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Combating Fatigue in the Office: Findings of a Participatory Ergonomics Intervention

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ABSTRACT

Background: The nature of unstandardized office work exposes call center agents not only to work-related musculoskeletal disorders (WRMSDs) but also to other mental and physical adversities. Despite this, the occupational health literature presents a surprising paucity of research on fatigue management interventions among call center agents. Accordingly, a participatory ergonomics intervention was designed to examine its effects on workers' mental and physical fatigue.

Methods: A quasi-experimental participatory interventional study using a single-arm pretest-posttest design was conducted among 84 call center agents at a private telecommunications company in Tehran, Iran. Prior to the intervention, data on mental and physical fatigue were collected via SOFI questionnaires. Participants then took part in a multifaceted intervention program comprising comprehensive office ergonomics training, work layout improvement, supervised on-site face-to-face visits, and provision of quality break time that included a regular exercise program. A follow-up evaluation was conducted after a six-month period. The Wilcoxon signed-rank test was applied to compare participants' perceived mental and physical fatigue before and after the intervention.

Results: The intervention had a significant effect on reducing the overall fatigue scale score ($P < 0.01$). However, the results for the subscales were mixed. "Lack of energy" was reported to decrease meaningfully ($P < 0.01$), while "lack of motivation" and "sleepiness" did not change significantly. Regarding physical fatigue, "physical discomfort" was perceived to be alleviated by the intervention ($P < 0.001$), although the condition of "physical exertion" did not improve significantly.

Conclusion: The findings indicated that the intervention had mixed effects on different aspects of employees' fatigue. Customizing interventions to target specific facets of occupational fatigue could be an effective strategy. Moreover, this study contributes to the growing body of literature suggesting that participatory ergonomic interventions can help improve work systems, particularly in managing occupational fatigue.

KEYWORDS: *Macroergonomics, Participatory Ergonomics, office workers, occupational fatigue*

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INTRODUCTION

Computer-based customer service work, i.e., call center work, accounts for approximately 3–4% of the working population, and it is one of the most rapidly growing occupations worldwide (1,2). Call center workers spend the majority of their time seated at a workstation, which typically includes a computer desk and chair, and interacting with a computer and virtual customers (3). As a result, the sedentary and static nature of their work—combined with the simultaneous use of communication devices and computers to consistently answer inquiries—makes them susceptible to mental and physical fatigue (4,5) (6).

The term "fatigue" is difficult to define in a way that is universally applicable; therefore, different fields offer their own relevant definitions of the phenomenon (7). In the field of ergonomics, Ahsberg et al. (2000) provide a comprehensive categorization of fatigue, encompassing general, physical, and mental dimensions (8). From a physical perspective, fatigue is the result of the physical demands of an activity, manifesting in the pulmonary, circulatory, and metabolic systems, as well as in local muscular strength, joints, and the spinal column (9). From a mental perspective, fatigue arises from prolonged periods of demanding cognitive activity and is characterized by feelings of weariness, sleepiness, and low energy (10,11).

Fatigue is a highly prevalent phenomenon and is associated with significant physical and psychosocial morbidity (12). WRMSDs are often observed to begin with muscles feeling fatigued and achy, progressing into more serious conditions that impair limb movement or diminish muscular strength and power (13). Fatigue has also been shown to adversely affect workforce productivity and work ability (14). Moreover, work-related fatigue may lead to interpersonal consequences, including decreased quality of communication with colleagues and customers (15).

The literature provides ample evidence that the etiology of work-related fatigue is multifaceted and involves a complex interaction among personal (e.g., demographic characteristics and working behaviors), physical (e.g., workstation layout and awkward or static posture), and psychosocial factors (e.g., social support and rest breaks) (14,16,17). Correcting posture, incorporating regular micro-exercises during work, and instilling ergonomically sound behaviors in employees are among the proven practices that can alleviate work-related fatigue (18,19). Improving workplace conditions—particularly by refining employee posture—not only reduces physical fatigue but also, according to emerging evidence, may positively influence cognitive aspects of work, including mental workload and mental fatigue (20-22). However, such associations remain a matter of controversy, and further investigation is warranted (23).

