



Patterns and trends in injuries due to chemicals based on OSHA occupational injury and illness statistics

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ABSTRACT

The Occupational Safety and Health Administration (OSHA) and the Bureau of Labor Statistics (BLS) provide the Survey of Occupational Illness and Injury (SOII) statistics from 1992 to 2006, which is often used to measure the rate of injuries and illness in industry. The present system of gathering and classifying this data was implemented in 1992 with minor changes in 2002.

It is hoped that using these statistics to measure safety progress and determine patterns of injury will guide further improvements in chemical safety. Recognizing such factors as what chemicals most frequently cause injury can help to focus safety efforts regarding that chemical. Factors such as what part of the body is most commonly affected by particular chemicals can lead to improved personnel protection practices.

This paper provides a detailed analysis of injuries due to chemicals using OSHA's SOII data, which offers valuable insight into measures that should be taken to reduce injuries due to chemicals.

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1. Introduction

The OSHA Survey of Occupational Illness and Injury (SOII) statistics are the most common injury statistics used to measure the rate of injuries and illness in industry. The present system of gathering and classifying this data was implemented in 1992. Data are presently available on a consistent basis through 2006 providing a 15-year period for examining trends and patterns of injuries involving chemicals.

Less frequently quoted are the more detailed demographic statistics gathered for cases with "days away from work" (DAFW). For DAFW injuries it is possible to determine those that are due to chemicals, the nature of the injury, the body part affected, the number of days away, the industry segment and demographic information about the victims. The demographic information includes gender, age, occupation and length of service.

These statistics are based on a yearly representative sampling of more than 150,000 of approximately 7.5 million establishments and are extrapolated to make estimates for the entire country. Injury sources are classified into over 200 categories of chemicals and chemical products.

Injuries involving chemicals as a percentage of all DAFW cases have decreased from 2% to 1.5% over the study period. That means

that injuries due to chemicals are decreasing more rapidly than injuries in general. While a relatively small portion of all cases, it still represents a significant number of injuries and lost productivity. It is likely that continuing reductions in injuries will increasingly rely on focused efforts to prevent specific types of injuries as larger categories of injury are more effectively addressed.

It is hoped that using these statistics to measure progress and determine patterns of injury will help to continue improvements in chemical safety. Recognizing such factors as the chemicals that most frequently cause injury in a given industry group can help to focus safety efforts. Factors such as what body part is most commonly affected can lead to improved personnel protection practices.

This study was not undertaken to answer a specific question about injuries due to chemicals but to explore what can be learned through analysis of the OSHA statistics. While this research can only offer a sampling of this type of analysis it illustrates how others can apply OSHA data to their specific situation. In general only data that is readily available to the public through the OSHA-BLS website is utilized. However, it should be recognized that more detailed or complex analysis can be performed with assistance from BLS.

Extensive data are available on the Bureau of Labor Statistics web site. The data are available in tables as well as through a database query system. There are also tables and charts available on the Mary Kay O'Connor Process Safety Center web site <http://psc.che.tamu.edu/>. These tables include more complete versions of the tables in this paper and tables supporting the graphs. In most

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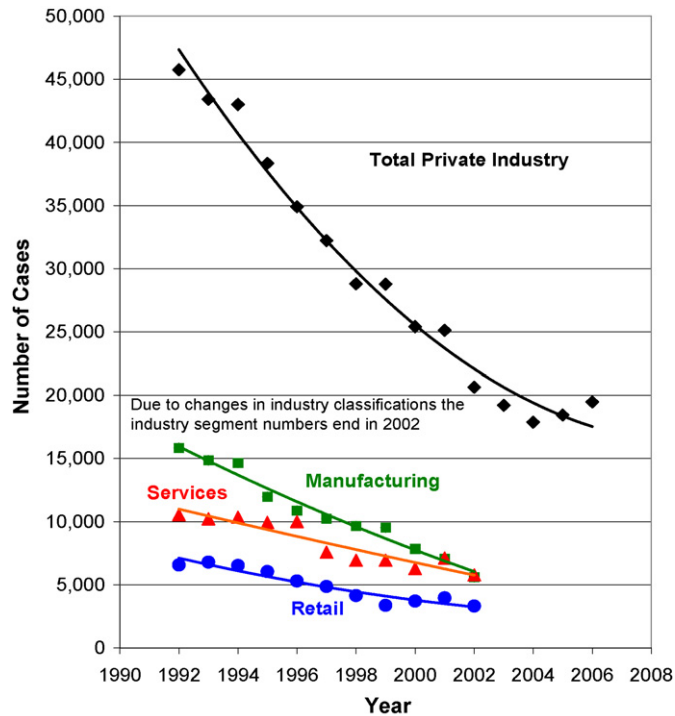


Fig. 1. OSHA cases w/days away from work, due to chemicals (private industry and top three of nine major sectors).

cases both injury rates and number of injuries are in the spreadsheets, while this paper may only contain one or the other.

