

# Occupational Injuries Among Working Adolescents in New York State

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**Objective.**—To determine the number, distribution, determinants, and health consequences of occupational injuries among working adolescents in New York State.

**Design.**—A retrospective, population-based analysis of New York State workers' compensation award data and the Annual Demographic File, a supplement to the US Bureau of the Census Current Population Survey.

**Participants.**—Adolescents, aged 14 through 17 years, who received workers' compensation awards for occupational injury from 1980 through 1987.

**Main Outcome Measures.**—(1) Numbers, types, and rates of occupational injuries in working adolescents by age, sex, industry, and occupation; (2) health consequences of injury, especially disability and death; and (3) secular trends in injury award rates.

**Results.**—A total of 9656 adolescents were compensated for occupational injuries; 4201 compensated adolescents (43.5%) suffered permanent disability; 31 working adolescents died. The annual mean rate of compensated occupational injury was 28.2 per 10 000 adolescent workers. Rates were higher in males than in females and ranged from 8.2 per 10 000 in 14-year-old male workers to 46.8 per 10 000 in 17-year-old male workers. Highest rates by industry were seen in manufacturing (49.0/10 000 adolescent workers) and agriculture (46.2/10 000). Unskilled labor was the most dangerous occupation (52.3/10 000).

**Conclusion.**—Occupational injuries are a substantial and underrecognized contributor to the continuing epidemic of injury among adolescents.

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INJURY is the leading cause of lost years of life and a major cause of morbidity and disability among adolescents in the United States.<sup>1-9</sup> The contribution of occupational injuries to the epidemic of adolescent injury has not been adequately studied.

Each year, more than 100 occupational fatalities are estimated to occur among working adolescents.<sup>10</sup> Amputations, burns, fractures, eye injuries, and electrocutions have been reported.<sup>11-15</sup> In 1980, more than 23 000 adolescents in 24 states filed workers' compensation claims for occupational injuries,<sup>5</sup> and in 1988, more than 30 000 work-related injuries and illnesses were reported among children and adolescents in 26 states.<sup>16</sup>

More than 4 million children and adolescents are legally employed in the

United States.<sup>17</sup> The conditions under which they work must comply with state child labor protection laws and with federal wage, hour, and safety regulations specified by the Fair Labor Standards Act of 1938. Except in agriculture, which the Fair Labor Standards Act regulates only to the age of 16 years, it prohibits work with dangerous machinery and toxic substances for children less than 18 years old in all industries. At age 14 years, adolescents may deliver newspapers, stock supermarket shelves, ring up and bag groceries, pump gas, and wash cars. However, work with most power tools, including meat slicers, pizza dough kneaders, and carpentry equipment, is prohibited. Construction work and work as assistant on a vehicle is prohibited until age 18.<sup>18-20</sup>

In violation of state and federal child labor laws, an additional large number of adolescents are employed illegally. Both US citizens and undocumented immigrants work for long hours at less than the legal minimum wage and on dangerous, prohibited machinery.<sup>21</sup> In 1988, the US General Accounting Office reported a 145% increase in detected violations of federal child labor law over the preceding 5 years.<sup>16</sup> The General Accounting Office estimated that 18%

of 15-year-old workers were illegally employed.<sup>22</sup> A 1988 survey of 1106 high school students with work experience revealed that 24% had been asked to work "off the books."<sup>23</sup> An analysis of fatalities among working children by the Occupational Safety and Health Administration found that 70% involved violations of either the Occupational Safety and Health Act and/or the Fair Labor Standards Act.<sup>10</sup>

In New York State, approximately 428 000 adolescents aged 14 through 17 years are employed each year (Tom Corban, written communication, March 1989; unpublished data from the March 1985, 1986, and 1987 Current Population Surveys conducted by the Bureau of Labor Statistics of the New York State Department of Labor). To determine the distribution, determinants, and health consequences of occupational injury in this population, we performed an epidemiologic analysis of workers' compensation data.

## METHODS

### Injury Data

Data on injuries among working adolescents aged 14 through 17 years were obtained from the New York State Workers' Compensation files for the years 1980 through 1987. Workers' compensation data in New York State are entered in a computerized file at the time of closure of each case after legal criteria for eligibility have been satisfied and the workers' compensation board has determined the amount of the award.<sup>24</sup> Rejected claims are not entered into the computer files and are not available by age, sex, industry, or other identifying criteria.

