Characteristics of the top five most frequent injuries in United States mining operations, 2003-2007

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Introduction

Research in the field of mining safety and health in the United States plays an important part in protecting the lives of miners. The National Institute for Occupational Safety and Health (NIOSH) Mining Program conducts surveillance, studies and developmental work aimed at improving the safety and health of miners. With recent reviews of the Mining Program by the National Academy of Sciences and the Mining Program response (NIOSH, 2008), the importance of setting goals, conducting high quality engineering and scientific research and evaluating the outputs, outcomes, relevance and impacts of these projects has been reemphasized. Surveillance of reported injuries is a first step in deciding on research directions and in designing specific projects. Groups of injuries often share features and attributes that suggest common causes and may respond to similar preventive efforts. Identifying groups of injuries also serves to prioritize intervention efforts.

The Mine Safety and Health Administration (MSHA) Accident and Injury database (MSHA, 2008) provides individual case reports of mining injuries, illnesses and certain no-injury accidents (events such as roof falls that stop mine production or miners' activities for more than one hour). This database is an indispensable resource for researchers and stakeholders needing information on the statistics of these events. From an epidemiological perspective, research projects target groups of miners at risk due to specific patterns of work, equipment, mine settings and the management of safety and health in their mines. Incidence rates are provided by the MSHA data for selected variables, such as surface/underground location, standard industrial classification and state. While incidence rates are the preferred measure for all variables, denominators are not typically available; for example, to more clearly understand the data about injury by occupational type, it would be necessary to conduct demographic surveys. A current survey of the demographics of the mining industry should be complete by 2010, which will allow incidence rates to be developed for a number of variables such as age, occupation and experience. This survey will provide the first update of its kind since the first survey was conducted in 1985.

This report describes an alternative method of analyzing and presenting MSHA data for the purpose of identifying high-cost, high-severity injuries and illnesses. Researchers at the NIOSH Spokane Research Laboratory (SRL) developed programs to find the top five most frequent accident classes, natures of injury, types of accidents and other selected variables from the MSHA database. Studying these variables gives a cross-sectional snapshot of the most frequent groups of injuries within a commodity, regional group or time period, and allows researchers to quickly understand developing patterns for new research projects. The primary benefit of this approach is to

Table 1 — Top five MSHA accident/injury classifications by mine location, all commodities, 2003-2007.

Mine location	AI class	Number	Percent
Underground	Handling material	5,216	29.3%
	Machinery	2,674	15.0%
	Slip or fall of person	2,563	14.4%
	Powered haulage	1,943	10.9%
	Fall of roof (underground)	1,919	10.8%
	Other	3,458	19.5%
	Total	17,773	100.0%
Surface	Handling material	12,575	35.6%
	Slip or fall of person	8,032	22.7%
	Hand tools	4,971	14.1%
	Machinery	4,059	11.5%
	Powered haulage	2,903	8.2%
	Other	2,791	7.9%
	Total	35,331	100.0%

facilitate the setting of priorities, although at the expense of not listing all levels for every variable. For those variables with many levels and "other" levels of 50% or more, the next group of five levels are listed in the text. For those wishing to see complete lists of injuries by frequency, the MSHA database is available for downloading (MSHA, 2008).

Methods

Results were tabulated for the period 2003 through 2007. Cases included all fatal and nonfatal injuries to mine operator employees through degree 6 (injuries without death, days away, or restricted activity). Illness cases (degree 7) will be reported in a separate study, as will cases involving contractors. Software used in producing this report included the Statistical Analysis System (SAS, version 9.1) and Microsoft Office Excel 2003.

Results

Table 1 shows the top five most frequent accidents/ injuries by MSHA classification. Injuries incurred while handling materials far outnumbered other major classes of injury. At 34% of all underground and surface injuries, this class includes injuries resulting from overexertion and most often involves the back. This class encompasses tasks related to maintenance and machine repair, in addition to materials handling. The "slip or fall of person" class ranks in the top 3 both underground and on the surface. The notably higher percentage of this injury class in surface mining (23% vs. 14% underground) may be a reflection of the much larger scale of many surface operations, with larger equipment and powered haulage machinery. Opportunities for slips and falls range from mounting and dismounting machinery and vehicles to walking and running.

