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TERRY'S MONTESSORI SCHOOL, INC.
CINCINNATI, OHIO

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SUMMARY

In June 1993, the National Institute for Occupational Safety and Health (NIOSH) received a request from the owner and an employee of Terry's Montessori School, Inc. in Cincinnati, Ohio, for a health hazard evaluation to identify and evaluate possible causes of musculoskeletal problems among teachers and aides at the school. NIOSH investigators conducted an initial site visit to the school on October 4, 1993. Investigators spoke with the owner, administrators, and teachers; made measurements of workstation and furniture dimensions; and distributed a questionnaire to school employees. A second site visit was conducted on November 22, 1993, to discuss the results of the questionnaire and the need for additional data collection activities. A third site visit was made on February 11, 1994, to observe and videotape the work activities of school employees.

The questionnaire was completed and returned by 21 of 22 employees. Back pain/discomfort was the most common musculoskeletal complaint, reported by 61% of respondents. Neck/shoulder pain, and hand/wrist pain were reported by 33% and 11% of respondents, respectively. Because back pain was the most prevalent condition reported, the ergonomic evaluation focused on identifying its possible work-related causes.

Observation and analysis of work activities indicated that employees spend significant periods of time kneeling, sitting on the floor, squatting, or bending at the waist. Furthermore, staff members who work with smaller children (i.e., 6 weeks to18 months of age) performed more lifts and assumed more awkward lower extremity postures than employees who work with older children (3-4 years). Analysis of two lifting tasks using the NIOSH lifting equation indicated that employees who handle small children may be at increased risk of lifting-related low back pain.

Employees may be at increased risk of low back pain and lower extremity (i.e., knee) injury due to work activities that require awkward or heavy lifts and static working postures. Recommendations for reducing or eliminating these risks by modifying the workplace and changing the organization and methods of work are presented in this report.

KEY WORDS: SIC 8351 (child day care services), back injury, lumbo-sacral stress, back pain, ergonomics, musculoskeletal problems.

INTRODUCTION

In June 1993, the National Institute for Occupational Safety and Health (NIOSH) received a request for a health hazard evaluation (HHE) at Terry's Montessori Pre-School in Wyoming, Ohio. The requestors, the owner and an employee, indicated concern about musculoskeletal problems associated with facilities and equipment designed to accommodate small children. An initial site visit was conducted on October 4, 1993, at which time NIOSH investigators interviewed the owner and teaching administrators, distributed a questionnaire to school employees, and measured work station and furniture dimensions. A second site visit was conducted on November 22, 1993, to discuss the results of the questionnaire and the need for additional data collection activities. A third site visit was made on February 11, 1994, to observe and videotape the work activities of school employees.

BACKGROUND

Terry's Montessori School was founded in 1972 and currently occupies three buildings. Care for children between the ages of 6 weeks and 3 years is provided in Building 1, for children between the ages of 3 and 4 years in Building 2, and for children over 4 years in Building 3. Because Buildings 1 (435 Crescent Ave.) and 2 (425 Crescent Ave.) are located next door to each other and were considered by the requestors to be the locations where musculoskeletal problems were of most concern, the NIOSH investigation focused on these two buildings.

At the time of the initial site visit, 68 children were under the care of 19 teachers in Buildings 1 and 2. During the summer months, enrollment is reduced approximately 50%. Teachers work staggered hours between 7 am and 6 pm. Each teacher works an 8-hour day and has 1 hour for lunch. Most teachers have a 9-month contract and work full-time during this period.

The school buildings house several rooms, each of which is set up for a different type of activity. Teachers, usually two per room, stay in their assigned rooms. Children move throughout the building, participating in whichever activities they prefer. The flow of children is controlled only when too many children gather in any one area.

Only one workers' compensation claim has been filed by an employee of the school during its 21 years of operation. Nonetheless, the owner and school administrators cited recent complaints of back and knee pain among staff members as the reason for the HHE request.

