AMERICAN JOURNAL OF INDUSTRIAL MEDICINE 43:251–261 (2003)

External Cause-Specific Summaries of Occupational Fatal Injuries. Part II: An Analysis of Years of Potential Life Lost

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Background *Fatal injury surveillance data provide an opportunity to assess the impact of occupational injuries and may indicate which industries or occupations are appreciably more hazardous than others, and thus should be given priority in public health intervention.*

Methods *Fatalities from the National Traumatic Occupational Fatality surveillance system served as the basis for examining external cause (E-code) specific impact summaries. Years of potential life lost (YPLL) were calculated for fatal injuries in the years 1983–1994. Industries and occupations were compared with respect to frequency of fatal injuries. In addition, injuries in categories of external causes are examined across all industries and occupations.*

Results *Machinery, electric current, homicide, falls, and transportation-related are the external cause groups highlighted by high frequency/rate of occurrence. Electric current event groups are also characterized by high average YPLL. Poisoning, conflagration, and lightning were also identified in several occupations as having high associated average YPLL.*

Conclusions *The external-cause-specific analysis of average YPLL identified industries and occupations where, on average, younger workers were dying in fatal injuries. Noteworthy in this assessment were homicides and falls. The YPLL measure coupled with more commonly employed indices (e.g., rates) may provide a fuller description of the impact of occupational fatal injuries.* Am. J. Ind. Med. 43:251–261, 2003.
Published 2003 Wiley-Liss, Inc.†

KEY WORDS: YPLL; E-codes; electrocution; fall injuries

INTRODUCTION

Occupational fatal injuries remain a major public health concern in the United States. The magnitude of this problem has been tracked by a number of government agencies through a number of surveillance instruments such as the National Traumatic Occupational Fatalities surveillance system maintained by the National Institute for Occupational Safety and Health and the Census of Occupational Injuries (CFOI) or the Annual Survey of Occupational Injuries and Illnesses (ASOII) by the Bureau of Labor Statistics. These instruments are described in a companion article [Bailer et al., 2003]; in it, we present an analysis of fatal injury rates as a

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Accepted 15 October 2002
DOI 10.1002/ajim.10190. Published online in Wiley InterScience (www.interscience.wiley.com)

function of external causes of death along with industry and occupation classifications. In the present article, we explore patterns of injury events along with metrics of impact within different external causes of injury (E-codes). In particular, we focus on average years of potential life lost (YPLL) as a summary characteristic of fatal injuries. This index has been discussed in other contexts such as how it relates to legal issues associated with compensation schemes for individuals who lose years of life due to a hazardous exposure [Robins and Greenland, 1991]. These two articles are intended to provide a descriptive strategy that we hope will assist in the identification and prioritization of intervention targets.

METHODS

Data

The occupational fatal injury data considered in this analysis comes from the National Institute for Occupational Safety and Health's (NIOSH) National Traumatic Occupational Fatality (NTOF) injury surveillance system [NIOSH, 1993]. Details of the inclusion criteria for records from these data are described in the methods section of the companion article presenting a rate analysis of these data [Bailer et al., 2003].

Years of Potential Life Lost Calculations

The YPLL is the life expectancy given survival to a particular age. Our YPLL calculations were based on US Vital Statistics tables for men and women based upon data from all races combined [Anderson, 1999]. These life tables include the predicted years of life remaining for individuals who have attained a specified age. Since the life expectancy at an exact age at death is not available in these life tables, we averaged the life expectancy for the two age intervals in the life tables that bracketed each observed age at death. For example, an NTOF entry corresponding to the death of a 37-year-old female worker would have a YPLL constructed as the average of the life expectancy for females at ages 37 and 38 years. Again, this is because the life table provides life expectancy at the beginning of intervals (37–38 and 38–39 years would be the two bracketing age intervals for the hypothetical 37-year-old worker in our example). YPLL has been used in a previous study of occupational fatal injuries in the United States although not at the level of considering separate external cause of death groupings [Gilbert et al., 1998].

Statistical Methods

The primary methods employed in this analysis were descriptive. In particular, a series of analyses were performed in which E-codes with the largest average YPLL within industry or occupation were identified. External causes had to have ten deaths assigned to them to be considered for highest average years of potential life lost in the Industry and Occupation tables, and 5 deaths assigned to be considered for the industry/occupation combination average years of potential life lost table.

