately 60,000 households. The CPS is a probability sample, and the survey is conducted by the U.S. Bureau of the Census for the U.S. Bureau of Labor Statistics. The survey collects information about each employed member of a household, including age and sex, class of worker, and industry and occupation. Data on number of hours worked the week prior to the survey are also collected.

The criteria for reporting number of hours worked changed in 1994. For this reason, rate calculations in this report that use the CPS denominator are based on the number of employees in a particular subgroup, rather than on the number of hours worked.

Mine and Employment Data: MSHA

These data include all work hours reportable to MSHA. Mine operators must report quarterly all hours worked at any operation where any individual worked during any day in that calendar quarter. Independent contractors must report quarterly hours related to the following activities:

- Mine development, including shaft and slope sinking
- Construction/reconstruction of mine facilities including building/rebuilding preparation plants and mining equipment, and building additions to existing facilities
- Demolition of mine facilities
- Construction of dams
- Excavation or earth-moving activities involving mobile equipment
- Installation of equipment, such as crushers and mills
- Equipment service or repair on mine property for a period exceeding 5 consecutive days at a particular mine

Accident, Injury, and Illness Data: MSHA

The MSHA accident, injury, and illness database includes all occupational injuries and illnesses reportable to MSHA. For mine operators, reportable occupational injuries include any onsite injury to an employee for which medical treatment is administered or that results in death or loss of consciousness, inability to perform all job duties on any day after the injury, restriction of work or motion, lost workdays, temporary assignment to other duties on any day after the injury, transfer to another job, or termination. First-aid injuries are not reportable provided that there are no lost workdays, restricted work activity, or transfer because of the injury. Reportable occupational illnesses include any illness or disease of an employee that *may* have resulted from work or exposure at a mine or for which an award of compensation is made. Independent contractors working on mine property must report injuries and illnesses in the activities for which they are required to report work hours (listed above).

1986 Mining Industry Population Survey (MIPS): U.S. Bureau of Mines

This survey obtained information on job title or occupation, principal equipment operated, work location at the mine, experience at present job, experience at present company, total mining experience, job-related training during the preceding 2 years, age, sex, race, and education.

The MIPS covered all workers employed in anthracite coal (SIC 111), bituminous coal (SIC 121), metal (SIC 101-106, 109, 281), stone (SIC 141, 142, 324, 327), sand and gravel (SIC 144), and nonmetal (SIC 131, 145, 147, 149, 289, 299) mining during March through September 1986. The survey design used a two-stage stratified random sampling. The primary sampling units (first stage) were the mine establishments; the secondary sampling units were the employees within each sampling unit. The characteristics used to stratify the primary units were the industry (anthracite coal, bituminous coal, metal, stone, nonmetal), mine type (underground, surface, plant or mill), employment size class (1-19, 20-49, 50-99, 100-249, 500-999, 1,000 and above), and status code (active, intermittent). The sampling frame used was the 1985 preliminary address and employment file maintained by MSHA.

Respirable Coal Mine Dust Data: MSHA

These data were obtained from MSHA and represent respirable coal mine dust levels measured by MSHA inspectors at surface and underground mines beginning in 1970. The data include the sample collection date, dust concentration, occupation associated with the sample, an MSHA designator as to the validity of the sample, and the mine at which the sample was obtained.

The MSHA respirable coal mine dust samples are obtained by drawing mine air through a filter at the rate of 2 L/min, with a cyclone used to extract nonrespirable particles prior to the filter. The dust weight collected on the filter is multiplied by 1.38 to complete the conversion to Mines Research Establishment (MRE) units. The "MRE" designation indicates that measurements obtained by MSHA were converted so that they would be equivalent to those obtained with an instrument on which the U.K. standards have been based (Isleworth type 113A gravimetric dust sampler).

Respirable Coal Mine Quartz Dust Data: MSHA

These data were obtained from MSHA and represent respirable quartz levels derived from respirable coal mine dust samples collected by MSHA inspectors at surface and underground coal mines beginning in 1982. The data include the sampling date, sampling time, initial and final weights, percent quartz, production level during sampling, the occupation associated with the sample, and the mine at which the sample was obtained.

