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A Detailed Analysis of Work-Related Injury Among Youth Treated in Emergency Departments

Elizabeth B. Knight, MPH, Dawn N. Castillo, MPH, and Larry A. Layne, MA

Telephone interviews were conducted with 146 14- to 16-year-olds who incurred an occupational injury treated in an emergency department during the period July through September 1992. Thirty-two percent of the injuries occurred as the result of using equipment. Over half the workers reported not having received prior training on how to avoid injury. The injury limited normal activities for at least 1 day for 68% of the youth and for more than a week for 25%, corresponding to an estimated 6,208 (95% CI: 4,277, 8,139) and 2,639 (95% CI: 1,580, 3,699) youths nationwide, respectively. Employment in retail trades, equipment use, lack of training, and burn injuries were associated with increased limitation of normal activities. Nineteen percent of the youths appear to have been injured in jobs declared to be hazardous, or typically prohibited for their age (14- and 15-year-olds) under federal child labor laws. The prohibited job directly contributed to the injury in 64% of these cases.

Key words: adolescents, children, child labor, occupational injury, Fair Labor Standards Act, burn injury

INTRODUCTION

The National Institute for Occupational Safety Health (NIOSH) estimates that 64,100 14 to 17 year olds were treated in hospital emergency departments for work-related injuries in 1992. This corresponds to an occupational injury rate of 5.8 per 100 full-time equivalents [Layne et al., 1994]. Based on 1982 data from a nationally representative sample of emergency departments, 16- and 17-year-old males and females had 2 and 1.5 times the rate of work-related injury of male and female adults, respectively [Coleman and Sanderson, 1983]. A Swedish study [Jacobsson and Schelp, 1988] found similar results; the occupational injury rate of males aged 15–19 years was twice as high as that of all workers aged 20 and older.

Research into work-related injury among adolescents has allowed for the development of a risk profile. Multiple studies have demonstrated that, in general, (a) males have a higher rate of occupational injury than females [Parker et al., 1994a;

Division of Safety Research, National Institute for Occupational Safety and Health, Morgantown, West Virginia.
Elizabeth Knight was an Association of Schools of Public Health/Centers for Disease Control and Prevention intern at the Division of Safety Research when this work was completed.
Address reprint requests to Dawn N. Castillo, MPH, Division of Safety Research, National Institute for Occupational Safety and Health, 1095 Willowdale Road, Mail Stop 180, Morgantown, WV 26505.
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Layne et al., 1994; Brooks et al., 1993; Belville et al., 1993; Schober et al., 1988; Jacobsson and Schelp, 1988; Rivara, 1985; Coleman and Sanderson, 1983], (b) injury rates increase with age [Layne et al., 1994; Brooks et al., 1993; Belville et al., 1993; Parker et al., 1991; Rivara, 1985], (c) the retail trade sector has one of the highest rates and accounts for the largest proportion of nonfatal occupational injuries [Layne et al., 1994; Belville et al., 1993; Banco et al., 1992; Parker et al., 1991; Schober et al., 1988], and (d) the use of cutting instruments accounts for a substantial proportion of nonfatal injuries [Layne et al., 1994; Brooks et al., 1993; Banco et al., 1992; Parker et al., 1991].

Despite research that has recently provided statewide and national estimates of adolescent work-related injury rates, data on the circumstances surrounding these injuries or on resulting disability are scant. Richter and Jacobs [1991] note "a paucity of data on exposures and outcomes associated with different kinds of work for children." The lack of more descriptive information on the relationship of injury to type of work, type of equipment, and work conditions is a barrier to prevention. The purpose of the present study, which examines detailed data on work-related injuries among 14- to 16-year-olds treated in emergency departments, is twofold: (a) to analyze the circumstances under which adolescent occupational injuries occur; and (b) to assess how serious the injuries are in terms of medical care and limitation of normal activities.

MATERIALS AND METHODS

The U.S. Consumer Product Safety Commission (CPSC) operates the National Electronic Injury Surveillance System (NEISS), which collects information on product-related injuries from a nationally representative sample of 91 hospital emergency departments. Hospitals participating in NEISS are from a probability sample of all hospitals in the United States and its territories stratified by geographical region and hospital size [US Consumer Product Safety Commission, 1994. Marker et al., 1988].

