Disabling Injuries to Childcare Workers in Minnesota, 1985 to 1990

An Analysis of Potential Risk Factors

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Injuries to clients in childcare centers have been studied to some degree, but the problem of worker injuries in childcare centers has remained unexplored. To investigate this problem, data were accessed from two sources for the years 1985 to 1990: 1) Minnesota Department of Jobs and Training for data pertinent to the populations of childcare center workers for each year of the study, and the 2) Minnesota Department of Labor for all case files relevant to reported injuries incurred by childcare center workers for each year of the study. Data analyses were conducted of all injuries as well as a subanalysis of back injuries incurred by female workers.

The overall injury rate for the 6-year period was 1.08 per 100 workers. Of the 440 childcare worker injury cases, a mean age of 32 years (range, 17 to 72 years) was identified; 50% of all cases were below the age of 29 years. Analysis by subclassifications of childcare workers indicated that cooks had the highest injury rate (3.61 per 100 workers) and the greatest mean number of weeks of temporary total disability (13.2 weeks). According to anatomic site, injuries involving the back accounted for the greatest proportion of the total injuries (34.1%); 49% involved lifting a child. To protect childcare workers adequately, additional policies and regulations will be required, as well as further study in this area. Emphasis in the area of back injury is clearly needed, including education on proper lifting techniques and relevant application of engineering technology.

Of further concern is the possibility for persistent disability among many of these workers, which can be costly to government and leave the worker financially strained. Although limited data regarding costs were available, the mean cost identified for daycare worker injuries was $3759, and this does not account for personal costs associated with these injuries. Such costs, in concert with the impact of physical trauma and associated limitations incurred by the employee as well as the limitations imposed upon the employer, make this an important problem.

Every year in the United States, work-related injuries account for between 7,000 and 11,000 fatalities, hospitalization of approximately 88,000 workers, and the loss of 75 million work days.[1] In addition to the medical costs of injuries, the social and economic consequences of workplace injuries, including lost wages, medical insurance claims, production delays, lost time of coworkers, and equipment damage, are enormous.[2] In 1989, the estimated cost of workplace injuries was 48.5 billion dollars.[3] During the same year, Minnesota employers paid about 1 billion dollars for workers' compensation coverage.[4] This does not account for the pain, stress and stress-related illnesses, economic insecurity, and a diminished quality of life experienced by workers and their families, especially when permanent disability is involved.[1,5]

One of the greatest problems associated with understanding the magnitude of the occupational injury problem is a lack of accurate data. The Occupational Safety and Health Administration (OSHA) requires employers to keep records of 1) injuries that cause 1 or more days of absence from work or "restricted activity" at work, and 2) injuries that require medical attention but cause less than 1 day of missed work.[6] Firms with 10 or fewer employees are exempted from OSHA's record-keeping requirements. Throughout the United States, as well as in Minnesota, a substantial percentage of businesses are included in this group. Additionally, the accuracy of employer reports of injury is questioned because, despite the reporting and record-keeping regulations, it has been shown that there is serious underreporting of both morbidity and mortality events.[7] The concern became enhanced when OSHA

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0096-1736/93/3512-1236$03.00/0

implemented a new enforcement policy in 1981, under which industries with a lost workday injury rate less than the national average have been exempted from regular inspections. This system, it is argued, encourages employers to underreport injuries.[8]

Within the overall occupational injury problem, injuries to childcare workers in Minnesota were identified for investigation because, whereas injuries to clients have been studied to some degree and highlighted by the media, the problem of worker injuries has remained unexplored. Childcare centers are also referred to as daycare centers. Because they typically employ very few workers, as is the case with the self-employed and small businesses, they have been largely excluded from various studies.[9]

The purpose of this epidemiologic study was not only to determine the incidence, types, and severity of worker injuries in childcare centers, but also to identify variables potentially associated with these injuries. Through this approach, strategies for prevention and control can be established more realistically.

Methods and Materials

Approval for an archival study was granted by the University of Minnesota's Committee on the Use of Human Subjects in Research before initiation of this study. To investigate this problem, data were accessed from two sources for the years 1985 to 1990 (Table 1): 1) Minnesota Department of Jobs and Training for data pertinent to the populations of childcare center workers for each year of the study, and 2) Minnesota Department of Labor for all case files relevant to reported injuries incurred by childcare center workers for each year of the study. Cases were identified through the selection of any individual identified with the Standard Industrial Classification code 8351 (child daycare services) who had missed at least 3 days of work due to a work-related injury. Data pertinent to these cases were entered onto a separate file within the Department of Labor's computer system for specific analysis. The Statistical Package for the Social Sciences[10] was used to generate frequencies and cross-tabulations. In addition, specific rates were calculated per 100 workers.

TABLE 1
Childcare Centers and Childcare Center Workers by Year—Minnesota, 1985–1990

Year	No. of Centers	No. of Workers	Mean No. of Workers per Center
1985	907	5457	6.02
1986	1014	6098	6.01
1987	1097	6602	6.02
1988	1170	6993	5.98
1989	1220	7280	5.97
1990	1311	7884	6.01

Limitations in the data sources specific to childcare workers have impacted on this research effort. Denominator data needed to establish injury rates among the various classifications within Standard Industrial Classification 8351 were available only for 1986. However, based on information from the Minnesota Department of Jobs and Training, 1986 data were used as basis for other years since there was no apparent change in the proportions of workers in the various classifications from 1985 to 1990 (L. Carlsted, personal communication, 1991). As shown in Table 1, the mean number of workers per center did not change over this period. The lack of population data specific to age and gender prevented relevant calculations and rate adjustments.

