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Demand-Control-Support or Effort-Reward Imbalance? Which Model of Stress Assessment is More Effective in Office Workers?

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Abstract

Background: The Demand-Control-Support (DCS) and Effort–Reward Imbalance (ERI) models are well-known occupational stress assessment models which aid in identifying factors that may contribute to stress in the workplace. This study aimed to explore the function of the DCS and ERI models in an ergonomic quasi-randomized control trial study.

Materials & Methods: This study was a quasi-randomized control trial with two parallel groups. A total of 332 office workers participated. The intervention involved an individualized ergonomic training. Measurements were performed at baseline as well as after 1, 3 and 6 months. The effect of the interventions for each model and its indicators along the follow-up periods were measured with a repeated measures ANOVA test.

Results: The overall interaction effect of time and group was significant (P value < 0.001) for social support. A significant difference was found for control at all three follow-ups (P value < 0.001), and a partially significant difference was observed for social support at the 6-month follow-up (P value = 0.002). The impact of time on reward (P value = 0.005) and effort-reward imbalance (P value = 0.008) was significant in the intervention group.

Conclusions: Depending on the nature of the job being assessed and the type of ergonomic intervention, each model measures different aspects of the effect of the intervention on job stress, but the combination of two models can also cover broader aspects of job stress. This study was performed only on office staff. It would be better to undertake studies on line staff as well to verify the accuracy of the results.

Keywords: Ergonomics, Occupational Stress, Randomized Controlled Trial, Psychological Models

Introduction

Assessing and measuring occupational stress is crucial as it helps identify stressors in the workplace which can negatively affect employees' physical and mental health. Models such as the Demand-Control-Support (DCS) [1] and Effort-Reward Imbalance (ERI) [2] provide valuable frameworks for assessing these factors. These models examine aspects such as work demands, job control, social support, as well as the balance between effort and reward, enabling organizations to understand the causes of stress and implement strategies to improve working conditions along with employee well-being [3, 4]. When designing experimental studies on occupational stress, it is critical to select the right theoretical framework and assessment model. The DCS [1] and ERI [2] models are widely used. DCS evaluates stress based on job demand, control, and social support, while ERI focuses on the imbalance between effort and reward. These models help identify workplace stress factors, aiding organizations in improving conditions as well as employee well-being [5, 6]. DCS links stress to high demands, low control, and insufficient support, while ERI associates it with an imbalance between high effort and low rewards [7, 8].

The DCS and ERI models are critical for understanding employee health and well-being [6, 9, 10]. The DCS model focuses on "job strain," where high demands and low control negatively influence health [11, 12]. The ERI model highlights health risks from imbalances between high effort and low rewards. Both frameworks examine the interplay of job demands, control, effort, and rewards, aiding in understanding presenteeism in small and medium enterprises [13-15]. DCS and ERI questionnaires have favorable construct validity, but they have limitations in terms of content validity [10]. Researchers highlight key job characteristics influencing employee well-being and provide foundations for interventions to boost occupational health and mitigate stress-related issues. These extensively studied models offer substantial empirical evidence linking work factors to health outcomes [6, 16] and significantly advance understanding of occupational stress, supporting organizations in fostering healthier work environments [4].

Recent research has compared the DCS and ERI models for ascertaining occupational stress. Studies suggest that while both models are valuable, the ERI model often presents stronger predictive power [4, 8]. ERI has been validated for its psychometric properties and links to poor health [2]. Both models have been associated with burnout [16,17], fatigue, depression [18], and self-rated health [19]. Psychosocial factors derived from these models explain health inequalities [20, 21], though ERI predicts academic burnout more effectively [22]. Additionally, ERI and DCS influence musculoskeletal pain in workers, with DCS being more predictive for blue-collar workers. However, ERI presents greater sensitivity in identifying psychosocial risks for such symptoms [23, 24]. Ota et al. study found no significant relationship between DCS or ERI models and smoking cessation among middle-aged male employees in Japan, suggesting inconsistent links between psychosocial job characteristics and smoking cessation [25]. Another study [26] noted that balanced rewards and sufficient support aid insomnia recovery, while overcommitment and high job strain may trigger insomnia. These findings emphasize the need to consider various aspects of job stress when assessing health impacts. The DCS model addresses job tasks, while the ERI model puts emphasis on situational and personal conditions. Different stress factors influence outcomes such as insomnia [26, 27].