Table 2 shows the relative rankings of injuries by mine subunit. Strip mines and quarries reported almost 50% of the total injuries, while mills and preparation plants were nearly comparable, with 42%. Mines with underground operations may also have miners working at surface shops and yards physically located at the mine site, and these subunits contributed about 4% of total injuries.

For the period studied, underground bituminous coal mine injuries far outnumbered injuries in other standard industrial classifications (SICs) with underground operations (Table 3). The relative risk of injury for underground bituminous coal operations was 2.8 times the injury risk for surface coal operations. Coal operations are, therefore, a major reason

Table 2 — Most frequent injuries by mine subunit, separated by mine location, all commodities, 2003-2007.

Mine Location	Subunit	Number	Percent
Underground	Underground operations	17,773	100.0%
Surface	Strip, quarry	17,505	49.5%
	Mill, preparation plant	14,872	42.1%
	Surface-at-underground	1,449	4.1%
	Dredge	1,101	3.1%
	Independent shops	215	0.6%
	Other	189	0.5%
	Total	35,331	100.0%

Table 3 — Top five injury rates by standard industrial classifications (SIC), separated by mine location, all commodities, 2003-2007.

Mine location	SIC	Number	Percent	Hours worked	Incidence rate*
Underground	Coal, bituminous	15,566	87.6%	392,118,045	7.9
	Gold (lode & placer)	422	2.4%	15,691,669	5.4
	Platinum group	318	1.8%	11,354,591	5.6
	Limestone (crushed & broken)	314	1.8%	16,664,987	3.8
	Trona	267	1.5%	7,820,590	6.8
	Other	886	5.0%	36,663,439	4.8
	Total	17,773	100.0%	480,313,321	7.4
Surface	Coal, bituminous	6,283	17.8%	444,976,372	2.8
	Limestone (crushed & broken)	5,919	16.8%	305,643,310	3.9
	Sand & gravel	5,816	16.5%	336,722,659	3.5
	Cement	3,772	10.7%	125,049,504	6.0
	Copper ore	1,297	3.7%	76,617,799	3.4
	Other	12,244	34.7%	618,776,257	4.0
	Total	35,331	100.0%	1,907,785,901	3.7

*Injuries per 100 full-time equivalent miners per year

why the overall relative risk of underground mines is double that of surface mines (with an injury incidence rate of 7.4 vs. 3.7—Table 3). Underground mining in the remaining top five SICs, gold (lode and placer), limestone (crushed and broken), platinum group and trona, has an average incidence rate of 5.1 injuries per 100 FTEs per year; compared with the corresponding surface rate of 4.0, this shows that coal mining displays the greatest contrast between underground and surface risks.

Parts of body injured are shown in Table 4. With percentages very similar in both surface and underground settings, injuries to fingers, backs and knees account for 40% of all injuries. Eye injuries in surface mining may be a reflection of wind and dust conditions.

The ages of injured miners (Table 5) display a few differ-

Table 4 — Top five parts of body injured by mine location, all commodities, 2003-2007.

Mine location	Part of body	Number	Percent
Underground	Finger(s)	2,875	16.2%
	Back	2,533	14.3%
	Knee	1,631	9.2%
	Multiple parts	1,108	6.2%
	Hand	1,054	5.9%
	Other	8,572	48.2%
	Total	17,773	100.0%
Surface	Finger(s)	6,178	17.5%
	Back	5,549	15.7%
	Knee	2,634	7.5%
	Eyes	2,508	7.1%
	Shoulder(s)	2,032	5.8%
	Other	16,430	46.5%
	Total	35,331	100.0%

Table 5 — Top five age groups for number of injuries by mine location, all commodities, 2003-2007.