Note the injury rates in this paper are per 10,000 employees rather than the much more common 100 employees that are used when addressing all injuries rather than injuries with a particular cause.

The numbers of injuries stated in this paper are the numbers extrapolated by the BLS to include the entire US.

2. Trends in the number and rates of injuries from 1992 to 2006

The trend in the number of DAFW cases from 1992 to 2006 due to chemicals is dramatically downward for the period, dropping from 45,700 to 19,500 (53%) cases per year, 5.5% compounded annually. The number of private industry employees has increased 28% during this period. Therefore the annual rate of injury (injuries per 10,000 employees) is dropping even more quickly at about 7.1% per year. There is a reduction in the rate of injury due to chemicals from 6.3 to 2.1 (67%) over the 15 years. The numbers of cases for all industry and the three major contributing industry segments are shown in Fig. 1.

These reductions in rates compare favorably with the overall injury number and rate reductions. The number of injuries due to chemicals is falling at 5.5% versus 4.4% annually for all causes of injury. The rate of injuries due to chemicals is falling at 7.1% versus 5.6% for all causes of injury.

During this 15-year period, the real US gross domestic product increased by 58% (3.1% annually) [1]. The real GDP (inflation adjusted GDP) is the actual increase in goods produced. Thus on a productivity basis the rate of DAFW cases decreased by about 10% annually.

While these numbers appear very encouraging, they may overstate the actual progress. The days away cases exclude “restricted activity” cases. The trend for “days away” cases for all causes has

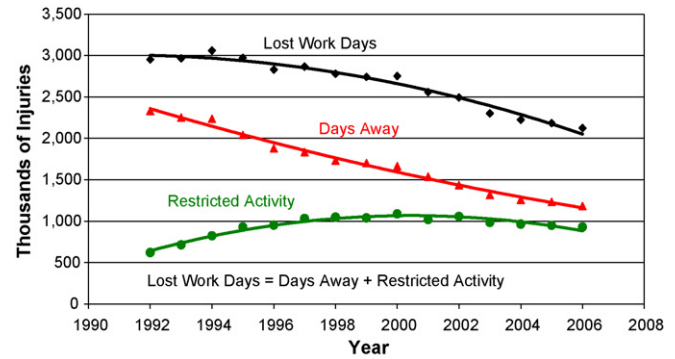


Fig. 2. Injuries for all private industry, all causes. Source: OSHA OII.

been steadily downward for the 15-year period. However the trend for “restricted activity” cases was upward for much of this period although it peaked around the year 2000 and has been decreasing since then. This is illustrated in Fig. 2. Since the detailed data is not gathered for “restricted activity” cases, it is not possible to determine if this relationship exists for cases due to chemicals.

The reasons for these opposing trends are subject to debate. One possibility is that industry is increasing efforts to reduce days away by bringing workers in for “restricted activity” rather than being given time off from work. The motivation for this might be to improve the apparent safety record or to reduce workers compensation costs. Another, more positive, explanation might be that injuries are becoming less severe and/or treatment has improved so that workers are better able to return on a “restricted activity” basis. This viewpoint is expressed by Ruser [2], “days away from work are becoming shorter and less frequent” and postulated that “increased job safety and faster return to work of injured workers may account for this development.”

Conway and Svenson [3] discuss the decline in DAFW cases from 1992 to 1996. They explore various explanations, including “the well known shift in employment out of traditionally highly hazardous manufacturing industry jobs and into relatively less hazardous service industry employment; an increase in underreporting of workplace injuries and illnesses; a growing emphasis on cost control among employers and insurers in response to rising worker compensation costs; increased efforts on the part of employers and unions to identify and eliminate workplace hazards; and more effective OSHA enforcement and consultation activities.” They conclude that “recent reforms in workers’ compensation programs at the state level and industry initiatives in implementing workplace safety and health programs as being primarily responsible for the rate reduction.”

3. Severity of injuries (number of lost work days per case due to chemicals)

OSHA reports the number of lost days per injury case [4–6]. In this research, we use this parameter as an indicator of the “severity” of an injury. Fig. 3a shows the trends in the number of days away per incident. The number of days away could also be an indicator of the portion of the workers compensation costs related to lost wages. It reveals that there is similar rate of improvement for all levels of “severity”. This indicates that there is progress in reducing more severe as well as less severe injuries.

Generally the rate of decline is highest for the less “severe” cases. The cases with 1 day away declined at a rate of 8.7% annually. The rate of decline was progressively less for cases with more days away. The cases with 21 to 30 days away declined at an annual rate of 4.5%. The only anomaly in this trend was that the cases with 30 plus days away declined at an annual rate of 6.9%.