Lee et al. study found the ERI model to be more strongly associated with work-related musculoskeletal symptoms than the DCS model, particularly among ICU nurses, though combining both models revealed no additional benefit [28]. On the contrary, the DCS model better predicted counterproductive work behaviors in nurses [11]. Chen et al. [29] found that work stress measured by both models could predict Internet addiction risks in IT engineers. Choobineh et al. [29] found both models effective for evaluating occupational stress related to back pain in nurses but did not assess their performance in predicting back pain incidence. A large-scale cross-sectional study [9] explored the effects of the DCS and ERI models on employee well-being, supporting both models and revealing their independent cumulative effects on poor well-being from psychological or physical demands. The study also tested the relative contributions of each model, considering personal and situational factors. A strong relationship was observed between both models and major depression [13] and work engagement [30]. A study in China reported that combined high demands/job control ratio, low social support, and high ERI heightened risks for depressive symptoms [31]. Tseng et al. [32] found the ERI model more suitable for ascertaining psychological stress and quality of life, with higher coefficients in both mental and physical health compared to DCS. ERI was also a stronger predictor of sickness absence owing to low back symptoms than DCS [33].

As briefly described in previous studies, researchers have compared the performance of DCS and ERI models in the following domains: psychosocial occupational characteristics and smoking cessation [25], insomnia [26, 27], work-related musculoskeletal disorders [23, 24, 28], counter-productive work behaviors [11], internet addiction [29], low-back pain [33, 34], employee well-being or health [9, 19, 21], psychological distress [20, 35], quality of life or work [32, 36], mental health or depression [13, 15, 18, 31, 36, 37], sickness absence [33, 38, 39], presenteeism [15], burnout [17, 22, 37, 40], fatigue [18], work engagement [30], incidence of prediabetes and diabetes [3, 16], and blood pressure [7]. However, no landmark study has examined the function of these two models in a controlled trial study, through in systematic reviews, cross-sectional or longitudinal studies, the differences between these two models have been indicated. Thus, this research was conducted for examining the predictive power of job stress of the DCS and ERI models in an ergonomic quasi-randomized control trial study.

Materials and Methods

This study was a quasi-randomized controlled trial study with two parallel groups including ergonomic training intervention and non-interventional control group. According to the protocol of a previously published study, Following the baseline survey, the interventions were implemented for the first group, after which follow-up was done at intervals of one, three, and six months [14]. The study implementation process is displayed in Fi. 1.

The participants included 332 office workers in different departments in Isfahan Province, Iran. All participants belonged to the white-collar workers, whose main tasks were working in the office environment and working with computers. The participants had the desired level of health and no musculoskeletal disorders diagnosed by a physician. Also, the participants had at least one year of office work experience and none of them had received any formal ergonomics training in the last two years.

Initially, all participants completed consent forms and questionnaires. Then, a blind researcher, who was unaware of the study's groupings, randomly assigned the participants into two groups: control and intervention. Since the participants worked in different companies and the intervention group needed to be fully separated from the control group both physically and in terms of communication, instead of sorting participants into two groups, the companies they worked for were randomly assigned to the two study groups. Nevertheless, the number of participants in both groups was almost the same. Figure 1 displays the number of people assigned to the study groups.