The results regarding the effectiveness of ergonomic interventions among office workers remain inconsistent to date (24,25). To address such discrepancies, the literature suggests that participatory and multicomponent ergonomic interventions should be considered, as they appear to offer advantages over single-component approaches (26-28). Several studies among office workers have shown that workstation modifications in line with ergonomic principles—reinforced with operational training—can lead to reductions in adverse work outcomes, including fatigue and discomfort (1,19,29). In their review, Juhanson and Merisaluit (2017) posited that such interventions are among the most effective means of improving working conditions (30). Nonetheless, the overall effectiveness of ergonomic interventions requires further investigation and supporting evidence (25).

According to Armitage and Sprigg (2011), there was a surprising paucity in the body of research regarding interventions among call center workers—and based on current knowledge, this observation remains relevant today (1). Therefore, the primary purpose of this paper was to investigate the effectiveness of a participatory, multicomponent ergonomics intervention program on the mental and physical fatigue of call center employees. The program targeted personal (office ergonomics training), physical (work layout improvement), and psychosocial (quality break time) aspects of the work system.

MATERIALS AND METHODS

Study design

This non-randomized interventional study (quasi-

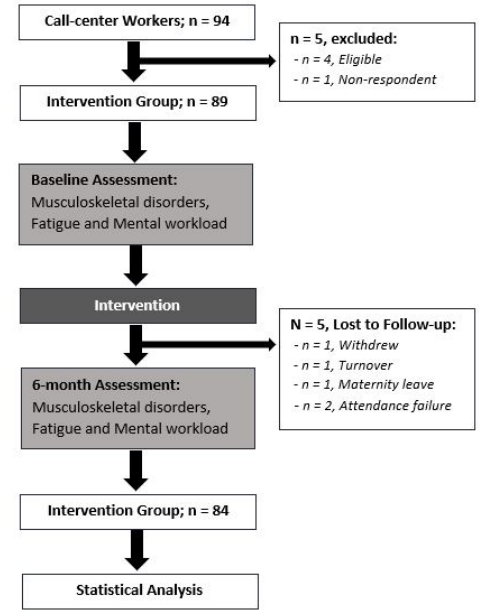

Figure 1. **Study profile and participant flow**

experimental) was conducted using a one-group pretest-posttest design at a telecommunications company in Tehran, Iran, from March 2017 to September 2017. Participants received office ergonomics training and were provided with quality break time enriched by an exercise program over a six-month period. Survey data regarding their work-related musculoskeletal disorders (WRMSDs) and mental workload—both reported elsewhere (31)—as well as fatigue were collected before and after the intervention. The study flow diagram is presented in Figure 1.

The study was participatory in nature. Participatory ergonomics refers to the practice of engaging employees in developing and implementing workplace changes aimed at achieving desirable outcomes such as improved productivity and health (32). It is defined as the "involvement of people in planning and controlling a significant amount of their own work activities, with sufficient knowledge and power to influence both processes and outcomes to achieve desirable goals," as described by Wilson (1995) (33). In our study, the necessary knowledge about ergonomics and how to translate it into participants' own work layouts and activities was conveyed to them. This enabled participants to act as agents of change and independently make necessary workstation modifications, even in the absence of supervisors or the research team. The ethics committee of the Industrial Engineering Department at Caspian Higher Education Institute approved the study.

Subjects and Setting

The study population consisted of all full-time call center workers at a private telecommunications company in Tehran, selected by census. Prior to the study, informed consent was obtained from all participants. Inclusion criteria required employees to perform more than 24 hours of computer-based customer service work per week (at least 4 hours per day) and to have no active workers' compensation claims involving the upper limbs. All employees worked in standard cubicles and each had a designated computer setup, including a flat-screen monitor, keyboard, mouse, and headset. Their job involved answering phone calls and handling customer inquiries. There was minimal use of written materials, with most procedures conducted on the computer. Regarding the physical layout, cubicles were largely uniform across the organization. Office furniture was generally non-adjustable, and there was little evidence of managerial efforts to upgrade workstations ergonomically. Additionally, initial awareness of ergonomic principles appeared to be low within the organization.

Intervention

The multifaceted participatory intervention program comprised four components, each

suitably tailored to the needs of the community and targeting different aspects of the work.