The use of Worker's Compensation files also imposes limitations upon the data: 1) an unknown number of events may occur for which no claim is made, 2) only workers covered by state compensation laws are included (self-employed persons, students, and certain other groups are excluded), and 3) injury cost data are limited because only 66% of the cases were closed at the time of study.[11] Limited data were available for medical and rehabilitation costs because the Minnesota Department of Jobs and Training does not systematically collect all medical cost data.

Results

A total of 440 childcare center worker injury cases were identified from 1985 to 1990. The mean age for these workers was 32 years (range, 17 to 72 years); women accounted for 93% of the cases.

Rates of Injury

As shown in Fig. 1, the overall injury rate for 6-year period was 1.08 per 100 workers. Little variation in rates by year, which ranged between 0.92 and 1.24 per 100 workers, was identified.

According to subclassifications of daycare workers (Fig. 2), cooks had the highest injury rate (4.03 per 100 workers). The next highest rates occurred in the classifications of childcare workers (1.94 per 100 workers) and managers/administrators (1.60 per 100 workers).

Anatomic Sites, Types, Sources, and Mechanisms of Injuries

According to the anatomic site (Fig. 3), injuries involving the back accounted for the greatest proportion (34%). Injuries to the lower (20%) and upper (12%) extremities, as well as multiple site injuries (13%) were the next most frequently reported.

Analyzed by type of injury, sprains accounted for 48% of the injuries. As shown in Fig. 4, other types of injuries including burns (1%), contusions (7%), cuts (4%), dislocations (6%), fractures (7%), joint inflammation (1%), and multiple injuries (3%) represented less than 30%; the "all other" classification represented 22% (14% nonclassifiable; 4% not otherwise classified; 3%, scratches and abrasions; 1%, concussions).

Analyzed by the source of injury (Fig. 5, Table 2), "another person" was involved in the injury events most frequently (30%); work surfaces, including floors and stairs, accounted for 20% of the injuries. Although the "all others" classification accounted for 33%, it included wide-ranging sources (e.g., furniture, windows). When analyzed by mechanism of injury (Fig. 6), "overexertion" was re-

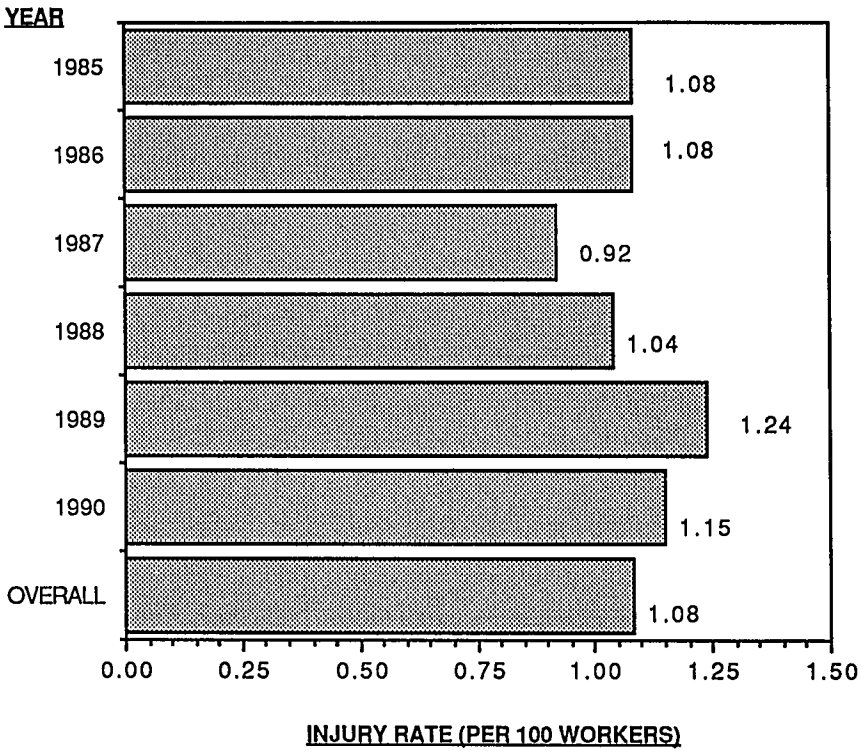

Fig. 1. Disabling injury rates among childcare workers by year—Minnesota, 1985 to 1990.