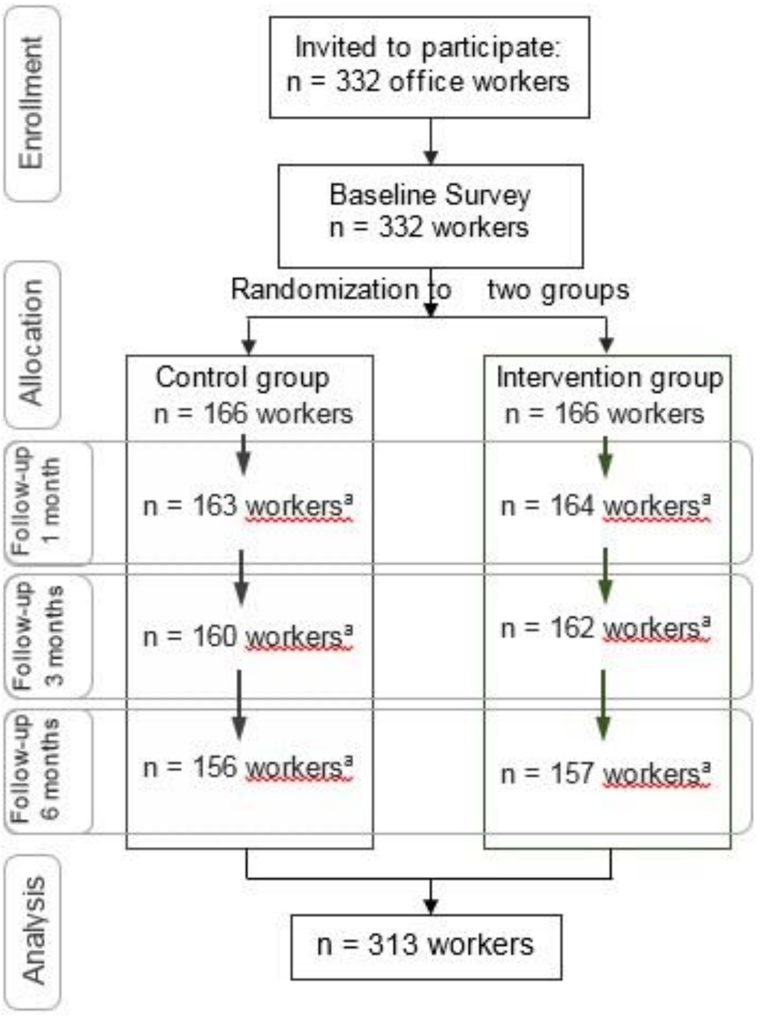

Fig.1. Participants' flow chart.

a. Reduction in the number of workers in follow-up was owing to voluntary departure or participants' unwillingness to continue the study.

Intervention groups:

Ergonomics Training: In this group, the participants received an individual ergonomic training intervention in three two-hour workshops. In the first workshop, they were introduced to the concepts of ergonomics and its principles. They then got acquainted with office-related musculoskeletal disorders and office syndromes. Next, in the second workshop, the principles of ergonomics in controlling musculoskeletal disorders and ergonomic solutions for office work environment were taught such as office work station adjustment tips, monitor chair, keyboard and other equipment with practical examples. In the third session, the focus was on psychosocial stress in the work environment as well as their control methods. Finally, according to the objectives of the study, the job stress control training framework based on models DCS [1] and ERI [2] models was presented to the intervention group.

At the end of this workshop, psychological stress in workplace reduction techniques and workplace communication improvements were discussed via the method of collective interview and interactive training. Stress Prevention at Work Checkpoints: Practical improvements for stress prevention in the workplace book [41] was applied in the meeting as a guide for choosing stress control methods. For practical training, parts including job demands (checkpoints 6–10), job control (checkpoints 11–15), social support (checkpoints 16–20), physical environment (checkpoints 21–25) and job security (checkpoints 41–45) of this book were utilized in the workshops.

Control group: The participants in this group received no intervention.

Demand Control Model: Occupational stress factors included demand, control, and job support based on job demands-control-support model [1], which were evaluated by the Persian version of Job Content Questionnaire (JCQ) [42]. Control, psychosocial job demands, and social support indices were calculated and analyzed. Further, the number of participants in four active, inactive, low-strain, and high-strain groups during the follow-up times was determined for each group according to DCS model instructions. Reliability of JCQ Questionnaire in the current study was α = 0.697. The validity of this version of the questionnaire has also been confirmed in Choobineh et al. [42] and Babamiri et al. [11] studies. The reliability of this questionnaire has been determined to be greater than 0.7 in the two previous studies.