In a collaborative agreement between CPSC and NIOSH, data on work-related injuries to youth younger than 18 years (including injuries not involving a product) have been collected since July 1992. Consistent with national guidelines for determination of an injury at work [Jenkins et al., 1993], injuries were considered work-related if they were sustained while performing work done for compensation on or off employer premises, or while arriving or leaving work, or on a break from duties if the injury was sustained on employer premises. In deviation from the national guidelines, injuries incurred while performing volunteer work for an organized group, such as a hospital volunteer organization or a charity group, were also considered work related for this study.

Information on the victim, injury, industry, and a brief descriptive scenario are abstracted from emergency department records. A detailed description of the surveillance system and an analysis of the first 6 months of data have been previously reported [Layne et al., 1994].

A follow-back study was undertaken to gather detailed information not available from emergency department records. The follow-back survey included all surveillance cases aged 14 to 16 years treated during the 3-month period July 1 through September 30, 1992. Seventeen-year-olds were excluded from the survey because financial constraints limited the number of surveys that could be conducted. Exclu-

sion of 17-year-olds was preferable to interviewing a sample of 14- to 17-year olds identified through NEISS (a sample of emergency departments in the United States) because subsampling from a sample increases the sampling error of the estimates [Cochran, 1977].

A questionnaire that elicited details about the circumstances surrounding the injury, job characteristics, resulting disability, and demographics was used. Parental consent was sought to interview the injured minor by telephone. When requested by the parent/guardian or when repeated attempts at reaching the child were unsuccessful, parents or responsible adults were interviewed. All but two interviews were conducted by a single interviewer; 90% of the questionnaires were completed within 2 months of the injury treatment date. Industry and occupation data were coded according to the Standard Industrial Classification Manual, 1987 [Office of Management and Budget, 1987] and the Bureau of Census Alphabetic Index of Industries and Occupations, 1980 [Bureau of the Census, 1980], respectively.

The Fair Labor Standards Act of 1938 (FLSA) is the primary federal law regulating wages and working conditions of American adults and children. Regulations issued under the FLSA limit the hours and occupations that 14- and 15-year-old youth may work, prohibit employment in specified hazardous agricultural work for youth younger than 16, and prohibit employment in specified hazardous nonagricultural work for youth younger than 18 years. Types of work declared to be hazardous under the FLSA are included as prohibited occupations for 14- and 15-year-olds. There are numerous exemptions to the FLSA, such as youth working on their parents' farm and youth in work experience programs. Additionally, the ages at which hazardous work is prohibited differ for agricultural and nonagricultural work. Instead of attempting to identify violations of the FLSA, we focused on identifying cases in which injuries resulted from work typically prohibited for 14- and 15-year-olds, and work declared to be hazardous under the FLSA. We followed guidelines within the Child Labor Requirements of the FLSA [US Department of Labor, 1990a,b] to classify work as to whether or not it was a "prohibited" occupation for 14- and 15-year-old workers, and whether or not the work was declared to be "hazardous" (14- to 16-year-olds). These assessments were based on information provided by the respondent on the injury event, and typical duties and equipment used during work. Because the child labor requirements are a complex set of regulations, it was not possible to definitively make these classifications. Therefore, cases were coded as "probably," "probably not," or "not enough information."

Each case treated in an emergency department participating in NEISS is assigned a statistical weight that reflects how many similar cases it represents nationally [US Consumer Product Safety Commission, 1994a,b]. Therefore, it is possible to produce national estimates from NEISS data. However, because of the relatively small number of workers surveyed, extrapolation to the national level was not appropriate for many factors of interest because the estimates would have been unstable. Unless noted, data presented in this paper are actual numbers and proportions from the survey, not weighted estimates. Therefore, with some few exceptions, data presented in this paper should be interpreted as a case series as opposed to data from a nationally representative sample.

