

Work Hazards and Workplace Safety Violations Experienced by Adolescent Construction Workers

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Objective: To describe the working conditions of adolescents employed in construction in North Carolina, documenting hazards, safety practices, and prohibited activities.

Design: A cross-sectional telephone survey.

Setting: North Carolina.

Participants: Adolescents (aged <18 years) with work permits for the construction industry in North Carolina during summer 2001.

Main Outcome Measures: Types of jobs, work tasks, supervisory conditions, tools, equipment, and processes.

Results: A total of 187 survey respondents were in this study. Adolescents were employed in varied construction settings and business types. Nineteen of the 187 permitted workers were younger than 16 years, despite prohibitions against their employment in construction unless

working for their parents. The remainder (n=168) were working legally based on age, but most performed prohibited tasks. In fact, 84% of all the 16- to 17-year-olds had performed at least 1 clearly prohibited task and 47% had performed 3 or more. Although most reported being supervised and working with others, approximately 19% of all respondents reported working where they were not in hearing distance of other workers. Data were collected from teenagers with work permits, suggesting that these adolescents may work for more responsible employers. If violations of child labor laws exist in this group, it is likely that adolescents without permits are exposed to even greater hazards and violations.

Conclusion: Involvement of teenagers in dangerous and/or prohibited tasks is cause for concern and suggests a pressing need to examine the enforcement of existing laws and the need for additional protection.

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DESPITE OCCUPATIONAL safety and health gains in recent decades, construction remains one of the most dangerous industries in the United States. Construction workers are exposed to a wide variety of dangerous circumstances or conditions, including work at heights, in trenches, and in confined spaces, exposure to motor vehicles and heavy equipment,^{1,2} and a variety of other physical and chemical hazards.³⁻⁵ Specific tasks and exposures vary based on trade (eg, painters vs electricians), the workers' level of experience or skill, and the work organization at any given work site.

Although only 3% of 15- to 17-year-old workers are employed in construction,⁶ the industry ranks second only to agriculture in annual number of fatal injuries for workers younger than 18 years.⁷ The part-time or seasonal nature of the work of most teenagers makes it difficult to estimate their ac-

tual time at risk. However, data suggest that teenagers employed in construction have fatality rates twice as high as construction workers 25 to 44 years of age.⁸ The leading causes of death for construction workers, including those younger than 18 years, are falls, electrocutions, and being struck by objects.⁹ Prior research has indicated that between 38% and 86% of work-related adolescent deaths are associated with performance of prohibited activities.^{10,11}

Two sets of policies address safety for adolescent workers: child labor laws and Occupational Safety and Health Administration (OSHA) regulations. The Fair Labor Standards Act¹² and the US Department of Labor's regulations¹³ adopted pursuant to the Fair Labor Standards Act provide the framework for all federal child labor provisions. Federal law, however, does not address all employers and employees. Therefore, like all other states, North Carolina has its own set of child labor laws¹⁴ and regulations.¹⁵ The North Carolina law ex-

tends the employment restrictions of the federal law to cover all employers and teenaged workers in the state not subject to the federal law. Additionally, North Carolina regulations define 9 detrimental occupations prohibited for all workers younger than 18 years at any business in the state.¹⁶ The OSHA regulations¹⁷ govern the safety of all workers regardless of age and provide a general backdrop for the more restrictive child labor laws.

Under both federal and North Carolina child labor law, teenagers younger than 16 years are prohibited from working in construction¹⁸ unless for a business wholly owned by their parent(s).¹⁹ Teenagers 16 and 17 years of age may work in construction and perform tasks not listed among either the 17 “hazardous occupations” identified in the federal regulations²⁰ or the 9 “detrimental” occupations identified in the North Carolina regulations.¹⁶ For example, the federal rules prohibit teenagers of these ages from engaging in roofing work, trench and excavation work, operation of powered woodworking machines, and wrecking and demolition work, whereas the North Carolina rules add prohibitions for other work such as welding and work that requires the use of a respirator. Neither state nor federal child labor regulations apply to workers 18 years and older.