Workers' compensation files contain information on the age and sex of each compensated adolescent, the industry and occupation in which each injury occurred, the source and nature of injury, the extent of injury, and the estimated indemnity cost. Disability may be permanent or temporary. Permanent disability includes fatal injuries, as well as injuries that permanently incapacitate an adolescent (partially or fully), injuries that result in partial or complete loss of vision or hearing, and injuries resulting in the loss or loss of use of any limb or appendage. Temporary disability

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ity is defined as any injury or illness from which an adolescent will fully recover, but at a cost of 8 or more unpaid work days.<sup>25</sup>

All employees in New York State are covered under workers' compensation, with certain exceptions. These include federal and certain local government employees as well as the following: (1) adolescents employed on family farms; (2) farm laborers earning less than \$1200 per year on nonfamily farms; (3) household workers employed less than 40 h/wk by the same employer; (4) baby-sitters and yard and household workers working for a single family; and (5) workers for certain nonprofit organizations.<sup>25</sup> No estimates are available on the number of youths who are employed in these excluded sectors.

Whether legally or illegally employed, minors in New York State are entitled to workers' compensation if the injury occurred in the course of employment and resulted in at least 8 days of disability. Adolescents employed under illegal working conditions are eligible for double compensation if they are injured on the job.<sup>26</sup> Work-related homicides and occupational diseases are compensable. Occupational diseases documented among working adolescents in New York State included occupational asthma and contact dermatitis. Because they accounted for only 0.2% of workers' compensation awards, illnesses were not distinguished from injuries in our analysis.

## Population Data

Estimates of the numbers and demographic distribution of adolescents working in New York State from 1980 through 1987 were derived from the Annual Demographic File, a supplement to the Current Population Survey conducted each March by the US Bureau of the Census.<sup>27</sup> Based on a stratified cluster sample of 6000 households across New York State, employment estimates are calculated by the Census Bureau for reported work performed during the previous calendar year by any household member aged 15 years or older (Tom Corban, written communication, March 1989; unpublished data from the March 1985, 1986, and 1987 Current Population Surveys conducted by the Bureau of Labor Statistics of the New York State Department of Labor). To account for the fact that the Annual Demographic File provides data on the size of the work force in the year preceding the survey, 1 year was subtracted from the age of workers reported at the time of the survey. Thus, adolescents reported by the Annual Demographic File to be aged 15 through 18 years at the time of the interview were considered, in our analy-

sis, to be aged 14 through 17 years at the time of their actual work. Adolescents were defined as those under 18 years of age in accordance with the definition in the Fair Labor Standards Act.

No estimates are available in the Annual Demographic File on the number of adolescents who work without legal resident status or in multiple industrial settings or occupations during the year.

## Calculation of Injury Rates

Injury rates were calculated per 10 000 working adolescents per year. The number of compensated injury awards in each year was used as numerator and the number of working adolescents in the same year as denominator. Injury rates by industrial division (eg, agriculture, retail trade, or construction) were based on Standard Industrial Codes,<sup>28</sup> and injury rates by job category (eg, sales clerk, cashier, or farm worker) were based on Standard Occupational Codes.<sup>29</sup>

To accurately reflect time trends in work-related adolescent injury rates, we converted the workers' compensation database from year of award to year of injury, using our finding that 56% of workers' compensation claims were granted awards within 1 year, 86% within 2 years, and virtually all within 8 years. Through back-calculation based on these data, we developed an algorithm to generate an estimated number of injuries that occurred each year from 1980 through 1987 (details describing the methodology are available from the author on request). Age, sex, and industry- and occupation-specific injury rates were based on the average number of injuries per award year. Also,  $\chi^2$  tests were used to assess significance between proportions.<sup>30</sup> Ninety-five percent confidence intervals for rates of injury were calculated using the method of Haenszel et al<sup>31</sup> based on the Poisson distribution.

Adolescent work is characteristically part-time.<sup>32</sup> In 1986 and 1987, the proportion of working adolescents in New York State who were attending high school was 98% for 15-year-old workers, 90% for 16-year-old workers, and 71% for 17-year-old workers (Tom Corban, written communication, March 1989; unpublished data from the March 1985, 1986, and 1987 Current Population Surveys conducted by the Bureau of Labor Statistics of the New York State Department of Labor). Since adolescents tend to have varied hours of work during the year, with differences occurring between the summer and school months, between weekdays and weekends, and during vacation periods, working hours recalled in March for the Annual Demographic File survey for the previous

Table 1.—Number of Working Adolescents and Workers, Compensation Award Rates by Age and Sex, in New York State, 1980 Through 1987

Characteristic	No. of Working Adolescents	Injury Awards, No. (Rate)*
Annual average	427 578	1207 (28.2)
Age, y		
14	54 845	45 (8.2)
15	91 171	76 (8.3)
16	118 959	325 (27.3)
17	162 603	761 (46.8)
Sex		
M	221 427	905 (40.9)
F	206 151	302 (14.6)

\*Rates are of average annual workers' compensation awards calculated per 10 000 working adolescents per year. Source: New York State Annual Demographic File and New York State Workers' Compensation Files.

calendar year may be inaccurate. To minimize the effects of this bias, we chose to use the number of working adolescents rather than full-time equivalents (FTEs) for the calculation of injury rates.