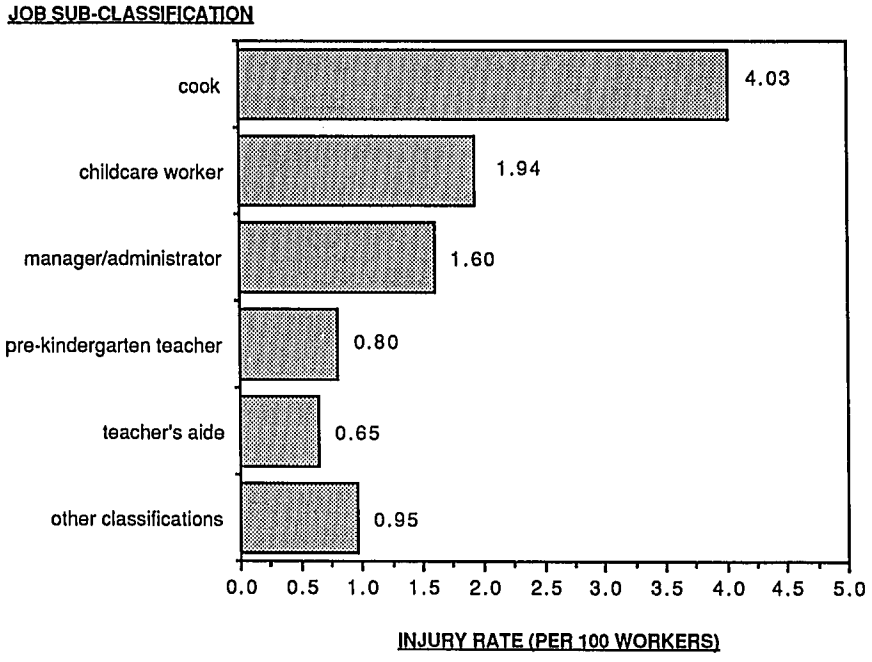

Fig. 2. Disabling injury rates among subclassifications of childcare workers—Minnesota, 1985 to 1990.

ported in 34% of the cases. Falls were the second most commonly reported mechanism, accounting for 21%; "struck by or struck against" accounted for 16%.

Temporality

As shown in Fig. 7, a much greater incidence of injury events occurred during the "first quarter" (January, February, March) of the year (30%), compared with the other quarters. Based on cross-tabulations among all injuries involving falls, 40% were reported during the first quarter. The injuries involving vehicles were also reported most often during the first quarter (32%). Analysis of injury events, by day of the week, revealed no particular variations from Monday through Friday (range, 18% to 21% of total cases). As would be expected, the proportions of injuries incurred during weekends was notably low.

Lost Time

Analysis of temporary total disability (TTD), a proxy for severity, revealed that the job subclassification of cooks was associated with the greatest mean number of weeks of lost time (13.2). This was followed by the subclassification of childcare workers (8.4 weeks) and teachers' aides (6.6 weeks). As shown in Fig. 8, the 50 to 59-year age group was associated with the greatest mean number of weeks of TTD (10.9 weeks), followed by the 70 to 79- and 40 to 49-year age groups (8.6 and 8.5, respectively).

Analyzed by body part, injuries to the trunk (excluding back) were associated with a mean number of 9.8 weeks of TTD, whereas back and lower extremity injuries were associated with a mean lost time of 7.9 and 6.1 weeks, respectively. The most frequent types of injuries to the trunk included sprains (42%) and contusions (21%). Based on the type of injury, dislocations were associated with the greatest mean number of weeks of TTD (21.9 weeks), followed by cuts (7.7 weeks) and sprains (6.7 weeks).

Analyzed by the source of injury, "bodily movement" was associated with the greatest mean number of weeks (11.5 weeks) of lost time, followed by "vehicles" (10.0 weeks) and "other persons" (7.9 weeks). When analyzed by mechanism of injury, highway crashes were associated with the greatest amount of lost time (mean, 15.5 weeks). The mechanisms of "bodily reaction" (11.5 weeks) and "overexertion" (7.7 weeks) were the next most common.

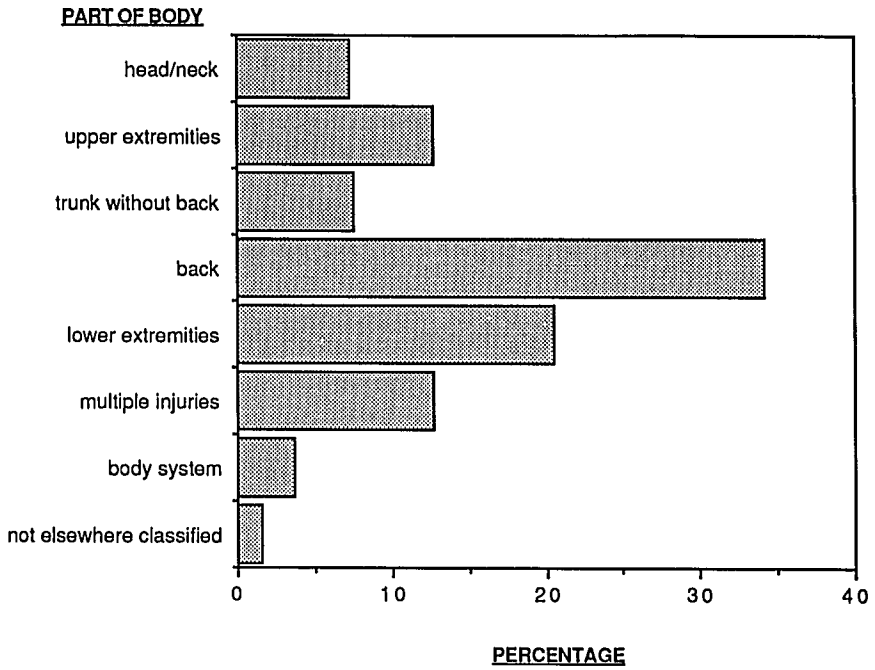

Fig. 3. Disabling injuries among childcare workers by anatomic site—Minnesota, 1985 to 1990.