National Occupational Health Survey of Mining (NOHSM): NIOSH

The National Occupational Health Survey of Mining was designed by NIOSH to characterize health-related agents found at U.S. mines. A sample of mines representing 66 different mineral commodities was surveyed during 1984-1989. A total of 491 mines employing 59,734 miners were surveyed during that period, including 431 metal/nonmetal mines and 60 coal mines. The mines surveyed were selected from a total of 2,131 mines that employed 297,322 miners. Although NIOSH surveyed only a representative sample of mines in each mineral commodity, the data were projected over all of the mines in each of those mineral commodities. Each mine's survey included three phases: questionnaire, chemical inventory, and worksite visit. During the worksite visit, surveyors (1) made observations of the numbers of potential exposures (by sex and occupation of workers) to chemical and physical agents; musculoskeletal overload conditions; welding, brazing, and soldering processes; and abrasive grinding processes; (2) obtained samples of bulk dust from selected worksites within each mine; and (3) made observations of the controls associated with the potential exposures.

APPENDIX B. METHODS

Injury and Illness Rates: CFOI Data

Numerator data for these rates came from CFOI data files; denominator data came from the Current Population Survey (CPS). To compute the fatality rates for each year, the total number of deaths that occurred during the year in each industry sector was divided by the number of employees in that sector. For presentation purposes, fatal injury rates were then multiplied by 100,000 to obtain the rate per 100,000 workers.

Injury and Illness Rates: MSHA Data

Numerator data for the rates came from MSHA accident and injury file. Denominator data came from the MSHA employment files, and for the variable occupation only, from the Mining Industry Population Survey. To compute the average annual rates during 1986-1995, the total number of deaths during the 10-year period was divided by the total number of hours worked during 1986-95 to obtain the injury rate per hour worked for 1986-1995. Average annual rates for subunits were calculated as the total number of deaths in a specified subunit during 1986-1995, divided by the number of hours worked in the subunit during 1986-1995, to obtain the injury rate per hour worked for each subunit. Yearly rates were computed as the total number of deaths in the specified year divided by the total hours worked in that year to obtain the injury rate per hour worked for that year. All injury and illness rates per hour worked were then multiplied by 2,000, the typical number of hours worked in 1 year by an employee working a 40-hr week, to obtain the rate per full-time equivalent worker. For presentation purposes, fatal injury rates and illness rates were then multiplied by 100,000 to obtain the rate per 100,000 full-time equivalent workers; nonfatal injury rates were multiplied by 100 to obtain the rate per 100 full-time equivalent workers. Occupations were grouped into BOC categories. Data on occupation were available for 1986 only. Estimates on the incidence of injury by occupational group for the entire 10-year period were made by determining the proportion of workers in each occupational group in the 1986 data and applying these proportions to the data on hours worked for all years. This type of extrapolation assumes that the proportion of workers in each occupational group was constant over the 10-year period.

Proportionate Mortality Ratio

The proportionate mortality ratio (PMR) is defined as the observed number of deaths with the condition of interest (mentioned as underlying or contributing cause) in a specified occupation or industry divided by the expected number of deaths caused by that condition. The expected number of deaths is the total number of deaths in the occupation or industry of interest multiplied by the proportion, defined as the number of cause-specific deaths for the condition of interest divided by the total number of deaths in the population. The PMRs in the report have been internally adjusted for age (i.e., 15-34, 35-54, 55-74, and 75 years and over) and for race. Confidence intervals were calculated assuming a Poisson distribution of the data.

Exposure Data Selection

MSHA respirable coal mine dust samples selected for analysis were restricted to those samples that met *all three* of the following criteria:

(1) Samples obtained in the 50 States or Washington, DC (the U.S. Virgin Islands and Puerto Rico were excluded);
(2) Samples designated by MSHA as valid; and
(3) Samples coded as "designated occupation," "non-designated occupation," or "designated work position" with valid occupation codes, or "designated area" other than "intake air."