## RESULTS

From 1980 through 1987, a total of 9656 work-related injury awards were made to adolescents aged 14 through 17 years in New York State. With an average of 427 578 adolescents employed each year, this number represents an annual compensated occupational injury award rate of 28.2 per 10 000 working adolescents. These injuries include an average of one death per year for 14- and 15-year-old workers and three deaths per year for 16- and 17-year-old workers. During this period, 31 adolescents died of work-related injuries.

## Injury Award Rates by Age and Sex

Lowest injury award rates (8.2/10 000 and 8.3/10 000) were found among 14- and 15-year-old workers, respectively (Table 1). For 16- and 17-year-old workers, injury award rates were approximately three and six times higher (27.3/10 000 and 46.8/10 000, respectively). Although only three times as many 17-year-old workers were represented in the work force as 14-year-old workers, they incurred 17 times as many injuries.

Males and females were almost equally represented in the adolescent work force. There were more males working at ages 14 and 15 years, and more females at ages 16 and 17 years. At every age, however, injury award rates for males exceeded those for females by almost a 3:1 ratio. At age 14 years, males had an average injury award rate of 10.6 per 10 000 compared with 4.2 per 10 000 for females. At age 17, the average injury award rate for males was 70.4 per 10 000 compared with 24.2 per 10 000 for females.

Table 2.—Age-Specific Workers' Compensation Award Rates by Industry in New York State, 1985 Through 1987

SIC*	Industry	Average No. of Adolescents Employed	Average Annual Age-Specific Rates, y†				
			14-17	14	15	16	17
F, G	Trade	212 522	33.2 (31,36)	2.7 (1,6)	3.9 (2,6)	30.2 (26,35)	57.1 (52,62)
I	Service	139 074	16.0 (14,18)	2.6 (1,5)	5.8 (3,9)	19.4 (15,25)	28.1 (24,33)
D	Manufacturing	26 729	49.0 (41,58)	44.2 (29,65)	47.3 (30,71)	51.0 (33,75)	51.2 (38,68)
H, J	Finance and government	23 219	17.7 (13,24)	18.0 (4,53)	14.1 (4,36)	11.6 (6,21)	23.6 (15,35)
C, E	Construction and transportation	13 062	32.6 (24,44)	...	10.3 (2,30)	21.1 (10,40)	62.6 (42,90)
A	Agriculture	12 972	46.2 (36,60)	13.8 (3,40)	24.7 (12,45)	67.2 (39,108)	72.3 (49,103)

\*SIC indicates Standard Industrial Classification code.

†Rates calculated per 10 000 working adolescents. Numbers in parentheses represent 95% confidence limits for rates. Source: New York State Workers' Compensation Files and New York State Annual Demographic Files.

### Injury Award Rates by Industry

Manufacturing (49.0/10 000) and agriculture (46.2/10 000) were the industrial sectors with the highest overall rates of work-related injury awards (Table 2). The manufacturing sector employed only 11% of 14-year-old workers and 5% of 15-year-old workers, but had by far the highest rates of injury among these younger workers (44.2/10 000 and 47.3/10 000, respectively). Almost half of all injuries in manufacturing were attributable to the newspaper industry (48%), while the other half were distributed widely across an array of manufacturing areas, including food products (10%), fabricated metal products (6%), and industrial, commercial, and computer equipment (5%).

Agriculture, which employed only 3% of all working adolescents, was the second most hazardous industry overall and accounted for the highest injury rates among 16- and 17-year-old workers (67.2/10 000 and 72.3/10 000, respectively). The majority of injuries occurred on dairy farms (39%), on crop-producing farms (37%), and in agricultural services (17%). Most of the injuries in the agricultural services sector took place in landscape and horticultural services (56%) and in veterinary and animal services (36%).

The trade sector had the third highest injury rate—33.2 per 10 000. This sector, which consisted predominantly (95%) of retail establishments, employed about half of all working adolescents. Its relatively high injury rate and its large number of adolescent employees made it responsible for 56% of all compensated adolescent injury awards. Injuries occurred primarily in eating places (41%), grocery stores (32%), and general-merchandise stores (7%).

The service industry was the second largest employer of adolescents (it employed 33% of the adolescent work force), had a relatively low injury rate of 16.0 per 10 000, and accounted for only 19% of adolescent injury awards. Injuries in this sector occurred primarily in amusement and recreation services (24%) and in health services (21%), predominantly

skilled nursing facilities. Hotels and other lodging places as well as social, educational, and business services each contributed about 10% to injuries in the service sector.

The construction industry accounted for 2.2% of adolescent injury awards and most of these resulted from work for special trade contractors (70%) and on residential buildings (12%).