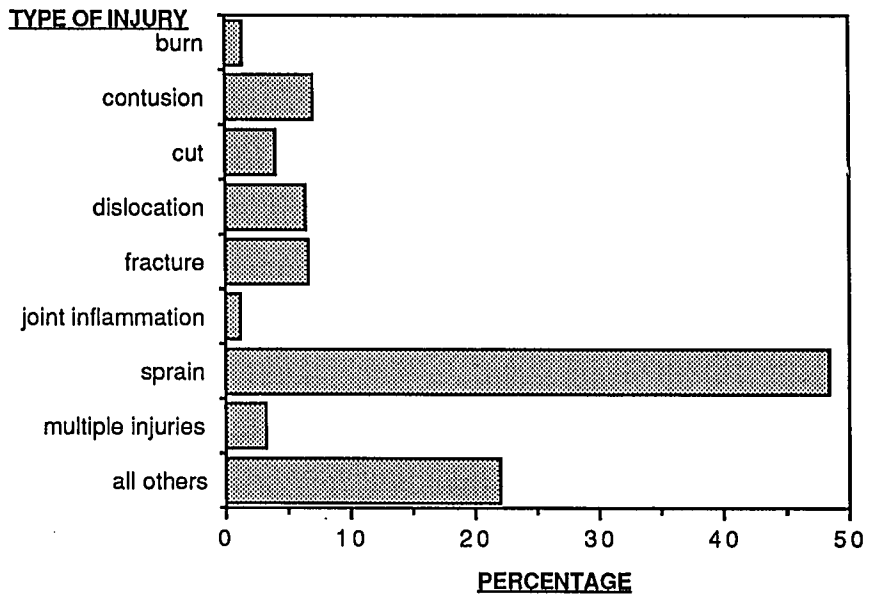

Fig. 4. Types of disabling injuries incurred by childcare workers—Minnesota, 1985 to 1990.

Job Subclassifications

Further analysis was conducted to elaborate on the key findings that there were variations in injury rates among the job subclassifications of Day Care Workers (SIC 8351). Among the job subclassifications, with the exception of teachers' aides, the part of body most frequently injured in each job classification was the back (range, 25% to 39%); childcare workers had the greatest proportion (39%), followed by prekindergarten teachers (35%) and cooks (34%). Teachers' aides incurred a proportion of injuries to the lower extremities (28%) comparable with that of back injuries (27%). Cooks were the only workers who incurred the greatest proportion of their injuries to the upper extremities (24%). Although sprains were identified as the most frequent type of injury among all of the job subclassifications, 17% of the injuries to cooks were burns; further analysis revealed that, of all the burns, 50% occurred to the upper extremities.

According to the source of injury, there was variation among the subclassifications of childcare workers, but other "persons" were reported as being involved most frequently among the subclassifications of childcare workers (37%), prekindergarten teachers (33%), teacher's aides (33%), and "other" (23%). The most frequent source of injury among cooks was boxes (31%); among managers/administrators, work surfaces were most often reported (21%). All subclassifications of child daycare service employees reported "overexertion" as the mechanism of injury in at least 25% of the cases. Cooks (41%) and childcare workers (44%) reported overexertion more often than did the workers in other job subclassifications.

Back Injuries

Given the magnitude of the back injury problem, a subanalysis was conducted to explore potential risk factors. In this analysis, men were deleted because of small numbers; however, the proportion of back injuries among the female cases (32%) was not different from the total male and female cases (34%). The age groups reporting the greatest proportions of back injuries were the 20 to 29-year age group (39%), followed by the 40 to 49- (26%) and 30 to 39- (21%) year age groups. Although no denominator data were available to establish age group rates, 50% of the injuries identified in the 40 to 49-year age group and 25% of the injures reported in the 20 to 29-year age group were back injuries.

By type of injury, 69% of the back injuries reported among these female childcare workers were sprains; the remaining included an "all other classification" (14%), dislocations (13%), joint inflammation (3%), and burns, cuts, contusions and fractures (<1%

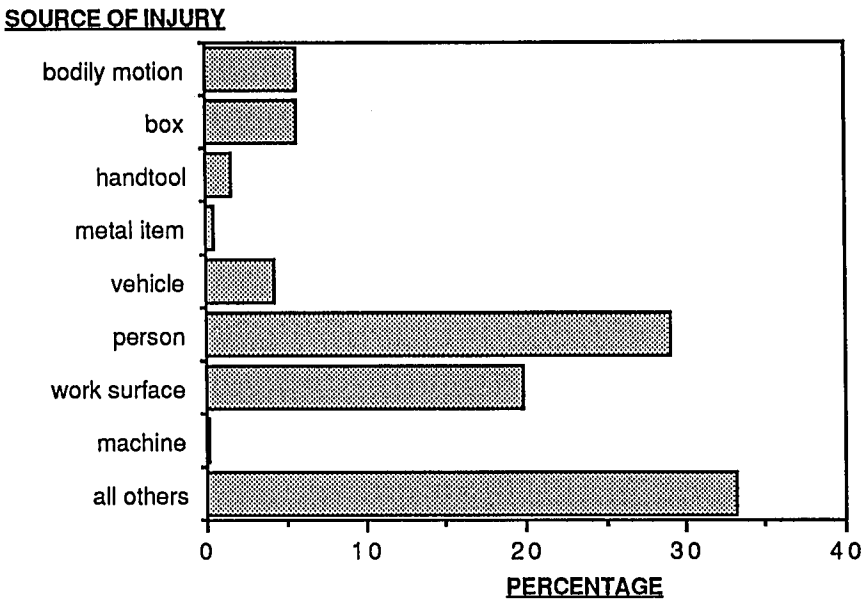

Fig. 5. Sources of Disabling injuries to childcare workers—Minnesota, 1985 to 1990.