Mine location	Age group	Number	Percent
Underground	50-54	2,762	15.5%
	45-49	2,704	15.2%
	30-34	2,451	13.8%
	25-29	2,378	13.4%
	35-39	1,926	10.8%
	Other	5,552	31.2%
	Total	17,773	100.0%
Surface	45-49	5,090	14.4%
	40-44	4,597	13.0%
	50-54	4,530	12.8%
	35-39	4,337	12.3%
	30-34	4,175	11.8%
	Other	12,602	35.7%
	Total	35,331	100.0%

ences with respect to surface or underground locations, but the differences are small. The youngest age group shown in the top five, 25-29-year-olds, account for 13% of injuries underground, but less than 11% of surface injuries. In general, percentages by age group are similar. While these findings are helpful, true differences in risk for one age group vs. another requires a denominator, such as age group-specific employment or hours worked.

Table 6 shows injuries by miner activity-when-injured. Consistent with the MSHA classification (Table 1), handling supplies or materials accounts for nearly 17% of all injuries, both underground and on the surface. Injuries while doing machine maintenance and repair show potentially the biggest difference (9% underground vs. 20% surface). The "other" category for underground includes, in descending order of frequency, activities such as moving a power cable, operating a roof bolter/inserting bolt, getting on or off equipment, operating a mantrip, and operating a roof bolter/drilling, among others.

The source of injury (Table 7) is dependent on underground or surface location, with metal items not elsewhere classified (NEC) (pipe, wire, nails) showing a large difference (14% of all surface injuries vs. 8% underground). The injuries resulting from falls of roof (Table 1) often involve caving rock, coal or ore, as shown in Table 7. In underground mines, the 52.6% of sources of injury labeled "other" include broken rock, coal and ore; underground mining machines; conductors; belt conveyors and knives. In surface mines, the 54.5% of source of injury labeled "other" include metal-NEC; ground; metal covers, guards; broken rock, coal and ore and surface mining machines.

The incident rates for the nature of injury received are roughly the same for underground vs. surface injuries (Table 8), but the percentages reveal differences of interest. Fractures,

Table 6 — Top five activities-when-injured by mine location, all commodities, 2003-2007.

Mine location	Activity	Number	Percent
Underground	Handling supplies or materials	2,729	15.4%
	Hand tools (not powered)	1,742	9.8%
	Machine maintenance and repair	1,617	9.1%
	Walking/running	1,579	8.9%
	Roof bolter, NEC	1,200	6.8%
	Other	8,906	50.1%
	Total	17,773	100.0%
Surface	Machine maintenance and repair	6,877	19.5%
	Handling supplies or materials	6,188	17.5%
	Hand tools (not powered)	4,683	13.3%
	Get on or off equipment	3,316	9.4%
	Walking/running	3,031	8.6%
	Other	11,236	31.8%
	Total	35,331	100.0%

Table 7 — Top five sources of injury by mine location, all commodities, 2003-2007.

Mine location	Source	Number	Percent
Underground	Caving rock, coal, ore	2,926	16.5%
	Mine floor, bottom	2,018	11.4%
	Metal-NEC	1,496	8.4%
	Mine jeep	1,001	5.6%
	Metal covers, guards	988	5.6%
	Other	9,344	52.6%
	Total	17,773	100.0%
Surface	Metal-NEC	5,002	14.2%
	Ground	3,788	10.7%
	Metal covers, guards	2,749	7.8%
	Broken rock, coal, ore	2,573	7.3%
	Surface mining machines	1,954	5.5%
	Other	19,265	54.5%
	Total	35,331	100.0%

in particular, account for 17% of all underground injuries, but account for only about 12% of all surface injuries.

As mentioned above, differences in rates of injury between occupational groups (job titles) are best studied when denominator data is available, so that occupation-specific rates can be compared. The current approach (Table 9) shows several differences, such as injuries to laborers underground (18%) vs. laborers on the surface (14%), that may be due primarily to differences in the numbers employed. Mechanics or repairmen also show a large difference, with 7% of all underground injuries vs. 23% of all surface injuries. However, for prioritizing research and preventive efforts, this table identifies specific occupations that merit attention.