### Injury Award Rates by Occupation

Unskilled labor had the highest injury award rate (52.3 per 10 000) of all major occupational groupings (Table 3). The majority of compensated injuries among unskilled adolescent laborers occurred in stock handlers and baggers (40%). Additional injuries occurred among machine operators (17%), freight and material handlers (6%), precision production, craft, and repair operators (6%), and garage and service station attendants (5%).

Building service workers and guards were the occupational group with the second highest injury rate (39.5 per 10 000). Most of the injuries in this group involved janitors and cleaners (81%).

Among food-service occupations, which ranked third in injury rates (36.9/10 000), compensation awards went mostly to food preparers (61%), cooks (11%), waiters and waitresses or their assistants (11%), and food-counter workers (10%).

Adolescents were injured in farm occupations at a rate of 26.3 per 10 000. The majority of the injured were farm workers (64%), followed by gardeners and groundskeepers (14%), and animal caretakers (5%).

Almost half of the working adolescent population was employed in either sales and administrative support occupations (26%) or in food-service occupations (20%). Adolescents injured in sales and administrative support included newspaper deliverers (43%), messengers and clerks (31%), demonstrators, models, and promoters (15%), and cashiers (9%). In managerial and professional specialty occupations, compensation awards for

work-related injury were made most frequently to recreation workers (31%), followed by athletes and dancers (19%).

Construction workers and mechanics were injured at a rate of 25.0 per 10 000. Injuries occurred predominantly as mechanics or repairers on automobiles (24%) and other equipment (21%), but also as carpenters (16%) and painters and plasterers (11%). Adolescent workers in these trades were sometimes identified as apprentices.

### Disability and Death Among Working Adolescents

A high proportion (43.8%) of the 9656 adolescent occupational injuries suffered from 1980 through 1987 caused permanent disability, including lacerations, amputations, fractures, dislocations, multiple injuries, and gunshot wounds. Thirty-one occupational injuries (0.3%) resulted in death (Table 4).

For every three adolescents permanently disabled through work-related injury, four incurred temporary disability. When stratified by age, permanent disabilities accounted for 57% of the injuries among 14- and 15-year-old workers compared with only 42% among 16- and 17-year-old workers ( $P < .005$ ). When stratified by sex, permanent disabilities accounted for 46% of the injuries among males compared with only 37% among females ( $P < .01$ ).

When analyzed by industrial sector, permanent disability rates exceeded temporary disability rates by a ratio of 1.17 in agriculture, 1.07 in manufacturing, and 1.03 in finance and government. The two industrial sectors with the highest ratio of permanent to temporary disability awards also had the highest number of deaths—newspaper delivery (five deaths) and farm labor (six deaths).

A review of the 31 work-related fatalities by age showed four, five, nine, and 13 deaths among 14-, 15-, 16-, and 17-year-old workers, respectively. Half of the deaths of 14-year-old workers involved farm work with agricultural machinery. All 15-year-old workers killed on the job were struck by motor vehi-

Table 3.—Age-Specific Workers' Compensation Award Rates by Occupation in New York State, 1985 Through 1987

Occupation	Average No. of Adolescents Employed per Year	Average Annual Age-Specific Rates, y*				
		14-17	14	15	16	17
Sales	105 393	15.9 (14,19)	24.0 (16,35)	11.7 (7,18)	10.4 (7,14)	20.6 (16,26)
Food service	83 000	36.9 (33,41)	1.4 (0,8)	4.8 (2,9)	37.7 (31,46)	67.9 (59,78)
Unskilled labor	66 576	52.3 (47,58)	7.0 (2,18)	9.5 (5,16)	50.5 (44,63)	82.1 (72,93)
Amusement and health	45 716	14.0 (11,18)	0.9 (0,5)	3.5 (1,8)	14.8 (9,24)	47.9 (34,65)
Clerical	36 723	20.2 (16,26)	3.1 (0,17)	5.9 (1,17)	22.3 (13,36)	25.5 (19,34)
Farm workers	28 813	26.3 (21,33)	4.4 (1,11)	20.0 (10,35)	32.8 (21,50)	56.2 (40,76)
Managerial and professional specialty	18 846	10.6 (6,16)	6.7 (0,37)	8.1 (1,29)	15.5 (6,34)	10.0 (5,18)
Building service and guard	17 967	39.5 (31,50)	7.1 (1,21)	14.0 (5,31)	56.1 (34,88)	70.5 (51,94)
Construction and mechanic	7959	25.0 (15,39)	...	5.8 (0,32)	12.8 (3,37)	43.8 (25,71)

\*Excludes 16 585 adolescents with unknown occupations. Rates calculated per 10 000 working adolescents. Numbers in parentheses represent 95% confidence limits. Source: New York State Workers' Compensation Files and New York State Annual Demographic File.