Effort reward model: Another part of job stress was measured by the Persian version of the effort reward imbalance questionnaire [43], which was applied in the study to ascertain ERI and overcommitment. The Cronbach's alpha reliability of the questionnaire for effort, reward, and overcommitment was 0.708, 0.722, and 0.642, respectively.

Confounders: Only individual demographic variables measured included gender and age were considered as Confounders.

Data analysis was conducted on the completed data of participants who finished the study and filled out the questionnaires for all three follow-up periods. Quantitative and qualitative variables are described by mean ± standard deviation (SD) and frequency (percentage), respectively. By considering baseline measurements as covariates, a repeated measures ANOVA test was employed to examine the effects of time (3 levels) and group (2 levels) factors as well as the interaction between group and time. Bonferroni's post-hoc test was also utilized (for between-group comparisons at each time point). In this analysis, the two groups (intervention and control) were considered as the between-subjects factor, with the time points (1, 2, and 3 weeks after the interventions) treated as the within-subjects factor. All statistical analyses were conducted using the SPSS software version 18. P-value < 0.05 was considered a significant level.

Results

Participant characteristics: Out of 322 participants at the beginning of the study, 313 completed all the data and were selected to analyze the results. These participants were between 24 and 55 years old with mean age of 36.6 ± 6.29 years. Further, 58.5% of the participants were male and the rest were female. A total of 157 participants in the intervention group and 156 participants in the control group completed the study.

There was no significant difference in the age and gender of the participants in the two study groups.

Demand Control Model: As the difference in the mean scores of the outcome variables including control and psychological job demands in the baseline is significant between the two groups, by adjusting the effects of baseline scores, the findings of statistical analysis of these two variables of DCS model are reported in the first two rows of Table 1. However, no significant difference was found in the mean social support scores at baseline with no adjustment made for this variable. The statistical analysis of social support is outlined in the third row of Table 1 in the same order.

Table 1. Mean score changes in DCS model during follow-up times

Outcome	Group	Baseline	Follow times			P-value¶	P-value‡		
			1 month	3 months	6 months		Time	Group	Time*Group
Control (24-96)	Intervention	68.31±9.43	68.36±8.79	68.01±8.5	68.04±8.33	<0.001	<0.001	0.35	0.637
	Control	65.65±7.68	65.37±7.49	65.29±6.97	65.15±7.18	<0.001			
P-value*		0.007	0.001	0.001	0.001				
Psychological job demands (12-48)	Intervention	33.66±4.33	33.6 ±4.41	34.15±8.32	34.29±8.23	0.167	0.003	0.346	0.626
	Control	31.37±3.71	31.34±3.74	31.44±3.68	32.13±7.63	0.009			
P-value*		<0.001	0.519	0.278	0.517				
Social support (8-32)	Intervention	22.31±3.58	22.31±3.28	22.53±2.97	22.75±2.95	<0.001	0.412	0.253	<0.001
	Control	22.25 ± 3.3	22.18±3.15	22.13±3.04	21.74±2.86	<0.001			
P-value*		0.837	0.729	0.247	0.002				

¶ P-value derived from single repeated measurement ANOVA
‡P-value derived from overall repeated measurement ANOVA
* P-value derived from adjustment for multiple comparisons: Bonferroni.

According to the findings of the single repeated measures ANOVA (separately in each group), the effect of time on the response variable was presented. According to the results, there is a significant difference in the mean response in the intervention group at different times for control (P-value < 0.001) and social support (P-value < 0.001), while no statistical significance was found for psychological job demands (P-value = 0.167). The effect of time for the control group is reported to be significant (P-value < 0.001) for all three variables in the model using the same statistical analysis method.