The geographic distribution of mines in the U.S. is a familiar feature of the industry. Table 10 ranks the states by number of injuries by mine location, along with the injury incidence rates for those states. The predominance of coal mines likely explains the high number of injuries at underground mines in the eastern states, as the mostly non-coal mines of western states are surface mines. Note that the states are ranked in order of the number of injuries; the incidence rates are more indicative of the averages risks for that state. Note also that, because every state has many sand and gravel operations (the most common type of surface mine), the five states most frequently reporting surface mine injuries account for only 28.4% of those injuries. The 71.6% of injuries at surface mines in "other" states include, in descending order, Kentucky, Nevada, Indiana, Alabama and Florida, among others.

Commodity-specific results

In the second phase of the analysis, the MSHA data were first stratified into commodity groups (coal and metal- non-metal).

Table 8 — The nature of the top five most frequent injuries by mine location, all commodities, 2003-2007.

Mine location	Nature	Number	Percent
Underground	Sprain, strain	5,886	33.1%
	Cut, laceration	4,504	25.3%
	Fracture	2,955	16.6%
	Contusion, bruise	1,851	10.4%
	Unclassified	564	3.2%
	Other	2,013	11.3%
	Total	17,773	100.0%
Surface	Sprain, strain	12,381	35.0%
	Cut, laceration	7,856	22.2%
	Fracture	4,388	12.4%
	Contusion, bruise	2,751	7.8%
	Unclassified	1,472	4.2%
	Other	6,483	18.3%
	Total	35,331	100.0%

Table 9 — Numbers of injuries by mine occupation, separated by mine location, all commodities, 2003-2007.

Mine location	Occupation	Number	Percent
Underground	Roof, rock bolter	3,402	19.1%
	Laborer	3,121	17.6%
	Mechanic, repairman	1,231	6.9%
	Shuttle car operator	1,056	5.9%
	Continuous miner operator	1,019	5.7%
	Other	7,944	44.7%
	Total	17,773	100.0%
Surface	Mechanic, repairman	8,191	23.2%
	Cleaning plant or media operator	5,795	16.4%
	Laborer	4,839	13.7%
	Bulldozer operator	2,445	6.9%
	Truck driver	2,215	6.3%
	Other	11,846	33.5%
	Total	35,331	100.0%

For each group injuries were rank-ordered by frequency to obtain the commodity-specific top fives. Summarized below for coal and the remaining non-coal cases are the major highlights of this analysis.

Coal. "Handling material" injuries top the list of accident-injury classes for both underground and surface mines, followed by machinery and slip or fall of person classes (Table 11). For underground coal, a persistent problem is injuries resulting from falls of roof. For the remaining top five classes of injury, very similar percentages were observed for machinery (12% to 15%) and for powered haulage (about 11% in both underground and surface mines). Controlling very powerful machines and vehicles is a challenge in all mines. The combination of machinery and powered haulage classes accounts for 23% to 26% of all injuries in coal mining. Slip or fall of person injuries were not as equally distributed. They accounted for 14% of underground cases, but almost 28% of surface cases.

Table 12 shows the numbers and percentages of injury for subunits within overall coal mining operations. In surface coal mines, the strip/quarry subunits reported almost 58% of injuries for the period. Mills and preparation plants were next, with 24%, while the surface-at-underground accounted for 14%.

Occupation differentiates coal and metal-nonmetal mines, in that roof and rock bolters rank highest in number of injuries

Table 10 — Numbers of mining injuries by state, separated by mine location, all commodities, 2003-2007.