Table 4.—Number of Workers' Compensation Awards and Percent Permanent Disability by Type of Injury in New York State, 1980 Through 1987\*

Type of Injury	No. of Injury Awards	Permanent Disability, %
Traumatic injuries	5360	42.6
Fracture	1750	67.9
Sprain, strain	1732	19.4
Contusion, crush	893	27.3
Multiple injury	524	56.1
Dislocation	145	65.5
Hernia, rupture	124	...
Amputation	118	100.0
Concussion	59	0.3
Gunshot wound	15	53.3
Lacerations	3413	51.1
Cut, laceration, puncture	3354	51.5
Scratches, abrasion	59	30.5
Skin conditions	782	21.5
Burn/scald	682	21.8
Chemical burn	49	28.6
Dermatitis	45	4.4
Freeze/frostbite	6	50.0
Systemic injuries	64	21.9
Inflamed joint, tendon	29	31.0
Poisoning	17	11.8
Other (eg, electrical shock)	18	11.1
Unspecified/unclassified	37	48.6
<b>Total</b>	<b>9656</b>	<b>43.8</b>

\*Source: New York State Workers' Compensation Files.

cles and died of head trauma, 60% as newspaper deliverers.

Sixteen- and 17-year-old workers were fatally injured in a wider range of industrial and occupational settings than were 14- and 15-year-old workers. Three 16-year-old workers died from gunshot wounds during holdups: One was employed as an attendant at a gas station, one as a stock clerk in a grocery store, and one as a cashier in a restaurant. Three 16- and 17-year-old farm laborers were fatally injured by farm equipment: One death occurred at a dairy farm, one at an ornamental nursery, and one at an animal specialty service. One 17-year-old farm laborer died on a dairy farm from gas inhalation, probably hydrogen sulfide in a manure pit. Another 17-year-

old worker was asphyxiated by carbon monoxide at a trucking storage depot.

Severity of injury was reflected in the amount of compensation paid to injured adolescents. In New York State, compensation is generally limited to two thirds of the weekly wage earned prior to the injury. In the case of permanent injury, an allowance is made for higher benefits. During the period under study, awards to compensated adolescents averaged \$268 for temporary disability, \$2700 for permanent disability, and \$6605 for death. Workers' compensation at that time paid a flat fee for work-related deaths that involved no dependents. This fee was raised over the years to a maximum of \$6500 per death in 1987. The only fatally injured adolescent with de-

pendents in our study was a 16-year-old gas station attendant whose dependents were calculated to receive a total of \$38 863.

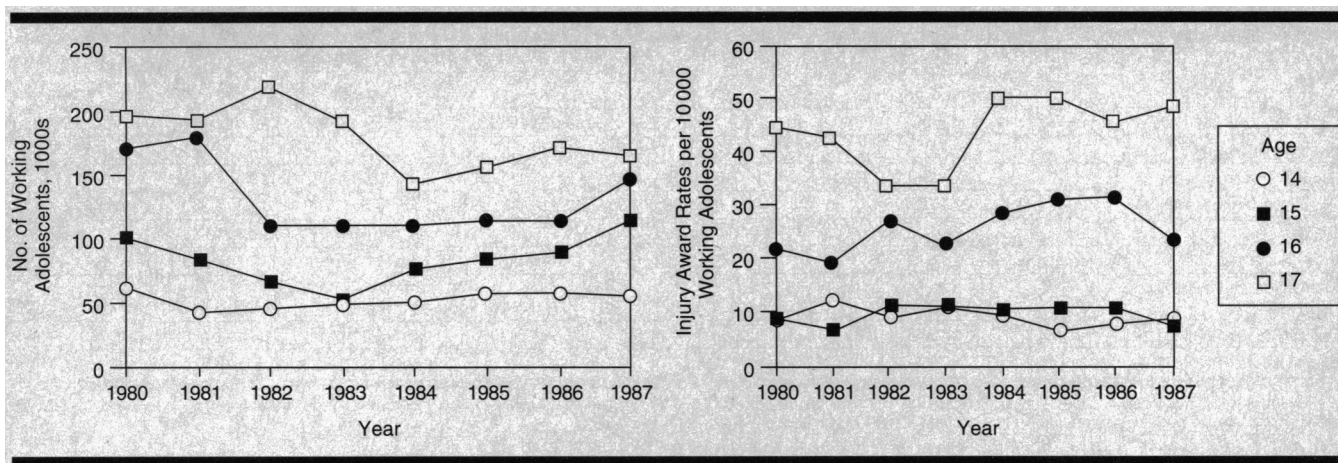
### Time Trends in Work-Related Injury Awards

From 1980 through 1983, the annual injury award rate in New York State fluctuated around 26.0 per 10 000 working adolescents. This relatively stable rate occurred in spite of a shrinking adolescent work force. Then, from 1984 through 1986, injury award rates rose faster than the expanding adolescent work force, resulting in an increased annual injury award rate of 30.1 per 10 000. A drop in injury awards in 1987 returned the rate to its previous lower level, despite continuing expansion of the adolescent work force.