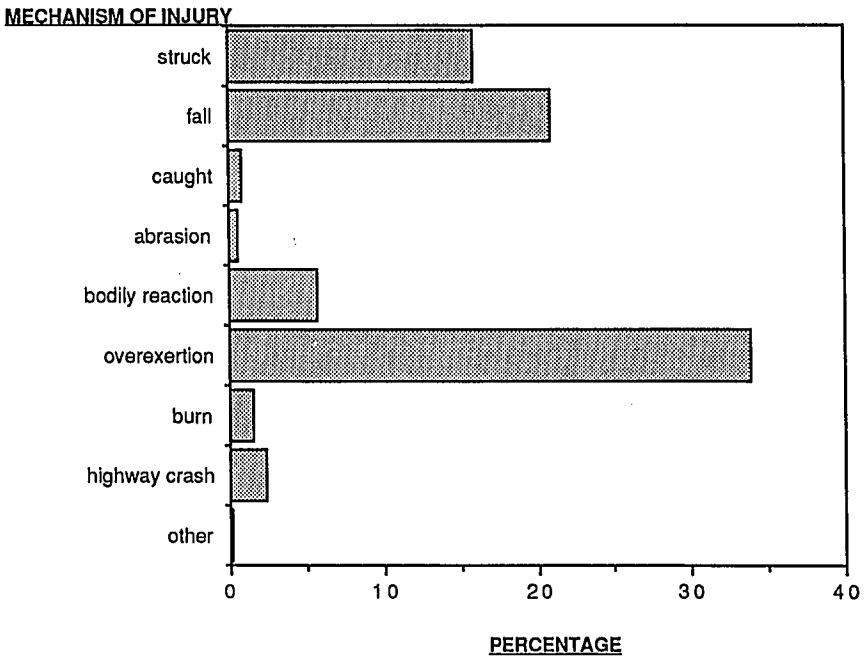

Fig. 6. Mechanism of disabling injuries incurred by childcare workers—Minnesota, 1985 to 1990.

each). According to the source of injury, 48% of the back injuries involved another person; the "all other" (29%), boxes (9%), work surfaces (7%), bodily motion (5%), vehicles (1%), and machines (1%) classifications accounted for the remainder (Table 3). Overexertion was the mechanism of injury in 69% of the cases; the remaining included "other" (16%), falls (7%), bodily reaction (5%), struck by or struck against (2%), and highway crash (1%). Through further analysis of descriptions of the injury event, it was found that 48% of the back injuries were associated with lifting a child, 9% occurred when lifting boxes, 7% as a result of falls, and 2% from vehicle crashes; the rest could not be determined from the data.

Analysis of back injuries according to job subclassification and types of injury, revealed that sprains were a primary type of injury: managers/administrators, 83%; childcare workers, 72%; prekindergarten teachers, 71%; cooks, 70%; "all others," 61%; and teachers' aides, 59%. Dislocations accounted for 30% of the back injuries among cooks, 24% of the teacher aides, 17% of manager administrators, 13% of the "all other" classification of employees, 9% of childcare workers, and 7% of prekindergarten teachers.

Further analysis of back injuries by source revealed that, among the job subclassifications, teachers' aides reported the highest percentage of injuries involving another person (65%), followed by prekindergarten teachers (54%), childcare workers (51%), managers/administrators (50%), cooks (10%), and "all others" (12%). Among the cooks, 50% of the back injuries

TABLE 2
Sources of Disabling Injuries to Childcare Workers by Job Classification—Minnesota, 1985–1990

Job Classification	Source, No. (%)								
	Bodily Motion	Boxes	Hand Tools	Metal Items	Vehicles	Another Person	Work Surfaces	Machines	All Others
Cook	1 (3)	9 (31)	2 (7)	–	–	1 (3)	2 (7)	–	14 (48)
Childcare worker	10 (9)	4 (4)	1 (1)	1 (1)	1 (1)	41 (37)	15 (14)	1 (1)	35 (32)
Manager/administrator	1 (4)	2 (8)	–	–	3 (12)	4 (17)	5 (21)	–	9 (38)
Prekindergarten teacher	2 (2)	2 (2)	3 (3)	1 (1)	6 (5)	36 (31)	27 (23)	–	38 (33)
Teacher's aide	4 (7)	1 (2)	–	–	3 (5)	19 (31)	14 (23)	–	20 (33)
Other	6 (8)	5 (7)	–	–	4 (6)	19 (27)	16 (22)	–	21 (30)

