Adolescent Occupational Injuries Requiring Hospital Emergency Department Treatment: A Nationally Representative Sample

Larry A. Layne, MA, Dawn N. Castillo, MPH, Nancy Stout, EdD, and Patricia Cutlip

A B S T R A C T

Data from a nationally representative sample of emergency departments for the 6-month period July through December 1992 were used to examine nonfatal occupational injuries sustained by adolescents aged 14 through 17 years. There were 679 occupational injuries, corresponding to an estimated 37 405 injuries nationwide. Males constituted 65.8% of the injury victims. The injury rate for males was 7.0 per 100 full-time employees, compared with 4.4 for females. Lacerations to the hand or finger accounted for 25.6% of all injuries. The majority of injuries occurred in retail trades (53.7%), which also had the highest rate (6.3 per 100 full-time employees). Seventy-one percent of the injuries in retail trade occurred in eating and drinking establishments. (*Am J Public Health.* 1994;84:657–660)

Introduction

Among affluent countries, the United States has the largest proportion of its children in the workforce.[1] Although the psychosocial effects of youth employment are controversial,[2–4] the potential for physical injury must be recognized. Castillo et al. report an occupational fatality rate of 5.1 per 100 000 full-time employees for 16- and 17-year-olds.[5] Many fatally injured youths were involved in activities prohibited by federal child labor laws.[5,6]

Several studies have examined nonfatal occupational injuries among adolescents.[7–14] The only published study that reported rates for the entire United States used 1982 data from the National Electronic Injury Surveillance System (NEISS). The rates for 16- and 17-year-olds, 8.2 per 100 full-time males and 3.0 per 100 full-time females, were exceeded only by the rates for 18- and 19-year-olds.[15]

In this study we use NEISS data to describe nonfatal occupational injuries sustained by youths aged 14 through 17 years in the latter 6 months of 1992 that required hospital emergency department treatment. National estimates are presented by age, sex, and industry divisions. The causes and types of injuries are also described.

Methods

The injury data reported here were extracted from NEISS, which is maintained by the Consumer Product Safety Commission (CPSC). NEISS contains information on product-related injuries collected from a national sample of 91 hospital emergency departments in the United States. Through a collaborative effort between the National Institute for Occupational Safety and Health (NIOSH) and CPSC, data on work-related injuries to persons aged 14 through 17 years have been collected since July 1992. This paper presents data for the first 6 months of surveillance, July through December 1992.

Hospitals participating in NEISS were selected from a probability sample of all hospitals in the United States and its territories, stratified by geographic area and hospital size.[16,17] Variances and confidence intervals were calculated on the basis of weighted estimates,[18] but CPSC recommends that confidence intervals not be calculated for weighted estimates of less than 1200. The numbers presented in the tables represent estimates for the number of injured adolescents in the United States for the entire 6-month period.

A work-related injury was defined as any injury sustained during work performed for pay or other compensation, regardless of eligibility for workers' compensation. Also included were injuries sustained during volunteer work for organized groups such as volunteer fire fighters, hospitals, and charity groups. Persons in the military were excluded from this analysis because employment data comparable to those of civilians were not available and the sample included cases from only one of the five military branches.

Industry information was coded according to the *Standard Industrial Classification Manual.*[19] The nature of the injury was derived directly from the physician's diagnosis.[20]

Although data were not available for the first 6 months of 1992, an estimate for the entire year was extrapo-

The authors are with the Division of Safety Research, National Institute for Occupational Safety and Health, Morgantown, WVa.

Requests for reprints should be sent to Larry A. Layne, MA, Division of Safety Research, National Institute for Occupational Safety and Health, 944 Chestnut Ridge Rd, Morgantown, WV 26505.

This paper was accepted November 15, 1993.

Editor's Note. See related editorial by Pless (p 537) and articles by Castillo et al. (p 646) and Parker et al. (p 606) in this issue.