While injury award rates for 14- and 15-year-old workers remained relatively constant throughout the 8-year period, rates for older adolescents showed considerable variation (Figure). The rate for 16-year-old workers increased relatively consistently from a low of 19.1 per 10 000 adolescent workers in 1981 to a high of 31.3 per 10 000 in 1986. Injury award rates for 17-year-old workers, which had decreased steadily from 44.2 per 10 000 in 1980 to 32.4 per 10 000 in 1982 and 1983, surged to 48.9 per 10 000 in 1984 and remained relatively high through 1987.

### COMMENT

The data presented in this article demonstrate that adolescents in New York State are injured, disabled, and killed in many different work settings. Each year, more than 1200 adolescents are awarded compensation for work-related injury. Each year, an average of 525 adolescents suffer some degree of permanent disability. Each year, on average, four adolescents die of injuries sustained at work. Our data found an annual occupational injury award rate of 28.2 per



Number of working adolescents and workers' compensation award rates in New York State, 1980 through 1987. Source: New York State Workers' Compensation Files and New York State Annual Demographic Files.

10 000 working adolescents in New York State from 1980 through 1987.

These data confirm the results of other studies documenting that work makes an important but underrecognized contribution to the continuing epidemic of adolescent injury in the United States.<sup>6,33</sup> The estimated number of 15- to 19-year-olds killed each year at work (110)<sup>10</sup> is comparable to the number killed in falls (103), in fires (126), on bicycles (129), by poisoning (191), and by unintentional firearm injuries (266).<sup>6</sup> The importance of occupational injuries is substantiated further by a population-based survey of emergency department visits and hospital admissions in Massachusetts. This survey found that 24% of adolescent injuries treated in an emergency department were work-related and that they resulted in a longer average length of hospital stay than other adolescent injuries.<sup>6,34</sup> By contrast, 17% of the adolescent injuries treated in an emergency department in Massachusetts were due to sports trauma.<sup>6</sup> Data on fatal farm injury rates<sup>35</sup> and studies of workers' compensation data in other states also demonstrate the substantial toll taken among adolescents in the United States by occupational injury.<sup>36,37</sup>

Consistent with results from other studies, our rates of compensated occupational injury rose sharply with age. In Connecticut, 14-year-old workers accounted for 0.5% of occupational injuries per year, while 17-year-old workers accounted for more than 50%.<sup>37</sup> In Massachusetts, the proportion of work-related injury increased from 2.5% among 14-year-old workers to 26% among 17-year-old workers.<sup>38</sup>

Whether the marked dichotomy in injury rates by age reflects the success of current child labor laws or is the result of some other factor is not clear. Are older adolescents involved in more hazardous work, with less supervision and

more dangerous machinery, or is there something inherently different about how older adolescents approach work? Risks to older adolescents may also be increased by working longer hours. Differential reporting of occupational injuries by age may be another partial explanation.

A limitation of this study is that both the number of work-related injuries and the number of working adolescents in New York State are seriously underreported. Reasons for underreporting injury include lack of knowledge about workers' compensation, intimidation by employers, and fear of losing a job, especially if a child is working in violation of the law or if the family's immigration status is uncertain. Lack of health insurance and lack of a primary health provider may deter adolescents from seeking medical care. Lack of awareness by health professionals that adolescents might have been injured at work also appears to contribute to underreporting; many physicians do not take histories of occupational exposure. Finally, the restrictive eligibility criteria that exist for workers' compensation awards in New York State contribute to underestimates of the true injury rate. In particular, the minimum requirement of 8 days of work missed deters reporting of minor injuries, although the number of denied adolescent workers' compensation claims, which is not available on the computerized records, is estimated to be small (R. Israel, oral communication, March 1992).

Substantial variation in adolescent injury rates is reported across published studies. A factor responsible for this variance is lack of standardization in methods for calculating injury rates. To minimize recall bias in our analysis, we chose to use the number of working adolescents as our denominator. However, to compare our results with those from

studies that are based on FTEs, we converted our denominator into FTEs, using the 1988 General Accounting Office estimates.<sup>22</sup> Our resulting occupational injury rates were 1.1 per 100 FTEs for 16-year-old workers and 1.9 per 100 FTEs for 17-year-old workers. These rates are much lower than the injury rate of 16.0 per 100 FTEs that was calculated in the Massachusetts study of 16 and 17-year-old workers, in part because the Massachusetts' rates were based on longer working hours: an average of 24 h/wk, 26 wk/y<sup>38</sup> instead of the General Accounting Office estimates of 21 h/wk, 23 wk/y.