Pain in the back, hips, and lower limbs caused by mechanical stresses on the lumbar spine presents one of the most common and costly problems in occupational health. It has been estimated that the lifetime prevalence of moderate to severe low back pain in the general population may be as high as 70%.[2]

Low back pain can be caused by direct trauma to the spine or a single "overexertion" of the muscles and ligaments, or it can result from multiple strains (i.e., repetitive trauma).[3] Lifting is a major cause of work-related back pain and impairment. Repeated lifting can cause pathological degeneration of the discs which lie between the vertebrae, causing damage to the spine, nerve irritation and pain. Bending, stooping, pushing/pulling and prolonged sitting can also contribute to the onset of injury.[4] There is some evidence that work-related psychological stress and lifestyle factors may increase the likelihood of back pain and the subsequent risk of prolonged disability.[5]

Knee injury also can be caused by undue mechanical stresses on the joint, imposed by activities which require prolonged squatting or kneeling. Previous research has shown that postures which require near-maximum knee flexion can produce shear forces sufficient to stretch or otherwise damage knee ligaments.[6] Furthermore, squatting and kneeling have both been associated with a variety of nerve compression disorders.[7,8]

Children are often not perceived as producing lifting/handling difficulties because they are generally considered to be "lightweight". However, increasing complaints of chronic fatigue and low back pain have been reported among nursery school teachers in Japan, and it has been noted that caring for children can lead to postures which impose heavy static loads on the musculoskeletal system.[9-11] Tasks such as lifting children from floor level may require muscle strengths in excess of the capabilities of this largely female worker population.

METHODS

NIOSH investigators conducted an initial site visit to the school on October 4, 1993. Investigators spoke with the school's owner and two teaching administrators and examined the physical layout of the school and the design of furniture and equipment. Dimensions of tables, chairs, cribs, changing stations, etc. were measured and recorded.

All employees in Buildings 1 and 2 present on the day of the survey were approached individually to explain the purpose of the visit and to request their participation in completing a questionnaire. The questionnaire covered demographic characteristics, perceived physical workload of the job, symptoms of pain associated with musculoskeletal injuries, perceptions of overall workload and control over work, social support, and job satisfaction. Employees were instructed to complete the questionnaire before they left work, if possible, or to return it by mail to the NIOSH investigators. A pre-addressed, postage-paid envelope was provided.

A second site visit was conducted on November 22, 1993, to provide administrators with the results of the questionnaire and to discuss the need for additional data. A third site visit was conducted on February 11, 1994. At this time, NIOSH investigators observed and videotaped the work activities of school employees over a six-hour period. The NIOSH lifting equation[4] was

used to calculate acceptable weights of lift for two representative lifting tasks (lifting a child from a crib and from the floor). In addition, a work sampling study was performed to estimate the percentage of time employees spend performing various tasks and in certain postures. Specifically, a modified Ovako Working Posture Analyzing System[12](OWAS) was used to record the upper limb, trunk, and lower limb postures of nine employees. Once every ten to fifteen minutes, a description of the activity currently being performed by the employee was entered on a worksheet, along with a three digit-code describing the position of the upper limbs, trunk, and lower limbs at the time of the observation.

FINDINGS

Twenty-one of 22 questionnaires distributed to school employees were completed and returned to NIOSH investigators. Information provided by the school owner, an employee who works only in the kitchen, and a substitute teacher were excluded from the analysis described below.

All employees were female. They ranged in age from 23 to 53 years (average=36). Although the majority of employees had worked one year or less at Terry's Montessori Pre-School, the range in seniority was from several months to 10 years.

No work-related injuries during the past year were reported. Fourteen employees (78%), however, reported some pain or discomfort in at least one of the following areas of the body: neck/shoulder, back, hand/arm, and lower extremity. Back pain (11 employees, 61%) occurred most frequently, followed by neck/shoulder (6 employees, 34%), lower extremity (6 employees, 34%), and hand/wrist (2 employees, 11%). Of the 11 employees who reported back pain, 6 (55%) described it as very or extremely uncomfortable (levels 2 and 3 on a scale ranging from 1 to 3).

Employees who reported pain/discomfort differed in some of the personal and job characteristics known or suspected as risk factors for musculoskeletal disease(Table 1). For back pain, the most common complaint, the occurrence of pain appears to be related to caring for the youngest children, perceptions of higher job demand and physical effort, low seniority, and young age. The differences in these factors between employees with and without back pain, however, were not statistically significant.

Inspection of play areas in both buildings revealed that almost all of the furniture and equipment was designed for use by small children. Activity rooms and eating areas were equipped with miniature wooden tables (height = 12" to 16") and chairs (height = 9" to 12"). Sinks were located 20" above floor height. Changing tables (used infrequently) were located 20.5" to 22.5" above the floor to allow older children to climb onto the tables without assistance. Cots (assembled and used during nap periods) were 9.5" high.