RESULTS

Approximately 69,000 workers died from work-related injuries during 1983–1994 (Table I). Approximately 93% of the deaths occurred in men while over 80% occurred in white workers. The average YPLL was 35.6 years for males and 41.5 years for females. White workers dying at work averaged 35.6 YPLL, while blacks averaged 36.4 YPLL. Workers with unknown/other races averaged over 38 YPLL with each fatal injury. Construction, transportation and public utilities, manufacturing and agriculture/forestry and fishing were the industries with the greatest number of work-related fatalities. A separate ordering would be suggested by average YPLL. Public administration, mining, construction, and retail trade experienced the largest average YPLL. The occupations with the greatest number of fatalities were crafts, transportation, farmers/foresters/fishers, and laborers while the occupations with the highest average YPLL were laborers, service, and machinists/assemblers.

Table II presents industry/occupation categories ordered in terms of average YPLL. Mining/farming, forestry, fishing and agriculture, forestry and fishing/laborers exhibited average YPLLs in excess of 44 years. The top three in terms of YPLL involved either mining or agriculture/forestry/fishing and four of the top ten combinations involved laborers or clerical and administrative support.

Table III identifies the top ten external causes of fatal injury when ordered by average years of life lost. Machinery, electric current, homicide, falls, and transportation-related events were the external causes with the highest frequency of occurrence [see Table IV in Bailer et al., 2003]. Of these, only electric current (E-code 925) was among the top ten based on YPLLs; others included three aircraft related events, three drowning/watercraft events, lightning, and poisoning. "Powered aircraft accident unspecified" (E-code 841) also exhibited relatively high rates of occurrence and high average YPLL (39 years lost). Thus, two external causes (electric current and aircraft, unspecified) occurred with high frequency and among relatively younger workers. In Figure 1, we see that the external causes with the highest frequency of occurrence included homicide (E-codes 960–969), machinery accident (919), motor vehicle driver (810.0, 811.0, . . . , 819.0), struck by falling object or person (916, 917, 918), and electric current (925). In contrast, the external cause groups with the largest average YPLL were electric current, motor vehicle passenger (810.1, 811.1, . . . , 819.1), accidental drowning

TABLE I. Summary Characteristics of Occupational Fatal Injuries in the NTOF Database Within by Gender, Race, Occupation, and Industry for Years 1983–1994

	Number	% Deaths	Average YPLL	% Total YPLL
Gender				
Male	64,565	93.5	35.6	92.4
Female	4,519	6.5	41.5	7.6
Unknown	6	<0.1	NR	NR
Race				
White	55,725	80.7	35.6	80.0
Black	7,656	11.1	36.4	11.2
Other	5,020	7.3	38.7	7.8
Unknown	689	1.0	38.2	1.0
Industry				
Construction	12,470	18.1	37.0	18.6
Transportation/public utilities	11,883	17.2	35.7	17.1
Manufacturing	9,533	13.8	35.1	13.5
Agriculture/forestry/fishing	8,046	11.6	30.8	10.0
Services	7,268	10.5	35.7	10.5
Retail trade	6,088	8.8	36.1	8.8
Public administration	4,915	7.1	39.4	7.8
Unclassified	3,644	5.3	41.9	6.1
Mining	2,572	3.7	38.0	3.9
Wholesale trade	1,691	2.4	35.8	2.4
Finance/insurance/real estate	980	1.4	32.6	1.3
Occupation				
Precision production, craft, and repair	13,184	19.1	36.1	19.2
Transportation and material moving	12,412	18.0	35.7	17.8
Farming, forestry, and fishing	8,545	12.4	31.0	10.7
Laborers	7,814	11.3	39.8	12.5
Service	4,863	7.0	37.1	7.3
Executives, administration, and managers	4,852	7.0	32.1	6.3
Sales	4,441	6.4	33.4	6.0
Unknown	4,368	6.3	44.1	7.7
Machine operators, assemblers, and inspectors	2,769	4.0	36.6	4.1
Professional specialty	2,684	3.9	34.0	3.7
Technicians and related support	1,837	2.7	37.7	2.8
Clerical and administrative support	1,321	1.9	37.2	2.0
Total	69,090	100	35.9	100

(910), accidental poisoning (850–869), and water transport accident (830–838). Note that this figure includes a grouping of a number of external causes of death as opposed to the tables, which are presented at the level of individual external causes.

Table IV describes the injury external causes ordered by average years of life lost within industry. Table V provides the same information within occupation. When ordered by average YPLL, poisonings (858, 862, 868, 869) and lightning (907) appear as prominent events across multiple industries. In addition, the distribution of fatalities by external cause within an industry reflects the varied nature of the hazards encountered there. For example, high-YPLL events occurring in the agriculture, forestry, and fishing industry included a large number of water-related events such as drowning (831, 836, 832, 830, 838, 910) which might naturally be attributed to the fishing component of this industry grouping. Some events were common across industries. Electrocutions (925) were in the top ten list for 8 of the ten industries. Poisoning by other gases and vapors (869) also was observed in the top ten list of 8 of ten industries although it did not occur with a frequency approaching that of electric current.