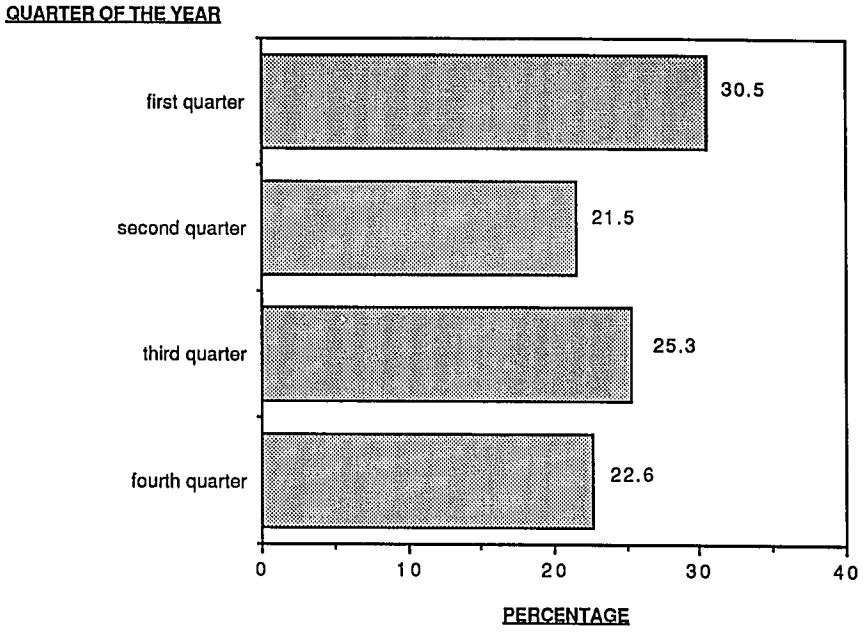

Fig. 7. Disabling injuries incurred by childcare workers by quarter of the year—Minnesota, 1985 to 1990.

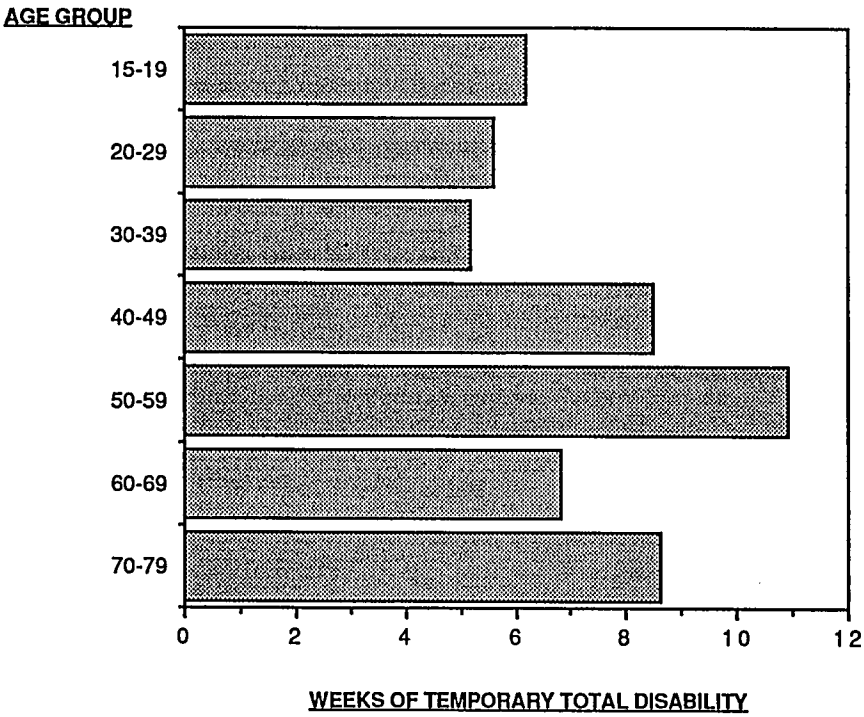

Fig. 8. Weeks of temporary total disability among groups of childcare workers—Minnesota, 1985 to 1990.

involved boxes; among managers/administrators and the "all other" job subclassification, boxes accounted for 17% and 10% of the back injuries, respectively. According to mechanism of injury, overexertion was involved in 88% of the back injuries to cooks, whereas it was associated with 72% of the injuries to childcare workers, 67% of the injuries to manager/administrators, 66% of the injuries to prekindergarten teachers and 48% of the injuries to the "all other" classification.

Costs of Disability

Although only 66% of the total cases were available for analysis of costs, a mean cost of $3759 (range, $270 to $6201) was identified among all injuries. These costs included temporary total disability, temporary partial disability, permanent partial disability, permanent total disability and lump sum payments, which may include some payment for medical expenses. Otherwise no medical or rehabilitation costs are included in these costs. The most costly injuries were associated with the trunk (excluding back) (mean, $6202), multiple injuries (mean, $3579), and back injuries (mean, $3060). The mean cost of total disability paid between 1985 and 1990 was $3183.