Except for a two-hour period in the afternoon when the children are napping, employees spend almost all of their time interacting with the children in activity rooms throughout the facility. Observation of working postures revealed that, on average, teachers and aides spend approximately 25% of their time squatting, kneeling or sitting on the floor when working with the children. The frequency of these postures was somewhat greater among teachers who work with younger children (31%) than teachers who supervise older children (18%). Teachers spend an additional 25% of their time seated, usually on the cots (during nap time) or on the small wooden chairs designed for use by the children. Neither of these furniture pieces provides adequate back or knee support for adults; furthermore, rising from a low sitting position imposes substantial stresses on the ligaments of the knees. The chair's smaller seat pan also tends to concentrate the body's weight on a smaller area of the buttocks and thighs.

Feeding the children was associated with a high frequency of bending at the waist and squatting. In one 5-minute observation period during lunch, one employee was observed to bend forward at the waist at a rate of 4 times per minute, to fill drink glasses, distribute cookies, wipe spills, etc. On several occasions, this posture was maintained for several seconds (up to 36 seconds). Teachers were also observed bending to use the child-size sinks in the play/feeding areas, despite the availability of adult-sized sinks in the food preparation areas.

Lifting occurred infrequently except in areas occupied by infants and small toddlers. In these areas, employees were observed bending over to lift infants to and from cribs or changing tables and rocking children in their arms in an effort to put them to sleep. Evaluation of two representative lifting tasks (lifting an infant over the side of a crib, and lifting a child from the floor, to a position where the employee is standing and holding the child) using the NIOSH lifting equation[4] revealed that both tasks may pose increased risk for lifting-related low back pain (Table 2). Notably, the infant playroom was also one of the few areas where "adult-sized" furniture was provided for employees to sit while holding the children or observing their play activities.

DISCUSSION

The results of this investigation support the conclusion that employees at this site may be at increased risk of back and lower-extremity musculoskeletal disorders due to activities which require sustained periods of kneeling, stooping, squatting or bending. Lifting small infants or toddlers may exacerbate this risk. Fortunately, many of the awkward knee, leg, and trunk postures observed during the site visit could have been avoided. In many cases, it appeared that employees may not be not aware that certain sitting and lifting postures can impose excessive loads on the musculoskeletal system. For example, several employees were observed leaning over cribs, or lifting infants out of cribs without first lowering the side (which would have reduced the amount of bending and trunk twisting required). Also, employees may not realize

that postures which involve extreme knee flexion or put most of the body's weight on the knees can do damage to the ligaments and tendons in the knee.

There is increasing recognition that work-related musculoskeletal disorders, including low back pain, are mutifactorial in nature. Many factors, including individual characteristics, physical and psychosocial aspects of work, and factors outside of work contribute to the occurrence and severity of pain. This study did not address the impact of non-work-related factors on the reported musculoskeletal problems.

RECOMMENDATIONS

Employees should be encouraged to avoid squatting or kneeling postures and to use lifting practices which will minimize stresses on the back. A description of recommended practices for lifting small children is provided in the Appendix.

Changes to the physical design of workstations and equipment items used by employees at the school may also minimize musculoskeletal stress.

a. Although we recognize that the Montessori method requires teachers to interact with children at the child's level, adult-sized chairs should be used by the staff at meetings, when recording notes, or at times when the children are asleep. At other times, adults should be provided with adjustable stools (with larger, cushioned seats and rollers for easy movement), which would allow a more appropriate seated posture (less knee flexion and effort to stand up).

b. In areas where similar equipment is used by both children and staff, items should be provided at heights appropriate for both. For example, additional sinks (located 28-34 inches above the floor) should be installed in play areas to allow staff members to wash hands and obtain clean rags without walking to the kitchen or bending.

c. The frequency of bending and squatting during meal time could be reduced by (a) providing beverages to smaller children in spill-proof cups to reduce the need for frequent clean-up) and (b) moving the eating area away from the play area at 435 Crescent Ave. This would prevent children who are eating from becoming distracted by other children playing in the area. (Several times, teachers were observed leaning over to turn the children away from the activity towards the table).

d. Equipment not used by children should be located at heights appropriate for adults. For example, in the building at 435 Crescent it was noted that the refrigerator (used to store milk and snack items) is located below waist level. Because children do not directly access the refrigerator, it should be raised to eliminate trunk bending. The heights of

mattresses and/or cribs in the infant room should also be raised to reduce the amount of bending required to lift infants from the cribs.