In the results of the overall repeated measures ANOVA (the last three columns on the right side of Table 2), if the main effect of time is significant, that is, regardless of group, the mean response at different times is significantly different in control (P value < 0.001) and psychological job demands (P value = 0.003), where the overall interaction effect of time and group in social support was significant (P value < 0.001). To interpret the findings at each time point, a post-hoc independent t-test with Bonferroni adjustment was employed to compare the mean response in two groups at different time points separately. A significant difference was found for control at all three follow-ups (P value < 0.001) whereby a partially significant difference was found for social support at the 6-month follow-up (P value = 0.002). Other variables were not significantly different in single, overall or multiple comparisons. Changes in the percentages of active, passive, low-stress and high-stress participants over the follow-up period of the study were set as nominal variables and it was not possible to undertake a parametric statistical analysis on them; thus, these percentages are presented for two separate intervention and control groups in Fig. 2.

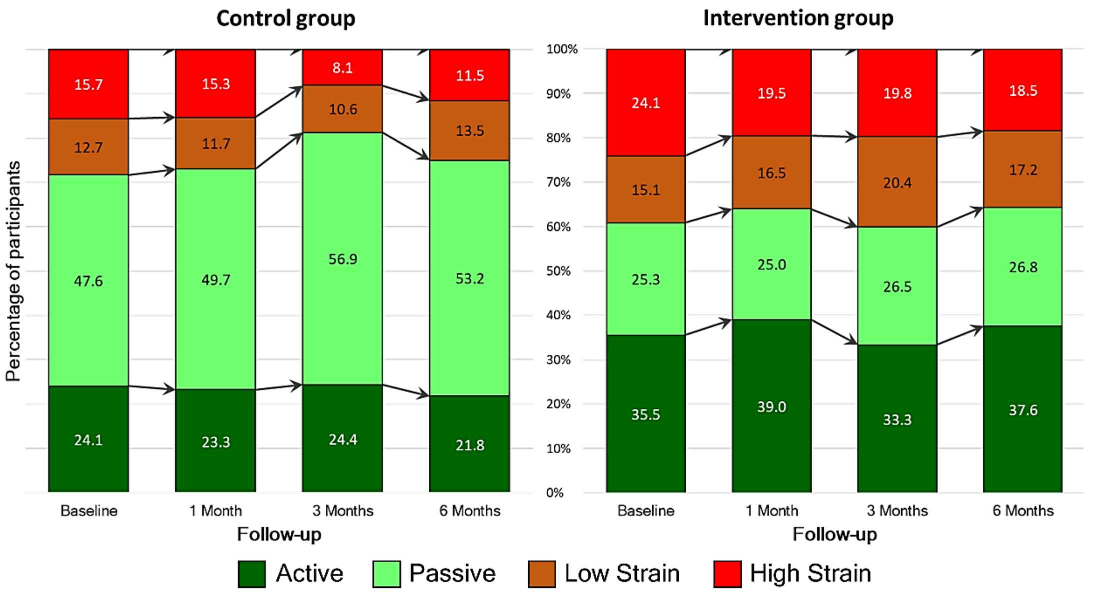

Fig 2. Percentage of participants according to DCS model for two groups in three follow-up times

Effort reward model: Similar to the statistical analysis conducted on the DCS model, the variables of ERI model, including effort, reward, and effort-reward imbalance, were significantly different in the two intervention and control groups at the baseline, so the effect of the scores was adjusted in the baseline with its results separated by the main variables of this model, as outlined in Table 2.