Data on the number of youth for whom the injury resulted in a restriction of their normal activities were sufficient to support extrapolation to national estimates. To produce national estimates, the statistical weights in the NEISS surveillance system

TABLE I. Demographics of Youths With Occupational Injuries by Response to Survey, July–September 1992

Characteristic	Responders (n = 146) No. (%)	Nonresponders (n = 28) No. (%)	Fisher's exact test p-value
Gender			
Males	93 (64)	22 (79)	.19
Females	53 (36)	6 (21)	
Age, years			
14	15 (10)	5 (18)	.08
15	36 (25)	11 (39)	
16	95 (65)	12 (43)	
Race (interview)			
White, non-Hispanic	92 (63)	NA	NA
Black, non-Hispanic	23 (16)	NA	
Hispanic	16 (11)	NA	
Other	4 (3)	NA	
Unknown	11 (7)	NA	

were adjusted to account for nonresponse in the telephone survey, and 95% confidence intervals (CI) were calculated.

The software program StatXact (Cytel, Cambridge MA) was used to obtain exact p values for statistical significance tests. Fisher's exact test for row and column independence in a single contingency table [Fleiss, 1981] was used to compare groups on categorical demographic variables. To measure the impact of the injury on the child's life, the following question was asked: "How many days did you cut down or not do the things that you usually do in school, at work, or play, as a result of this injury?" Responses were placed in one of three categories, as a measure of disability: 0 days, 1–7 days, and 8 or more days. The Cochran-Armitage test for trend [Fleiss, 1981] was used to assess the relationship of worker characteristics and injury circumstances to increasing limitation of normal activities.

RESULTS

Sample

There were a total of 174 surveillance cases for the reference period, corresponding to an estimated 9,996 (95% CI: 7,204, 12,788) 14 to 16 year olds with occupational injuries treated in emergency departments from July through September 1992. The interview was completed for 146 cases (84% response rate). Of the 28 nonresponse cases, 21 could not be contacted and 7 refused consent. Though not statistically significant, responders appeared to more likely to be female and older than nonresponders (Table I). Because race, as recorded on the medical record, was missing for 43% of the nonresponders, a comparison of race could not be made between responders and nonresponders. We were also unable to test for differences in socioeconomic status between these two groups due to lack of information.

The injured worker was interviewed in 87% (127/146) of the interviews; a proxy (parent or guardian) was interviewed for 13% of the cases. Although the use of proxies often resulted in incomplete questionnaire data, no significant differences were detected between the proxy and nonproxy cases in terms of age ($p = .86$), gender ($p = .61$), or race ($p = 1.0$).

Worker Characteristics

The age, gender, and race distribution of interviewed cases is shown in Table I. Seventy-eight percent were on summer break at the time of their injury. Of those on summer break, 61% reported working during summer only, while 38% also worked during the school year.

Temporal Characteristics

Eighty-eight percent of the injuries took place in July and August (45% and 43%, respectively), with 12% in September. The majority of the cases occurred between noon and 6 p.m. Only two workers were injured before 7 a.m. or after 10 p.m. On the day of incident, the average length of time at work prior to the injury was 3.5 hr. Seven percent were injured within the first hour and 8% after 6 hours of work. Thursday, Friday, and Saturday were the most common days of injury occurrence. Eighty-seven percent of the injured workers received emergency department treatment on the same day as the injury; 96% were treated within 1 day.

Job Characteristics

Table II lists industries and occupations of the injured youths. Eating places were the most common industry, representing approximately one third of the cases. Though type of restaurant was not specifically queried in the interview, 32 respondents reported that the industry was a fast-food restaurant. This represents 22% of all cases and must be considered conservative because of the lack of a standard question regarding the type of restaurant. Fifty-two workers (36%) were in food preparation and service occupations. The majority (78%) of injured youths worked for a person not associated with the family. About 8% worked for a relative (nonparent) or family friend. Less than 4% worked for a parent or guardian.

Injury Circumstances

Location. Ninety-seven percent of the victims were working (i.e., not on break or at lunch) when the injury occurred. Fifty-four (37%) injuries occurred in either a commercial kitchen, food preparation area, dishwashing room, or dining area. The commercial kitchen, involved in 30 (20%) injuries, was the most common location.

