Direct Costs and Patterns of Injuries Among Residential Carpenters, 1995–2000

Hester J. Lipscomb, PhD
John M. Dement, PhD, CIH
Robert Behlman

Workers' compensation records for residential contractors were combined with hours worked provided by the union to examine injury rates and costs among union carpenters between 1995 and 2000. Brief text descriptions were reviewed to describe more costly injuries. Costs per hour worked decreased over 6 years, largely because of declines in rates and mean costs for falls from elevations. Higher costs were associated with injuries from falls, raising framed walls, setting steel I-beams, and pneumatic nail guns. Prevention priorities should include fall protection; methods to safely set steel beams, raise and brace framed walls; and steps to prevent injuries from pneumatic tools. Cost data provide an important measure that is useful in focusing prevention; combined with even limited descriptions of injuries target areas for intervention can be identified based on frequency or severity. (J Occup Environ Med. *2003;45:875–880*)

Fatal and lost work time injuries in the construction trades continue to rank among the highest in the United States,[1–5] and risk does not appear to be equal for all workers.[6,7] Construction workers are difficult to study because of the organization of their work, including constantly changing work sites, jobs of relatively short duration, and even frequently changing employers for many workers. These issues are particularly salient for residential carpenters, who often work in small crews of four to five workers. Workers' compensation coverage is provided, in most states, by multiple carriers, making access to claims data for large groups of workers difficult to obtain. Residential construction workers are also less likely to be unionized than those in commercial construction, making it difficult to enumerate the workforce or their injuries. Consequently, there are relatively few published reports that address work injury experiences of this sector of the construction industry.[8,9] Reported here are analyses of injuries among residential carpenters based on workers' compensation claims over the 6-year period, 1995 to 2000, from a group of self-insured contractors who hired union labor in the area surrounding St. Louis, Missouri.

Materials and Methods

Site of Work and Data Sources

Computerized workers' compensation loss information from January 1, 1995, through December 31, 2000, were obtained from Canon-Cochran Management Services, Inc., the management service for a group of five

From the Division of Occupational and Environmental Medicine and Department of Community and Family Medicine, Duke University Medical Center, Durham, North Carolina (Dr Lipscomb, Dr Dement) and Behlman Builders, Chesterfield, Missouri (Mr Behlman).

Funding by National Institute for Occupational Safety and Health RO1 OH03809.

Address correspondence to: Hester J. Lipscomb, PhD, Division of Occupational and Environmental Medicine, Duke University Medical Center, Suite 600A, Erwin Square, 2200 W. Main, Durham, NC 27705; e-mail address: hester.lipscomb@duke.edu.

DOI: 10.1097/01.jom.0000083035.56116.46

TABLE 1
Costs of Injury Among Carpenters by Cause of Injury Union residential carpenters, St Louis, Missouri 1995–2000*

	All Injuries			Injuries With Costs Over $10,000		
Cause of Injury	*n*	**Sum of Costs (rank)**	**Mean**	*n*	**Sum of Costs (rank)**	**Mean**
Struck by/against	236	$ 909,815 (3rd)	$ 3,855	28	$ 697,050 (3rd)	$24,895
Overexertion	180	1,152,921 (2nd)	6,405	30	931,221 (2nd)	31,041
Cut or rubbed	83	137,620	1,658	4	87,972	21,993
Fall from elevation	72	1,773,924 (1st)	24,638	28	1,704,101 (1st)	60,861
Puncture	62	53,285	859	2	25,983	12,992
Fall—same level	49	151,532	3,093	5	109,943	21,989
Repetitive action	48	293,642	6,118	10	239,222	23,922
Foreign body	48	14,125	294	–	—	—
Bodily reaction	45	285,604	6,347	13	232,727	17,902
Caught	36	404,962	11,249	7	345,179	49,311
Slip or trip	34	142,026	4,177	4	95,419	23,855
Stepped in/on	22	73,730	3,488	2	57,550	28,775
Motor vehicle	1	14,857	—	1	14,857	—
Other/missing	29	102,281	3,527	2	56,693	28,347
Overall	945	$ 5,510,324	$ 5,510	136	$ 4,597,917	33,808

* Incurred costs for medical care, indemnity, and impairment.

large, self-insured homebuilders and carpenter contractors in the St. Louis, Missouri area. This is the only area of the United States with a large unionized residential workforce; all five contractors hire union carpenters. Contractors were *requested* to report all injuries to the management company but were *required* to report all injuries that involved medical care of more than $1000 dollars or lost time from work beyond the day of injury.