Table 2. Mean score changes in ERI model during follow-up times

Outcome	Group	Baseline	Follow times			P-value¶	P-value‡		
			1 month	3 months	6 months		Time	Group	Time*Group
Effort (6-24)	Intervention	15.80± 2.93	15.88±2.66	15.92±2.63	15.84 ± 2.69	0.616	0.258	0.737	0.171
	Control	15.17± 2.61	15.43 ± 2.35	15.28 ± 2.37	15.26 ± 2.43	0.321			
	P-value*	0.048	0.478	0.261	0.695				
Reward (10-40)	Intervention	24.78± 4.10	24.76± 3.50	24.81± 3.54	24.66± 3.78	0.005	<0.016	0.016	0.169
	Control	26.51± 4.44	25.81± 3.80	26.16± 3.88	25.88± 3.96	0.514			
	P-value*	< 0.001	0.006	0.357	0.050				
ERI (0.25-2)	Intervention	1.09 ± 0.29	1.09 ± 0.26	1.09 ± 0.26	1.10 ± 0.28	0.008	0.004	0.293	0.018
	Control	0.99 ± 0.29	1.02 ± 0.27	1.00 ± 0.26	1.01 ± 0.27	0.283			
	P-value*	0.002	0.021	0.717	0.443				

¶ P-value derived from single repeated measurement ANOVA
‡P-value derived from overall repeated measurement ANOVA
* P-value derived from adjustment for multiple comparisons: Bonferroni.

Following a single repeated measures ANOVA analysis, the effect of time on reward (P-value = 0.005) and ERI (P-value = 0.008) was found significant in the intervention group. In the results of the overall repeated measures ANOVA (P-value marked with ‡), if the effect of time is significant, that is, regardless of the group, the mean response at different times is significantly different in reward (P-value = 0.016) and ERI (P-value = 0.004), and in case the effect of the group is significant, that is, regardless of time, the mean response is significantly different between the groups in reward (P-value = 0.016). Further, the overall interaction effect of time and group in the ERI variable was significant (P-value = 0.018). Similar to the single and multiple comparisons for DCS model, a significant difference was obtained for reward at one-month follow-up (P value = 0.006) and partially significant difference in the sixth months (P value = 0.050), and for ERI variable only in the first month (P value = 0.021). In single, total or multiple comparisons, other variable variations were not significantly different. Fig. 3 demonstrates the trend of changes in mean effort-reward imbalance scores during the follow-up times in a clearer way.

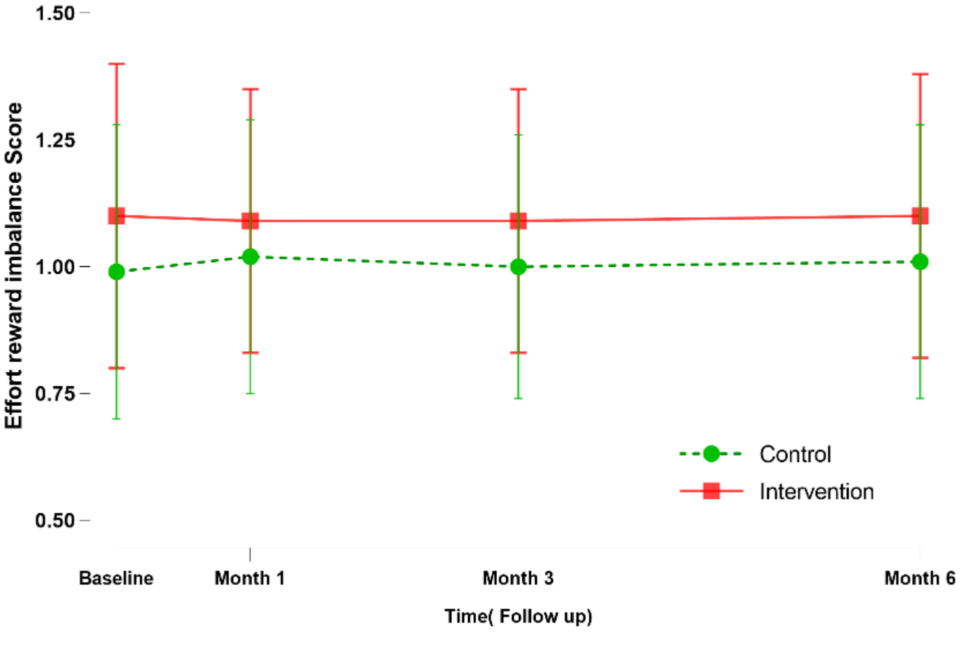

Fig 3. Effort Reward imbalance changes at follow-up by intervention and control groups