Tasks. Frequent tasks being performed at the time of injury and the leading diagnoses and affected body parts associated with the tasks are presented in Table III. Moving materials or freight was the most common task. Lacerations were a leading nature of injury for several task categories: cooking or food preparation, janitorial work, and stocking shelves or cutting up boxes. Approximately 20% (29) of the workers reported that they were performing a new or unfamiliar task (15) or a task not part of their usual duties (14) at the time of injury. Nearly one third (32%) reported they were working quickly at the time of injury.

Equipment use. About one third of all the cases (47/146) were using or working on some type of equipment that contributed to their injury. An additional six cases were injured by equipment used by a coworker. Table IV lists the major types of equipment that contributed to injuries. About 50% of the equipment was power-driven machinery. Cutting tools (including knives, slicers, razors, and cutters) accounted for one third of the equipment contributing to injury. Food service machinery accounted for 28% of the equipment. In order of frequency of occurrence, the most common individual items overall were tractors, knives, razors, and deep fryers.

TABLE II. Industries and Occupations of Youth With Occupational Injuries, July–September 1992 (N = 146)

	No. (%)
Industry (SIC code)	
Eating places (5812)	49 (34)
Elementary and secondary schools (8211)	10 (7)
Grocery stores (5411)	9 (6)
Amusement and recreation services, n.e.c. (7999)	8 (6)
Hospitals (806)	5 (3)
Other	50 (34)
Not classified	15 (10)
Occupation (BOC code)	
Food preparation and service (433–444)	52 (36)
Janitors and cleaners (453)	14 (10)
Sales clerks (267–278)	12 (8)
Groundskeepers, gardeners, nonfarm (485, 486)	11 (7)
Stock/freight handlers and baggers (877, 888)	9 (6)
Attendants, amusement/recreation facilities (459)	8 (5)
Farm workers (479)	7 (5)
Laborers, except construction (889)	7 (5)
Construction (567, 579, 869)	5 (3)
Volunteers (NA)	4 (3)
Other	9 (6)
Not classified	8 (6)

TABLE III. Diagnosis* and Body Part Affected* Associated With Frequent Tasks[a] (N = 146)

Task	No. (%)	Diagnosis, no.	Body part, no.
Moving materials or freight	25 (17)	Strain/sprain, 9 Contusion/abrasion, 9	Lower arm/wrist, 8 Hand/finger, 5
Cooking or food preparation	19 (13)	Laceration, 8 Heat burn, 7	Hand/finger, 12 Lower arm/wrist, 4
Janitorial work	18 (12)	Laceration, 6 Strain/sprain, 4	Hand/finger, 6 Lower trunk, 4
Stocking shelves/ cutting up boxes	14 (10)	Strain/sprain, 5 Laceration, 5	Shoulder, 3 Lower arm/wrist, 3 Lower leg/ankle, 3

*Only the two leading categories are included.
[a]Excluded from this table are other tasks (with fewer than 10 cases), which accounted for 86 additional cases.

Preventive Measures

Training. The prevalence of safety training was assessed by asking injured workers: "Prior to your injury, had you received any instruction on how to avoid injury while doing this type of work (or working with this equipment)?" Forty-five (31%) workers responded that they had, and 79 (54%) had not. A supervisor gave the training in nearly 80% of the cases where training was received. About half the training was specific to tasks or equipment use and half was general. The training medium was primarily verbal instruction.

Supervision. Presence of a supervisor was assessed by asking the worker:

TABLE IV. Equipment Used by Worker or Coworker That Contributed to Injury (n = 53) in Survey of Adolescents, July–September 1992

Description		Frequency
Food service machinery		15
Industrial deep fryer	4	
Grill	3	
Food slicer	3	
Other	5	
Plant and industrial vehicles		7
Tractor	5	
Forklift	1	
Pallet jack	1	
Knife		5
Box cutter/razor		5
Garden machinery		4
Other		17

"Were you alone when you were injured or were there other workers in the immediate area who you were working with?" If the worker reported that others were in the area, the worker was asked, "Were any of these people responsible for supervising you?" Thirty-four (23%) workers were alone in the immediate work area when they were injured. A supervisor was present for 29 (20%) cases.