Comprehensive office ergonomic training

After the baseline assessment, two 90-minute group training sessions were held by the authors at the workplace to increase participants' awareness regarding basic office ergonomic principles. Topics included the etiology of WRMSDs (including fatigue), and the significance of work layout alterations and workplace stretching exercises to prevent fatigue and WRMSDs. Additionally, subjects were taught risk self-assessment skills to enable them to readjust their workplace accordingly. At the end of the sessions, a concise visual pamphlet, consisting of all the materials covered, was distributed to the attending participants.

Work layout improvement

As far as improving the work layout was concerned, with the support of top management, noteworthy modifications were made to the physical workstation. The most important changes included improvements to some existing chairs, the replacement of unadjustable chairs with adjustable ones equipped with arm- and headrests, and the provision of footrests and standard stands for the screens.

Supervised on-site face to face visits

The next day after training sessions, researchers began visiting participants while they were performing everyday tasks in their cubicles and monitored how the education translated into their daily activities. Moreover, these personal visits aimed to change participants' behavior, if needed, by utilizing a motivational interviewing approach. Motivational interviewing is a concise, person-centered intervention designed to enhance intrinsic motivation for behavior change by understanding and reducing the client's ambivalence (34). Participants were approached one by one, and if an inappropriate exercise was observed during their usual tasks, snapshots were taken. Subsequently, the pictures were discussed, and possible solutions were generated. After the face-to-face training, research team members revisited their mentees on a bimonthly basis. These follow-up visits were conducted to ensure that participants maintained healthy work practices and postural habits.

Provision of quality break time encompassing regular exercise program

Prior to the study, an agreement was reached with key stakeholders of the company to provide employees with an additional rest break opportunity halfway through their work shift. However, it was up to the employees to find the right moment so that it would not impact customer attendance or the overall workflow of the system. During training sessions, the length of the exercise program was discussed with the relevant parties and agreed to be 10 minutes. Regarding the content of the program, participants were advised to perform a set of stretching and joint mobilization exercises targeting the whole body, including both upper and lower body, once a day when they felt their muscles were tense or fatigued. This exercise program was essentially devised in parallel with the procedure of another study; nevertheless, it was slightly tailored to the needs of the population (19). Additionally, a log was given to each participant to be ticked each day when the exercise was performed, and it was later monitored regularly by supervisors and researchers.

Outcome measures

Outcomes of the study were measured at the 6-month time point after the baseline assessment. The prevalence of WMSDs was the primary focus of the study, the results of which are reported elsewhere (31). The Swedish Occupational Fatigue Inventory (SOFI-20) was used to assess work-related fatigue among employees (7). Its dimensions are Lack of Energy, Physical Exertion, Physical Discomfort, Lack of Motivation, and Sleepiness. Lack of Energy is a general dimension of the fatigue phenomenon, encompassing both mental and physical aspects; however, in the context of service work, it primarily reflects the mental aspect of fatigue. Physical Exertion refers to whole-body sensations that may result from dynamic work and, to some extent, indicate metabolic exhaustion. Physical Discomfort pertains to more localized bodily sensations that may arise from static or isometric workloads. Lack of Motivation, on the other hand, is primarily a mental dimension of fatigue, reflecting how detached and uninvolved a person feels in their job. Lastly, Sleepiness describes the sensation of feeling drowsy. The scale is rated on a Likert scale

ranging from 0 (never had this feeling) to 20 (had this feeling to a very high degree). The reliability and validity of this scale have been reported as satisfactory in the Persian population (35).

Data analysis

Data were analyzed using the SPSS software package. The normality of the variables was assessed using the Shapiro-Wilk test. Since the distribution of the variables was not normal, non-parametric tests were used to analyze the data. The Wilcoxon signed-rank test was applied to evaluate subjects' perceived fatigue before and after the intervention. The p-value was set at $\alpha \leq 0.05$ for statistical significance

RESULTS

Demographic characteristics of the call center workers are presented in Table 1. The mean age of the participants was 28.1 ± 3.69 years, and the majority of them were female (76%). According to the table, the average BMI was 24.2 ± 3.69, which falls within the normal (fit) range. Regarding education, 59 (70%) of the call center workers were university graduates, while the remaining 30% held a diploma. Additionally, 67 participants (80%) had a job tenure of less than three years.