Mine location	State	Number	Percent	Hours worked	Incidence rate*
Underground	West Virginia	4,467	25.1%	113,369,640	7.9
	Kentucky	4,260	24.0%	103,021,856	8.3
	Pennsylvania	1,647	9.3%	43,876,893	7.5
	Illinois	1,590	8.9%	31,573,614	10.1
	Alabama	1,058	6.0%	23,979,827	8.8
	Other	4,751	26.7%	164,108,981	5.8
	Total	17,773	100.0%	479,930,811	7.4
Surface	Texas	2,291	6.5%	147,067,723	3.1
	Pennsylvania	2,180	6.2%	96,603,002	4.5
	California	2,072	5.9%	84,920,997	4.9
	Arizona	1,850	5.2%	93,556,566	4.0
	West Virginia	1,651	4.7%	102,102,594	3.2
	Other	25,287	71.6%	1,383,327,819	3.7
	Total	35,331	100.0%	1,907,578,701	3.7

*Injuries per 100 full-time equivalent miners per year

Table 11 — Top five MSHA accident/injury classifications by mine location, coal mines, 2003-2007.

Mine location	AI class	Number	Percent
Underground	Handling material	4,568	29.3%
	Machinery	2,361	15.2%
	Slip or fall of person	2,181	14.0%
	Fall of roof (underground only)	1,774	11.4%
	Powered haulage	1,682	10.8%
	Other	3,017	19.4%
	Total	15,583	100.0%
Surface	Handling material	1,945	29.8%
	Slip or fall of person	1,815	27.8%
	Machinery	789	12.1%
	Hand tools	771	11.8%
	Powered haulage	714	10.9%
	Other	499	7.6%
	Total	6,533	100.0%

Table 12 — Subunits most frequently reporting injuries, separated by mine location, coal mines, 2003-2007.

Mine location	Subunit	Number	Percent
Underground	Underground operations	15,583	100.0%
Surface	Strip, quarry	3,761	57.6%
	Mill, preparation plant	1,576	24.1%
	Surface-at-underground	943	14.4%
	Auger (coal)	130	2.0%
	Independent shops	86	1.3%
	Other	37	0.6%
	Total	6,533	100.0%

Table 13 — Top five occupations reporting injury, separated by mine location, coal mines, 2003-2007.

Mine location	Occupation	Number	Percent
Underground	Roof, rock bolter	3,361	21.6%
	Laborer	2,757	17.7%
	Shuttle car operator	1,040	6.7%
	Continuous miner operator	987	6.3%
	Belt, conveyor man	930	6.0%
	Other	6,508	41.8%
	Total	15,583	100.0%
Surface	Mechanic, repairman	1,508	23.1%
	Laborer	873	13.4%
	Bulldozer operator	808	12.4%
	Truck driver	540	8.3%
	Cleaning plant or media operator	410	6.3%
	Other	2,394	36.6%
	Total	6,533	100.0%

Table 14 — Top five activities-when-injured by mine location, coal mines, 2003-2007.

Mine location	Activity	Number	Percent
Underground	Handling supplies or materials	2,391	15.3%
	Using hand tools (not powered)	1,532	9.8%
	Walking/running	1,414	9.1%
	Performing machine maintenance and repair	1,380	8.9%
	Roof bolter, NEC	1,148	7.4%
	Other	7,718	49.5%
	Total	15,583	100.0%
Surface	Performing machine maintenance and repair	1,190	18.2%
	Handling supplies or materials	1,009	15.4%
	Getting on or off equipment	969	14.8%
	Using hand tools (not powered)	711	10.9%
	Walking/running	513	7.9%
	Other	2,141	32.8%
	Total	6,533	100.0%

in underground coal mines (22%, Table 13), but rank much lower in number of injuries in underground metal-nonmetal mines (less than 3%, data not shown). In surface coal mines, mechanics and repairmen top the list of occupations reporting injuries, consistent with the activity table (Table 14), where machine maintenance and repair is the most frequent activity resulting in injury.

Table 14 shows the top five activities-when-injured for coal mines. Handling supplies or materials are a significant contributor to injury totals, both underground and on the surface. Machine maintenance and repair injuries are twice as frequent on the surface as underground, primarily owing to the increased role of maintenance in large-scale surface operations.

