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Flexible workspace design and ergonomics training: Impacts on the psychosocial work environment, musculoskeletal health, and work effectiveness among knowledge workers

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ABSTRACT

A macroergonomics intervention consisting of flexible workspace design and ergonomics training was conducted to examine the effects on psychosocial work environment, musculoskeletal health, and work effectiveness in a computer-based office setting. Knowledge workers were assigned to one of four conditions: flexible workspace ($n = 121$), ergonomics training ($n = 92$), flexible workspace+ergonomics training ($n = 31$), and a no-intervention control ($n = 45$). Outcome measures were collected 2 months prior to the intervention and 3 and 6 months post-intervention. Overall, the study results indicated positive, significant effects on the outcome variables for the two intervention groups compared to the control group, including work-related musculoskeletal discomfort, job control, environmental satisfaction, sense of community, ergonomic climate, communication and collaboration, and business process efficiency (time and costs). However, attrition of workers in the ergonomics training condition precluded an evaluation of the effects of this intervention. This study suggests that a macroergonomics intervention is effective among knowledge workers in office settings.

1. Introduction

Teamwork is a fundamental means by which corporations conduct organizational activities and meet business goals in a global economy. As a result, teamwork that fosters positive group dynamics is essential to organizational effectiveness in complex, computer-based work environments. The importance of effective teamwork is underscored by the occurrence of work-related musculoskeletal disorders (WMSDs) and psychological stress among knowledge workers (e.g., Aaras et al., 2001; Bernard et al., 1994; Buckle, 1997; Carayon and Smith, 2000; Hagberg et al., 1995; Hedge, 1988; Marcus and Gerr, 1996; Schleifer and Ley, 1996). To mitigate these adverse health trends and enhance work effectiveness, organizations are redesigning physical workspaces and providing ergonomics training (e.g., Ketola et al., 2002; Nelson and Silverstein, 1998; Sauter et al., 1990). Although there is a growing interest among employers to improve office workplaces, there are only a few well-designed field studies that have examined the effects of office ergonomics interventions on workers' health and performance (Brewer et al., 2006; Karsh et al., 2001; National Research Council Institute of Medicine, 2001).

Macroergonomics is an organizational design approach that can reduce health risks and increase performance by providing flexible physical work environments and accommodating the ergonomics needs of individual employees and project teams. This approach to organizational design incorporates an understanding of the individual components of the work system as well as their interrelationships, specifically the social, technical, and physical environments (Hendrick and Kleiner, 2002). Emphasis is placed on participation of workers in the workspace design process in terms of understanding work process needs and business requirements (O'Neill, 2007), and training in the optimal use of the workspace as a tool for safe and effective work (Brisson et al., 1999; Bohr, 2000; Kukkonen et al., 1993; Robertson and O'Neill, 1999). In the macroergonomics design approach, enhancing workers' control over their work environment allows them to influence decisions about where and how they might work (McLaney and Hurrell, 1988; O'Neill, 2007; Robertson and Huang, 2006), leading to improved physical health and performance (Karasek and Theorell, 1990).

Ergonomics training is another fundamental element of our macroergonomics approach, as it can integrate ergonomics into an organization and play a key role in linking the corporate goals

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with ergonomic practices. Additional benefits of ergonomics training are that it provides employees with the necessary knowledge on how they should arrange their individual and team workspace, and it promotes healthy computing habits (Amick et al., 2003; Bohr, 2000; Brisson et al., 1999; Robertson and O'Neill, 1999; Verbeek, 1991).

In this field intervention study, we employed a macroergonomics approach to design an office ergonomics intervention, which included two important work systems elements: workspace flexibility and training. This approach incorporates the theoretical models proposed by Smith and Carayon (1996), Sauter and Swanson (1996), and Bongers et al. (1993) which suggest a theoretical relationship between work organization and WMSDs and how the physiological, psychological and behavioral stress reactions to psychosocial work stressors, including physical workplace stressors, can affect WMSDs both directly and indirectly. We investigated the effects of flexible workspace design and ergonomics training on outcomes related to psychosocial work environment factors, workspace satisfaction, group performance and health among office workers. The participants in this macroergonomics intervention were assigned to one of the following groups: (1) ergonomics training (training-only), (2) flexible workspace-only (WS-only), (3) flexible workspace+ training (WS+T), and (4) no-intervention control. We expected that ergonomics training and flexible workspace design together would enable the workers to work most effectively. Moreover, these intervention effects would be expected to translate into behavioral changes (for example, re-arranging/adjusting workspaces, changing computing work habits), thereby leading to a reduction in musculoskeletal discomfort and an increase in psychosocial work environment factors, environmental satisfaction, group performance, and business process efficiency. We proposed the following hypotheses for this study:

Hypothesis 1. The increase in ergonomics knowledge will be higher for the WS+T group and training-only group as compared to a no-intervention control group.

Hypothesis 2. Self-reported musculoskeletal discomfort will be lower for the flexible workspace (WS-only) group as compared to a no-intervention control group.

Hypothesis 3. There will be a greater reduction in self-reported musculoskeletal discomfort for the flexible workspace and ergonomics training (WS+T) group as compared to the WS-only, training-only, and control groups.

Hypothesis 4. Self-reported psychosocial factors (job control, participation, collaboration, communication, corporate culture, ergonomics climate), and workspace design (overall design, lighting, privacy) satisfaction will increase for the WS-only and training-only groups, with a greater increase for the WS+T group as compared to a control group.

Hypothesis 5. Self-reported group performance (group effectiveness) and business process efficiency will be enhanced with an increase in workspace flexibility (WS-only) and greater performance and efficiency for the WS+T group as compared to a control group.

2. Methods

2.1. Setting and participants

The new office environment was located on four floors within the corporate office building of a large US management-consulting firm. All study participants were classified as ''knowledge workers'' who used a computer 4 or more hours per day and performed fundamentally similar tasks. Senior management invited 1250 employees to participate in the study (750 involved in the workplace redesign effort and 500 for the control group). The control group was in another building consisting of traditional cubicle offices. Employees who agreed to participate electronically signed an approved IRB consent form and completed a web-based survey. Information on gender, age, and race were not collected due to the company's human resource policy.

2.2. Study design

A quasi-experimental, non-randomized, design was used in which one pre-intervention survey (2 months prior) and two post-intervention surveys (3 and 6 months after) were used to collect data from the experimental and control groups (Campbell and Stanley, 1966). The interventions consisted of: (1) a new flexible office workspace with adjustable workstations and a flexible overall facility layout that included a variety of conveniently located meeting spaces of different sizes and (2) office ergonomics training that encouraged the employees to exert control over how the workspace was used. There were a total of four groups as described earlier (i.e., WS+T, training-only, WS-only, and control groups).

2.3. Office workplace intervention

Management defined four goals for the workplace intervention project, which were as follows: (1) create a new concept for work environments that enables greater worker effectiveness, (2) provide ergonomically designed workspaces that enhance employees' health and well-being, and supports employees' job tasks by being adaptable to the changing work process through flexible, moveable and adjustable workspaces, (3) increase communication and collaboration among individuals, groups and departments, and (4) create operational efficiencies through business process effectiveness. Facility and ergonomics teams were established that led several employee Workplace Change Communication initiatives and conducted workspace ergonomic needs analyses. The new, flexible workspace was architecturally designed to create a sense of openness, provide natural lighting throughout the workspace, and enhance auditory and visual privacy. The layout of the individual workstations was a soft ''U'' shape with each workstation having adjustable storage and paper management tools. Each workstation was equipped with a highly adjustable ergonomic chair.

2.4. Office ergonomics training intervention

An instructional design model based on a systems approach was used to create the office ergonomics training. This instructional model consists of five processes: (1) needs analysis, (2) design, (3) development, (4) implementation, and (5) evaluation (Kirkpatrick, 1979).

2.4.1. Needs analysis

In the analysis phase, we interviewed and collaborated with the company's corporate safety and facilities managers to identify existing related office health and ergonomics training programs and to determine if workers had been previously trained. We identified the corporate ergonomics/safety process of managing these issues and the follow-up procedures to responding to employees' requests regarding their office ergonomics needs. This analysis provided for the establishment of a baseline of prior knowledge of the study participants, to identify the corporate