Discussion

The overall injury rate for childcare center workers from 1985 to 1990 was 1.08 per 100 workers, with little variation identified over the 6-year period. Although these rates are somewhat lower than the means identified for workers in all occupations, during the same period in Minnesota (range, 2.79 to 2.96 per 100 employees), the true rates are underestimated by virtue of the data source utilized since only injuries involving 3 or more days of lost time were included. Although no denominator data were available to establish specific injury rates by age, the 20 to 29-year age group was identified as having the highest proportion of injuries (39%); this may reflect the proportion of this work force in the 20 to 29-year age category. Among all of the job subclassifications, cooks had the highest injury rates and used the greatest amount of TTD.

To assess why the injuries among the job subclassification of cooks were associated with the highest mean number of weeks of TTD (13.2), one would have to examine the variables associated with these workers more closely. Although 24% of injuries to cooks occurred to their upper extremities, these injuries accounted for the least amount of TTD (mean, 2.8 weeks). Back injuries, which accounted for 34% of the injuries to cooks, accounted for the most TTD (mean, 27.4 weeks). Although sprains were the type of injury most frequently reported, dislocations were associated with the greatest TTD (mean, 41.8 weeks); these were primarily as-

TABLE 3
Sources of Disabling Back Injuries to Childcare Workers by Job Classification—Minnesota, 1985–1990

Job Classification	Source, No. (%)						
	Bodily Motion	Boxes	Vehicles	Another Person	Work Surfaces	Machines	All Others
Cook	–	5 (50)	–	1 (10)	–	–	4 (40)
Childcare worker	4 (9)	3 (7)	–	22 (51)	1 (2)	1 (2)	12 (28)
Manager/administrator	–	1 (17)	–	3 (50)	1 (17)	–	1 (17)
Prekindergarten teacher	–	1 (2)	1 (2)	22 (54)	4 (10)	–	13 (32)
Teacher's aide	–	–	–	11 (65)	–	–	6 (35)
Other	3 (13)	2 (9)	1 (4)	8 (35)	4 (17)	–	5 (22)

sociated with overexertion due to lifting activities. The variation in TTD between the two diagnostic categories of sprains and dislocations may be due to differences in time loss authorization patterns among practitioners making these diagnoses. Although other "persons" were reported to have been involved in only 3% of the injuries to cooks, this source was associated with a mean of 79.0 weeks of TTD.

Among all job subclassifications, the 50- to 59-year age group used the greatest mean number of weeks of TTD, possibly because recovery time may be positively related to age. It is important to note that age adjustments could not be made because of the lack of relevant denominator data.

According to anatomic site, the back accounted for 34% of all injuries among the childcare workers. Nationally, it has been reported that back injuries represent 22% of all worker injury cases and 32% of Workers' Compensation cases.[3] In Minnesota in 1990, back injuries represented 20% of all reported injuries and 31% of all worker injury claims reported to the Department of Labor and Industry.

According to White and Gordon[12], workers such as childcare workers exposed to heavy manual handling tasks are three times more likely to develop compensable low back pain than other workers. Chaffin[13] also reported a greater rate of back injuries among those workers employed at jobs requiring high lifting strength compared with those requiring little or no lifting.

Because of the costs associated with low back problems, in terms of lost productivity and compensation payments, this has become a major focus of attention. The primary prevention measures used by industry have included education, preemployment testing, and modifications of the workplace.[5] Although education on proper lifting techniques may be effective in preventing back injuries, engineering strategies, where appropriate, have been shown to be the most successful, generally, in preventing injuries.[15]

A primary finding pertinent to back injuries in this study was that 48% of all back injuries in childcare workers were related to lifting a child. It is usual in industry to assume that employees who develop back injuries are not lifting in the manner that has been advised. However, lifting ability is not only a function of the lifter, but of the shape of the object lifted.[7] Handling children, using the proper lifting technique, can be difficult because they may be heavy and, possibly, in constant motion. As a result, childcare workers may often lift with their feet and bodies placed in awkward positions. To control this problem, attention should be directed to those job classifications that require lifting of children to further study the characteristics of the injury events and associated risk factors that could enable identification of specific prevention and control strategies more readily. A primary strategy might involve educating employees on using proper lifting techniques[14]; the degree of relevant education received by workers in this study is unknown. Additionally, cribs and changing tables can be designed ergonomically to enable employees of different heights to use them comfortably and without consequence of injury.

In this study, cooks reported lifting "boxes" as the most frequent source of injury. Kitchens can be designed to prevent unnecessary lifting of heavy boxes; ordering supplies and food in smaller, lighter packages can also improve this situation. At a minimum, workers must be informed of the maximum weight they can lift without assistance.[13] By identifying variables potentially associated with back and other injuries, the occupational health professional is better able to develop appropriate prevention and control strategies.

It was also identified that 71% of all of the burn injuries occurred among cooks. These can be prevented with the use of available protective clothing, utensils, and appliances that are designed with safety in mind.

The greatest proportion of injuries occurred in the first quarter of the year. To assess the patterns of injury adequately by month of the year, denominator data (ie, the total number of employees working in each month) are necessary. For prevention and control purposes, staffing patterns by day of the week must be analyzed relative to injury incidence to assess potential associations. It is interesting to note that 40% of the falls were reported during the first quarter of the year. It is possible that slippery walks and wet floors from melted snow could have contributed to these falls. Fall-related injuries can be controlled both indoors and outdoors. Indoors, floors should be designed with rough surfaces or covered with rugs to prevent slipping, especially when wet. Outdoors, walkways and parking lots can be kept free of snow and ice with proper maintenance and attention. Attention to the design and integrity of stairs, with regard to the standards

for width, depth, height, slope, railings, and illumination, must be followed.[16]

The fact that 32% of injuries involving vehicles occurred during the first quarter may also have been due to slippery roads. Although it was not known whether or not the workers involved in the motor vehicle crashes were wearing seatbelts, it has been shown that appropriate use reduces both injury severity and death[15]; however, the use of airbags in concert with seatbelts provides the greatest protection.