These data included coded descriptors of loss cause (mechanism of injury) and direct costs incurred for medical treatment, indemnity, and permanent impairment for each injury. Limited free text descriptions (50 characters) of the injuries from the first reports of injury were also provided. No information was available on sex, age, or race of the injured worker.

Union carpenters receive health and retirement benefits through trusteed health and welfare funds, and contractors hiring union labor pay into these trusts based on the hours worked by the workers they hire. The local health and retirement trust provided the union carpenter hours worked by contractor for each of the six years of interest documenting work hours at risk.

Analyses

To define injuries and time at risk on the same basis, all analyses were limited to claims of residential carpenters. The distributions of the coded cause of injury were examined and total costs incurred for medical, indemnity, and permanent impairment were stratified by cause of injury. For claims that remained open at the time of the analyses ($<5\%$) reserve amounts (estimated for the specific injury) were used in these calculations.

Carpenter hours worked were stratified by year and summed for the entire 6-year period. Costs per hour of carpenter work and mean costs per claim were also calculated overall and for the more costly causes of injury by year. Overall and paid lost-time injury rates, which occur in Missouri after the seventh day beyond the day of injury, were calculated per 200,000 person-hours of work (or 100 full-time equivalents). Stratified rates for the more costly injury causes, including injuries resulting from being struck by or against something, falls and overexertion injuries, were calculated by year.

In an attempt to learn more about circumstances surrounding more serious events and possible prevention recommendations, the text descriptions of higher cost claims, initially those resulting in over $10,000 and then $50,000 of direct costs, were reviewed.

Results

Over the 6-year period, a total of 5,267,268 hours were worked by carpenters hired by these five contractors; equivalent to 440 carpenters working 2000 hours each year. Carpenter hours hired per year averaged 175,575 per contractor. During the same time period, 945 workers' compensation claims were filed; 53 (5.6%) did not involve medical care or paid lost time (indemnity).

The distribution of all causes of injury and associated costs are presented in Table 1. Fourteen percent ($n = 136$) of claims resulted in costs of over $10,000 and were responsible for 83% of direct costs. The majority of the costs were associated with lost-time claims.

Over the 6-year period medical costs were responsible for 48% of direct costs, indemnity for 16%, and impairment for 36%. Reserve costs for open claims could not be allocated to medical, indemnity or impairment costs; those claims are not included in the proportions.

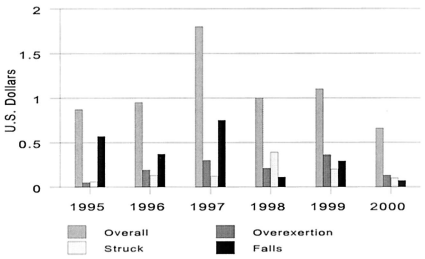

Fig. 1. Incurred cost per hour worked by mechanism of injury. Union residential carpenters, St. Louis, Missouri, 1999 to 2000.

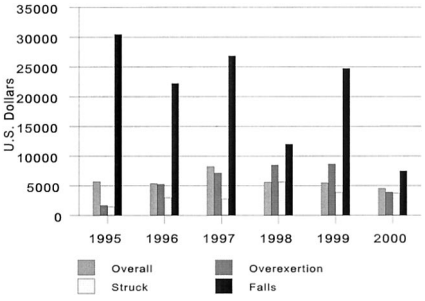

Fig. 2. Mean cost per claim by mechanism of injury. Union residential carpenters, St. Louis, Missouri, 1995 to 2000.