TABLE 1—Estimated Number and Rates[a] of Adolescent Occupational Injuries in the United States, by Age and Sex, July through December 1992

	Males		Females		Total	
Age, y	No.	Rate	No.	Rate	No.	Rate
14[b]	1028	...	274	...	1302	...
15	2904	6.7	1136	2.6	4040	4.7
16	7084	6.1	4352	4.7	11 436	5.5
17	13 583	7.6	7044	4.7	20 627	6.3
All	24 599	7.0	12 806	4.4	37 405	5.8

Note. Because each number represents one injured adolescent, the numbers were rounded to the nearest integer. Owing to this rounding, the numbers in the rows and columns may not add up to the exact number presented in the totals.
[a]Injury rates were calculated per 100 full-time employees; adolescents injured doing volunteer work were excluded from the rate calculations.
[b]Rates were not calculated because hourly employment data were not available for 14-year-olds.

TABLE 2—Estimated Number of Adolescent Occupational Injuries in the United States, by Body Part Injured and Nature of Injury, July through December 1992

	Nature of Injury						
Body Part	Laceration	Contusion or Abrasion	Sprain or Strain	Burn	Fracture or Dislocation	All Other	Total
Hand or finger	9560	2233	961	1620	614	1592	16 579
Leg, knee or ankle	1189	928	1638	420	356	423	4954
Head, face, or neck	1111	941	34	1092	0	1466	4644
Wrist or arm	853	961	1199	843	342	252	4449
Trunk or shoulder	51	1097	2073	267	77	183	3749
Foot or toe	132	590	137	327	166	818	2171
All other	0	69	0	60	0	732	860
Total	12 896	6819	6042	4629	1555	5465	37 405

Note. Because each number represents one injured adolescent, the numbers were rounded to the nearest integer. Owing to this rounding, the numbers in the rows and columns may not add up to the exact number presented in the totals.

lated from the estimated number of adolescents injured from July through December 1992. To account for the seasonal variability of adolescent work, we assumed that the adolescent injury pattern for 1992 followed the same monthly patterns as for the years 1982 through 1986. Using the monthly distribution of adolescent injuries from previous surveillance, we computed an annual estimate for the entire year of 1992. (NEISS occupational injury data were collected by NIOSH for the years 1982 through 1986. These data were analyzed by month for workers aged 14 through 17 years for the 5-year period. The monthly weighted distribution was used to estimate the number of injuries that occurred during the first 6 months of 1992, a period for which data were not collected.)

In computing injury rates, labor force data from the Bureau of Labor Statistics' Current Population Survey were used as the denominator.[21] The Current Population Survey is a monthly national survey that includes employment information for persons as young as 15 years old. Employment data were converted to full-time employee equivalents.

Injury rates were not calculated for 14-year-olds because of the lack of hourly employment data. Because employment data from the Bureau of Labor Statistics do not include volunteer work, adolescents injured while performing volunteer work were not included in the rate calculations.

This study focuses on nonfatal injuries only. Data from emergency departments tend to underestimate fatal injuries because many victims of traumatic injury die before ever reaching an emergency department.[22] The NEISS system did not include any fatalities to adolescents during the period of this study.

Results

There were 679 occupational injuries to 14- through 17-year-old civilian workers reported in NEISS (July through December 1992). This number represents an estimated 37 405 (95% confidence interval [CI] = 28 000, 46 800) injuries nationwide to adolescent workers for the 6-month period. An estimated 297 (0.8%) of these injured adolescents were performing volunteer work; approximately 948 of the injured youth required hospitalization. It is estimated that about 64 100 (95% CI = 48 100, 80 200) work-related injuries to adolescents were treated in emergency departments during the entire year of 1992.

Table 1 shows the distribution of injuries and injury rates by age and sex for the 6-month period. Males accounted for a larger percentage of injuries (65.8%) and had a higher injury rate than females. The injury rate per 100 full-time employee equivalents for 16- and 17-year-olds combined (for comparison with rates found in other studies) was 7.0 for males and 4.7 for females.