Worker Knowledge and Behavior Change

When the victims were asked: "Before you were injured did you know that you could be injured doing what you were doing?" Nearly half (45%) said that they did not. As a result of the injury, 60 (41%) workers changed the way they did their work, for example, 28 said they were more cautious. Four workers (3%) quit their jobs as a result of the injury.

Impact of Injury

Medical treatment. Five (3.4%) of the 146 cases were hospitalized for their injuries. Additionally, 61 (42%) workers suffered injuries requiring a return visit to a hospital, clinic, or private doctor. Of those with return visits to a clinician, the only treatment required by 22 was an evaluation of their condition, while 18 had sutures removed. Less frequent forms of treatment included follow-up with specialists, physical therapy, surgery, setting of bones, and follow-up tests.

Restricted activity. The injury limited normal activities for at least 1 day for 100 (68%) of the youth and for more than a week for 25%. This corresponds to an estimated 6,208 (95% CI: 4,277, 8,139) youth nationwide whose normal activities were restricted for at least 1 day and 2,639 (95% CI: 1,580, 3,699) youth nationwide whose activities were restricted for more than a week as a result of work-related injuries incurred from July through September, 1992. Lack of prior training, employment in the retail industry, equipment use, and burns were positively associated with increased disability (Table V). The test of trend analysis demonstrates a significant tendency for the number of days of restricted activity to increase with the proportion of youth reporting one of the above-mentioned circumstances.

TABLE V. Survey Among Occupationally Injured Youth, July–September 1992: Test for Trend Between Circumstances of Injury and Days of Restricted Activity

Circumstance	Zero days (n = 33) No. (%)	1–7 days (n = 63) No. (%)	8+ days (n = 37) No. (%)	Exact test for trend p-value
Gender				
Male	24 (73)	37 (59)	23 (62)	.455
Female	9 (27)	26 (41)	14 (38)	
Age				
14 or 15	12 (36)	23 (36)	9 (24)	.333
16	21 (64)	40 (64)	28 (76)	
Race				
White	21 (75)	43 (75)	29 (85)	.389
Nonwhite	7 (25)	14 (25)	5 (15)	
Unknown[a]	5	6	3	
Prior training				
Yes	15 (50)	20 (35)	9 (25)	.049
No	15 (50)	37 (65)	27 (75)	
Unknown[a]	3	6	1	
Supervisor present				
Yes	5 (16)	12 (19)	12 (33)	.102
No	27 (84)	50 (81)	24 (67)	
Unknown[a]	1	1	1	
Equipment use				
Yes	8 (24)	21 (34)	19 (51)	.024
No	25 (76)	41 (66)	18 (49)	
Unknown[a]	0	1	0	
Retail industry				
Yes	12 (36)	23 (36)	25 (68)	.010
No	21 (64)	40 (64)	12 (32)	
Hazardous work				
Probably	2 (6)	7 (12)	4 (11)	.661
Probably not	29 (94)	54 (88)	31 (89)	
Unknown[a]	2	2	2	
Strain/sprain				
Yes	6 (18)	13 (21)	5 (14)	.705
No	27 (82)	50 (79)	32 (86)	
Burn (except chemical)				
Yes	1 (3)	5 (8)	7 (19)	.037
No	32 (97)	58 (92)	30 (81)	

[a]Unknowns not included in the test for trend.

Burn Injuries

Burn cases were examined more closely because this was the only type of injury significantly associated with increased disability. Of 14 burns, 11 were scalds and 3 were thermal burns. Two of the thermal burns resulted from contact with a hot lawn-mower muffler. Two of the scald injuries were severe enough to require hospitalization, for eight nights and five nights, respectively.

TABLE VI. Prohibited Jobs Held by 14- and 15-Year-Old Workers That Contributed to Injury (n = 14) in Survey of 146 Youths

Description	No.
Occupation declared hazardous	4
Operation of power-driven machinery	2
Construction occupation	2
Warehousing or storage job	2
Public utilities job	2
Cooking job	1
Transportation occupation	1

Only 5 of the 14 burn victims reported receiving prior training on how to prevent on-the-job injury. Nine burns occurred in the fast-food industry; seven of these were caused by hot grease. Three workers incurred their burn injury from slipping on a wet floor and falling into hot grease or against a hot grill.