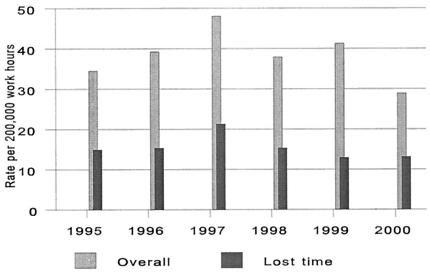

Fig. 3. Overall and lost time injury rates. Union residential carpenters, St. Louis, Missouri, 1995 to 2000.

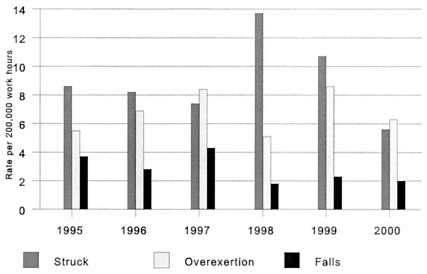

Fig. 4. Injury rates by cause. Union residential carpenters, St. Louis, Missouri, 1995 to 2000.

Total direct costs per hour of work are presented in Fig. 1 by year. Over the 6-year period direct costs averaged $0.66 per hour worked, with the lowest costs in 2000. Costs per hour worked declined most dramatically for injuries from falls.

Mean costs per claim by year are presented in Fig. 2. Among the three most costly injury causes, falls were responsible for the highest costs per claim but the costs decreased markedly (>25% reduction) from 1999. In 1999 and 2000 overexertion injuries were responsible for the greatest costs. Mean costs per fall were markedly down in 2000 averaging approximately $7500 per fall compared with the range in previous years of $30,000 per fall (1995) to $12,000 per fall (1998).

The overall injury rate was 35.9 per 200,000 hours worked, and the paid lost-time injury rate was 14.5 per 200,000 hours worked. Overall and lost-time injury rates by year are presented in Fig. 3. The highest rates occurred in 1997 and the lowest rates were seen in 2000. Overall rates and rates of lost-time injuries declined 16% and 12%, respectively, over the six years with declines of 40% and 38% between the peak years of 1997 and 2000.

Patterns for the more costly causes of injury were variable (Fig. 4). Injuries from being struck by or against something increased particularly in 1998 but declined in 1999 and 2000. Falls from elevations increased slightly in 1997 from the baseline year, but remained lower after that. Overexertion injuries fluctuated but remained slightly higher in 2000 than in 1995.

Brief descriptions of the more costly injuries are presented in Table 2. There were 21 of these injuries with costs over $50,000; these 2.2% of claims resulted in $1,961,704 (43%) of direct costs. Nine (42.9%) of these were falls; four (19%) were the result of walls falling; two (9.5%) occurred when lifting walls; and two (9.5%) from setting steel beams. The remaining three involved head, shoulder and back injuries which were not well described in the available text.

Discussion

The inclusion of direct cost data and brief text injury descriptions in the analyses of the workers' compensation experience of these residential carpenters added a dimension that is useful in prioritizing injury prevention strategies. Overall, falls from elevations, which ranked third in frequency, were responsible for the highest costs and the highest costs per claim. In contrast, relatively few injuries involved a worker being caught in or between objects, but these injuries were also responsible for a disproportionate share of costs. The brief text descriptions identified that these high cost events resulted, in large part, from carpenters being caught by walls that fell over. Based on the small number of events of this nature, the vast majority of walls are braced adequately. However, being hit by a 200- to 300-pound wall can cause a devastating injury. Overexertion injuries resulted from multiple tasks, which can make prevention daunting. However, the majority of costs associated with these injuries resulted from two tasks—lifting framed walls and setting steel beams. This level of information is useful in developing more concrete prevention recommendations to workers, their union representatives in this case, and the contractors who are responsible for safety on their work sites.