Table 2 illustrates the results of the study on work-related fatigue and its dimensions. At baseline, the overall score of mental fatigue was 62.33 ± 11.16, which was significantly above the midpoint. Among the dimensions, Lack of Energy (68.3 ± 18.57) was higher than Lack of Motivation (64.54 ± 19.99), and both were relatively high. Additionally, Physical Exertion had the lowest score, 47.13 ± 10.88. After the intervention, overall fatigue was reported to be 60 ± 10.82, which was significantly lower than the baseline ($P < 0.01$). Similarly, Lack of Energy decreased to 66.25 ± 18.00, showing a meaningful reduction compared to baseline ($P < 0.01$). Physical Discomfort also declined significantly after the intervention ($P < 0.001$). On the other hand, changes in the scores for Physical Exertion and Sleepiness were not statistically significant after the intervention.

DISCUSSION

This study was conducted to determine the effectiveness of a multicomponent participatory ergonomics intervention among 84 call center workers of a telecom company. In brief, the intervention—which included comprehensive ergonomic training (both formal and on-site), work layout improvement, and quality break time incorporating regular exercises—had a significant effect on reducing the overall score of the fatigue

Table 1. Demographic characteristics of the participants

Variable	(Mean ± SD) or %
Age (yrs)	28.1 ± 3.69
BMI	24.2 ± 2.6
Gender	
Male	20 (24%)
Female	64 (76%)
Education	
BSc	59 (70%)
Diploma	25 (30%)
Job tenure	
More than 3 years	17 (20%)
Less than 3 years	67 (80%)

Table 2. Scores of work-related fatigue and its dimensions before and after the intervention

Dimensions	Before intervention mean (SD, median, range)	After intervention mean (SD, median, range)	Z	P-value [a]
Overall score	62.33 (11.16, 63.37, 59.75)	60 (10.82, 61, 56.5)	- 2.818	0.005 **
Lack of energy	68.3 (18.57, 68.75, 81.25)	65.01 (18.07, 66.25, 80)	- 2.695	0.007 **
Lack of motivation	64.54 (19.99, 64.37, 85)	61.1 (17.38, 61.87, 76.25)	- 1.176	0.240
Physical Exertion	47.13 (10.88, 49.37, 50)	48.33 (12.95, 50, 56.25)	- 0.625	0.532
Sleepiness	59.8 (12.74, 61.25, 61.25)	58.75 (13.27, 61.25, 70)	- 1.230	0.219
Physical Discomfort	71.86 (14.26, 73.75, 66.25)	66.85 (15.72, 65.62, 75)	- 3.593	0.000 **

[a] Wilcoxon signed rank test was conducted.
** $P \leq 0.01$.

scale, although the results for its subscales were mixed. Among the physical dimensions, Physical Discomfort was perceived to be alleviated by the intervention, whereas Physical Exertion did not show significant improvement. Regarding the mental dimensions, Lack of Energy was reported to decrease meaningfully, while Lack of Motivation and Sleepiness did not change significantly.

Based on the results, physical discomfort was reported to reduce significantly among call center workers, a finding that is in line with other studies (24)(36)(29). A study among VDT workers showed that workplace exercises, including range of motion, stretching, and eye relaxation, reduce whole-body discomfort and postural adjustment (in-chair movements), implicating the relationship between posture and workplace exercises (37). In another study, Sjorgen et al. (2005) conducted a study among office workers and showed that performing workplace exercises can reduce headache and neck symptoms, while it doesn't affect the prevalence of shoulder symptoms (38). Similarly, Kamalikhah et al. (2018) studied the effectiveness of different interventions and found that both ergonomic intervention (i.e., work layout modifications) and educational intervention (i.e., ergonomic training) can separately affect people's posture, resulting in a significant reduction in MSD complaints (39). These findings demonstrate that a proper workstation, which is modified and used in line with ergonomic principles, and performing regular exercises during work can reduce physical adversities.

The comparison between pre- and post-intervention results also interestingly showed that the score regarding the "lack of energy" item improved. That is to say, the improvements helped call center workers maintain higher levels of mental energy during work. This finding can be explained by the results of other studies, where providing quality break time enriched with stretching and joint mobilization not only reduced call center workers' musculoskeletal disorders but also decreased their mental effort, including memory and concentration (19). Such findings corroborate those of Rhenen et al. (2005), who reported reduced psychological adversities, such as mental fatigue, in approximately 50% of the employees who participated in a physical intervention program (40). It is highly possible that optimal physical conditions, including layout reconfiguration and an exercise program, could improve the psychological working condition by not wasting time and mental energy on physical adversities such as physical discomfort.