TABLE II. Top 10 Industry/Occupation Combinations When Ordered by Average Years of Potential Life Lost Over Years 1983–1994

Industry/occupation	Deaths	Mean YPLL
Mining/farm, forestry, fish	17	44.4
Agriculture, forestry, fish/laborers	188	44.1
Mining/laborers	215	43.3
Construction/clerical and administrative support	36	42.3
Wholesale trade/clerical and administrative support	40	41.9
Retail/clerical and administrative support	90	41.6
Retail/laborers	692	41.4
Mining/clerical and administrative support	13	41.3
Retail/technicians and support	11	41.2
Wholesale trade/laborers	240	40.9
Total for industry/occupations	62,604	35.4

While homicide with firearms (965) and electric current (925) also show up in the top ten external cause listing for the executive, administration, and manager occupations ordered by average YPLL, poisoning (869, 868) and other events had the highest YPLLs (Table V). Additional aircraft events (841, 840) along with watercraft or drowning events (910, 832, 830) are highlighted as significant events for professional, specialty occupations. Poisoning (850) and animal-related events (828, 906) were also observed. Technical or support occupations high average YPLL events included the common transportation-related events (812, 816), falls (882), homicide (965), and electric current (925) along with conflagration (891) and poisoning (869). Homicide with firearm and explosives (965) was both a frequent and high average YPLL external cause for sales occupations. In addition, other homicide code (963) or firearms (922) were observed along with motor vehicle related events (812, 815, 810). Homicide (963, 965, 966) was both a high frequency and high average YPLL event group for clerical occupations. Conflagration (891 or 892) was a high average YPLL event that was observed in both clerical and service occupations (although not at an extremely high frequency). Water-related events including watercraft accidents and drowning (831, 836, 832, 830, 838) were all present in the top ten YPLL list for farming, forestry, and fishing occupations (most likely attributable to fishing activities in these occupations). Environmental factors such as lightning (907) and cataclysmic storms and floods from storms (908) also occurred in this occupation group. While the electric current (925) events were both frequent and associated with high average YPLL, a number of the rarer events were associated with high average YPLL in crafts occupations. In particular, poisoning (862, 855, 869) and conflagration (890, 892) were noteworthy. Machine operators occupations experienced events that might be predicted from this occupational context, e.g., electric current (925), caught accidentally in or between objects (918) but also conflagration (891), poisoning (869), and explosions in watercraft (837) and in other settings (923). Transportation occupations were associated with drowning (832, 910), watercraft events (834, 838), poisoning (855), and conflagration/fire events (892, 899) but lightning (907) is also a significant event (in terms of high average YPLL although associated will only 14 deaths). Finally, fatal electric current (925) injuries occurred with high frequency and high average YPLLs in laborers. In a pattern observed with other YPLL-ordered events in occupations, we see poisoning, lightning, and conflagration with high average YPLL in laborers. Finally, some events were observed in a number of the top ten average YPLL groups within occupations. For example, electric current (925) appears in the top ten list for 9 of 11 occupations while watercraft-related events (830, 832 or 838) appear in 5 of 11 occupation lists.

TABLE III. Top 10 Injury External Causes (E-Codes) When Ordered by Average Years of Life Lost for Occupational Fatal Injuries Occurring in Years 1983–1994

E-code	Injury description	Deaths	Average YPLL
844	Other specified air transport accident	118	42.19
925	Accident caused by electric current	4,372	41.10
907	Lightning	184	40.90
869	Poisoning accident by other gases and vapors	343	40.69
922	Accident caused by firearm missile	321	40.51
832	Other drowning in watercraft accident	506	40.11
910	Accidental drowning or submersion	1,046	39.82
838	Other water transport accident	187	39.73
841	Powered aircraft accident unspecified	2,645	38.86
840	Aircraft accident during takeoff or landing	273	38.39
	Total deaths	68,892	35.96

