The Effects of Body Mechanics Instruction on Work Performance

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Thirty food service workers were randomly assigned to two groups; one group received body mechanics instruction while the other did not. The application of the instruction was measured by evaluating the subjects' use of body mechanics on a novel lifting and lowering task and during performance on the job. Results indicated that the group which received instruction performed significantly better on the novel task than the group that received no instruction. However, no significant difference between groups was found in performance in the work environment. The role of the occupational therapist in a work-related safety program is also discussed.

Since occupational back injury is one of the most disabling, costly, and frequent work-related injuries, it is desirable to minimize or prevent the occurrences of such injuries whenever possible. Body mechanics instruction offers a practical way to educate workers in the efficient use of the human body in the performance of work activities.

With the increasing focus on the prevention of occupational injuries, it would seem that the knowledge base and functional approach of the occupational therapist can be used by industry and self-insured companies as a means of increasing worker safety through instruction in and application of body mechanics techniques necessary for safe lifting and lowering.

Review of Literature

For the past 40 years, it has been postulated that lifting heavy loads should be done with a straight back and bent knees to decrease the risk of an overexertion injury to the back (Shephard, 1974). There is general consensus regarding this accepted biomechanical technique for properly lifting and lowering objects (Broer & Zernicke, 1979; Chaffin, 1975; Frederick, Clark, Brown, Nelson-Allen, & Amble, 1983; Garg & Saxena, 1979; Grandjean, 1982; Shephard, 1974). Although there are other methods, controlled studies to determine their effectiveness have yet to be done (Chaffin, 1975).

Currently, manual handling and lifting are the topics of major concern among health professionals incorporating ergonomic principles in treatment; efforts are aimed at the identification of safer lifting and handling techniques. Back injuries represent a major source of insurance claims against employers, absenteeism, disability payments to the injured worker, and loss of livelihood to the injured party leading to early retirement (Grandjean, 1982). For these reasons, back pain has become a specialty within the science of ergonomics (Hayne, 1984).

In U.S. industry, at least 25% of all compensable injuries are overexertion injuries to the low back (Kroemer, 1983). The Department of Labor and Industries in the state of Washington reported that the average time lost from work per serious back claim is more than 125 days (Chaffin, 1975). A study by Matheson (1984) indicated that in the majority of 132 injured workers "injuries were the result of performing a safe job in an unsafe manner" (p. 57). Nachemson also asserted that working methods involving unskilled manipulation were the precursors to an increased risk of back injury (Grandjean, 1982). Such injuries can be avoided through an ergonomic design of the job and the careful training and selection of workers (Kroemer, 1983). Ayoub, Selan, and Liles (1983) contended that the goal of ergonomics is to
design tasks in such a way that their demands remain within the worker's capacity.

Training in occupational back injury prevention provides benefits to both workers and employers. Lepore, Olson, and Tomer (1984) reported significant reductions in terms of the average annual cost of expenditures for back injuries (67.5%), average annual cost per claim (76%), and severity of injuries as measured by absenteeism (71%). If the focus of the allied health professions is changing to emphasize prevention, preventive occupational therapy treatment of work-related back injuries is needed.

It was the purpose of this study to examine the effectiveness of instruction in the body mechanics of lifting and lowering on the subsequent use of body mechanics in the work environment. The following questions were the focus of concern:

1. On a novel lifting and lowering task, is there a significant difference in the body mechanics measures between subjects who receive instruction in body mechanics techniques and those who do not receive such instruction?

2. In the work environment, is there a significant difference in the body mechanics measures between subjects who receive instruction in body mechanics techniques and those who do not receive such instruction?

Methodology

Subjects

Subjects in this study were food service employees at a small liberal arts university located in the Pacific Northwest. Food service workers were chosen as subjects because of the heavy lifting requirements on the job and the university's desire to enhance the safety of its employees. From a list of all food service personnel, a random sample of 36 subjects and 18 alternates was selected. Subjects were randomly placed into one of two groups; the experimental group received body mechanics instruction and the control group did not. After some subjects were excluded for medical reasons, the experimental group consisted of 14 women and the control group consisted of 2 men and 14 women.

Definition of Terms

For the purposes of this study, body mechanics was operationally defined as the efficient use of the body that allows for the lessening or elimination of physical strains that may cause injury and simultaneously aids in accomplishing work more quickly and efficiently (Frederick et al., 1983). The body mechanics principles observed were the straight-back, bent-knee method of lifting and the four high-risk work style factors of horizontal displacement, spinal torque, pace/object control, and forward/rearward stability (Frederick et al., 1983; Matheson, 1984). Lifting and lowering was defined as bimanual vertical displacement of objects without mechanical aids (Matheson, 1984). Transfer was defined as the lateral movement of an object at waist level or table height.