In contrast to physical discomfort and lack of energy, the results showed that there was no significant change regarding other dimensions of work-related fatigue. It was not surprising to see that physical exertion remained unchanged after the improvements. We argue that, since being a call center worker does not involve heavy and dynamic activities, physical exertion—which is described as "a whole-body sensation that may be the result of dynamic work and, to a certain extent, the sign of metabolic exhaustion" (40) was not significant in the beginning to be affected by the intervention.

In addition to physical exertion, sleepiness did not change significantly after the intervention. In other words, participants did not feel more or less sleepy compared with the pre-intervention condition. The relationship between sleepiness and physical exercise is difficult to establish, and the literature is contradictory. In a study by Braeckman et al. (2011), which was conducted among drivers, there was no association between leisure physical activity and sleepiness score, while in a study by Dahlman et al. (2011) among navy sailors, such an association was significant (40,41). The fact is that there are many confounders that can affect such a relationship (e.g., sleep quality and quantity, drug and caffeine consumption) that were not collected in our study; therefore, the non-existence of such a relationship should be interpreted cautiously.

Lack of motivation was another psychological aspect of fatigue that did not change after the intervention. That is, call center workers were not more motivated regarding their job. According to Herzberg's two-factor theory, improving the physical condition of work can be considered a hygiene factor, which can only reduce employee dissatisfaction. In contrast, motivational factors are found within the actual job itself (e.g., achievement, advancement, and growth) (11).

CONCLUSION

To summarize, the intervention—including comprehensive ergonomic training (formal and on-

site), work layout improvement, and quality break time involving regular exercises—had a significant effect on reducing the overall fatigue of call center workers, although the results for different aspects of fatigue were mixed. Therefore, customizing interventions to target various dimensions of occupational fatigue would be a practicable strategy. The contribution of this study lies in the growing body of literature suggesting that a multicomponent ergonomic intervention can bring significant improvements to both work systems and employees. In parallel with the participatory intervention literature, we acknowledge that it is equally important to ensure employees understand the true necessity of such practices (e.g., through motivational interviewing) and diligently apply them, since they are the main agents of change (42) (43). Our findings show that although the primary focus of many physical interventions has been on improving physical aspects of the workplace, multicomponent interventions are indeed capable of enhancing the cognitive dimensions of work as well.

Limitations and strengths of the study

First, the major limitations of the current study were the lack of a control group and the non-randomized nature of the study. Since we were asked to design the intervention for all employees, it was not feasible to allocate a portion of the population to a control arm or to randomize the participants. That is why a census was agreed upon as the best choice. Additionally, since all employees were working and spending their time in the same environment, having a control arm could have led to information sharing, producing contamination issues. Accordingly, the results of this study should be interpreted with caution.

Second, all the study outcomes were evaluated using self-report measures, although the use of valid and reliable instruments may have helped compensate for this limitation.

Third, we did not assess the effectiveness of the office ergonomic training immediately following the baseline sessions. However, the on-site, face-to-face ergonomic training served not only to evaluate such effectiveness but also to address misunderstandings and correct improper behaviors.

Finally, the six-month window used to measure the outcomes of the intervention appears limited, and the true impact should ideally be assessed over a longer timeframe.

In spite of all the aforementioned limitations, our study possessed several major strengths, which are discussed here. First, the main strength was that the intervention was designed to be multifaceted, employing different strategies (personal, physical, and psychosocial) to improve the working experience of individuals. This approach was undertaken due to existing literature questioning the effectiveness of single-solution interventions (24)(28). Second, full participation was indeed an advantage of this study. Although awareness of ergonomic principles was low at baseline, the full commitment of management and the active participation of employees throughout the study enabled rapid dissemination and adoption of the intervention. Last but not least, a multi-outcome evaluation was conducted to assess the effectiveness of the intervention, including both physical and mental aspects of fatigue. Such evaluations can provide a broader perspective on how interventions can impact work systems.

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CONFLICT OF INTEREST

No conflict of interest has been declared by the authors.

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