North Carolina is 1 of 41 states with a work permit system that regulates the employment of workers younger than 18 years. Typically, the employer initiates the process by completing a portion of the form that specifies the job for which the teenager is being hired. The adolescent then obtains the signature of a parent or legal guardian on the permit and takes it to the Department of Social Services, which, if the system works as prescribed, issues the certificate only after verifying the youth’s age and the legality of the work proposed for a child of that age. Filed with the state’s Department of Labor, a unique work permit is required each time an adolescent begins work for a new employer.

This descriptive study was performed to assess the work experiences and hazard exposures of adolescents working in construction jobs in North Carolina with an ultimate aim of identifying areas that need intervention to improve safety. Because prior research has noted that labor law violations are frequent among young construction worker fatalities,²¹ we had a particular interest in examining lapses in adherence to child labor restrictions.

METHODS

SUBJECT IDENTIFICATION AND ELIGIBILITY

We collected data by telephone interview with working North Carolina teenagers younger than 18 years employed in construction during summer 2001. We identified study subjects by obtaining and sorting all work permits filed with North Carolina during a 4-month period and selecting the permits that indicated that a teenager was being hired to do construction work. These permits contain information on the worker’s name, address, telephone number, age, and sex and a few words indicating the type of work the adolescent was being hired to do. Teenagers who filed for work permits between May and August 2001 were all eligible for inclusion. Workers were screened out at the time of interview if they had worked fewer than 10 days in con-

struction, if they had been interviewed in the pilot study the prior summer, or if their work had been limited to office duties.

PROTECTION OF HUMAN SUBJECTS

The interview protocol was reviewed and approved by the Public Health Institutional Review Board, The University of North Carolina at Chapel Hill. All subjects were minors, so interviewers first contacted a parent or guardian using the telephone number listed on the work permit and obtained oral permission to conduct the interview with their adolescent after reading a statement about the purpose of the study, risks and benefits, and confidentiality procedures. For those adolescents whose parents consented, interviewers obtained their assent in a similar manner. We provided both parents and teenagers with the local telephone number for the North Carolina Department of Labor for more information about child labor laws and worker safety issues.

SURVEY INSTRUMENT

We consulted with staff from the North Carolina Department of Labor and used items from previous surveys and focus groups with teenagers in North Carolina to develop the survey instrument.²²⁻²⁴ The instrument was pilot tested with a sample of 135 eligible North Carolina adolescents who had obtained work permits in 2000 for construction jobs. For the pilot test interviews, each respondent was debriefed at the conclusion of the interview to ascertain if there were questions that were confusing or offensive. The pilot interviews were carefully timed to allow adjustments in the length of the questionnaire to no more than 20 minutes. The final instrument consisted of 134 questions about work hours, training, exposure to chemicals, electrical hazards, supervision practices, and use of safety devices.

DATA COLLECTION

We collected data by telephone survey using trained interviewers employed by The University of North Carolina Department of Biostatistics Survey Research Unit using a computer-assisted telephone interview program. Interviews were conducted between September and October 2001.

DATA MANAGEMENT AND ANALYSIS

Once interviews were completed, we converted the CATI files to SAS files for data editing and analysis and generated basic descriptive statistics examining the teenagers’ report of employer characteristics, their endorsement of work conditions and exposures, and safety practices. All analyses were conducted using SAS statistical software for Windows, version 8.2.²⁵ Data were analyzed depending on the age of the respondent as indicated on the work permit, with those aged 16 to 17 years combined and separated from those younger than 16 years.

RESULTS

THE RESPONDENTS

We identified 324 teenagers younger than 18 years with work permits that indicated construction jobs. Thirty-eight were determined to be ineligible because of language barriers (n=2), not taking the job in construction (n=8), not having worked 10 days for the employer (n=19), having participated in the pilot interview (n=3),

Table 1. Demographics of 187 Adolescent Construction Worker Respondents, North Carolina, Summer 2001

Characteristics	No. (%)
Race	
White	159 (85.0)
Black	12 (6.4)
Other	16 (8.6)
Age on work permit, y	
14	5 (2.7)
15	14 (7.5)
16	101 (54.0)
17	67 (35.8)
Last grade completed in school	
<9th	7 (3.8)
9th	27 (14.6)
10th	64 (34.6)
11th	76 (41.1)
12th	11 (5.9)
Prior work in construction	41 (21.9)
Has concurrent paid jobs outside of construction	25 (13.4)
Ever participated in apprenticeship program related to construction	50 (26.7)

or lacking a telephone (n=6). There also were 38 refusals, 24 because parents denied consent, 12 because teenagers refused to participate, and 2 because eligible teenagers with parental permission could not be reached. In addition, 19 households could not be reached, making it impossible to determine their eligibility. Interviews were conducted with 227 adolescents. Assuming those 19 we could not reach had the same proportion of eligibility as those we reached results in a response rate of 80%.