DISCUSSION

Average YPLL quantifies the case-specific impact of a fatality in that the years of potential life lost is averaged over all fatalities in a particular event group, e.g., industry. In our analysis, we focused on average YPLL as opposed to other YPLL constructions. A natural alternative that might be considered is the total YPLL. As we see in Figure 2a, average YPLL and total YPLL appear uncorrelated for industry divisions ($r = 0.102$). Thus, total YPLL does provide information distinct from the average YPLL. However, the total YPLL is primarily driven by the number of deaths in a group. Total YPLL is plotted versus total deaths for industry division in Figure 2b. From this plot, we see that these two quantities are highly correlated ($r = 0.994$). In fact, the only industry that substantially deviates from the line of perfect association is agriculture/forestry/fishing. The large number of deaths coupled with the relatively lower total YPLL suggests that

TABLE IV. Top 10 Injury External Causes (E-Codes) Within Industry Ordered by YPLL for Occupational Fatal Injuries Occurring in Years 1983–1994

Industry	E-Code	Injury description	Deaths	Average YPLL
Agriculture, forestry, fishing	831	Watercraft accident causing other injury	14	43.8
	836	Machinery accident in water transport	17	42.9
	925	Accident caused by electric current	447	41.6
	869	Poisoning accident by other gases and vapors	40	40.6
	950	Suicide or self poisoning by solid or liquid	12	40.4
	832	Other drowning in watercraft accident	216	40.1
	830	Accident to watercraft causing submersion	240	38.7
	907	Lightning	67	38.7
	838	Other water transport accident	54	38.2
	910	Accidental drowning or submersion	245	37.7
		Total for industry	7,834	30.7
Mining	892	Conflagration not in building or structure	35	42.8
	868	Poisoning other utility gas or other CO	18	42.0
	818	Other noncollision motor vehicle accident	17	41.7
	965	Homicide with firearms and explosives	25	41.5
	869	Poisoning accident by other gases and vapors	31	41.5
	925	Accident caused by electric current	170	41.4
	832	Other drowning in watercraft accident	13	40.7
	928	Unspecified environmental accident	87	40.5
	917	Struck accidentally by objects or persons	64	39.4
	816	Motor vehicle loss of control no collision	103	39.4
		Total for industry	2,476	38.1
Construction	862	Accidental poisoning by petroleum products	12	44.4
	907	Lightning	44	43.2
	925	Accident caused by electric current	1,736	41.8
	890	Conflagration in private dwelling	22	41.6
	869	Poisoning accident by other gases and vapors	50	40.8
	858	Accidental poisoning by other drugs	13	40.5
	913	Accidental mechanical suffocation	461	39.8
	910	Accidental drowning or submersion	148	39.5
	805	Hit by rolling stock	15	39.3
	891	Conflagration in unspecified building	43	39.1
		Total for industry	12,408	37.0
Manufacturing	862	Accidental poisoning by petroleum products	23	43.4
	821	Nontraffic accident with off-road vehicle	14	41.4
	957	Suicide by jumping from high place	11	40.6
	912	Suffocation by inhalation/ingestion of object	23	40.6
	925	Accident caused by electric current	526	40.2
	907	Lightning	12	39.6
	950	Suicide or self poisoning by solid or liquid	14	39.6
	869	Poisoning accident by other gases and vapors	89	39.2
	810	Motor vehicle collision with train	53	39.0
	846	Unspecified accident with powered vehicle	14	38.8
		Total for industry	9,472	35.2
Trans./comm./PU	832	Other drowning in watercraft accident	135	40.8
	855	Drug poisoning central nervous system	13	40.1
	913	Accidental mechanical suffocation	63	39.3
	925	Accident caused by electric current	662	39.3

(*Continued*)

TABLE IV. (*Continued*)