Different reporting mechanisms among the states<sup>39</sup> also contribute to the observed variance in published occupational injury rates. Thus, workers' compensation databases from states with fewer restrictions than New York State may yield higher occupational injury rates. This difference may explain Schober's<sup>36</sup> reported rates of 12.6 per 100 FTEs for male and 6.6 per 100 FTEs for female 16- and 17-year-old workers. Those rates were based on workers' compensation claims from nine states without minimum lost-time requirements. Similarly, a study in Connecticut of work-related injury claims produced an injury rate of 150 per 10 000 working 16- and 17-year-olds,<sup>37</sup> a rate much higher than the rate in New York State.

In the 1980s and early 1990s, there was a resurgence of child labor in the United States that appears to reflect a convergence of four factors<sup>21</sup>: (1) a strong economy with full adult employment in our geographical area during the years (1980 through 1987) covered by this study; (2) increased poverty among families and an increase in the number of children living below the poverty line<sup>40</sup>; (3) a growing number of illegal immigrants; and (4) relaxed enforcement of federal child labor laws.



In our examination of time trends in adolescent occupational injury rates, we observed that, despite fluctuations in employment, annual injury rates remained relatively constant for 14- and 15-year-old workers, but increased among 16- and 17-year-old workers, especially from 1983 through 1985. Increases in rates of work-related injury, which were also reported during this period among adults, have been associated with business cycle upswings when inexperienced workers are hired and production is accelerated.<sup>41</sup>

## CONCLUSION

In summary, the number of injuries experienced by working adolescents is substantial in the United States. Despite the large variations in estimates of reported adolescent work-related injury rates, and despite the fact that adolescents have lower injury rates than adults (who experience injuries at a rate of 8.6 per 100 full-time, adult US workers<sup>42</sup>), occupational injuries are a serious problem and contribute to the continuing epidemic of adolescent injury. Finally, because occupational injuries in children and adolescents are entirely the consequence of human economic activity, they ought, in theory, to be preventable. Therefore, we offer the following approach to prevention.

## Research

- Further research to identify the types of work situations and events associated with injuries.

## Data Collection

- Development of better systems for monitoring the working patterns of adolescents.
- Development of better surveillance methods for identifying work-related injury.
- Increased diagnostic sensitivity of primary care providers and emergency department staff to the possibility that traumatic injury in children or adolescents may have been caused at work.
- Use of coding with standard definitions for industry, occupation, source, and nature of injury.

## Education

- Better job, health, and safety training, and supervision of employed adolescents.
- Increase awareness among parents, school officials, and employers about child labor laws and the potential hazards of adolescent work.

## Legal Measures

- Better enforcement of existing child labor laws.

- Wider extension of child labor laws to cover agricultural employment and other exempt industries.

- Revisions in child labor laws, specifically updating of lists of machinery prohibited for use at work by children and adolescents, based on known hazards.

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## References

1. Committee on Trauma Research, Commission on Life Sciences, National Research Council, Institute of Medicine. *Injury in America: A Continuing Public Health Problem*. Washington, DC: National Academy Press; 1985.
2. Baker SP, O'Neil B, Karpf RS. *The Injury Fact Book*. Lexington, Mass: Lexington Books; 1984.
3. National Safety Council. *Accident Facts: 1988*. Chicago, Ill: National Safety Council; 1988.
4. National Center for Health Statistics. *Vital Statistics of the United States, 1984*. Hyattsville, Md: US Dept of Health and Human Services, Public Health Service; 1987.
5. Division of Injury Control, Center for Environmental Health in Injury Control, Centers for Disease Control and Prevention. Childhood injuries in the United States. *AJDC*. 1990;144:627-646.
6. Children's Safety Network. *A Data Book of Child and Adolescent Injury*. Washington, DC: National Center for Education in Maternal and Child Health; 1991.
7. Halperin SF, Bass J, Mehta KA, Behs KD. Unintentional injuries among adolescents and young adults: a review and analysis. *J Adolesc Health Care*. 1988;4:275-281.
8. Waller AE, Baker SP, Szocka A. Childhood injury deaths: national analysis and geographic variations. *Am J Public Health*. 1989;79:310-315.
9. Centers for Disease Control and Prevention. Years of potential life lost before age 65—United States, 1987. *MMWR Morb Mortal Wkly Rep*. 1989;38:27-29.
10. Suruda A, Halperin W. Work-related deaths in children. *Am J Ind Med*. 1991;19:739-745.
11. Scott G. Teenager's fingers severed in Queens bakery accident. *New York Newsday*. September 29, 1988; section A:35.
12. Butterfield B. Injured, then abandoned: working children put at risk by uninsured employers. *Boston Globe*. August 5, 1990; section A:1,3.
13. Baker B. Kids at work: the tragic costs of child labor. *Common Cause Magazine*. July/August 1990; 11-14.
14. Kolata G. More children are employed, often perilously. *New York Times*. June 21, 1992; section 1:1.
15. Bagli C. Some 'hard workers' in garment district are just 12 or 14. *New York Observer*. January 9, 1989:10.
16. Human Resources Division. *Child Labor—Increases in Detected Child Labor Violations Throughout the United States: Briefing Report to Congressional Requesters*. Washington, DC: US General Accounting Office; April 1990. Publication GAO/HRD-90-116.
17. Corban T. *Current Trends in Youth Employment*. Albany: Division of Research and Statistics, New York State Dept of Labor; 1988.
18. Division of Labor Standards. *Laws Governing the Employment of Minors in New York State*. Albany: New York State Dept of Labor; 1988 Publication LS 331(7-88), 15M.