For this analysis, we restricted our study population to 187 respondents, eliminating those whose responses indicated predominantly office work (n=1) or work that was not for construction firms (eg, working for colleges painting dorm rooms) as reported by 39 respondents. Demographics of the study population are given in **Table 1**.

WORK ENVIRONMENTS

Table 2 gives the type of construction work (not mutually exclusive) done by the businesses that employed the teenagers. Approximately half worked in businesses that were owned by members of their own families or in which family members also worked. Respondents indicated, on average, that they usually worked 8 hours a day, with a range of 3 to 12 hours.

WORK TASKS

Teenagers performed a wide variety of tasks at work sites and under varying conditions. As indicated in **Table 3**, the most common legal tasks that 16- to 17-year-olds reported involved cleaning the work area and getting tools, equipment, and supplies (>90%). Although all the tasks presented in Table 3 are legal for teenagers 16 and 17 years old to perform, a number are dangerous activities, particularly in the hands of an unskilled worker, such as operating a jackhammer or working with equipment that could contact power lines.

Table 2. Characteristics of the Work Environments of 187 Adolescent Construction Workers, North Carolina, Summer 2001

Primary Type of Construction	No. (%)
General carpentry, cabinetry, interior or exterior framing, sheetrock	51 (27.3)
Concrete, masonry	40 (21.4)
Electrical work	37 (19.8)
Plumbing	26 (13.9)
Trenching pipe laying	18 (9.6)
Heating, air conditioning, venting	15 (8.0)
Fence building, landscaping	6 (3.2)
Excavation, grading	13 (7.0)
Roofing	11 (5.9)
Painting, wallpapering	7 (3.7)
Demolition	3 (1.6)
All other	35 (18.7)

Table 3. Legal Work Tasks Engaged in by 16- and 17-Year-Old Construction Workers in North Carolina, Summer 2001*

Tasks Reported	No. (%)
Clean work area	161 (95.8)
Gone to get tools, equipment, supplies on the worksite	156 (92.9)
Used shovel	147 (87.5)
Used knife, box cutter, razor blades	137 (81.6)
Worked as watcher or spotter	125 (74.4)
Removed nails, rivets, screws	116 (69.1)
Used sledgehammer	113 (67.3)
Used handsaw	107 (63.7)
Lifted more than 50 lb (22.5 kg)	100 (59.5)
Used adhesives	92 (54.8)
Mixed mortar, concrete, plaster	67 (39.9)
Used jackhammer, hammer drill, or rotary hammer drill	44 (26.2)
Worked with paint thinners or solvents	27 (16.1)
Planted grass, shrubs, trees, other plants	32 (19.1)
Sprayed paint	27 (16.1)
Operated power lawnmower	21 (12.5)
Mixed paint or polyurethane	15 (8.9)
Worked with equipment where could come into contact with power line	7 (4.2)
Used power-driven post hole digger	6 (3.6)

*Legal tasks for 168 adolescents working in construction in North Carolina are any tasks other than those listed in the federal hazardous Occupation Orders, 29 CFR §570E, and the North Carolina Detrimental Occupations rule, 13 NC Gen Stat §12.0406.

PROHIBITED TASKS PERFORMED BY LEGALLY EMPLOYED ADOLESCENTS

Eighty-four percent of all the 16- to 17-year-old workers reported doing at least 1 task that is clearly prohibited (**Table 4**). Of those reporting doing prohibited activities, 19.1% reported just 1 activity, whereas 17.3% reported 2 activities and 47.0% reported 3 or more. More than a third reported operating power saws, whereas a quarter indicated working as an electrician's helper, being an outside helper on a motor vehicle, or working in trenches deeper than 4 ft (1.2 m).