Industry	E-Code	Injury description	Deaths	Average YPLL
	869	Poisoning accident by other gases and vapors	43	39.2
	910	Accidental drowning or submersion	140	39.2
	883	Fall into hole or other opening in surface	23	38.8
	840	Aircraft accident during takeoff or landing	125	38.8
	834	Fall from one level to another in watercraft	34	38.6
	838	Other water transport accident	68	38.4
		Total for industry	11,830	35.7
Wholesale trade	825	Other nontraffic motor vehicle accident	16	42.2
	918	Caught accidentally in or between objects	23	41.2
	925	Accident caused by electric current	71	40.8
	923	Accident caused by explosive material	45	38.8
	883	Fall into hole or other opening in surface	13	38.3
	815	Motor vehicle collision on highway	60	37.4
	953	Suicide by hanging, strangulation, suffocation	12	37.3
	822	Nontraffic MV accident with moving object	30	37.2
	919	Machinery accident	210	37.0
	913	Accidental mechanical suffocation	45	36.7
		Total for industry	1,673	35.8
Retail trade	869	Poisoning accident by other gases and vapors	10	42.7
	925	Accident caused by electric current	95	40.4
	815	Motor vehicle collision on highway	91	39.1
	812	Motor vehicle collision with other MV	311	38.4
	918	Caught accidentally in or between objects	22	38.3
	985	Firearm/explosive injury may be an accident	14	37.8
	965	Homicide with firearms and explosives	2,847	37.8
	910	Accidental drowning or submersion	18	37.7
	816	Motor vehicle loss of control no collision	147	37.4
	922	Accident caused by firearm missile	69	37.3
		Total for industry	6,048	36.1
Finance, insurance, real estate	925	Accident caused by electric current	24	39.0
	819	Unspecified motor vehicle accident	25	36.7
	812	Motor vehicle collision with other MV	111	36.0
	965	Homicide with firearms and explosives	229	35.4
	966	Homicide with cutting and piercing object	32	34.7
	841	Powered aircraft accident unspecified	43	33.6
	963	Homicide by hanging or suffocation	16	33.3
	953	Suicide by hanging, strangulation, suffocation	15	33.2
	910	Accidental drowning or submersion	13	33.0
	816	Motor vehicle loss of control no collision	34	32.4
		Total for industry	963	32.6
Services	962	Homicide by poisoning	13	44.8
	955	Suicide/self-injury by firearms or explosives	30	43.4
	980	Poisoned by solid/liquid may be an accident	11	42.6
	909	Cataclysmic earth surface movements	10	41.8
	830	Accident to watercraft causing submersion	22	41.5
	805	Hit by rolling stock	12	41.5
	832	Other drowning in watercraft accident	28	40.9
	910	Accidental drowning or submersion	171	40.8

TABLE IV. (*Continued*)

Industry	E-Code	Injury description	Deaths	Average YPLL
	869	Poisoning accident by other gases and vapors	32	40.1
	925	Accident caused by electric current	307	39.9
		Total for industry	7,255	35.7
Public administration	821	Nontraffic accident with off-road vehicle	36	47.7
	950	Suicide or self poisoning by solid or liquid	14	47.0
	843	Fall in, on, or from aircraft	10	46.8
	825	Other nontraffic motor vehicle accident	58	46.7
	922	Accident caused by firearm missile	93	46.5
	869	Poisoning accident by other gases and vapors	13	46.2
	838	Other water transport accident	17	46.0
	844	Other specified air transport accident	65	45.6
	910	Accidental drowning or submersion	78	44.3
	892	Conflagration not in building or structure	15	43.9
		Total for industry	4,854	39.4

this is an industry when fatal injuries occur with moderately high frequency among relatively older workers.

Limitations are inherent in the analysis of surveillance data. Many of the specific limitations associated with the analysis of the death-certificate based NTOF data have been extensively discussed in a variety of articles including the discussion of our companion article [Bailer et al., 2003]. The most relevant limitation for calculating YPLL from NTOF data is that the minimum age for inclusion in NTOF was 16 years old. Thus, occupational fatalities in workers