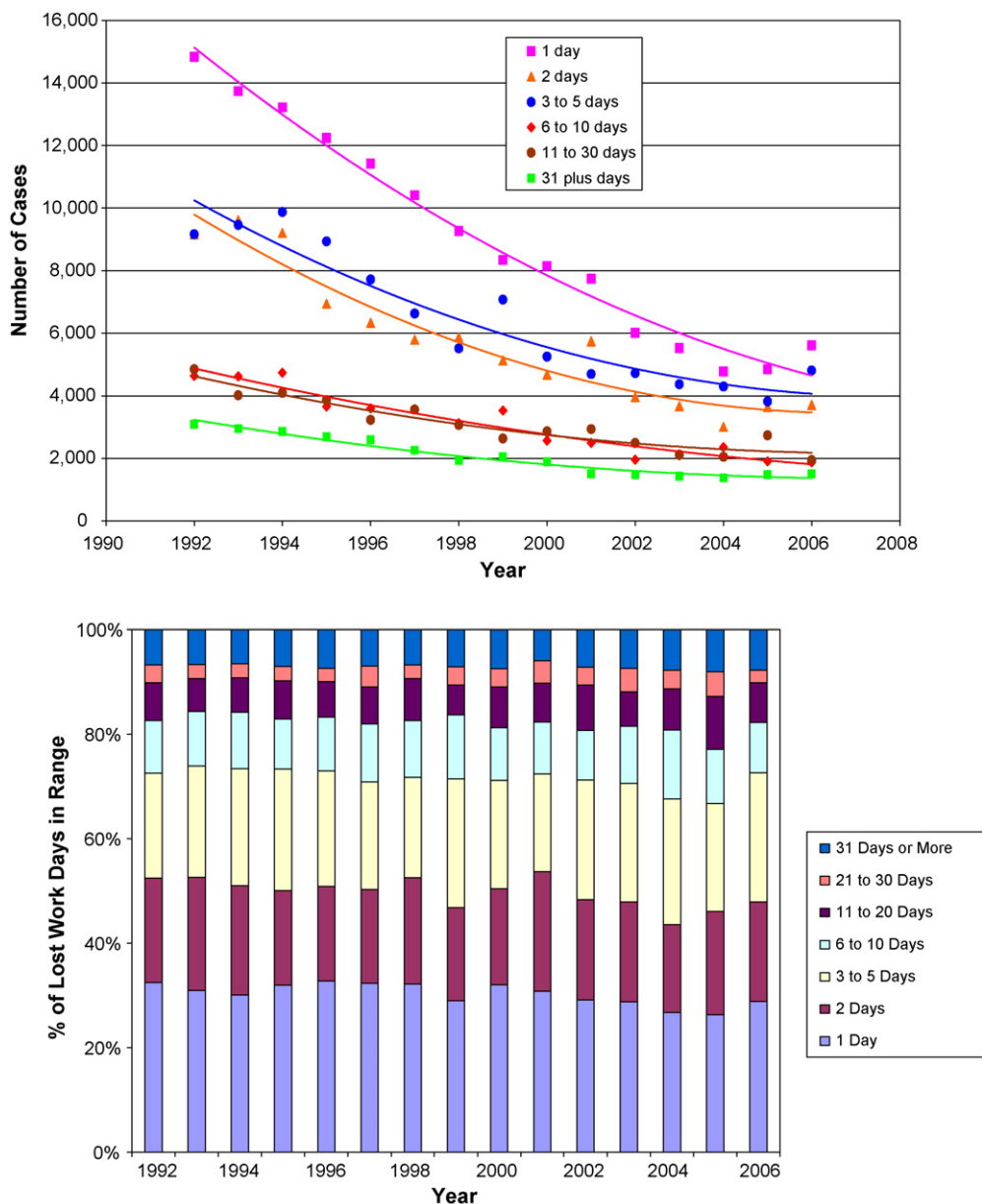


Fig. 3. Number of lost workday cases by number of lost days per case. Distribution of lost work days per case.

Over the 15-year period the number of days away due to chemical injuries has been reduced from an estimated 290,000 days per year to 135,000 days, a reduction of 155,000 (53%) days away per year. The median number of days away for injuries due to chemicals is 2.5 days. The median for all causes is much higher at 7 days.

Fig. 3b shows the relatively consistent trend across all injury severities. This seems to cast doubt on the theory that the days away cases are being reduced by shifting less severe cases to restricted activity. This is especially true now that restricted activity cases have also been decreasing for about 5 years. The chemical groups most commonly associated with more severe injuries, more than 20 days away from work, are shown in Table 1.