Table 4. Prohibited Tasks Reported by 16- to 17-Year-Old Construction Workers, North Carolina, Summer 2001*

Activity	No. (%)
Used handheld circular saw, skill saw†	60 (35.7)
Used any other reciprocating saw such as punch or jab saw or a Sawzall†	61 (36.3)
Worked as electrician or electrician's helper†	42 (25.0)
Worked in trenches, holes, or foundations deeper than 4 ft (1.2 m)†	38 (22.6)
Used power nail guns or staple guns†	34 (20.2)
Used power table saw†	21 (12.5)
Used power drill†	105 (62.5)
Operated forklift	24 (14.3)
Put on shingles or other roofing materials†	20 (11.9)
Used powder-activated tools (ie, using gun powder charge)	10 (6.0)
Used chainsaws†	1 (0.6)
Used explosives	0
Total No. of illegal activities reported	
0	28 (16.7)
1	32 (19.1)
2	29 (17.3)
3	23 (13.7)
≥4	56 (33.3)

*Illegal tasks for 168 adolescents listed in the federal Hazardous Occupation Orders, 29 CFR §570E, and the North Carolina Detrimental Occupations rule, 13 NC Gen Stat §12.0406. As illustrated by the tasks denoted by the dagger footnote, some of the federal Hazardous Occupation Orders and all North Carolina detrimental occupations contain exceptions for adolescents working under the supervision of bona fide apprenticeship and student learner programs.

†Legal for workers aged 16 and 17 years only if enrolled in a bona fide apprenticeship or student learner program.

Similarly, many of the respondents indicated performing a number of other tasks that, depending on the circumstances, may be illegal for workers younger than 18 years. We labeled these *suspect* tasks (**Table 5**) because we are unable to tell for sure if the activity was illegal without knowing more about the conditions under which it was performed. For example, 62 workers indicated they had driven a motor vehicle as part of the job. North Carolina law allows young workers to operate only certain motor vehicles on public roads but permits operation of most vehicles, except forklifts and other hoisting apparatus, on off-road sites (available at: http://www.nclabor.com/wh/fact%20sheets/joint_state_fed.htm). As another example, 46 teenagers indicated they had worked on a ladder, scaffold, or other structure at heights above 6 ft (1.8 m). It is noteworthy that this is the level at which OSHA mandates fall protection practices for all construction workers.

WORKERS POTENTIALLY ILLEGALLY EMPLOYED

Although teenagers younger than 16 years are prohibited from working in construction, unless working for a business owned completely by their parents, our study population included 19 teenagers younger than 16 years. By definition, all had been issued work permits to do construction work. A higher proportion (13 [68%]) of these underaged workers were employed in businesses that also employed other family members compared with 49%

Table 5. Suspect Tasks for 16- to 17-Year-Old Construction Workers, North Carolina, Summer 2001*

Activity	No. (%)
Drove motor vehicle†	62 (36.9)
Worked on ladder, scaffold, or other structure higher than 6 ft (1.8 m)	46 (27.4)
Outside helper on motor vehicle†	35 (20.8)
Worked on open floor joists	33 (19.6)
Worked on roofs doing other things (ie, besides shingles or roofing materials)§	28 (16.7)
Operated tractor or other heavy equipment†	24 (14.3)
Used miscellaneous saws and drills	10 (6.0)
Total No. of potentially illegal activities reported	
0	34 (20.2)
1	35 (20.8)
2	32 (19.1)
3	28 (16.7)
≥4	39 (23.2)

*Although the performance of these tasks by 168 adolescents could violate one of the Federal Hazardous Occupation Orders, 29 CFR §570E, or the North Carolina Detrimental Occupations rule, 13 NC Gen Stat §12.0406, insufficient information was gathered to make a firm determination of a violation.

†Adolescent workers 17 years and younger under federal law and adolescent workers aged 16 to 17 years under North Carolina law may legally drive a motor vehicle on public roads under certain restrictions and may also legally drive at a construction site, off public roads, except as noted here. Under federal law, adolescent workers aged 16 years may legally drive a motor vehicle if done at a construction site, off public roads. For both 16- and 17-year-old adolescents, motor vehicle driving is illegal in or around a mine, quarry, or logging or saw mill operation or in any excavation deeper than 4 ft (1.2 m), even if enrolled in a bona fide apprenticeship or student learner program, [29 CFR §570.52; NC Gen Stat §95-25.5(b) and (l)].