In summary, the problem of childcare worker injuries deserves more attention. Regulations that protect workers in industries with larger numbers of workers are integral to smaller industries. Where regulations pertinent to key sources of injury are nonexistent or inadequate, actions to control related injuries are essential. In situations where employees are required to operate a motor vehicle, and possibly transport clients, seatbelt use and cars with airbags should become a requirement. This could help reduce some of the serious injuries that result to workers as well as clients involved in motor vehicle crashes.

It is vitally important that adequate denominator data according to age, gender, and job subclassification of all childcare workers become available to assess true injury rates and make appropriate comparisons. Also, information about actual injury events must be documented more carefully and in greater detail. Without this information, it is not possible to draw further conclusions about these injuries and their potential causes. Beyond more comprehensive efforts is the need for analytic efforts, including case-control studies, to identify specific risk factors. Compared with other causes of death and disability, the amount of research funding allocated to the injury problem is small, yet injury accounts for more years of life lost and disability than do cancer and cardiovascular disease combined.[8]

Although the data available to this study were limited, it was found that between 1985 and 1990 injuries to childcare workers accounted for a mean number of 7.0 weeks of temporary total disability, with a mean cost of $3183 for total paid disability. Additional costs including lost-time payments, wage replacement, and lump sum payments, which may include some payment for medical expenses but did not account for personal costs associated with these injuries, increased this to a total mean cost of $3759. Other costs not included in these figures are costs to employers such as hiring temporary or permanent employees to replace the injured worker, the costs associated with training these replacements, and related lost productivity. Although the injury rates among childcare workers appear low compared with some industries, this area deserves attention due to the personal consequences of occupational injuries incurred by injured workers and their families. Although difficult to quantify, they include pain and suffering, stress and stress-related illnesses, economic insecurity, and a diminished quality of life, especially for permanently disabled workers.[2]

Among other problems in childcare centers, injuries to employees in these centers have recently been targeted for investigation by the Centers for Disease Control. This effort represents one of the first to look at the problem more critically.

Acknowledgments

Partial funding for this project was provided through the National Institute for Occupational Safety and Health and the Minnesota Environmental Health Association's Mary Lauren Olson scholarship.

We thank Brian Zaidman, Minnesota Department of Labor and Industry, St Paul, Minnesota, for his assistance with data access and computer programming for the project and Jackie Spies, Division of Licensing, State of Minnesota Department of Human Services, for her assistance in providing data on childcare centers.

References

1. Occupational Injury Prevention. Presented at the Third National Injury Control Conference, Denver, Colo, April, 1991:i-iv; *MMWR* 41:21–26, April 24, 1992.
2. National Committee for Injury Prevention and Control. *Injury prevention: meeting the challenge.* Oxford: Oxford University Press; 1989:178–182.
3. National Safety Council. *Accident facts* (1990). Chicago: National Safety Council:1991:1–3, 38.
4. Minnesota Department of Labor and Industry. Minnesota Safety Annual Report—Characteristics of Minnesota work-related injuries and illnesses 1983–1989. 1990:2–20.
5. Frymoyer JW. Back pain and sciatica. *N Engl J Med.* 1988:318:291–298.
6. *Preventing illness and injury in the workplace.* Office of Technology Assessment-Congress of the United States. Washington, DC: 1985:7–40.
7. Pollock ES, Keiming DG. *Counting injuries and illnesses in the workplace: proposals for a better system.* Washington, DC: National Academy Press;1987.
8. Rice DP, Mackenzie EJ, et al. *Cost of injury in the United States—A report to Congress.* San Francisco, CA: Institute for Health and Aging, University of California; and Baltimore: Injury Prevention Center, The Johns Hopkins University; 1989:68–89.
9. Waller JA: *Injury control: a guide to the causes and the prevention of trauma.* Lexington, MA: Lexington Books, D. C. Heath and Company; 1985:421–440.
10. Statistical Package for the Social Sciences Incorporated: SPSS/PC+ Statistics Version 4.0, Chicago, IL, 1990.
11. Olson DK, Gerberich SG. Traumatic amputations in the workplace. *J Occup Med.* 1986;28:480–485.
12. White AA, Gordon SL. Synopsis: workshop on idiopathic low-back pain. *Spine.* 1982;7:141–142.
13. Chaffin DB. Human strength capability and low-back pain. *J Occup Med.* 1974; 16:248–253.
14. Owen BD. The lifting process and back injury in hospital nursing personnel. *West J Nurs Res.* 1985;7:445–457.
15. Robertson LS. *Injuries: causes, control strategies, and public policy.* Lexington, MA: Lexington Books, D. C. Heath and Company; 1983:1–19.
16. National Safety Council. *Accident prevention manual for industrial operations, engineering and technology.* Chicago: National Safety Council, 1980:26–27.