Table 15 shows the numbers and rates for the bituminous vs. anthracite segments of the coal industry. These results confirm the results of earlier surveillance reports (NIOSH, 2004) in showing that the incidence rate for underground coal mining (7.9 injuries per 100 miners per year) is more than double the rate for surface coal mining (2.9 injuries per 100 miners per year). The anthracite coal segment is small compared to bituminous, accounting about 1% of employees in the coal mining industry.

Numbers and rates of injury occurrence in coal mines by state is shown in Table 16. West Virginia, Kentucky and Pennsylvania account for 66% of all underground coal mining injuries, in keeping with the large number of coal mines in these states. However, while Illinois ranks 4th for number of underground coal mining injuries, it has the highest injury incidence rate, with 10.3 injuries per 100 miners per year. In surface coal mining, the same three states top the list (Table 16). Wyoming appears in the list of top five states reporting injuries at surface coal mines, but it has the lowest incidence rate, 1.5 injuries per 100 miners per year.

Metal-nonmetal. As in coal mines, metal-nonmetal mines also have a significant problem with machinery and powered haulage. Nineteen percent of all injuries in surface mines, and 26% in underground mines, involved either machinery or powered haulage.

Table 17 shows the top five accident-injury classes for metal-nonmetal mines. Injuries in these mines fall into many of the same classes as the injuries occurring in coal mines (Table 11), with an exception for handling material injuries. While underground metal-nonmetal mines report about 30% as handling material injuries, metal-nonmetal surface mines report 37% (Table 17).

Table 18 shows most frequent subunits reporting injuries. Compared to coal mines, with 71% of all injuries occurring

Table 15 — Most frequent standard industrial classifications (SIC) by mine location, coal mines, 2003-2007.

Mine location	SIC	Number	Percent	Hours worked	Incidence rate*
Underground	Coal, bituminous	15,566	99.9%	392,118,045	7.9
	Coal, anthracite	17	0.1%	726,829	4.7
	Total	15,583	100.0%	392,844,874	7.9
Surface	Coal, bituminous	6,283	96.2%	444,976,372	2.8
	Coal, anthracite	250	3.8%	8,676,254	5.8
	Total	6,533	100.0%	453,652,626	2.9

*Injuries per 100 full-time equivalent miners per year

Table 16 — Top five states for numbers injured, by mine location, coal mines, 2003-2007.

Mine location	State	Number	Percent	Hours worked	Incidence rate*
Underground	West Virginia	4,443	28.5%	112,573,212	7.9
	Kentucky	4,189	26.9%	98,144,200	8.5
	Pennsylvania	1,591	10.2%	41,510,274	7.7
	Illinois	1,547	9.9%	29,941,173	10.3
	Alabama	1,054	6.8%	23,865,773	8.8
	Other	2,759	17.7%	86,810,242	6.4
	Total	15,583	100.0%	392,844,874	7.9
Surface	West Virginia	1,499	22.9%	94,289,137	3.2
	Kentucky	1,229	18.8%	83,185,928	3.0
	Pennsylvania	737	11.3%	36,577,135	4.0
	Virginia	466	7.1%	25,954,166	3.6
	Wyoming	414	6.3%	54,638,756	1.5
	Other	2,188	33.5%	159,007,504	2.8
	Total	6,533	100.0%	453,652,626	2.9

*Injuries per 100 full-time equivalent miners per year

underground (Table 12), 93% of metal-nonmetal mining injuries are reported by surface mines.

Metal-nonmetal mines share many of the characteristics of injuries occurring in coal mines, including very similar patterns of parts of body injured, natures and sources of injury and activities-when-injured (data not shown). Table 19 shows the top five states reporting metal-nonmetal mining injuries. Compared with the eastern locale of many coal mines, western states predominate for underground metal-nonmetal injuries, with Nevada, Montana, Wyoming and Idaho reporting 52% of underground mining injuries in this sector. Also, because every state has many sand and gravel operations, the five states most frequently reporting surface mine injuries account for only 29.7% of those injuries. The 70.3% labeled "other" include, in descending order, Florida, Wisconsin, Missouri, Georgia, and Indiana, among others.