Residential carpentry is hazardous work, but these analyses also document significant improvement in safety performance over a six-year time period among a group of self-insured contractors. The group would not have been able to self-insure, unless they had reasonable safety records. As members of the self-insured group, each contractor had the incentive to improve not only his/her own worksite safety performance, but also those of others in the self-insured group.

The cost for falls per hour worked declined substantially over the period of observation due to a decrease in the rate of falls, as well as the

TABLE 2
Injuries Resulting in Greater than $10,000 in Costs Union residential carpenters, St. Louis, Missouri 1995–2000*

Cause of Injury (*n*)	Description (*n* = number of injuries)
Overexertion (30)	Lifting/holding: walls (5), steel beams (4), wood (4), joists (2), timberstand (1), beam (1), drywall (1), truss (1), nails (1), unspecified (3) Pulling: trusses (1), soffit (1) Carrying: cabinet (1) Other: hurt elbow starting compressor (1); unspecified (3)
Struck by/against (28)	Falling objects: plywood/boards, including stack of 2 × 12s (6), wall (2), beam/joists (3), siding (1), drywall (1) Tools: Nail gun (8), power saw (2), hammer (1) Eye injury from strip of wood (1), nail (2) Hit head on ceiling (1)
Fall from height (28)	Through opening/landing (4), from ladders (3), trusses (2), sub-floor (2), roof (2), scaffold (1), bucket (1), window (1), foundation (1), 3rd floor (1), unspecified (10)
Bodily reaction (13)	Twisted knee (6) Strained ankle/foot (5) Back pain (1) Hernia and back pain (1)
Repetitive action (10)	Pain in wrist (4), hand (1), elbow (1), shoulder (1), knee (1), carpal tunnel/numbness (2)
Caught (7)	Wall fell on carpenter (3) Glove caught in saw (1) Hand/fingers caught against crane (1), between studs (1), by beam (1)
Fall from same level (5)	Slipped on: siding (1), stud (1), wet ground (1), not described (2)
Cut/rubbed (4)	Cut finger/hand on: saw (1), lumber bands (1), gusset (1), not described (1)
Slip/trip (4)	Slipped carrying plywood (1), down roof (1), in mud (1), not described (1)
Puncture (2)	Nail gun shot nail in shin (1), shot staple in knee (1)
Stepped in/on (2)	Twisted leg walking on job site (1), twisted knee stepping over trusses (1)
Other (2)	Knee injury not described (2)
Motor vehicle (1)	Hit by truck on job site (1)
Total (136)	

* Direct costs for medical care, indemnity, impairment.

mean cost per fall. Considering that costs for medical care and wages (on which indemnity payments are based) increased in this time period, the cost declines are particularly impressive. Injuries resulting from being struck by or against something declined 35% over this 6-year period but with lesser declines in associated costs. Overexertion injuries, largely involving manual materials handling, increased 20% in 2000 compared to 1995 but without the corresponding increases in cost.

These homebuilders took steps to decrease injuries and associated costs during this time period. Efforts included monthly job site inspections by outside safety specialists with written reports to upper management, changes to fall protection policies using OSHA Directive 3–0.1A for residential construction[10] as a guide to training and practice, and written and manual testing with pneumatic tools. Safety manuals were updated and training was addressed as an ongoing endeavor. An attempt was made to shift the overall emphasis of safety training to the importance of personal protection to the worker and his or her family, as opposed to meeting regulatory standards. The carpenters were seen as important participants in the overall effort. Incentive programs were used to peak employees' interest and participation with recognition and rewards changing over time to prevent the programs from becoming "stale." Policies were not mandated by the group, and each contractor made decisions about what steps he/she would take for their own company. The workers' compensation management company also worked to decrease costs for all the contractors through claims management and injury prevention efforts. These included the job site surveys with written reports, updating of safety manuals, investigation of large losses including collection of information from the injured worker, on-site tool box talks and briefings or "mini tool box talks" with job foremen about safety issues. A system of medical providers was also established to provide acute and longer-term care when necessary and a nurse manager was hired to facilitate and coordinate care and improve communication. These combined efforts likely made substantial contributions to the observed decline in both rates of injuries and costs involved.