Table 1 shows the groups that have had the highest average number of cases with more than 21 days away over the 15-year period. Common items such as cleaning and polishing agents and petroleum products are responsible for more severe cases than chemicals that are considered more hazardous. This is almost certainly due to the large number of people potentially

Table 1
Chemical groups causing cases with 21+ days away

	Average 1992–2006
Cleaning and polishing agents	308
Petroleum fuels and prods, natural gas	244
Metallic particulates, dusts, powders, fumes	184
Acids	196
Alkalies	167
Aromatics and hydrocarbon derivatives	129
Paint, lacquer, shellac etc.	119
Plastics, resins	83
Adhesives	69
Solvents, degreasers	64
Agricultural and pesticide	63
Carbon monoxide	55
Halogens and compounds	64
Ammonia and ammonia compounds	37
Total per year in the above categories	1782

exposed to these items compared to highly toxic or corrosive sub-

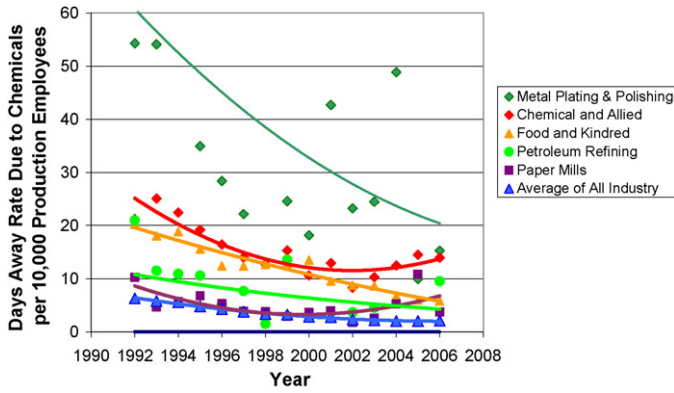


Fig. 4. Selected industry segments with high rates of “days away” due to chemicals.

stances. This emphasizes the need to handle all chemicals with care and take appropriate cautions even with the most familiar substances.

4. Industry groups associated with chemical injuries

Injuries due to chemicals occur in all industry groups. The largest numbers of injuries occur in the manufacturing, retail and service industries. The highest rates of injury occur in manufacturing. Only 4% of the “days away” due to chemicals are in the petrochemical manufacturing industries.

Fig. 4 illustrates some selected industries with high rates of injuries due to chemicals compared to the average for all industry, which is also shown. As expected, the chemical manufacturing industry has a high rate compared to the average for all industries. The food industry surprisingly has a rate nearly as high as the chemical industry. The metal plating and polishing industry has a rate about double that of the chemical industry. Two other heavy industries petroleum refining and paper mills have rates that are nearly as low as that of industry as a whole.

The chemical and allied products and the paper mills achieved their lowest rates in 2002 and have trended upward since that time.

Clearly there are industries whose practices should be improved to lower the rate of injury due to chemicals. Additional research into the causes and nature of these injuries is needed, but is generally beyond the scope of this paper. A detailed examination of injuries due to chemicals in a particular industry is not possible with the level of detail available to the public in the OSHA/BLS database.

The manufacturing, service and retail industries account for the largest numbers of injuries due to chemicals. Fig. 5 shows the chemicals most commonly associated with injuries for these three major industry segments. The figures shown are averages for the ten-year period. In all three segments cleaning and polishing agents are the main cause of injury.

5. Injury rate due to chemicals by length of employee service

Length of Service also called Job Tenure is an important factor in injury rates. It is defined as the length of time with the current employer. Those with less than 3 months of tenure are about 3.3 times more likely to be injured by chemicals than those with more than 5 years of tenure. This is a decrease from 4.2 times in 1992. This seems to indicate that workers are adopting safe work habits earlier in their tenure. In the 3–11 month and 1–5 year ranges for length of service the downward trend seems to have leveled off and may be increasing.

While the injury rates are clearly higher for those with less tenure, the 1–5-year employees account for the greatest number of injuries due to their larger numbers in the workforce, as shown in Fig. 7. Thus, while it is highly desirable to reduce the rate for inexperienced employees it is still essential to continue the development of safe work practices for more experienced workers.

Fig. 6 shows that “learning curve” for injuries due to chemicals is considerably steeper than that for injuries due to all causes.