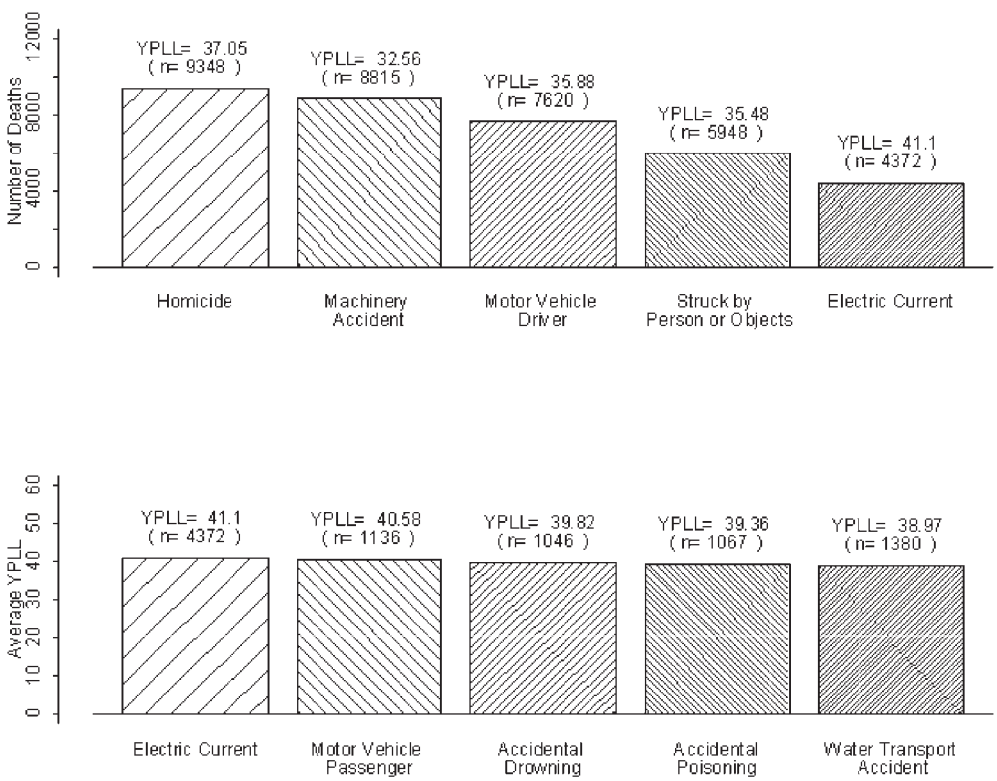

FIGURE 1. Bar charts comparing the top 5 external causes by count and by the average years of potential life lost for occupational fatal injuries occurring in years 1983–1994. Note that these are groupings of a number of specific external causes of death.

TABLE V. Top 10 Injury External Causes (E-Codes) Within Occupation Ordered by Average YPLL for Occupational Fatal Injuries Occurring in Years 1983—1994

Occupation	E-code	Injury description	Deaths	Average YPLL
Executives, administration, managers	869	Poisoning accident by other gases and vapors	13	42.0
	855	Drug poisoning central nervous system	10	40.0
	985	Firearm/explosive injury may be an accident	11	38.5
	821	Nontraffic accident with off-road vehicle	13	37.5
	810	Motor vehicle collision with train	31	36.4
	966	Homicide with cutting and piercing object	159	36.0
	799	Il-defined or unknown cause of death	11	35.9
	965	Homicide with firearms and explosives	997	35.4
	925	Accident caused by electric current	242	35.0
	922	Accident caused by firearm missile	31	34.2
		Total for occupation	4,806	32.1
Professional, specialty	821	Nontraffic accident with off-road vehicle	10	43.0
	850	Poisoned by analgesics, antipyretics, antirheumatics	14	41.8
	910	Accidental drowning or submersion	73	40.3
	828	Accident involving animal being ridden	31	39.3
	906	Other injury caused by an animal	25	39.0
	841	Powered aircraft accident unspecified	299	38.4
	840	Aircraft accident during takeoff or landing	34	38.3
	818	Other noncollision motor vehicle accident	15	38.0
	832	Other drowning in watercraft accident	17	37.9
	858	Accidental poisoning by other drugs	13	37.7
		Total for occupation	2,661	34.0
Technical, support	891	Conflagration in unspecified building	10	42.8
	869	Poisoning accident by other gases and vapors	11	42.7
	925	Accident caused by electric current	66	41.6
	882	Fall from building or other structure	17	41.4
	812	Motor vehicle collision with other MV	82	41.4
	965	Homicide with firearms and explosives	44	40.6
	923	Accident caused by explosive material	40	39.9
	913	Accidental mechanical suffocation	13	39.3
	816	Motor vehicle loss of control no collision	30	39.0
	840	Aircraft accident during takeoff or landing	104	37.6
		Total for occupation	1,816	37.8
Sales	925	Accident caused by electric current	53	38.9
	918	Caught accidentally in or between objects	15	36.6
	922	Accident caused by firearm missile	33	36.2
	965	Homicide with firearms and explosives	1,826	35.9
	812	Motor vehicle collision with other MV	403	34.9
	891	Conflagration in unspecified building	25	34.2
	963	Homicide by hanging or suffocation	40	34.2
	815	Motor vehicle collision on highway	84	34.2
	810	Motor vehicle collision with train	25	34.1
	910	Accidental drowning or submersion	15	33.7
		Total for occupation	4,410	33.4
Clerical	891	Conflagration in unspecified building	13	48.5
	810	Motor vehicle collision with train	12	44.9
	925	Accident caused by electric current	20	42.9
	950	Suicide or self poisoning by solid or liquid	13	42.8

TABLE V. (*Continued*)