19. National Child Labor Committee. Child labor and related law compendium. New York, NY: National Child Labor Committee; December 31, 1986.

20. Wage and Hour Division. *Child Labor Requirements in Nonagricultural Occupations Under the Fair Labor Standards Act*. Washington, DC: US Dept of Labor Employment Standards Administration; September 1985. Publication 1330.
21. Pollack SH, Landrigan PJ, Mallino DL. Child labor in 1990: prevalence and health hazards. *Annu Rev Public Health*. 1990;11:359-375.
22. Human Resources Division. *Child Labor—Characteristics of Working Children: Briefing Report to Congressional Requesters*. Washington, DC: US General Accounting Office; June 1991. Publication GAO/HRD-91-83BR.
23. Durski L. Child labor law survey of teenagers. In: *Child Labor Law Review: Report to New York State Commissioner of Labor*. Albany, NY: Intradepartmental Task Force on Child Labor; November 1988.
24. Baker EL, Melius JM, Millar JD. Surveillance of occupational illness and injury in the US: current perspectives and future directions. *J Public Health Policy*. 1988;9:198-221.
25. *Workers' Compensation Law Handbook of New York*. Binghamton, NY: Gould Publications; 1991.
26. *Analysis of Workers' Compensation Laws*. Washington, DC: US Chamber of Commerce; 1990.
27. Statistical methodology and reliability. In: *Statistical Abstract of the United States: 1991*. 111th ed. Washington, DC: US Bureau of the Census; 1992:913-917.
28. Executive Office of the President, Office of Management and Budget. *Standard Industrial Classification Manual*. Springfield, Va: National Technical Information Service; 1987.
29. *Standard Occupational Classification Manual*. Washington, DC: Office of Federal Statistical Policy and Standards, US Dept of Commerce; 1980.
30. Snedecor GW, Cochran WG. *Statistical Methods*. 8th ed. Ames: Iowa State University Press; 1980.
31. Haenszel W, Loveland D, Sirken MG. Lung-cancer mortality as related to residence and smoking histories. *J Natl Cancer Inst*. 1962;28:947-1001.
32. Nilsen DM. The youngest worker: 14- and 15-year-olds. *J Early Adolesc*. 1984;4:189-197.
33. Runyan C, Gerken E. Epidemiology and prevention of adolescent injury: a review and research agenda. *JAMA*. 1989;262:2273-2279.
34. Anderka MA, Gallagher SS, Azzara C. Adolescent work-related injuries. In: Program and abstracts of the 113th annual meeting of the American Public Health Association; November 19, 1985; Washington, DC. Abstract.
35. Rivara FP. Fatal and nonfatal farm injuries to children and adolescents in the United States. *Pediatrics*. 1985;76:567-573.
36. Schober SE, Handke JL, Halperin WE, Moll MB, Thun MJ. Work-related injuries to minors. *Am J Ind Med*. 1988;14:585-595.
37. Banco L, Lapidus G, Braddock M. Work-related injury among Connecticut minors. *Pediatrics*. 1992;89:957-960.
38. Brooks DR, Davis LK, Gallagher SS. Work-related injuries among Massachusetts children: a study based on emergency department data. *Am J Ind Med*. In press.
39. Barth PS, Hunt HA. *Workers' Compensation and Work-Related Illnesses and Diseases*. Cambridge, Mass: MIT Press; 1980:120-131.
40. Phillips KP. *The Politics of Rich and Poor: Wealth and the American Electorate in the Reagan Aftermath*. New York, NY: Random House; 1990.
41. Robinson JC, Shor GM. Business-cycle influences on work-related disability in construction and manufacturing. *Milbank Q*. 1989;67(suppl 2, No.1): 92-113.
42. Bureau of Labor Statistics. *Occupational Injuries and Illnesses in the United States by Industry: 1988*. Washington, DC: Bureau of Labor Statistics; August 1990. US Dept of Labor bulletin 2366.