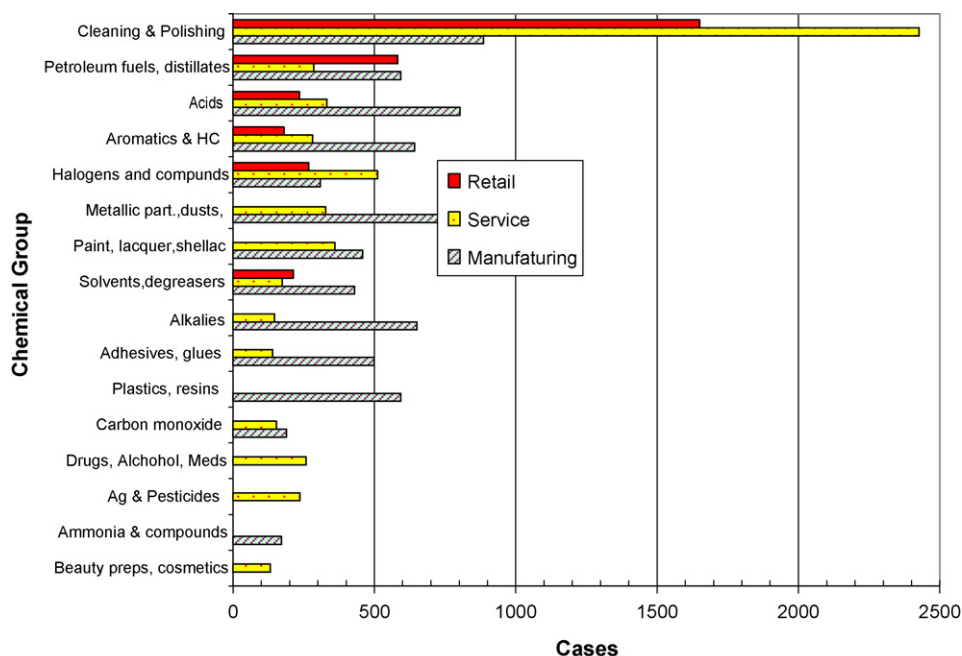


Fig. 5. Chemicals most commonly associated with injuries by selected industry segments (1992 to 2002).

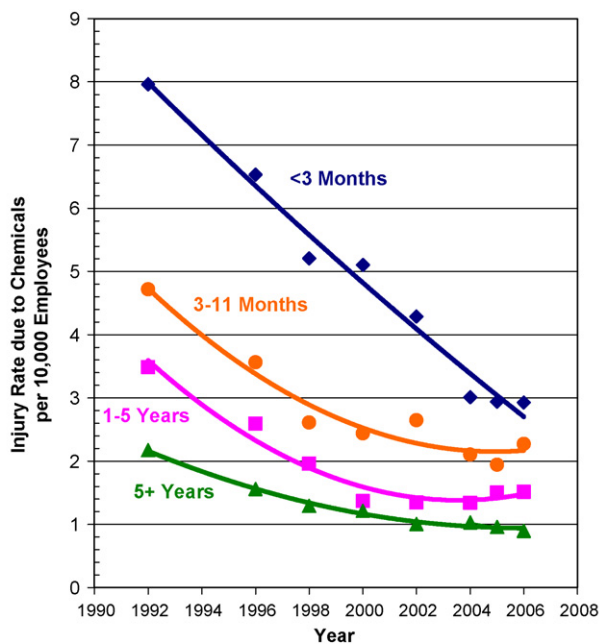


Fig. 6. Injury rate due to chemicals by length of service. Injury rates for chemicals and for all causes by length of service in 2006.

6. Trends in injury by age group

In Fig. 8 it is shown that injury rates have improved for all age groups and that injury rates decrease drastically with age. The exception to this trend is that 16–19 year olds have a lower than expected rate of injury. However, this trend seems to have reduced in recent years, with an upward trend in the rate.

The rates in Fig. 8 are calculated from OSHA numbers of injuries and populations from the Current Population Survey [7].

The approximate number of injuries for ten year age ranges are, 25 to 34, 35 to 44 and 45 to 54–4200; 16 to 24–3500; 55 to 64–1350 and 65 plus–200.

Fig. 8 shows a steeper reduction in injuries due to chemicals than for injuries due to all causes. This is especially true above age 55.

7. Trends in Injuries by race/ethnicity

Whites, Blacks and Hispanics have all experienced dramatic reductions in injury rates over the 15-year period of 1992 to 2006 as shown in Fig. 9. However, gaps between these groups remain.

