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Office Workers' Productivity Enhanced by Ergonomics

A new field study by researchers at the Upjohn Institute, the University of Texas, Liberty Mutual, Health and Work Outcomes, and Steelcase Corporation will examine the economic and health consequences of two ergonomic interventions. Until now, economists have almost entirely ignored the productivity impacts of ergonomics as a topic of research. A recent search of EconLit using the keyword "ergonomics" yielded 16 articles, and a search using "ergonomics" and "productivity" as keywords yielded none.

Most data sets utilized by economists are based on surveys of individuals and thus contain information on individual characteristics, including earnings and wages, but not work performance per se. Furthermore, health data found in surveys of individuals are often very general. A typical question may ask respondents whether or not they are disabled or to classify their overall health as "good, fair, or poor." Thus, existing data are not well suited to answer the question of whether ergonomic work practices are likely to reduce pain associated with musculoskeletal disorders (MSDs) and to improve worker performance. This new field study has been designed to address this research void.

The study, which will cover about 900 individuals in three separate firms, collects pre- and post-intervention data on productivity, absenteeism, and health. Results have been obtained from approximately 200 volunteer participants from the first firm in the study, a governmental agency that collects sales taxes. Following the study design, researchers assigned participants to one of three groups: a control group, a group that receives ergonomic training, and a group that receives an ergonomically designed chair and training. Data were collected from study participants in the two months immediately prior to the group assignments and implementation and during the second, seventh, and twelfth months post-intervention.

Study Design

This study utilizes a quasi-experimental design, meaning that instead of using random assignment, researchers deliberately allocate participants to groups. Random assignment is not feasible in this study because both interventions involve information. The primary concern is that contact between people in different groups might contaminate the study results. Workers who receive ergonomic training might share their new information with co-

workers nearby, especially if they happened to notice a co-worker using a less than ideal posture. In order to prevent information from "leaking," individuals were assigned to groups so that members of the control group would be physically separated from participants in the other two groups. Thus, where possible, all participants from the same building were assigned to the same treatment group. When this was not possible, people on different floors of the same building were assigned to different groups. Attempts were made to balance workload requirements and job descriptions as much as possible across the three groups, although pre-intervention differences exist. The data collection on dependent and independent variables prior to the implementation of the two interventions allowed us to correct for these preexisting differences at baseline.

To be included in the study, participants must spend at least six hours a day sitting in an office chair and at least four hours a day computing, they must be able to complete a questionnaire in English over the Internet at work, and they must not have filed a workers' compensation claim in the last three months. Furthermore, a company must be able to provide researchers with detailed data on both an individual worker's productivity and work hours in order to be included in the study.

Health Outcomes

The primary health-related hypothesis the study team developed is that the "training only" and "chair and training" interventions would reduce the pain of study participants relative to those in the control group. The two measures of pain used to evaluate this hypothesis are detailed below.

One form of pain data is collected from the administration of a series of Daily Health Diaries (DHDs), a short one-minute e-mail questionnaire that asks participants to rate their current level of pain for nine different body parts on a scale of 0–10, 0 being no pain and 10 being extreme pain. Thus, the scale ranges from a low of 0 to a high of 90. Daily Health Diaries are administered three times a day for an entire week during each survey month (–2, –1, 2, 7, and 12). Participants are asked to report pain levels at the beginning, middle, and end of the day for an entire work week. Each individual may report up to 15 pain levels a week in each survey month, which results in as many as 75 scores over the entire study. The DHD pain score is a series of instantaneous pain measures that cover one week out of a month.

The other pain data are derived from the SF-36 health instrument, a well-known and often-used survey. In addition to the DHD questions, study participants are asked two questions from the SF-36 that deal with pain. The questions ask how much bodily pain the individual had in the last four weeks, and how much that pain interfered with normal work. Responses to these two questions are then scaled from 0 (extreme pain) to 100 (no pain).

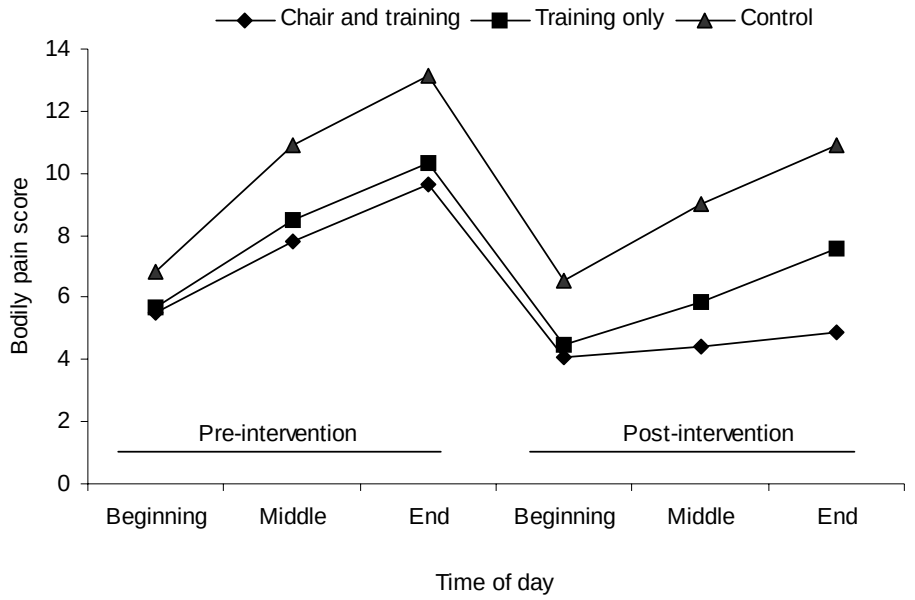
The two pain scores offer different insights into the effectiveness of the interventions and the relationship between work performance and different types of pain measures. The DHD score allows researchers detailed, contemporaneous measures of pain by body part, time of day, and day of the week. Whereas a full analysis of these effects will appear in an upcoming working paper, Figure 1 shows a preview. The left-hand side of the graph is the average pain score for the two pre-intervention months, by group and by time of day. The right-hand side of the graph shows average pain for the three post-intervention months, also by group and time of day. Figure 1 reveals two important features of the interventions. First, the chair and training intervention appears to be about twice as effective at reducing average pain levels as the training only intervention. Second, while the post-intervention pain scores for the training only participants are shifted down in a parallel fashion relative to the pre-intervention scores, the post-intervention line of pain scores for those in the chair and training group is shifted down and the slope flattened. Thus, those receiving the chair appear to not only start the day with lower pain levels, but pain appears to grow at a substantially slower rate over the workday.