Significant improvements in fall safety audit measures by third-party involvement focused on contractor organizational performance, have been previously reported, in this case the West Virginia University Safety and Health Extension.[11] Although the St. Louis contractors took a less formal approach, with each applying specific changes they chose, significant reductions were seen in measures of frequency and severity of falls. The common feature of these efforts is a systematic commitment to safety at the owner level.

Although the pattern of the injuries reported here is consistent with reports of other residential construction workers[9] and residential carpenters in particular,[12] the injury rates are higher than those reported by the

Bureau of Labor Statistics (BLS) for the same time period. The higher rates may be attributable to a number of things. First, these data included injuries that did not necessarily meet an OSHA recordable definition, and as expected, the lost-time injury rates are closer to, but still higher than, those reported by BLS. Higher rates have been reported previously in studies, representing both commercial and residential sectors, using similar research methods to those presented here with use of hours worked as measures of time at risk and workers' compensation records,[13,14] whereas BLS rates are based on a sample of OSHA log reports and estimates of aggregate hours for the sector.

Limitations and Strengths

As with any claims analyses, the findings are based on events that were reported. Anything that influenced whether a person filed a workers' compensation claim will be reflected in the findings. Although total carpenter time at risk was available, no information was available about time exposed to any given risk factor such as work at heights, specific tool use etc. No details were available on the circumstances surrounding the injuries beyond what was available from the first reports, which could have been more revealing. For example, from the brief text descriptions the size and weight of framed walls or beams associated with lifting injuries could not be determined, nor could the number of workers involved, their levels of experience, or the site conditions.

Data were used from a group of large, self-insured homebuilders and carpenter contractors who hired union labor, and for several reasons the data may not be entirely representative of the homebuilding industry. The findings may, in fact, fail to adequately represent risk across this sector of the industry for several reasons. Union carpenters typically go through a required four year apprenticeship program involving classroom instruction and supervised work. In addition, much homebuilding is performed by smaller contractors who may not have the same safety resources. Although there were significant improvements over the 6-year period, and the overall effect of these efforts appear obvious, the contribution of individual components made by the homebuilders and the management company could not be assessed through these analyses.

Despite these limitations, there were several strengths to this approach, the major one being that, while not perfect, the methods allowed insight into the experiences of a group of construction workers who are particularly challenging to study. Through computerized records, full ascertainment of reported injuries was available, and by using a union workforce an accurate measure of work hours was possible. The combined data sources provided events of interest and person-time at risk over a 6-year period, allowing the identification of patterns of injury risk and associated costs over time. Although very limited (50 characters), the free text information was much more useful than coded data in understanding the circumstances surrounding these injuries. When combined with the cost data they allow concrete preventive recommendations to be made for a small group of injuries responsible for the majority of costs.

Conclusion/Recommendations

Internal comparisons of direct costs associated with injuries among a well-defined occupational group may be particularly useful in focusing prevention efforts. It is clear from these analyses that there are a group of activities, or tasks, associated with particularly severe injuries among residential carpenters. The serious nature of falls from elevations is well documented among these workers,[3,9,11] but without incorporating cost data into the analyses of these injuries, circumstances associated with the more uncommon, but serious, events would not be noted. Specifically, these analyses identified raising and bracing framed walls and handling beams as activities that should be targets for prevention. Innovative engineering improvements could potentially reduce these injuries, and in the absence of engineering solutions careful attention to adequate manpower to avoid these serious injuries would be prudent. Cranes provide assistance and can lessen the chance of injuries if crews and operators are appropriately trained. Careful attention to appropriate bracing of walls after they are raised is also indicated. Supervisors and foremen should be aware of the risks, and apprentices and more seasoned workers should be trained in appropriate techniques to safely secure walls as the structure is going up. Methods to prevent injuries from power tools, particularly pneumatic nail guns/staplers are also needed. Although these data do not identify specific prevention strategies, other data indicate prevention should be through both engineering improvements and training.[15,16]

Residential construction has changed considerably in the last 20 years. Many new homes have more square footage, large open expanses, higher ceilings, and steeper roofs, to name a few common examples. These architectural changes result in longer, taller, and consequently heavier walls; increased needs for heavy steel or laminated beams that can provide wider expanses of support; and requirements for carpenters to work at significant heights. Safety efforts in this sector of construction must keep pace with these innovations. The incorporation of direct cost measures and brief injury descriptions into ongoing surveillance efforts could be useful in monitoring progress, such as that documented among falls in these residential carpenters.