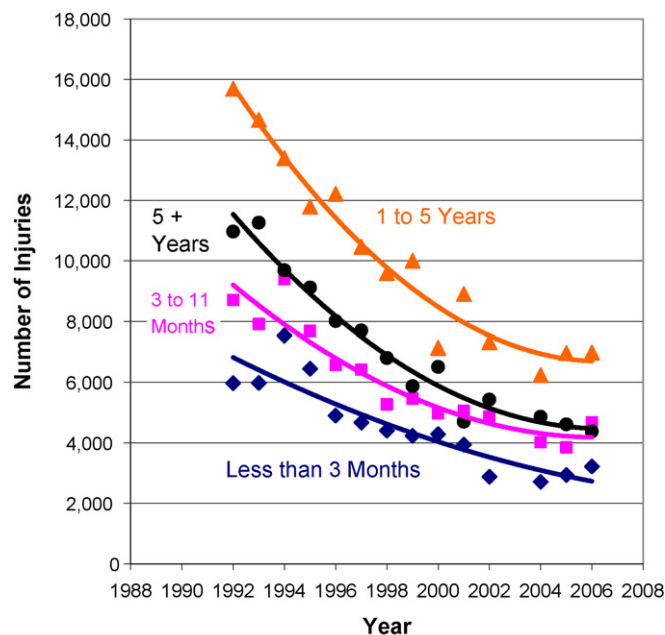


Fig. 7. Number of injuries by length of service.

Hispanics have suffered from the highest rate of injury throughout the period.

During this study period the ratio of the rate of injury of blacks to whites has stayed steady at about 1.7. However, amongst Hispanics that ratio has increased from 2.0 to 2.3.

There is quite possibly some inaccuracy in this analysis of the injury rates for ethnic groups since BLS makes this an optional reporting item. In 2006, 28% of cases had no reported ethnicity. Since it is the reporting establishment that makes this decision, not the victim, it is not clear whether this would be expected to bias the results. This percent of non-reporting has been virtually constant over the 15-year period and there is no apparent reason why there would be any tendency for the reporting of any particular ethnic group to vary with time. It would appear that the relative variations in injury rates over time actually occur although the absolute rates may be subject to a reporting bias.

8. Type of event or exposure

Table 2 shows the average number of “days away” cases with type of exposure from 1992 to 2006. According to Table 2, 94% of injuries due to chemicals are from simple exposure, which includes

Table 2 Event or exposure most commonly associated with injuries (annual averages, 1992 to 2006)

	Number of injuries	% of all injuries
Exposure to harmful substance	27,700	94
Contact with skin or exposed tissue	14,205	48
Inhalation of substance	7,410	25
Temperature extremes	1,601	5
Ingestion	239	1
Other exposure, unknown	4,244	14
Contact with objects or equipment	987	3
Fires and explosions	391	1
Bodily reaction or exertion	271	1
Totals	29,350	100

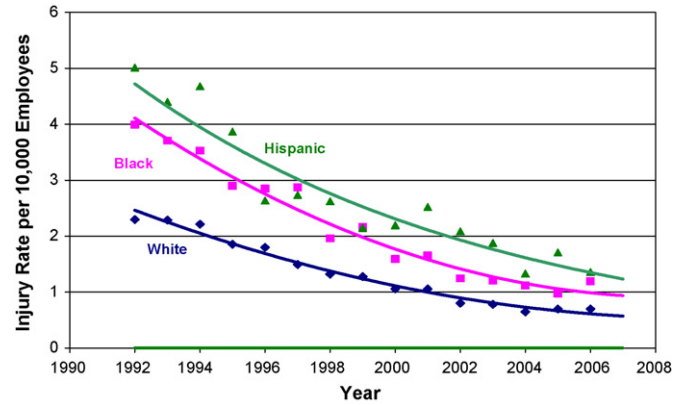
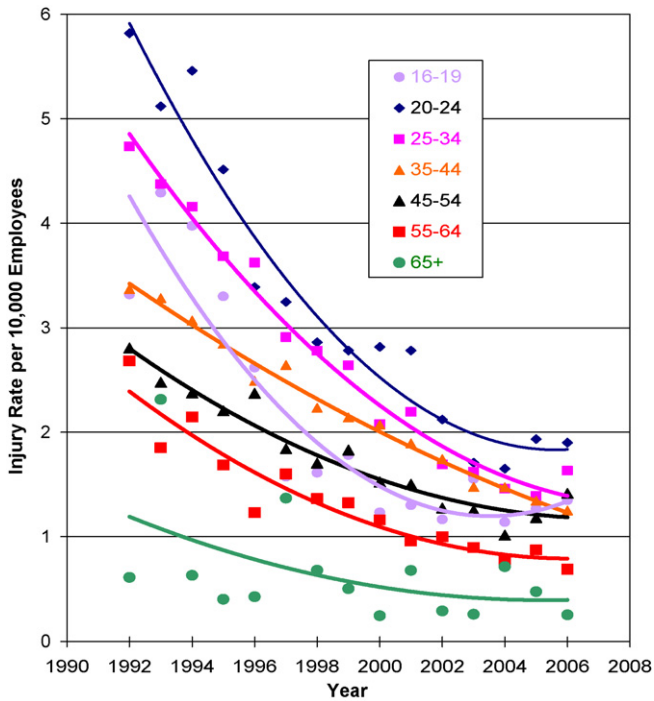


Fig. 9. Injury rates due to chemicals by race/ethnicity.

contact with skin, inhalation and ingestion. More dramatic events such as fires and explosions account for only 1.3% of the injuries. Note that some injuries due to chemicals are not due to their toxicity or flammability. A few percent of cases are due to such causes as slipping on a floor wet with a chemical or from lifting a container of a chemical, as in Table 2.