MSHA coal mine quartz samples selected for analysis are those samples that met all five of the following criteria:

(1) Samples obtained in the 50 States or Washington, DC (the U.S. Virgin Islands and Puerto Rico were excluded);
(2) Samples designated by MSHA as valid;
(3) Samples with sampling time greater than 0;
(4) Samples with quartz concentration greater than 0; and
(5) Samples coded as "designated occupation," "non-designated occupation," or "designated work position" with valid occupation codes, or "designated area" other than "intake air."

Since December 1972, the PEL for respirable coal mine dust has been 2 mg/m^3 MRE unless the quartz concentration at the particular mine has been found in excess of 5%. MSHA has no specific PEL for quartz in coal mines. MSHA's respirable coal mine quartz data are based on its analysis of respirable coal mine dust samples. However, for the period covered by this report, inspector samples with less than 0.45-mg net-weight gain were not analyzed for quartz. When the quartz content has been found to be in excess of 5% in dust from a particular mine, the 2 mg/m^3 MRE PEL is reduced based on the following formula:

$$\text{PEL} = \frac{10\ \text{mg/m}^3\ \text{MRE}}{\%\ \text{quartz}}$$

Using this formula, one sees that at 100% quartz the PEL would be 0.1 mg/m^3 MRE.

APPENDIX C. WORK ACTIVITY CATEGORIES USED FOR INJURIES IN MSHA ACCIDENT, INJURY, AND ILLNESS DATABASE

Vehicular and Transportation Operations	Conveyer belt (not riding) Forklift Haulage truck Jitney Load-haul-dump Locomotive (air trammer) Mantrip Shuttle car Utility truck Ride equipment Get on or off equipment, machines, etc. Spot cars, drop cars Couple/uncouple mine car/tractor/jeep, etc. Barge, boat, dredge Sprag/block/chock mine cars or other track equipment
Using or Operating Tools/Machinery	Drill face/rib/side/down/rise (not roof bolter) Auger (surface mine) Auger (underground mine) Bulldozer Continuous miner Cutting machine Front-end loader Grader Hoist Loading machine Longwall, shear, plow Mucking machine Power shovel/dragline/backhoe Shortwall Slusher Remove or position hydraulic jack Sand fill (backfilling stopes with sand, gob, etc.) Grinding Impactor Mill equipment Blow gun to blow out drilled holes Hand tools (powered) Bar down face, rib, or side, etc. Double jack Hand tools (not powered) Environmental tests/checks Welding and cutting Advance longwall roof support Coal tipple/crusher/cleaning plant/breaker Rock dust machine Scraper (rig), cans, etc.

	Surface equipment, NEC
	Underground equipment, NEC
	Roof bolter, drilling
	Roof bolter, inserting bolt
	Roof bolter, NEC
Constructing, Repairing, Cleaning	Hang or reposition tubing/pipe/rope/wire, etc.
	Lay or repair railroad track/roadbed, switching tracks, etc.
	Moving equipment
	Set brattice
	Set/remove/relocate props
	Surface construction, NEC
	Timbering (includes lagging and cribbing)
	Ventilation (maintenance/installation)
	Chute, pull or free
	Electrical maintenance/repair
	Machine maintenance/repair
	Rerail equipment
	Skip pocket (pull/free)
	Inspect equipment
	Brush floor
	Clean up
	Cement work; gunite crew, etc.
	Investigate, enter, or work in bins, tanks, etc.
	Wetting down working place
Protective Service Activities	Accident recovery (equipment and workers)
Materials Handling Operations	Handling supplies or material, load/unload
	Working with solvents
	Working with chemicals
	Working with noxious materials, NEC
	Hand load, hand shoveling/mucking
	Handling coal, rock, waste, or ore
	Handling explosives
	Handling timber
	Move power cable
Bodily Movement	Climb in raise/shaft/manway
	Climb scaffolds/ladders/platforms, headframes/derrick/towers
	Climb on piled material/ore/rock/ timber/stone
	Walking/running
	Crawling/kneeling
Other, NEC	Office and laboratory work
	Blasting; shoot coal
	Caging; operate elevator, manlift; etc.
	Change house, bathing, changing clothes, etc.