Lacerations were the most common type of injury incurred (Table 2). Contusions and abrasions, sprains and strains, and burns constituted a larger proportion of injuries among females (56.5%) than among males (41.7%), although the injury rates for these three types of injuries were similar for both sexes. However, males' injury rate for fractures and dislocations was twice that of females (0.2 and 0.1, respectively, per 100 full-time employee equivalents); males' laceration rate was nearly twice that of females (2.0 and 1.2, respectively, per 100 full-time employee equivalents).

The hand or finger was the most frequently injured body area (44.3%) (Table 2). For males, 44.5% of injuries were sustained in the hand or finger; the proportion for females was 40.2%. The leg, knee, or ankle accounted for 10.6% of the injuries to males and 18.4% of those to females.

The industry division of retail trade accounted for 53.7% of all injuries and had the highest occupational injury rate

among adolescent workers (Table 3). The largest proportion of injuries in the retail trade industry (71.2%) occurred in eating and drinking establishments (Table 4).

The retail trade industry was characterized by high proportions of lacerations (39.0%) and burns (17.7%) (Table 4). Of laceration injuries in retail trade, a majority resulted from being struck by objects and striking against objects. Hand or finger injuries constituted more than one half of all injuries in retail trade; 84.1% of the injuries to the hand or finger were lacerations. Retail trades accounted for 3553 burn injuries, which primarily resulted from contact with hot objects (73.9%) and exposure to caustic substances (14.8%).

The second-largest number of injuries to adolescents occurred in the service industry. Nearly two thirds of the injuries in the service industry occurred in health services, amusement and recreation, and educational services. Contusion and abrasion injuries were overrepresented in services (30.0%, compared with 15.2% in all other industries) (Table 4).

The agriculture industry accounted for 6.7% of all injuries among adolescents. While lacerations and contusions or abrasions were the most common types of injuries in agriculture, fractures and dislocations were more prevalent in agriculture (14.4%) than in other industries (3.4%) (Table 4). One fifth of all agricultural injuries resulted from being caught in running machinery or equipment.

The manufacturing industry had the second highest injury rate (Table 3) and accounted for 4.0% of all occupational injuries among adolescents. Sprains and strains were the most frequent type of injury in manufacturing (32.3%, compared with 15.5% for all other industries). Forty-seven percent of the sprains and strains in manufacturing were to the hand or finger and 24.8% were to the leg, knee, or ankle.

An examination of the industry divisions by sex shows that a large percentage of injuries incurred by females were in the retail and service industries (Table 3). In agriculture, the proportion of injuries incurred by males was 87.7%, compared with 64.2% for all other industries; also, 40.0% of the injuries in agriculture were to 14- and 15-year-old males, compared with 12.4% for all other industries.

TABLE 3—Estimated Number and Rate[a] of Adolescent Occupational Injuries in the United States, by Industry Division and Sex, July through December 1992

Industry Division	No. Injuries			Injury Rate
	Male	Female	Total	
Retail trade	12 634	7453	20 087	6.3
Services	4049	3632	7681	4.1
Agriculture	2195	308	2502	4.3
Manufacturing	1013	485	1498	5.1
Construction	832	0	832	4.8
Transportation, communication, public utilities	506	34	540	4.4
Wholesale	431	0	431	4.5
Public administration	325	34	359	4.3
Mining[b]	34	0	34	. . .
Finance, insurance, real estate[b]	0	0	0	. . .
Unknown	2580	861	3441	NA
All	24 599	12 806	37 405	5.8

Note. NA = not applicable. Because each number represents one injured adolescent, the numbers were rounded to the nearest integer. Owing to this rounding, the numbers in the rows and columns may not add up to the exact number presented in the totals.
[a]Injury rates were calculated per 100 full-time employees; 14-year-olds and adolescents injured doing volunteer work were excluded from the rate calculations.
[b]Rate was not calculated because of small numbers.