While Idaho's numbers are about one-half those of each of the other three states, its incidence rate (11.8 injuries per 100 miners per year) is more than double the average rate for the other three states (5.7).

Conclusions

Many injuries common to all mines, mine locations and commodities can be identified and their most prominent attributes highlighted through ranked lists by frequency. In the absence of more detailed, cause-specific incidence rates, such rankings can reveal general trends of mine injuries and classify them by nature, accident type and class. Most frequently

Table 17 — Top five MSHA accident/injury classifications by mine location, metal-nonmetal mines, 2003-2007.

Mine location	AI class	Number	Percent
Underground	Handling material	648	29.6%
	Slip or fall of person	382	17.4%
	Machinery	313	14.3%
	Powered haulage	261	11.9%
	Hand tools	251	11.5%
	Other	335	15.3%
	Total	2,190	100.0%
Surface	Handling material	10,630	36.9%
	Slip or fall of person	6,217	21.6%
	Hand tools	4,200	14.6%
	Machinery	3,270	11.4%
	Powered haulage	2,189	7.6%
	Other	2,292	8.0%
	Total	28,798	100.0%

Table 18 — Most frequent subunits reporting injuries by mine location, metal-nonmetal mines, 2003-2007.

Mine Location	Subunit	Number	Percent
Underground	Underground	2,190	100.0%
Surface	Strip, quarry	13,744	47.7%
	Mill, preparation plant	13,296	46.2%
	Dredge	1,099	3.8%
	Surface @ Underground	506	1.8%
	Independent shops	129	0.4%
	Other	24	0.1%
	Total	28,798	100.0%

Table 19 — Top five states reporting injuries by mine location, metal-nonmetal mines, 2003-2007.

Mine Location	State	Number	Percent	Hours worked	Incidence rate*
Underground	Nevada	379	17.3%	14,309,581	5.3
	Montana	339	15.5%	12,166,091	5.6
	Wyoming	271	12.4%	8,022,607	6.8
	Idaho	148	6.8%	2,505,767	11.8
	Missouri	137	6.3%	7,779,529	3.5
	Other	916	41.8%	42,302,362	2.1
	Total	2,190	100.0%	87,085,937	5.0
Surface	California	2,072	7.2%	84,920,997	4.9
	Texas	2,026	7.0%	123,606,282	3.3
	Arizona	1,810	6.3%	87,060,956	4.2
	Pennsylvania	1,443	5.0%	60,025,867	4.8
	Nevada	1,188	4.1%	74,284,761	3.2
	Other	20,259	70.3%	1,024,027,212	2.8
	Total	28,798	100.0%	1,453,926,075	4.0

*Injuries per 100 full-time equivalent miners per year

injured miners by age group, activity, and job title can provide valuable indicators not only of hazards and the problems that contribute to them, but also potential solutions.

From the miner's point of view, training, task and mine design, job hazard analysis, personal protective equipment and a variety of related measures can provide prevention for each such group of injuries on a one-by-one basis. For more systematic and long-term preventive results, research is often valuable in identifying solutions common to large groups of injuries. In particular, the patterns highlighted above provide a focal point for research, mine planning and safety and health and the continued reduction of risk for U.S. miners. In addition, groups of injuries with common causes provide useful baselines for evaluating the effectiveness of interventions. A general engineering control that facilitates safe operation of a mining machine, for example, can be evaluated using a pre- and post-intervention design. Such controls can then be evaluated using MSHA surveillance data, without developing costly reporting systems.

Further work is planned to investigate those groups of injuries displaying the largest differences between underground and surface.

Disclaimer

The findings and conclusions in this report are those of the authors and do not necessarily represent the views of the National Institute for Occupational Safety and Health.

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