Acknowledgments

This work was supported by a grant from the National Institute for Occupational Safety and Health (NIOSH) (RO1 OH103809). Its content are solely the responsibility of the authors and do not necessarily represent the official views of NIOSH. The authors want to acknowledge Dale Klatt from CCMSI and Ron Laudel, Benefits Plan Administrator, Carpenters' District Council of Greater St. Louis for providing data for these analyses. We also thank the five residential contractors who agreed to allow access to their workers' compensation information.

References

1. Fatal Occupational Injuries in the US, 1980–1994. *MMWR.* 1998;47:297–302.
2. Kisner SM, Fosbroke DE. Injury hazards in the construction industry. *J Occup Med.* 1994;362:137–143.
3. Sorock GS, Smith EO, Goldoft M. Fatal occupational injuries in the New Jersey construction industry, 1983–1989. *J Occup Med.* 1993;359:916–921.
4. Stone PW. Traumatic occupational fatalities in South Carolina, 1989–1990. *Public Health Rep.* 1993;1084:483–488.
5. US Dept of Labor, Bureau of Labor Statistics: Industry at a Glance, Construction. Available at: wysiwyg://24//http://www.bls.gov/iag/iag.construction.html. (April 25, 2002).
6. McVittie D, Banikin H, Brocklebank W. The effects of firm size on injury frequency in construction. *Safety Sci.* 1997; 271:19–23.
7. Salminen ST. Epidemiological analysis of serious occupational accidents in southern Finland. *Scand J Soc Med.* 1994;223:225–227.
8. Lipscomb HJ, Li L. Injuries among teens employed in the homebuilding industry in North Carolina. *Inj Prev.* 2001;7:205–209.
9. Dement JM, Lipscomb HJ. Workers' compensation experience of N. C. *residential construction workers, 1986–1994. Appl Occup Environ Hyg.* 1999;14: 97–106.
10. U. S. Department of Labor, Occupational Safety and Health Administration. June 18, 1999. OSHA Directives, STD 3–0.1A. Plain language revision of OSHA Instruction STD 3.1, Interim Fall Protection Compliance Guidelines for residential Construction.
11. Becker P, Fullen M, Akladios M, Hobbs G. Prevention of construction falls by organizational intervention. *Inj Prev.* 7:i64–i67, 2001.
12. Lipscomb HJ, Dement JM, Li L, Patterson D, Nolan J. Work-related injuries in residential and drywall carpentry. *Appl Occup Environ Hyg.* 2003;186:1–10.
13. Lipscomb HJ, Kalat J, Dement JM. Workers' compensation claims of union carpenters 1989–1992: Washington state. *Appl Occup Env Hyg.* 1996;11:1–8. Letter to the Editor, *Appl Occup Environ Hyg.* 1997;12:507–509.
14. Glazner JE, Borgerding JA, Lowery JT, Bondy J, Mueller KL, Kreiss K. Construction injury rates may exceed national estimates: evidence from the construction of Denver International Airport. *Am J Ind Med.* 1998;34:105–112.
15. Dement JM, Lipscomb HJ, Li L, Epling C, Desai T. Nail gun injuries among construction workers. *Appl Occup Environ Hyg.* 2003;185:1–10.
16. Lipscomb HJ, Dement JM, Li L, Patterson D, Nolan J. Nail gun injuries in residential carpentry: lessons from active surveillance. *Inj Prev.* 2003;9:20–24.