‡May be done at construction site, off public roads; illegal if on a public road, in or around a mine, quarry, or logging or saw mill operation, or in any excavation deeper than 4 ft (1.2 m), [29 CFR §570.52; NC Gen Stat §95-25.5(b)].

§Workers aged 16 to 17 years are permitted to work on roofs doing work on gutters and downspout work, construction of the sheathing or base of roofs, and the installation of television antennas and air conditioners, [29 CFR §570.67; NC Gen Stat §95-25.5(b)]. However, North Carolina law prohibits workers younger than 18 years from any work that involves the risk of falling a distance of 10 ft or more (≥3 m), so legality of these tasks depends on the height at which the work occurs, 13 NC Administrative Code §12.0406 (6).

(n=82) of the group in the 16- to 17-year age range. However, we cannot tell if the business was wholly owned by the teenager's parent (thus constituting legal employment) vs other family members (not legal employment) or if the business merely employed other family members in addition to the teenager.

These 19 adolescents were employed in varied types of construction businesses, including carpentry, interior and exterior framing, and hanging sheetrock (n=6), plumbing (n=3), trenching (n=1), heating and air conditioning (n=2), electrical work (n=2), roofing (n=2), concrete and masonry (n=2), excavation (n=2), and painting (n=1), with several of them reporting multiple types of construction work within the same business. Although 3 of the youngest workers reported spending some time working in the office of the firm, all spent at least part of their time doing construction labor.

As indicated in **Table 6**, these 14- to 15-year-olds performed a wide variety of tasks, with the group reporting a median of 13 of the tasks about which they were que-

ried. Some of these youngest workers engaged in tasks illegal even for their 16- and 17-year-old counterparts and also not allowable for teenagers working for parents. These tasks include working in trenches, being an electrician's helper, or using powder-activated tools. Although not given in Table 6, 5 of the 14- and 15-year-olds reported having worked at elevations above 6 ft (1.8 m), and 1 indicated he had worked on scaffolding or ladders without fall protection. Thirteen of these workers younger than 16 years were given the responsibility of being a spotter for other workers.

SUPERVISION PRACTICES

Consistent with much construction work, most of the teens worked in settings with few employees on site, with 54% indicating the business had fewer than 6 employees "usually present" at the worksite. Although most respondents indicated their work was checked more than once a day and that they were "told what to do and how to do it," nearly 20% of the respondents stated that they had worked completely alone, without being in hearing or sight distance of other workers.

COMMENT

MAJOR FINDINGS

Adolescent construction workers are exposed to numerous hazards, many working under illegal conditions and performing multiple types of illegal tasks. Most legally employed 16- and 17-year-old teenagers with permits to work in the construction industry in North Carolina in summer 2001 reported at least one activity that was illegal. A number of other activities these adolescents reported could have been illegal, depending on the circumstances. It was not uncommon for workers to report performance of multiple illegal or potentially illegal tasks. The illegal tasks reported by these adolescents include tasks that previous work has demonstrated to carry significant risk of morbidity, including high-cost injuries.²⁶ For example, the operation of nail guns was one of the prohibited tasks reported. The use of these easy-to-operate tools is often viewed as a relatively unskilled task assigned to new workers.²⁷ Suruda et al²¹ found that fatal injuries among young construction workers were most commonly associated with electrocutions, being struck by falling objects or equipment, and falls and engagement in several specific prohibited activities, including being an outside helper, demolition work, or operating power saws or hoisting apparatus. According to our data, these types of hazards are common exposures that require more attention and enforcement.