Occupation	E-code	Injury description	Deaths	Average YPLL
	922	Accident caused by firearm missile	11	42.5
	965	Homicide with firearms and explosives	278	41.7
	963	Homicide by hanging or suffocation	12	41.4
	966	Homicide with cutting and piercing object	42	40.8
	910	Accidental drowning or submersion	12	40.0
	816	Motor vehicle loss of control no collision	61	39.7
		Total for occupation	1,313	37.3
Service	855	Drug poisoning central nervous system	11	47.5
	840	Aircraft accident during takeoff or landing	20	44.6
	922	Accident caused by firearm missile	57	43.4
	892	Conflagration not in building or structure	14	42.6
	869	Poisoning accident by other gases and vapors	16	42.2
	957	Suicide by jumping from high place	16	40.8
	832	Other drowning in watercraft accident	10	40.5
	841	Powered aircraft accident unspecified	129	40.4
	910	Accidental drowning or submersion	104	40.2
	925	Accident caused by electric current	143	40.2
		Total for occupation	4,834	37.1
Farming, forestry, fishing	831	Watercraft accident causing other injury	12	46.5
	836	Machinery accident in water transport	16	42.5
	925	Accident caused by electric current	399	41.3
	869	Poisoning accident by other gases and vapors	42	40.2
	832	Other drowning in watercraft accident	205	39.7
	907	Lightning	63	39.0
	830	Accident to watercraft causing submersion	217	38.6
	838	Other water transport accident	47	38.1
	921	Accident caused by explosion of pressure vessel	21	38.0
	908	Cataclysmic storms, and floods from storms	13	37.2
		Total for occupation	8,457	31.0
Crafts	862	Accidental poisoning by petroleum products	23	45.9
	855	Drug poisoning central nervous system	13	43.3
	907	Lightning	29	42.3
	890	Conflagration in private dwelling	27	41.8
	838	Other water transport accident	20	41.5
	912	Suffocation by inhalation/ingestion of object	18	41.0
	869	Poisoning accident by other gases and vapors	104	40.5
	925	Accident caused by electric current	2,053	40.3
	892	Conflagration not in building or structure	33	40.1
	844	Other specified air transport accident	21	39.8
		Total for occupation	13,128	36.2
Machine operators, assemblers, inspectors	815	Motor vehicle collision on highway	16	44.5
	837	Explosion or fire in watercraft	10	44.2
	925	Accident caused by electric current	168	41.6
	869	Poisoning accident by other gases and vapors	33	40.4
	891	Conflagration in unspecified building	67	39.6
	910	Accidental drowning or submersion	30	39.1
	923	Accident caused by explosive material	186	39.1

(*Continued*)

TABLE V. (*Continued*)

Occupation	E-code	Injury description	Deaths	Average YPLL
	918	Caught accidentally in or between objects	58	39.0
	953	Suicide by hanging, strangulation, suffocation	25	38.5
	841	Powered aircraft accident unspecified	10	38.4
		Total for occupation	2,735	36.6
Transportation	832	Other drowning in watercraft accident	136	42.4
	834	Fall from one level to another in watercraft	26	41.9
	892	Conflagration not in building or structure	12	41.5
	855	Drug poisoning central nervous system	12	40.4
	907	Lightning	14	40.2
	925	Accident caused by electric current	346	40.1
	958	Suicide by other or unspecified means	11	39.7
	910	Accidental drowning or submersion	110	39.2
	838	Other water transport accident	66	38.5
	899	Accident caused by unspecified fire	22	38.2
		Total for occupation	12,294	35.7
Laborers	963	Homicide by hanging or suffocation	11	50.1
	912	Suffocation by inhalation/ingestion of object	14	47.1
	862	Accidental poisoning by petroleum products	13	46.0
	925	Accident caused by electric current	610	45.5
	907	Lightning	27	44.2
	922	Accident caused by firearm missile	15	43.1
	815	Motor vehicle collision on highway	65	43.1
	891	Conflagration in unspecified building	52	43.1
	921	Accident caused by explosion of pressure vessel	52	42.7
	816	Motor vehicle loss of control no collision	172	42.4
		Total for occupation	7,662	40.0

younger than 16 would not be incorporated in the YPLL analysis or any analysis based upon the NTOF data. This could potentially bias conclusions in occupations/industries (e.g., agriculture, retail trade, construction) with a large number of younger workers at risk of occupational fatal injuries [Windau et al., 1999].