TABLE 4—Estimated Number of Adolescent Occupational Injuries in the United States, by Industry Division and Nature of Injury, July through December 1992

Industry Division	Nature of Injury						
	Laceration	Contusion or Abrasion	Sprain or Strain	Burn	Fracture or Dislocation	All Other	Total
Retail trade	7836	2723	3193	3553	772	2011	20 087
Eating and drinking establishments	5524	1700	2188	3295	416	1177	14 299
Food stores	1270	608	433	132	184	304	2931
General merchandise	524	235	220	0	112	351	1442
All other retail	519	179	352	126	60	180	1416
Services	1772	2304	1258	698	218	1431	7681
Health services	932	807	375	278	0	107	2499
Amusement and recreation	146	308	420	0	150	214	1237
Educational services	340	290	0	270	0	215	1116
Social services	34	244	336	115	0	34	763
Hotels and lodging	60	0	77	0	34	325	495
All other services	261	655	51	34	34	536	1572
Agriculture	890	374	197	17	360	665	2502
Manufacturing	312	150	484	112	43	397	1498
All other	2086	1268	909	249	163	961	5637
Total	12 896	6819	6042	4629	1555	5465	37 405

Note. Because each number represents one injured adolescent, the numbers were rounded to the nearest integer. Owing to this rounding, the numbers in the rows and columns may not add up to the exact number presented in the totals.

Discussion

We estimate that 64 100 of the nation's adolescents were treated in emergency departments for occupational injuries in 1992, and that adolescents have an injury rate of 5.8 per 100 full-time employee equivalents. These national estimates must be considered conservative because they are based on a

study of only injuries treated in emergency departments. Previous studies have found that about 36% of all work-related injuries are treated in emergency departments,[15] and fatal injuries are rarely included in emergency department surveillance.[22]

Adolescent occupational injuries can be prevented only once hazards have been identified and age-specific intervention strategies have been developed and incorporated into the industry's safety and training programs. Injuries reported in retail eating and drinking establishments accounted for the largest number of injuries in any industry subcategory, a finding supported by a study of workers' compensation cases in the state of New York.[9] Many of these injuries, particularly burns and lacerations, occurred in fast food establishments. Implementing methods to prevent burns in eating and drinking establishments, such as those previously recommended on the basis of detailed work-site inspections,[23,24] could prevent about 5650 adolescent occupational burns each year. Detailed studies and work-site investigations could identify prevention strategies in other sectors of retail trade,[11] services, manufacturing, and agriculture.

Although the injury rate in agriculture was not high in comparison with those in other industries, there was some indication that these injuries were more severe. Fractures and dislocations accounted for a higher percentage of the injuries in agriculture than in other industries. This finding is similar to findings from studies of adolescent workers' compensation claims.[9,12] Agricultural occupations declared hazardous by the secretary of labor are sanctioned for youth as young as 16 (and for even younger children working on their parents' farms).[25] In contrast, the minimum age for work declared hazardous in nonagricultural occupations is 18.[26]

There are many workplace risk factors that are unique to the adolescent workforce. Hayes-Lundy et al. found that length of employment is not related to injury experience among youth.[23] In addition, adolescents may be less familiar than adults with workplace hazards and safety awareness. Working youth, their parents, and employers must be informed about child labor laws, the risk of injury to adolescent workers, and the workplace hazards that exist in industries where adolescents are employed. □

Acknowledgments

The authors gratefully acknowledge John Myers and Dr Terry Wassell for their statistical consultation; Dr Philip Landrigan and Dr David Parker for their reviews of this paper; and Art McDonald and Eileen Kessler of CPSC for their support in data collection and methodological review.