Federal and state child labor laws and OSHA regulations are designed to enhance worker safety. However, the system does not appear to be working. Although laws clearly prohibit work on construction sites by teenagers younger than 16 years unless working for a business owned by the parent, 10% of our respondents were younger than 16 years. They came from 17 different counties, indicating failures of the permitting system in mul-

Table 6. Illegal Tasks Reported by 14- to 15-Year-Old Construction Workers, North Carolina, Summer 2001*

Tasks Reported	No. (%)
Clean work area	18 (95)
Used shovel	17 (90)
Removed nails, rivets, or screws	15 (79)
Gone to get tools, equipment, or supplies at the worksite	15 (79)
Used knife, box cutter, or razor blades	14 (74)
Worked as watcher or spotter	13 (68)
Used power drill†	12 (63)
Used sledgehammer	12 (63)
Used adhesives	11 (58)
Used handsaw	9 (47)
Mixed mortar, concrete, or plaster	8 (42)
Lifted more than 50 lb (22.5 kg)	7 (37)
Worked with paint thinners or solvents	5 (26)
Mixed paint or polyurethane	4 (21)
Used power table saw†	4 (21)
Worked in trenches, holes, or foundations deeper than 4 ft (1.2 m)†	3 (16)
Used power nail guns or staple gun†	3 (16)
Used handheld circular saw or skill saw†	3 (16)
Used any other reciprocating saw such as a punch or jab saw or a Sawzall†	3 (16)
Outside helper on motor vehicle	3 (16)
Worked on roofs doing other things (ie, besides shingles or roofing materials)	2 (10)
Sprayed paint	2 (10)
Worked as electrician or electrician's helper†	1 (5)
Used jackhammer, hammer drill, or rotary hammer drill	1 (5)
Operated power lawnmower	1 (5)
Used power-driven posthole digger	1 (5)
Used powder-activated tools (ie, using gun powder charge)†	1 (5)
Operated power lawnmower	1 (5)
Worked on ladder, scaffold, or other structure higher than 6 ft (1.8 m)	1 (5)
Worked on open floor joists	1 (5)
Planted grass, shrubs, trees, or other plants	0
Worked with equipment where could come into contact with power line	0
Operated forklift†	0
Put on shingles or other roofing materials†	0
Used chainsaws†	0
Used explosives†	0
Drove motor vehicle	0
Operated tractor or other heavy equipment	0
Used miscellaneous saws and drills	0
Median No. of jobs (range)	13 (2-19)

*All work in construction (except for office and sales work) is illegal for 19 adolescents aged 14 to 15 years [29 CFR §570.33(f)(4); NC Gen Stat §95-25.5(c)] unless they are working for a business owned solely by one or both parents [29 CFR §203(l); NC Gen Stat §95-25.5]. There were 13 respondents who reported working at an establishment where other family members worked. For at least some of these, the parent may be the owner of the business, indicating the work was legal.

†Illegal tasks for adolescents aged 16 to 17 years (see Table 4 for details) and for all persons younger than 16 years, regardless of whether they are working for their parents or not.

iple locales. The data on illegal and suspect tasks, tools, and construction activities come from teenagers who report that they are told what to do and how to do it and that their work is supervised. Given that our sample of construction workers is based on work permits, the em-

ployers, by filling out the work permit, are demonstrating at least rudimentary understanding of the child labor laws. If the employers who are conforming with the work permit regulations are allowing illegal work and underaged workers, what illegal tasks or activities are being done by those teenagers employed by employers who do not comply with work permit regulations?

STUDY LIMITATIONS

The study relied on self-reported information collected as part of a cross-sectional study. Consequently, data are limited by recall and clarity of the items to the adolescent respondents. However, the nature of the information obtained would have been nearly impossible to obtain in any other manner, and there is no reason to suspect that the respondents were misrepresenting their experiences. We were also only surveying teenaged workers with work permits. We had no access to those working in construction without permits. We are likely to have observed the best-case scenarios in that firms that employ adolescents without permits are likely to be more permissive than we observed. It is also unlikely that we have an accurate representation of the immigrant workforce in our population, and these workers may be at particularly high risk²⁸ for a variety of reasons, including limited health and safety training and language barriers associated with quality training and supervision.²⁹ If anything, the exposures reported herein are probably an underrepresentation of the true risk. Because of the nuances in the law with respect to specific circumstances, we were unable to detect with certainty all instances of illegal activity. For example, it is possible some of the teens reporting having worked at heights above 6 ft (1.8 m) actually may have been at heights of 10 ft or more (≥ 3 m). Likewise, some of our questions about powered equipment were not specific enough to ascertain if the respondents were reporting illegal practices. Consequently, we cannot say for sure which work is in violation of state or federal laws. Workers younger than 18 years who are in formal apprenticeship programs are legally able to engage in all but 10 types of tasks that are otherwise prohibited for all workers younger than 18 years.^{19,20} Examples include being an outside helper on a motor vehicle, operating a forklift, using explosives, and using powder-activated tools (ie, using gunpowder charges).