Prohibited Jobs and Hazardous Work

Twenty-eight (19%) of all the injury cases appear to have involved a job or work activity typically proscribed under the FLSA. However, the proscribed work directly contributed to the injury in only 18 of these cases. There were 20 cases of 14- and 15-year-olds who were working in jobs typically prohibited for their age, and 15 cases of youth (14- to 16-year-olds) involved in work declared hazardous under the FLSA. Seven of the prohibited activities for 14- and 15-year-olds were also hazardous. All but two of the workers in these categories were male. Tables VI and VII list the types of prohibited jobs for 14- and 15-year-olds, and hazardous work (14 to 16 year olds) that directly contributed to injury. The law specifically proscribes use of power-driven meat slicers or operation of tractors of over 20 power-take-off horsepower; it is unknown whether the tractors or meat slicers reported here met those requirements.

DISCUSSION

When interpreting data from this study, it should be kept in mind that emergency department surveillance does not capture all types of occupational injuries [Fingar et al., 1992]. There are injuries for which medical treatment is never sought and injuries for which treatment is received from clinicians outside of the emergency department. Emergency department data tend to capture acute injuries, such as contusions and lacerations, whereas injuries such as sprains and strains are more frequently identified using worker's compensation data.

Additional limitations to generalization of these findings involve the seasonality and exclusion of 17-year-olds from the survey. Injuries incurred during the summer months, the time frame of this survey, may differ from those incurred during other times of the year. The exclusion of 17-year-olds is important because studies have demonstrated that this age has the highest frequencies and rates of occupational injury among adolescents [Layne et al., 1994; Brooks et al., 1993; Belville et al., 1993; Parker et al., 1991; Schober et al., 1988].

Our results are subject to both recall and nonresponse bias. Because 60% of the interviews were completed within 4 weeks and 90% within 2 months, recall bias

TABLE VII. Hazardous Work That Contributed to Injury of 14- to 16-Year-Olds (n = 9) in Survey of 146 Youths

Description	No.
Tractor operation	3
Operating an elevator, crane, or hoist	2
Operating power-driven meat processing machine	2
Motor vehicle delivery	1
Operating power-driven woodworking machine	1

should be minimal. Nonresponse bias is of some concern, particularly because responders appeared to be more likely to be female and older than nonresponders, and we were unable to compare the socioeconomic status of response and nonresponse groups. However, the response rate was relatively high, 84%, suggesting that the impact of nonresponse bias would not be great.

Although NEISS is based on a probability sample of hospital emergency departments in the United States, the limited size of this follow-back study prohibits generalization of many of the findings to the nation. However, these data do identify many findings that deserve further evaluation and highlight the necessity of obtaining detailed data for the development of appropriate intervention efforts.

National estimates were appropriate for the frequency of injuries in which youth experience a restriction in their normal activities. Our results demonstrate that occupational injuries have a substantial impact on youths' lives, with over 2,600 youth during a 3-month period experiencing restrictions in their normal activities for more than a week as a result of an occupational injury. Injuries resulting in at least 1 week of restricted injury accounted for 25% of all the injured youth. A survey in Minnesota also found a substantial impact of occupational injuries on the lives of youth, with 15% of injured youth experiencing a restriction in normal activities for more than 3 days and 9% for more than a week [Parker et al., 1994a]. The greater proportion of youth with more disabling injuries in the present study compared with the Minnesota study may be a reflection of the different definitions of injury between the two studies. All the injuries in the present study required emergency-department treatment. The definition of work-related injuries in the Minnesota survey is inclusive of injuries in which treatment was sought outside the emergency department, and injuries for which treatment was not sought but the injury affected consciousness or resulted in at least 1 day of restricted activity.