Productivity Effects

The individual productivity data from the first firm are particularly interesting to economists for two reasons. First, the firm's primary measure of individual productivity, monthly sales tax collections, is measured in dollars and is the "revenue" of the firm. Thus, the model of individual sales tax collections developed in this study can also be viewed as a production function in which an ergonomic intervention is one of the inputs. This makes a cost–benefit analysis straightforward—one simply compares the estimated increase in revenues post-intervention with their associated costs. Second, the firm is able to provide detailed monthly data on absenteeism and on hours worked per month. This level of detail allows the research team to separately analyze the effect of the intervention on lost work time (absenteeism) and on production per effective workday.

The effects of the two interventions on production per effective workday are analyzed fully in an upcoming working paper using difference-in-difference estimators that control for job characteristics, tenure, gender, and years of education. The first major finding of that study is that these particular ergonomic interventions have no effect on lost work time (absenteeism). However, the second major finding is that the chair and training intervention has a substantial and statistically significant effect on production per effective workday. Table 1 shows the coefficients from two different types of panel regressions, a fixed effects model and a random effects model, which summarize the net impact (in dollars collected) of the two interventions. While the training only intervention appears to affect sales tax collections positively, the coefficients associated with this intervention are not statistically significant. In contrast, the coefficients on the chair and training intervention are both positive and statistically significant. The chair and training intervention costs approximately $1,000 per employee, but the net impact

Figure 1 Average Bodily Pain Scores, by Group and Time of Day



of this intervention increases collections by either $325.09 or $354.18, depending on the estimation method. The chair and training intervention appears to pay for itself within three days using this methodology.

A second methodology yields similar results. This model first estimates the effect of the two interventions on pain, then the effect of pain on productivity. These two estimates are then combined to calculate the health mediated effect of the training only intervention and the training plus the chair intervention. Our results from both models indicate that the chair and training intervention reduces pain and improves productivity relative to the control group but does not affect sick leave. Furthermore, the productivity benefits that result from the chair and training intervention are quite large compared to the costs of the intervention. Our lowest estimate (from the health mediated model) of the benefit flows indicate that the chair and training intervention pays for itself within 10 working days. In contrast, the effect of the training only intervention is not statistically significant for any of the studied outcomes.

Table 1 Changes in Production per Effective Workday Post-Intervention

	Fixed effects	Random effects
Chair × post-interaction	354.18**	325.09**
Training × post-interaction	151.01	155.54

NOTE: These estimates control for gender, age, tenure at the firm, disability status, years of education, job type and level, pre-intervention group assignment, and individual-specific effects. ** = statistically significant at the 5% level.

Conclusion

The initial results from this new field study of ergonomics, health, and productivity appear to confirm that ergonomic interventions can lead to lower pain levels and increased productivity among office workers. These results are of interest to lawmakers considering the social costs and benefits of ergonomic work standards, to Occupational Safety and Health Agency regulators considering what type of work standards might be most appropriate in an office setting, to business managers seeking to improve the performance of their employees, and to economists interested in the relationship between health and economic outcomes.

The net impact of the chair and training intervention is not only statistically significant, it is large enough to cover its costs within days. The impact of training alone, however, is less certain at this time. While point estimates of the impact of training alone on pain and production are all in the expected direction, none of the impacts are statistically significant. This may change as more participants from the next two firms are added to the study.

Furthermore, the results presented here suggest that ergonomic interventions have a substantial impact on production per unit of time worked, and that an economic analysis of ergonomics on MSDs should not be confined to lost workdays alone. This additional economic channel may be empirically important because an ergonomic intervention that has a large effect on production per effective workday may have no corresponding effect on lost work time. Thus, past research on the benefits of ergonomic interventions that focuses solely on lost workdays may substantially underestimate the total benefits of such programs, or the costs of MSDs.

Suggestions for Further Reading

National Research Council, Panel on Musculoskeletal Disorders and the Workplace, Commission on Behavioral and Social Sciences and Education. 2001. *Musculoskeletal Disorders and the Workplace: Low Back and Upper Extremities.* Washington, D.C.: National Academy Press.

National Research Council, Steering Committee for the Workshop on Work-Related Musculoskeletal Injuries: The Research Base. 1999. *Work-Related Musculoskeletal Disorders: Report, Workshop Summary and Workshop Papers*. National Academy Press, Washington D.C.

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