Furthermore, although all respondents had worked at least 10 days, some had clearly worked longer than others, depending on when during the summer they began work. Although we cannot be sure, we suspect any biases associated with this factor are conservative, with more hazardous activities being undercounted given that some youth would not have had sufficient time to be assigned more difficult or dangerous tasks.

Finally, for the workers employed by family, our questions were not sensitive enough to differentiate those working for businesses owned wholly by the teenagers' parent vs businesses owned by other family members vs those not owned by family but employing other family members. Because of the allowance in the law for teenagers younger than 16 years to work for parent-owned businesses, we cannot tell which of the young workers

were working legally. However, the mere presence of children this age working at construction sites is cause for concern, regardless of the legal nuances. Similarly, we were unable to determine if some of the adolescents were in apprenticeships at the time of the study vs prior apprenticeship involvement or if a teenager had a birthday, making them eligible for different work than that indicated by their age on the work permit.

STUDY IMPLICATIONS

This research has uncovered areas in need of improvement in the regulation of a safer work environment for adolescents. First, underage teenagers (aged < 16 years) are being given permits to work in an industry in which their employment is certainly dangerous and may be illegal. Second, adolescent workers aged 16 and 17 years are legally employed in construction but performing tasks that are unsafe, illegal, or both. These findings suggest the need for improved enforcement of existing regulations and efforts to increase safety awareness and advocacy for stronger safety regulations.

The existing restrictions are not adequate to protect teenagers in this dangerous industry. For example, although teenagers are prohibited in North Carolina from working as an electrician's helper, it is naïve to think this adequately protects them from electrical hazards. Suruda et al²¹ identified electrocutions to be the largest single cause of deaths among teenagers in construction and not violating hazardous orders. Their findings are consistent with the findings of Lipscomb et al³⁰ that electrocutions among construction workers often involve workers other than electricians or linemen.

Moreover, construction work is dynamic, because sites and work conditions change frequently, workers are exposed to a variety of hazards, including those associated with dangerous equipment, and work is frequently performed at heights and in inclement weather. Although more mature, career construction workers who have been involved in many construction projects may be accustomed to these changes, inexperienced workers may find the constantly changing site to be chaotic. This may help explain the finding of Breslin and Smith³¹ that newer workers are more likely injured, regardless of age. However, even if the risks for younger workers may not be greater than for older workers, these young workers may require different interventions given the lack of overall maturity they bring to the job. The work permit system in North Carolina is intended to help screen youth from employment in prohibited work but also relies heavily on employers to correctly interpret and enforce the regulations. Without clearer employer education and sufficient enforcement, continuing violations are likely. It is critical that regulations be coupled with careful guidance from parents, teachers, and health care professionals.

IMPLICATIONS FOR FUTURE RESEARCH

Additional investigation of the tasks and situations in which young people are engaged in construction would be valuable, particularly assessing the adequacy of laws for workers of this age group and the barriers associated

with implementing and enforcing existing regulations or creating new ones. Understanding the challenges that employers face when hiring and supervising young workers and ensuring adherence to the laws could help point toward needed interventions. Studies of teenaged workers need to address both the formal and informal learning processes and also actual work practices on construction sites. Inexperienced workers learn from observation of other workers at the work sites, which means we must continue to try to understand safe and unsafe practices of more seasoned construction workers as well. Although it is more challenging to reach young workers without permits, we need to find ways to assess these workers to address their workplace safety as well. Dissemination research should explore how to improve the potential of teachers, parents, pediatricians, and other youth-oriented professionals and construction contractors to improve work safety for adolescents.