	Cross-over (conveyer) Escaping a hazard Horseplay Idle (eat lunch, coffee break, etc.) Observe operations Supervise Travel to and from work location Other, NEC
Activity, Unspecified	Unknown

APPENDIX D. U.S. BUREAU OF THE CENSUS OCCUPATION DIVISIONS

U.S. Bureau of the Census Grouping of Job Titles for Coal Operators

Source: U.S. Bureau of the Census [1982]

Executive, Administrative, and Managerial	Mine Foreman/Mine Manager/Mine Owner Fire Boss/Preshift Examiner Inspector Superintendent Union Representative Safety Representative Training Specialist
Professional Specialty	Surveyor Engineer—Electrical, Ventilation, Mining Safety Director Education Specialist
Technicians and Support	Transit Man
Administrative Support	Dispatcher Weighman Timekeeper/Clerk/Office Help
Protective Service	Watchman/Guard
Mechanics and Repairers	Mechanic/Repairman Belt Vulcanizer Oiler/Greaser Master Mechanic Maintenance Foreman
Construction Trades	Electrician Stoping Builder/Ventilation/Mason Wireman/Communications Man/Repairman Brattice Man Mason Carpenter Master Electrician
Extractive Occupations	Rock Duster Shotfirer/Shooter/Blaster Timberman/Propman/Jacksetter Trainee Drill Operator Continuous Miner Operator/Mole Cutting Machine Operator/Ripper Headgate Operator Jacksetter/Longwall/Advanceman Longwall Shear Operator/Plow Operator

	Rockman/Hang-Up Man/Chute
	Roof Bolter/Rock Bolter
	Roof Bolter Mounted
	Section Foreman/Shift Boss
	Tailgate Operator
	Utility Man
	Clean-Up Man
	Labor Foreman/Bullgang Foreman
	Belt Cleaner
	Rock Driller
	Rock Machine Operator
	Miner, NEC/Quarry Worker
	Auger Operator
	Highwall Drill Operator
	Lampman
	Assistant Mine Foreman/Assistant Mine Manager
	Outside Foreman
Precision Production Occupations	Pumper
	Shopman/Machinist
	Battery Station Operator
	Fan Attendant
	Boom Operator
	Machinist
	Preparation Plant Foreman/Mill Foreman
Machine Operators, Assemblers, and Inspectors	Coal Sampler
	Welder/Cement Man
	Welder
	Cleaning Plant Operator/Media Plant Operator/Boney Preparation Plant Operator/Crusher Worker
	Driver Operator
	Fine Coal Plant Operator
	Scalper/Screen Operator
	Dust Sampler/Laboratory Technician
Motor Vehicle and Rail Transport	Brakeman/Rope Rider/Snapper
	Motorman/Swamper/Switchman
	Driver/Tractor Operator/Jeep Driver
	Brakeman/Trip Rider
	Truck Driver
	Refuse Truck Driver
	Water Truck Operator
	Yard Engineer Operator/Fireman
Material Moving Equipment Operators	Belt/Conveyor Man
	Scoop Tram-Load Haul Operator
	Haul Loader/Hand Trammer
	Loading Machine Operator/St. Joe Shovel Operator
	Shuttle Car Operator/Ram Car Operator

	Stall Driver
	Scoop Car Operator/Unitrac Operator
	Hoistman/Engineer
	Transportation Trainee
	Skip Tender
	Loader Head Operator/Roscoe Operator
	Buggy Pusher
	Dump Operator
	Shuttle Car Operator
	Power Shovel Operator/Pitman
	Bulldozer Operator/Tractor/Heavy Equipment
	Barge Attendant/Boat/Dredge
	Car Dropper
	Grader Operator/Roadgrader Operator
	Crane Operator/Dragline/Backhoe
	Highlift Operator/Front-End Loader
	Rotary Bucket Excavator Operator
	Silo Operator
	Stripping Shovel Operator
	Tipple Operator/Topman/Binman
Handlers, Equipment Cleaners, Helpers, and Laborers	Electrician Helper
	Mechanic Helper
	Supplyman