Instruments

The instruments used in this study included the WEST 2 Work Capacity Evaluation Device (Work Evaluation Systems Technology, 1983) as the novel task and a modified version of the WEST 2 Body Mechanics Evaluation. The latter, a 17-item checklist, was designed specifically for the study to evaluate people's use of body mechanics during the lifting and lowering of weight trays weighing from 5 to 30 lb. The following factors were evaluated during lifting and lowering: control of spinal torque, bent hips and knees, maintenance of straight back, and pace/object control. While subjects were lifting above the waist, the following factors were evaluated: conservation of horizontal displacement (within one and one-half times the load-to-spine distance) and horizontal stance (with legs at least shoulder width apart). A total of 102 points could be collected from the 17 items being evaluated. Points were collected only if a task item was correctly performed. Interrater reliability was established at 96%.

A third instrument, the Work-Related Body Mechanics Evaluation, a 17-item checklist, was designed for this study to evaluate the subject's use of body mechanics during the lifting, lowering, or transferring of objects in the work environment. During lifting and lowering, the following factors were evaluated: bent hips and knees and maintenance of a straight back. The following factors were measured during transferring: conservation of horizontal displacement, spinal torque, and horizontal stance of at least shoulder width. A total score of 17 points could be attained. Points were accrued only if a task was correctly performed. Interrater reliability was established at 96.23%.

Procedure

Approximately 1 month before the data gathering was begun, a pilot study was conducted on the WEST 2 and in the work setting to ensure the validity of the modified WEST 2 checklist items cited above. As a result, a separate checklist was designed for the work environment. Pace/object control was not included because motions requiring repetition were not frequently observed in the work setting.

Two weeks prior to data gathering, the experimental group participated in a 1-hour body mechanics course that emphasized the high-risk work style factors and the necessity to maintain a straight back and
bending the hips and knees during the lifting and lowering of objects. A kinesiologic visual aid, Jack-the-Back, was used to facilitate a basic understanding of structure as it relates to function (see Figures 1 and 2). Each subject was required to lift and lower a 20 lb box from the floor to the waist, the waist to overhead, and overhead to the floor while being videotaped. Videotape feedback regarding individual techniques of lifting and lowering provided subjects with insight into the quality of their own body mechanics techniques. The occupational therapist who does preemployment screening for the university served as the instructor for the body mechanics class and also performed the WEST 2 evaluations. This allowed the primary researcher to remain blind to the group assignments while examining the subjects in their work environment.

Two weeks after the body mechanics class, all subjects were requested by the safety director of the university to attend a 20-min body mechanics evaluation during their working hours. The Modified WEST 2 Body Mechanics Evaluation was used to evaluate each subject in the experimental and control groups prior to a work environment observation.

One week after the body mechanics evaluations on the WEST 2 had been completed, the novel task subjects were observed in their work environment, the food service kitchen. Because it was not possible to remain unobtrusive, the subjects were told that the researcher was performing a job analysis to address the concerns that many workers had voiced during WEST 2 evaluations (i.e., that the evaluation did not truly evaluate the kinds of lifting and lowering required on the job). While performing the “job analysis,” the researchers conducted a covert body mechanics evaluation. After the work environment body mechanics observations had been completed, the members of the control group received the brief, 1-hour body mechanics course so that they would not be discriminated against.

Results

To investigate whether or not significant differences existed between the mean scores of both groups on the WEST 2 and in the work environment, independent t tests were performed. The group that received body mechanics instruction performed significantly better on a novel task (WEST 2) than the group that received no instruction (see Table 1). However, there was no significant difference between the groups in terms of performance in the work environment (see Table 2).

Because of the small sample size and the limited range of the scores, nonparametric, Mann-Whitney U tests were used to analyze the differences between group performance in the work environment on the lifting and lowering subtests (combined) and on the transfer subtest. No significant differences were found.
Discussion

The experimental group, which received prior instruction in body mechanics principles, demonstrated significantly better body mechanics techniques during the evaluation on the WEST 2 (novel task) than the control group, which received no prior instruction. Since the groups were randomly assigned, it is reasonable to conclude that this difference was produced by the knowledge gained through the instruction in body mechanics. This means that body mechanics instruction by an occupational therapist in a work-related safety program can result in the use of body mechanics techniques that are conducive to safe lifting and lowering.

In contrast, there was no difference between groups in body mechanics techniques used in the actual work environment for the total score or the subtests. In fact, the behaviors observed on the job were poor for all subjects, as evidenced by the low mean scores for both groups. This reflects that learning, as demonstrated by the superior WEST 2 performance of the experimental group, did not transfer to the work environment. Plausible explanations for these results include the strength of the worker’s preestablished habit patterns, the pace required on the job, the possible inappropriateness of the WEST 2 for the evaluation of body mechanics techniques necessary in a dynamic work environment, the arrangement of the work environment, and the possibility that the straight-back, bent-knee method of lifting and lowering is impractical.