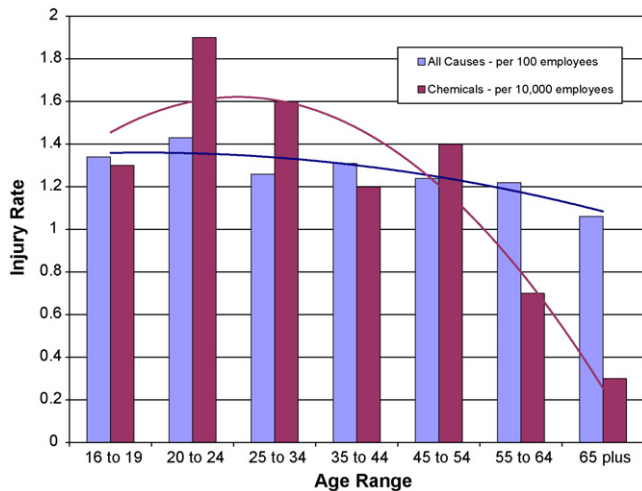


Fig. 8. Injury rates by age group for injuries due to chemicals. Injury rates for all causes and chemicals by age range in 2006

9. Parts of the body injured by chemicals

Three parts of the body account for almost 70% of the DAFW cases involving chemicals. These are the eyes, body systems and upper extremities. Body systems are internal systems, such as nervous, respiratory or endocrine system, which are most likely affected by chemicals that are inhaled or ingested.

94% of chemical injuries are due to simple exposure. Understanding the nature of these exposures would assist employers in preventing these common injuries Fig. 10.

Table 3 illustrates the chemicals most often associated with various parts of the body commonly injured by chemicals. Numbers are shown for all chemical–body part combinations with an average occurrence of more than 200 times per year. This is based on the average for 15 years.

Clearly injuries to eyes are a serious problem across almost all chemical types. Body systems are primarily affected by 11 chemical types. The upper extremities are most commonly injured by 6 chemical groups. The very large number of injuries to eyes by cleaning and polishing materials warrants further investigation of these injuries.

Table 3
Chemical group–body part combinations that account for 68% of chemical injuries (values are annual averages from 1992 to 2006; values shown are those greater than 200)

Chemical	Part of body injured					
	Eyes	Body systems	Upper extremities	Multiple parts	Trunk	Lower extremities
Cleaning and polishing	2335	790	924	269	258	305
Unspecified chemical	1155	1166	600	522	358	215
Nat gas, petroleum, fuels	593	255	599	278		
Acids	610	206	277	264		
Alkalies	604					394
Halogens and compounds	460	349				
Chemical products, unspecified	440	202				
Chemicals and chemical products nec	359	385				
Metallic part, dusts		760			252	
Paint, lacquer, shellac	300	444				
Aromatics and HC	311		223	242		
Solvents, degreasers	391					
Other chemical products	276					
Adhesives, glues			337			
Ag and pesticides		346				
Carbon monoxide		583				
Totals	7834	5486	2960	1575	868	914