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REFERENCES

- Center to Protect Workers' Rights. *The Construction Chart Book*. 3rd ed. Atlanta, Ga: Centers for Disease Control and Prevention; 2002.
- Kisner S, Fosbroke D. Injury hazards in the construction industry. *J Occup Med*. 1994;36:137-143.
- Schneider S, Susi P. Ergonomics and construction: a review of potential hazards in new construction *Am Ind Hyg Assoc J*. 1994;55:635-649.
- Burkhardt G, Schulte PA, Robinson C, Sieber WK, Vossenas P, Ringen K. Job tasks, potential exposures, and health risks of laborers employed in the construction industry. *Am J Ind Med*. 1993;24:413-425.
- Lipscomb HJ, Dement JM. Respiratory diseases among union carpenters: cohort and case-control analyses. *Am J Ind Med*. 1998;33:131-150.
- National Institute of Occupational Safety and Health. Recommendations to the US Department of Labor for changes to hazardous orders. 2002. <http://www.cdc.gov/niosh/docs/NIOSHRecsDOLHaz/default.html>. Accessed August 26, 2005.
- Castillo DN, Landen D, Layne L. Occupational injury deaths of 16- and 17-year-olds in the United States. *Am J Public Health*. 1994;84:646-649.
- US Department of Labor. *Report on the Youth Labor Force*. Washington, DC: Bureau of Labor Statistics; 2000.
- Windau J, Sygnatur E, Toscano G. Profile of work injuries incurred by young workers. *Mon Labor Rev*. 1999;122:3-10.
- Dunn KA, Runyan CW. Deaths at work among children and adolescents. *AJDC*. 1993;147:1044-1047.
- National Institute of Occupational Safety and Health. *Preventing Deaths and Injuries of Adolescent Workers*. Washington, DC: Dept of Health and Human Services; May 1995. Publication 95-125, NIOSH Alert.
- 29 USC §201 *et seq*.
- 29 CFR Part 570.
- Youth employment. NC Gen Stat §95-25.5.
- Youth employment. 13 NC Administrative Code §12.0400.
- Detrimental Occupations. 13 NC Administrative Code §12.0406.
- 29 CFR Parts 1910 (General Industry Standards) and 1926 (Construction Standards).
- 29 CFR §570.33(f)(4); NCGS §95-25.5(c).
- 29 USC §203(l); NCGS §95-25.5(i).
- 29 CFR Part 570, Subpart E.
- Suruda A, Philips P, Lillquist D, Sesek R. Fatal injuries to teenage construction workers in the US. *Am J Ind Med*. 2003;44:510-514.
- Dunn KA, Runyan CW, Cohen LR, Schulman MD. Teens at work: a statewide study of jobs, hazards and injuries. *J Adolesc Health*. 1998;22:19-25.
- Evensen CT, Schulman M, Runyan CW, Zakocs R, Dunn KA. The downside of adolescent employment: hazards and injuries among working teens in North Carolina. *J Adolesc*. 2000;23:545-560.
- Zakocs RC, Runyan CW, Schulman M, Dunn KA, Evenson C. Improving safety for teens working in the retail trade sector: opportunities and obstacles. *Am J Ind Med*. 1998;34:342-350.
- SAS Institute Inc. *SAS Version 8.2* [computer program]. Cary, NC: SAS Institute Inc; 1999.
- Lipscomb HJ, Li L. Injuries among teens employed in the homebuilding industry in North Carolina. *Inj Prev*. 2001;7:205-209.
- Lipscomb HJ, Dement JM, Nolan J, Patterson D, Li L. Nail gun injuries in residential carpentry: lessons from active injury surveillance. *Inj Prev*. 2003;9:20-24.
- Dong X, Platner JW. Occupational fatalities of Hispanic construction workers from 1992 to 2000. *Am J Ind Med*. 2004;45:45-54.
- O'Connor T, Loomis D, Runyan C, Dal Santo J, Schulman M. Adequacy of health and safety training among young Latino construction workers. *J Occup Environ Med*. 2005;47:272-277.
- Lipscomb HJ, Dement J, Rodriguez-Acosta R. Deaths from external causes of injury among construction workers in North Carolina, 1988-1994. *Appl Occup Environ Hyg*. 2000;15:569-580.
- Breslin C, Smith P. Age-related differences in work injuries: a multivariate, population-based study. *Am J Ind Med*. 2005;48:50-56.