U.S. Bureau of the Census Grouping of Job Titles for Metal/Nonmetal Operators

Source: U.S. Bureau of the Census [1982]

Executive, Administrative, and Managerial	Mine Foreman/Mine Manager/Mine Owner Fire Boss/Preshift Examiner Inspector Superintendent Union Representative Safety Representative Training Specialist
Professional Specialty	Surveyor Engineer—Electrical, Ventilation, Mining Safety Director Education Specialist
Technicians and Support	Transit Man
Administrative Support	Dispatcher Weighman Timekeeper/Clerk/Office Help
Protective Service	Watchman/Guard
Mechanics and Repairers	Mechanic/Repairman Oiler/Greaser Master Mechanic Maintenance Foreman
Construction Trades	Electrician Stoping Builder/Ventilation/Mason Brattice Man Wireman/Communications Man/Repairman Carpenter Master Electrician
Extractive Occupations	Shotfirer/Shooter/Blaster Timberman/Propman/Jacksetter Trainee Slusher Operator Drill Operator Continuous Miner Operator/Mole Cutting Machine Operator/Ripper Headgate Operator Jacksetter/Longwall/Advanceman Longwall Shear Operator/Plow Operator Rockman/Hang-Up Man/Chute Roof Bolter/Rock Bolter Roof Bolter Mounted Section Foreman/Shift Boss Tailgate Operator

	Utility Man
	Stope Miner
	Drift Miner
	Raise Miner
	Miner, NEC
	Contract Miner
	Rock Duster
	Clean-Up Man
	Labor Foreman/Bullgang Foreman
	Rock Driller
	Rock Machine Operator
	Surface Miner
	Claw Operator
	Drill Operator
	Miner, NEC/Quarry Worker
	Auger Operator
	Highwall Drill Operator
	Lampman
	Stone Finishing/Sizing Personnel
	Dimension Stone Cutter/Polisher
	Assistant Mine Foreman/Assistant Mine Manager
	Outside Foreman
Precision Production Occupations	Pumper
	Shopman/Machinist
	Battery Station Operator
	Fan Attendant
	Boom Operator
	Machinist
	Preparation Plant Foreman/Mill Foreman
Machine Operators, Assemblers, and Inspectors	Metal/Nonmetal Sampler
	Welder/Cement Man
	Welder
	Cleaning Plant Operator/Media Operator/ Boney Preparation Plant Operator/Crusher Operator
	Driver Operator
	Scalper/Screen Operator
	Stone Finishing/Sizing Personnel
	Dimension Stone Cutter/Polisher
	Dust Sampler/Laboratory Technician
Motor Vehicle and Rail Transport	Truck Driver
	Brakeman/Rope Rider/Snapper
	Motorman/Swamper/Switchman
	Refuse Truck Driver
	Water Truck Operator
	Yard Engineer Operator/Fireman

Material Moving Equipment Operators	Belt/Conveyor Man Bobcat Operator Scoop Tram-Load Haul Operator Mucking Machine Operator Hand Loader/Hand Trammer Loading Machine Operator/Joy Loader Operator/St. Joe Shovel Operator Shuttle Car Operator/Ram Car Scoop Car Operator/Unitrac Operator Crane Operator/Dragline Operator/Backhoe Operator Front-End Loader Operator Dump Operator Load-Haul-Dump Operator/Gizmo Operator Grader Operator Hoistman/Engineer Transportation Trainee Skip Tender Loader Head Operator/Roscoe Operator Power Shovel Operator/Pitman Bulldozer Operator/Tractor Operator/Heavy Equipment Operator Barge Attendant/Boat Operator/Dredge Operator Car Dropper Grader Operator/Roadgrader Operator Highlift Operator/Front-End Loader Rotary Bucket Excavator Operator Forklift Operator Silo Operator Tipple Operator/Topman/Binman
Handlers, Equipment Cleaners, Helpers, and Laborers	Electrician Helper Mechanic Helper Supplyman Laborer/Faceman/Move-Up Man/Pumpman Grizzly Man/Car Dump Operator Drill Helper Continuous Miner Helper Cutting Machine Helper Loading Machine Helper Roof Bolter Helper/Rock Helper Laborer/Mucking Machine Operator/ Pipeman/Ginman Trackman Cager Supplyman/Supply Truck Driver/ Warehouseman Laborer/Utility Man/Pumper Rodman Cager/Cage Attendant/Aerial Chainman Auger Helper Hoist Operator Helper Highwall Drill Helper

APPENDIX E. MSHA ACCIDENT CLASSIFICATIONS

Source: [MSHA 1997]

Electrical.—Accidents in which the electric current is most directly responsible for the resulting accident.