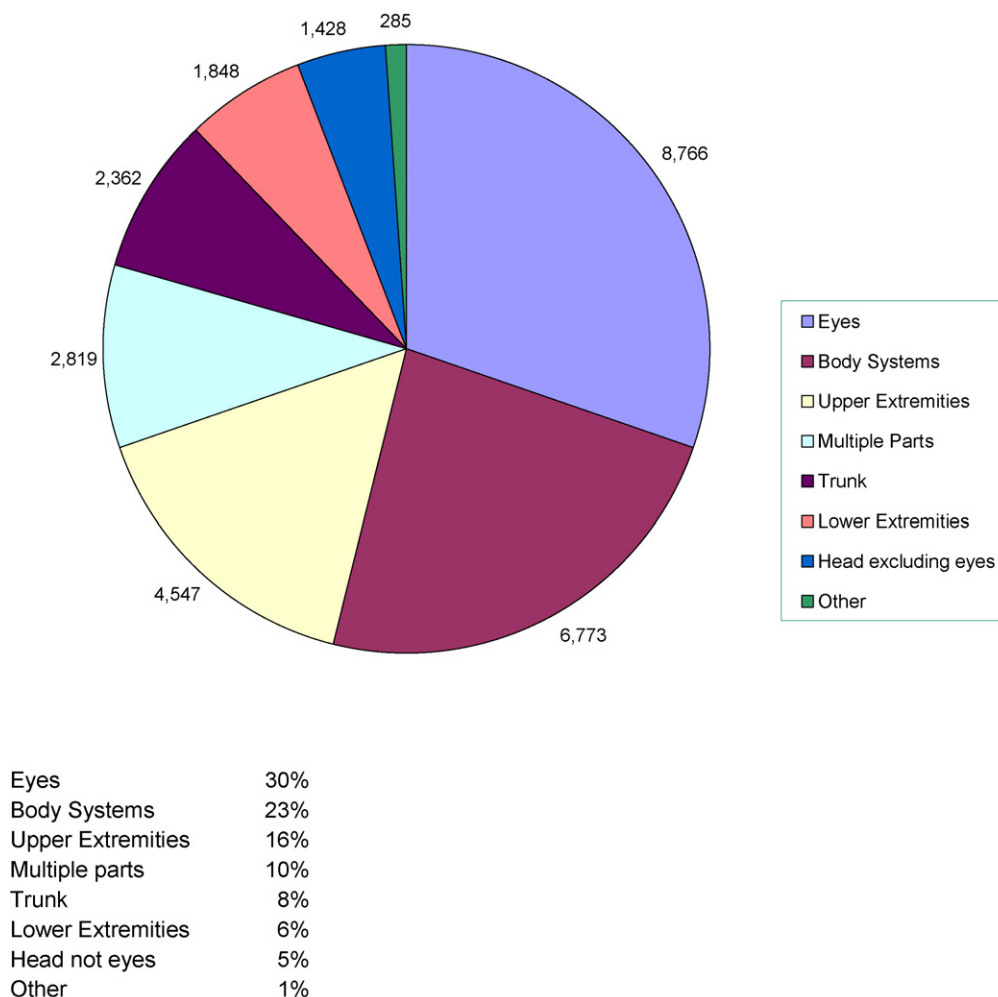


Fig. 10. Number of injuries by body part annual average 1992–2005.

10. Conclusions and recommendations

Detailed analysis of injuries due to chemicals using the OSHA/BLS SOII data offers valuable insight into the details of injuries due to chemicals and suggests areas that may deserve more effort to reduce injuries and areas that need further research to identify the causes. Over the 15-year period from 1992 to 2006 significant progress has been made in reducing injuries due to chemicals.

It has been shown that 94% of injuries are due to simple exposure to chemicals and 70% of the injuries are to the eyes, body systems or upper extremities. The chemicals most often causing injuries are common items such as cleaning and polishing agents and petroleum fuels.

Certain industries have injury rates that are much higher than average and may even exceed the rate in the chemical manufacturing industries. Metal plating and polishing industry has a rate roughly twice that of the chemical manufacturing industry. The food processing industry rate is nearly as high as the chemical industry. Clearly these are priority areas for industry, government, academia and insurance companies to focus their efforts.

Workers are much more likely to be injured early in their employment in a new job. This may be due to training or simply experience gained on the job.

Hispanics continue to experience higher injury rates than whites or blacks.

As the number of cases with “days away from work” continues to drop the statistical basis provided by the case and demographic data continues to decrease. At some point this will begin to interfere with further progress as industry and others attempt to focus on specific causes and circumstances of injuries. When this occurs it will be desirable to gather detailed data not only for DAFW cases but for restricted activity cases as well.

Detailed analysis can also be limited by the design of the on-line query system. It is generally possible to explore 2 variables but not 3 and even the 2 variable queries are limited. For instance, it is possible to get a detailed list of chemicals involved in cases in the food industry (SIC 20). However, it is not possible to determine the chemicals in industry groups within SIC 20. It is also impossible to determine, for example, the chemical and body part involved in cases within an industry group. These limitations are caused by the system’s limits on the number of factors that can be queried or limits in the combinations of factors that can be queried. BLS can make more complex queries on request but there may be a substantial delay. A more sophisticated system accessible to researchers would be desirable.

11. Topics for further study

Several patterns or trends in injuries due to chemicals have been identified that could benefit from further investigation, prob-

ably utilizing sources of data other than OSHA SOII. These topics include:

- The large number of injuries to eyes, body systems and upper extremities. Would simple personnel protective equipment reduce these incidents?
- The nature and cause of injuries in select industries with high rates of injuries due to chemicals.
- The large number of injuries, and the nature and cause of injuries, due to common chemicals such as cleaning and polishing agents and petroleum.
- The high number of injuries early in an employee's tenure at an establishment. What causes the rapid decrease in injury rate in the first months or years of employment and how can this be enhanced?
- The high rate of injuries to Hispanics. What are the causes of these high rates and what can be done to lower them?

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