To change highly ingrained habit patterns, it is necessary to incorporate cortical control over each aspect of the activity. In other words, a once subcortical activity requires continual cortical intervention if previously programmed habit patterns are to be overridden. The practice and repetition of lifting and lowering tasks with feedback on the correct use of body mechanics would increase the likelihood of changing ingrained habit patterns (Schmidt, 1975). Although this would require a greater amount of time, it might ultimately be more cost-effective for employers (Lepore et al., 1984).

Related to the concept of cortical control are the pace requirements of the job. Since the subjects in this study were required to serve 2,800 students daily, the job’s pace was vigorous. The food service kitchen resembled an assembly line wherein each worker was dependent upon another to perform the job. Speed was often a factor, and there was usually not sufficient time for cortical guidance through every aspect of a task. Under such circumstances, relearning could be difficult. Practice and repetition would enhance the probability of a subcortical response being elicited and must be considered by therapists developing a preventive program in body mechanics.

### Table 1
Analysis of Differences Between Groups on WEST 2 Performance

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>M</th>
<th>SD</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental</td>
<td>14</td>
<td>91.071</td>
<td>3.751</td>
<td>13</td>
</tr>
<tr>
<td>Control</td>
<td>16</td>
<td>64.688</td>
<td>13.205</td>
<td>42</td>
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<tr>
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<td>--</td>
<td>-7.212</td>
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*p < .001.*

The WEST 2 Work Capacity Evaluation Device may be limited in its use for the prediction of injury in a work environment that requires more than vertical lifting and/or lowering. This can perhaps be attributed to the static and predictable nature of the environment in which it is used. The work environment represents a dynamic and unpredictable nature of the environment in which it is used. The work environment represents a dynamic and unpredictable setting that would not appear to be congruent with the protocol of the WEST 2. The WEST 2 assumes an unstructured environment and evaluates lifting and lowering under optimal conditions. Since the WEST 2 does not impose an obstacle to the conservation of horizontal displacement, this high-risk work style factor can be completely controlled by the worker. In reality, workers’ jobs often involve lifting and lowering tasks under less than optimal conditions, as was the case in this study. Frequently, because of the equipment design or environmental obstruction, workers were forced to assume awkward positions when lifting and lowering heavy objects. The conservation of horizontal displacement in these instances was difficult if not impossible. Therefore, it would appear that the viability of the WEST 2 would be limited to situations where optimal job conditions for lifting and lowering prevail.

It seemed that the work environment was a factor that significantly impeded the transfer of learning. The layout of several machines and storage devices required the workers to assume positions that were not biomechanically advantageous for using the straight-back, bent-knee method of lifting and lowering (Chaffin, 1975). It is for this reason that the practicality of this particular method is being questioned. For example, Davis, Troup, and Burnard (1965) stated that experienced workers rarely use this technique when lifting heavy loads because it is not practical.

### Table 2
Analysis of Differences Between Groups on Work Performance

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>M</th>
<th>SD</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
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<td>14</td>
<td>7.286</td>
<td>2.644</td>
<td>9</td>
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<tr>
<td>Control</td>
<td>16</td>
<td>5.813</td>
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<td>11</td>
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<tr>
<td><em>t</em> test</td>
<td>--</td>
<td>-1.435</td>
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</table>

*a Not significant.*
practical. The authors posited that the straight-back, bent-knee method of lifting puts the quadriceps at a mechanical disadvantage so substantial that the average person cannot generate enough force in the legs to lift a heavy object from the ground. For optimal transfer of learning to occur, the occupational therapist needs to perform a job analysis of the actual working conditions and then teach body mechanics techniques that will be appropriate for the actual conditions encountered by the worker. The adaptation of the work environment, as well as work simplification techniques, may also be an appropriate adjunct to instruction in body mechanics.

Summary
This study was designed to determine whether body mechanics instruction by an occupational therapist in a work-related safety program is effective in (a) teaching body mechanics principles and (b) improving lifting and lowering performance in the work environment. The outcome revealed that subjects who received body mechanics instruction performed better in the static laboratory environment, but did not perform significantly better in the work environment.

In agreement with the literature, this study indicated a definite need for further research on the use of body mechanics instruction for the prevention of injuries in the work environment. Future efforts could focus on the effectiveness of different lifting and lowering techniques that have yet to be subjected to controlled research. Further research is also needed to assess the effectiveness of the WEST 2 Work Capacity Evaluation Device as a means of evaluating body mechanics and predicting the probability of work-related injury. Therapists designing a preventive program must (a) conduct a job analysis of the work environment, (b) determine the amount of instruction time needed, (c) consider the importance of repetition and practice for subcortical learning, and (d) determine the appropriateness of the assessment devices.

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References