Entrapment.—Accidents involving entrapment of persons.

Exploding Vessels Under Pressure.—Accidents involved with bursting of air hoses, air tanks, hydraulic lines, hydraulic hoses, standpipes, etc., due to internal pressure.

Explosives and Breaking Agents.—Accidents involving the detonation of manufactured explosives; includes Airdox or Cardox.

Falling, Rolling, or Sliding Rock or Material of Any Kind.—Accidents caused directly by falling material other than materials from the roof or face. Or, if material was set in motion by machinery, by haulage, by hand tools, or while being handled or disturbed, etc., the force that set the material in motion determines the classification. For example, where a rock was pushed over a highwall by a bulldozer and the rock hit another rock that hit and injured a worker—the accident is classified as machinery; machinery (a bulldozer) most directly caused the resulting accident.

Fall of Face, Rib, Pillar, Side, or Highwall (from in place).—Accidents in this classification include falls of material while barring down or placing props; also, pressure bumps and bursts. Not included are accidents in which the motion of machinery or haulage equipment caused the fall either directly or by knocking out support.

Fall of Roof, Back, or Brow (from in place).—Underground only - Accidents that include falls while barring down or placing props; also, pressure bumps and bursts. Not included are accidents in which the motion of machinery or haulage equipment caused the fall either directly or by knocking out support.

Fire.—Accidents related to uncontrolled burning of material or mineral in the mine environment. Not included are fires initiated by electricity or by explosion of gas or dust.

Handling Material.—Accidents related to handling packaged or loose material while lifting, pulling, pushing, or shoveling.

Hand tools.—Accidents related to nonpowered tools.

Nonpowered Haulage.—Accidents related to the motion of nonpowered haulage equipment. Included are accidents involving wheelbarrows, manually pushed mine cars, timber trucks, etc.

Powered Haulage.—Accidents related to the motion of powered haulage equipment. Included are accidents involving conveyors, front-end loaders, forklifts, shuttle cars, load-haul-dump units, locomotives, railroad cars, haulage trucks, pickups, automobiles, and personnel carriers.

Hoisting.—Accidents involving cages, skips, ore buckets, and elevators. The accident results from the action, motion, or failure of the hoisting equipment or mechanism. Included are equipment such as cranes and derricks only when used in shaft sinking; also, suspended work platforms in shafts. Not included is equipment such as chain hoists, come-alongs, and winches.

Ignition or Explosion of Gas or Dust.—Accidents resulting as a consequence of the ignition or explosion of gas or dust.

Impoundment.—Accidents caused by an unstable condition or failure of an impoundment, refuse pile, or culm bank requiring emergency preventative action or evacuation of an area.

Inundation.—Accidents caused by inundation of a surface or underground mine by a liquid (or semisolid) or a gas.

Machinery.—Accidents related to the motion of machinery. Included are all electric and air-powered tools and mining machinery such as drills, tuggers, winches, slushers, draglines, power shovels, loaders, and compressors.

Slip or Fall of Person (from an elevation or on the same level).—Accidents include slips or falls while getting on or off machinery and haulage equipment that is not moving, and slips or falls while servicing or repairing equipment or machinery.

Stepping or Kneeling on Object.—Accidents are classified in this category only where the object stepped or kneeled on contributed most directly to the accident.

Striking or Bumping.—This classification is restricted to those accidents in which an individual, while moving about, strikes or bumps an object, but is not handling material, using hand tools, or operating equipment.

Other.—Accidents not elsewhere classified.