Nineteen percent of the injured youth were injured in jobs typically prohibited under federal child labor laws during the study period. In more than half of these injuries, the prohibited work directly contributed to the injury. The U.S. General Accounting Office estimated that in 1988 at least 11%, or 99,000, of 15-year-olds worked in prohibited occupations [US General Accounting Office, 1990]. Weak enforcement of federal child labor law is documented [US General Accounting Office, 1992; National Safe Workplace Institute, 1992; US General Accounting Office, 1990; Beyer, 1993; Simonson, 1993] and may explain the prevalence of violations.

Our results show that employment in retail trade, equipment use, lack of training, and burns were all associated with injuries resulting in greater disruption of the youths' normal activities. NEISS surveillance revealed that the retail trade has the highest industry-specific adolescent occupational injury rate and that nearly 75% of

retail trade injuries occur in eating and drinking places [Layne et al., 1994]. Teenagers constitute nearly one quarter of the work force in eating and drinking places, a work force that is projected to reach eight million by the year 2000 [Personick, 1991]. Our finding that retail trade injuries are associated with longer time periods in which normal activities are restricted underscores the importance of focusing on the hazards of child labor in this sector.

Half of all burn injuries in our sample were caused by hot grease in fast-food restaurants. The association of grease burns with slipping on a floor has been previously reported [Heinzman et al., 1993; Hayes-Lundy et al., 1991]. The severity of occupational burn injuries is well documented [Parker et al., 1994b; Heinzman et al., 1993; Hayes-Lundy et al., 1991; Inansci and Guidotti, 1987; Rossignol et al., 1986]. However, medical staff of a burn center report that many teenagers do not understand the potential severity of an injury caused by hot grease [Hayes-Lundy et al., 1991].

A Utah burn study illustrates that focused studies have the potential to pinpoint factors related to on-the-job injury. By inspecting fast-food restaurants and interviewing teenage employees and managers, the researchers assessed how employee orientation, training, grill and fryer cleaning procedures, and disposal of grease each play a role in the occurrence of grease burns [Hayes-Lundy et al., 1991]. The study resulted in a set of recommendations for each component. Coarse quarry tile floors and frequent cleaning with grease-cutting agents were recommended as interventions for burns caused by slipping. The use of slip-resistant soles may also help prevent injury.

There appears to be a need for interventions specific to particular pieces of equipment. For example, tractors, which were involved in five injury cases in our study, have also been associated with a considerable number of occupational injury deaths of youth [Castillo et al., 1994; Dunn and Runyan, 1993; Suruda and Halperin, 1991; Rivara, 1985]. Cutting instruments are particularly problematic in nonfatal injuries. A study that looked at 1,176 occupational injuries among 14- to 17-year-olds treated in emergency departments in Massachusetts found that cutting instruments were involved in 229 (20%) cases [Brooks et al., 1993]. A review of occupational injuries to Connecticut minors revealed that one third of all lacerations were caused by a single tool, a case cutter, which is a razor used to open boxes [Banco et al., 1992].

It has been suggested that inexperience may increase youths' risk for on-the-job injury [Layne et al., 1994; Kinney, 1993]. The potential for the prevention of adolescent occupational injuries through training deserves investigation. Less than half the injured youth reported that they had received prior instruction on how to avoid injury while performing their work duties. It is not surprising, therefore, that 45% also said that they did not know they could be injured by doing what they were doing.

When investigating the potential of training programs to impact the incidence of occupational injuries to youth, the spectrum of training efforts needs to be appreciated. Training programs vary from mere education to programs with demonstration, incentives, feedback, and follow-up. Resources guiding adult worker education have recently been developed [Wallerstein and Rubenstein, 1993], but training methods for adolescent workers should take into account the unique perceptions, attributes, and capabilities of youth [Brooks et al., 1993; Zuckerman and Duby, 1985]. Some researchers have suggested that job safety should be taught in the school system [Jacobsson and Schelp, 1988; National Safe Workplace Institute, 1992].

CONCLUSIONS

This study was undertaken on the premise that occupational injuries to adolescents occur in predictable patterns and are controllable. Our results demonstrate the utility of a follow-back interview survey in providing descriptive information and identifying specific circumstances related to work injuries. By linking lack of training, equipment use, retail work, and burns to the more disabling injuries seen in hospital emergency departments, we have identified target areas for intervention and evaluation studies.

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