References

1. Richter ED, Jacobs J. Work injuries and exposures in children and young adults: review and recommendations for action. *Am J Ind Med.* 1991;19:747–769.
2. Greenberger E, Steinberg L. *When Teenagers Work: The Psychological and Social Costs of Adolescent Employment.* New York, NY: Basic Books Inc; 1986.
3. Stephens W. *Our Children Should Be Working.* Springfield, Ill: Charles C Thomas; 1979.
4. Steinberg L, Dornbusch SM. Negative correlates of part-time employment during adolescence: replication and elaboration. *Dev Psychol.* 1991;27:304–313.
5. Castillo DN, Landen DD, Layne LA. Occupational injury deaths of 16- and 17-year-olds in the United States. *Am J Public Health.* 1994;84:646–649.
6. Suruda A, Halperin W. Work-related deaths in children. *Am J Ind Med.* 1991;19:739–745.
7. Brooks DR, Davis LK, Gallagher SS. Work-related injuries among Massachusetts children: a study based on emergency department data. *Am J Ind Med.* 1993;24:313–324.
8. Glor ED. Survey of comprehensive accident and injury experience of high school students in Saskatchewan. *Can J Public Health.* 1989;80:435–440.
9. Belville R, Pollack SH, Godbold JH, Landrigan PJ. Occupational injuries among working adolescents in New York State. *JAMA.* 1993;269:2754–2759.
10. Parker DL, Carl W, French LR, Martin FB. Characteristics of adolescent work injury reported to the Minnesota Department of Labor and Industry. *Am J Public Health.* 1994;84:606–611.
11. Banco L, Lapidus G, Braddock M. Work-related injury among Connecticut minors. *Pediatrics.* 1992;89:957–960.
12. Heyer NJ, Franklin G, Rivara FP, Parker P, Haug JA. Occupational injuries among minors doing farm work in Washington State: 1986 to 1989. *Am J Public Health.* 1992;82:557–560.
13. Parker DL, Clay RL, Mandel JH, Gunderson P, Salkowicz L. Adolescent occupational injuries in Minnesota: a descriptive study. *Minn Med.* 1991;74:25–28.
14. Schober SE, Handke JL, Halperin WE, Moll MB, Thun MJ. Work-related injuries in minors. *Am J Ind Med.* 1988;14:585–595.
15. Coleman PJ, Sanderson LM. Surveillance of occupational injuries treated in hospital emergency rooms—United States, 1982. *MMWR.* 1983;32:31SS–37SS.
16. *The NEISS Sample (Design and Implementation).* Bethesda, Md: US Consumer Product Safety Commission, Division of Hazard and Injury Data Systems; March 1986 (revised October 1992).
17. Marker D, Waksberg J, Branden J. *NEISS Sample Update: Final Report.* Rockville, Md: Westat, Inc.; June 3, 1988. Publication CPSC-C-87-1144.
18. *National Electronic Injury Surveillance System (NEISS): Estimated Generalized Relative Sampling Errors.* Bethesda, Md: US Consumer Product Safety Commission; September 1988.
19. *Standard Industrial Classification Manual, 1987.* Washington, DC: Office of Management and Budget; 1987.
20. *National Electronic Injury Surveillance System Coding Manual.* Bethesda, Md: US Consumer Product Safety Commission; 1985.
21. *Annual Average Supplements: Employment and Earnings.* Washington, DC: US Bureau of Labor Statistics; 1993:40(issue no. 1).
22. Rivara FP. Fatal and nonfatal farm injuries to children and adolescents in the United States. *Pediatrics.* 1985;76:567–573.
23. Hayes-Lundy C, Ward RS, Saffle JR, Reddy R, Warden GD, Schnebly WA. Grease burns at fast-food restaurants: adolescents at risk. *J Burn Care Rehabil.* 1991;12:203–208.
24. Centers for Disease Control and Prevention. Occupational burns among restaurant workers—Colorado and Minnesota. *MMWR.* 1993;42:713–716.
25. *Child Labor Requirements in Agriculture under the Fair Labor Standards Act* (Child Labor Bulletin no. 102). Washington, DC: US Dept of Labor, Employment Standards Administration, Wage and Hour Division; 1984. WH publication 1295.
26. *Child Labor Requirements in Nonagricultural Occupations under the Fair Labor Standards Act* (Child Labor Bulletin no. 101). Washington, DC: US Dept of Labor, Employment Standards Administration, Wage and Hour Division; 1978. WH publication 1330.