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1. Terry's Montessori Pre-School
2. OSHA Region V (Chicago)

Copies of this report shall be posted by the employer in a prominent place accessible to the employees for a period of 30 calendar days.

TABLE 1
Occurrence of Pain/Discomfort
by Personal and Work-related Factors
Terry's Montessori Pre-School
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Factor[1]	Back Pain/Discomfort		Shoulder Pain/Discomfort		Lower Extremity Pain/Discomfort	
	Present	Absent	Present	Absent	Present	Absent
Age (yrs)	34	38	35	38	34	36
BMI[2]	.03	.03	.03	.03	.03	.03
Seniority (yrs)	1.8	3.0	4.7	1.0	2.8	1.9
Youngest child cared for (yrs)	1.3	2.2	1.7	1.7	1.3	1.9
Oldest child cared for (yrs)	3.7	3.2	3.8	3.3	3.2	3.6
Perceived physical effort[3]	13	11	13	12	12	12
Job demand[4]	3.5	2.8	3.3	3.1	3.8	3.0
Job control[4]	3.3	3.5	3.4	3.3	3.3	3.4

[1] Average for all employees
[2] BMI = body mass index = weight/(height)^2
[3] Physical effort scores are based on a scale, which ranges from 6 (very, very light) to 20 (very,very heavy). Scores from 11-13 are considered fairly light to somewhat hard.[13]
[4] Job demand and control scores range from 1 (very little) to 5 (very much)[14]

TABLE 2
NIOSH Lifting Equation Evaluation

Task 1: Lifting Infant from Crib

Object Weight (lbs)*		Hand Location (inches)				Vertical Distance (inches)	Asymmetric Angle		Frequency (lifts/min)	Coupling
		Origin		Dest			Origin	Dest		
Min	Max	H	V	H	V	D	A	A	F	C
20	30	25	20	10	45	25	0	0	< 0.2	Poor

Task 2: Lifting Child from the Floor

Object Weight (lbs)*		Hand Location (inches)				Vertical Distance (inches)	Asymmetric Angle		Frequency (lifts/min)	Coupling
		Origin		Dest			Origin	Dest		
Min	Max	H	V	H	V	D	A	A	F	C
20	30	15	10	10	45	35	0	0	< 0.2	Poor

*Weight of toddler - assumed to range from 20 lbs. at approximately 9 months, to 30 lbs. at approximately 18 months of age.

Task		Lifting Equation Components							Results	
		LC	HM	VM	DM	CM	AM	FM	RWL	LI
1	Origin	51	0.40	0.93	0.89	0.90	1.0	1.0	15.2 lbs	**1.3 (min) 2.0 (max)**
	Dest	51	1.00	0.89	0.89	0.90	1.0	1.0	36.3 lbs	0.6 (min) 0.8 (max)
2	Origin	51	0.67	0.85	0.87	0.90	1.0	1.0	22.7 lbs	0.9 (min) **1.3 (max)**
	Dest	51	1.00	0.89	0.87	0.90	1.0	1.0	35.5 lbs	0.6 (min) 0.8 (max)

LI > 1.0 (indicated in **bold**) indicates task may present an increased risk of lifting-related low back injury to the workforce.

APPENDIX

Recommendations for Lifting/Handling Small Children*

(1) Before lifting a child to a working surface (e.g., a changing table), prepare the work surface beforehand to minimize the need to reposition the child during or after the lift.

(2) Before lifting infants from cribs, lower the bed side and slide the child across the mattress toward the body before attempting the lift. If possible, the child should be moved into a sitting position and turned so that the back is near the body (this allows the child's weight to be held as close to the body as possible). Raising the height of the crib/mattress should be considered to reduce forward bending during lifts.

(3) Before lifting children from the floor, kneel down beside the child and place one arm between the child's legs with the palm of the hand on the child's stomach. The other hand should be placed under the child at shoulder level. The child should be rolled towards the body so that the child's back is nearest the body. If the hand is pressed against the child's stomach, the child will bend the hips, becoming easier to lift. The hand on the child's shoulder should slide down and around to the child's thigh while supporting the child's body on the forearm. Once the child has been lifted onto the lap, it is safe to stand.

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* Adapted from: Corlett, E.N., Lloyd, P.V., Tarling, C., Troup, J.D.G. and Wright, B. 1992. The Guide to the Handling of Patients, 3rd Edition. National Back Pain Association, Middlesex, UK.