A statistical limitation associated with an analysis is related to our decision to require $\geq$10 deaths for average

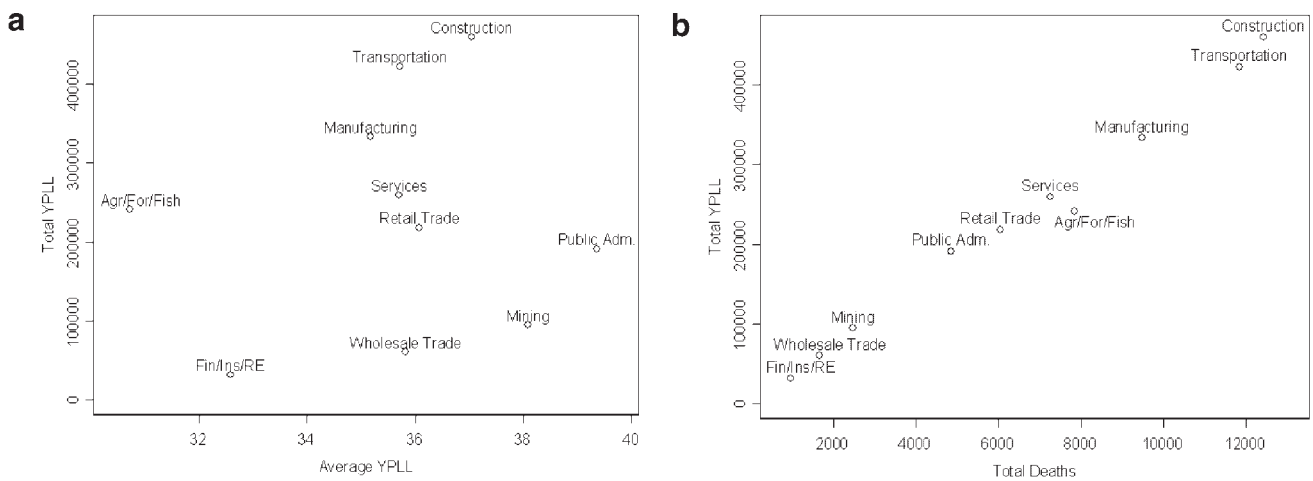

FIGURE 2. **a**: Scatterplot of total YPLL versus average YPLL for different industry divisions (r = 0.102). **b**: Scatterplot of total YPLL versus total number of deaths for different industry divisions (r = 0.994).

YPLL calculation for industry or occupation divisions or $\geq$5 deaths for average YPLL calculation for combined industry-occupation divisions. The margin of error for an average YPLL based upon ten observations would be approximately $2(15)/\sqrt{10} = 9.5$ years (assuming a SD of 15 which was near the largest we observed in our analysis). Thus, the average YPLL estimates based upon small numbers of events should be viewed with caution. As an aside, twice the margin of error corresponds to the width of an approximate 95% confidence interval for estimating the population average YPLL.

Electric current event groups are not only characterized by high frequency of occurrence but also characterized by high average YPLL. Thus, electric current is clearly highlighted as an external cause of death that is widely affecting younger workers, as indicated by the high average YPLL and high rates of occurrence across most industries and occupations. While less frequent, watercraft-related, poisoning, conflagration, and lightning often appear with high average YPLLs in different occupations. Other external causes exhibiting high YPLL and counts include homicide and falls.

YPLLs are constrained on one extreme by life expectancy and on the other extreme by the age when entering the workforce. Thus, the YPLL is expected to range from about 15 to 60 years while fatal injury rates can vary over orders of magnitude. This implies that YPLLs in comparison to fatal injury rates will not show dramatic differences between occupation or external causes. It is worth considering which measure is most meaningful in conveying the risk of an occupation to a worker. We suspect that rates may seem less intuitive than YPLLs; however, this may represent an important research investigation for risk communication researchers. In addition, the YPLL is clearly a function of the age structure of the workforce. An industry with a relatively older workforce could not demonstrate as much impact on a YPLL measure as an industry with a relatively younger workforce. Thus, given equal age-specific rates in two industries, the industry with the relatively younger workforce will produce more YPLL. Ultimately, we recommend investigators consider both rates and YPLL when examining the impact of occupational fatal injuries. Recently, Bena et al. [2001] addressed this point in graphical representations of fatal injury rates plotted versus YPLL. In their displays, the injury rates were plotted on a log-scale while the YPLL were plotted untransformed. This effectively gave greater weight to the YPLL data in that rates and YPLLs were both represented in terms of the range of observed values and the rates were interpreted as order of magnitude changes in rates while YPLLs were interpreted in terms of years.

ACKNOWLEDGMENTS

We are grateful to Pat Cutlip and Suzanne Marsh of the NIOSH Division of Safety Research for their assistance with the NTOF data and for the comments and suggestions provided by Dawn Castillo, Dana Loomis, and Larry Reed on an early draft of this article. In addition, we are grateful to Steve Gilbert for his assistance in setting up the analysis data sets. Finally, we appreciate the comments and suggestions from an anonymous reviewer and the editor.

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