Discussion

In a quasi-randomized control study, 157 office workers received individualized ergonomic training. Occupational stress was ascertained using the DCS and ERI models, and their findings were compared with the control group based on statistical analysis. In a general comparison, these interventions could achieve significant changes on some subscales of each model. Although both models measured different aspects of occupational stress, they revealed the effects of individual ergonomic interventions on common aspects of occupational stress. The ERI is a subjective approach that focuses on the worker's experience and subjective reports of stress at work. In contrast, the DCM is an objective measure. In this discussion, we will first discuss the findings from DCS and ERI separately, and at the end we will compare the two models.

The overall effect of the intervention on control was significant. A significant difference was found at the sixth month of follow-up. The impact of the intervention was only significant for the control. The control in the third month showed a significant difference compared to the previous follow-up. These results can be considered concordant with the findings of the study [30]. The overall effect of the intervention on psychological demands was not significant. Jonge et al. found that high psychological needs and efforts have a stronger effect on employee well-being [9]. The effect of the intervention was only significant on demands. Inoue et al [30] noted higher psychological demands to be the main influence on work engagement. According to the analysis of Babamiri et al. in the DCS model, demand has a positive and significant relationship with counterproductive work behavior of individuals and organizations, while support has a negative and significant relationship [11]. The concurrent effect of intervention group and time on social support was effective, with social support increasing over time in the intervention group. The study by Garbarino et al. was also in accordance with the moderating effect of support on job stress [37]. However, the study by Inoue et al [30] did not find a significant difference in changes in support over the course of the study. Note that the focus of the study [30] was on work engagement, whereas in the current study the focus was on ergonomics training. In the intervention group, the ratio of high strain to low strain workers diminished over time. Of course, most of the reduction in the number of high strain workers can be observed in the one-month follow-up. In the same group, the ratio of active to passive workers increased in the first month, then declined and increased again in the sixth month of follow-up. In the control group, there was no significant difference in the ratio of participants in the groups when comparing the first and last follow-up times of the study.

The study time or the implementation of the intervention alone or overall did not have a significant effect on the effort. Nevertheless, in a cross-sectional study [19, 37], effort was significant. The separate effect of follow-up time and ergonomic intervention on reward was effective and significant. In the first and sixth months of follow-up, a significant difference was found between the two study groups. Reward in the ERI model has indicated a negative and significant relationship with counterproductive work behavior [11]. The effect of the simultaneous interaction of the study group and follow-up time has been effective on effort-reward imbalance, with a significant difference reported between the two groups in the first month of follow-up. Effort-reward imbalance in the intervention group increased from a mean of 1.09 to 1.10. This growth also occurred in the control group. Other studies also confirmed the significant effect of effort-reward imbalance [24, 28].

According to the present study findings, depending on the type of intervention in the DCS model, social control and support, and in the ERI model, reward and effort-reward imbalance changed significantly along the follow-up sessions. Thus, it can be concluded that only some aspects of each model are effective on identifying psychological stress in the work environment, and this explanation has been confirmed by other studies [4, 5, 8, 24, 29, 31, 35, 38]. Babamiri et al reported that both models can predict counterproductive work behavior. Meanwhile, the DCS model can be somewhat stronger in the nursing work environment [11]. Fa Yu et al [24] also found that the DCS model performed better when used in combination with low social support. The effect on physical demands was better than on psychological demands for depressive symptoms. However, the study [8] noted that these two models have differences in the assessment of job stress and psychological distress, and the ERI model may be a better predictor of stress in work environments with a small difference. The ERI has also been found to be a better predictor of academic burnout in Korean adolescents [22], work-related depression [13], psychosocial job characteristics and sickness absence owing to low back symptoms [33], as well as other jobs with high job stress [12, 28].

The study focused on a limited group of white-collar participants, making the findings non-generalizable to other occupations. The intervention was implemented solely through individual training based on occupational psychosocial factors, without evaluating the impact of managerial or engineering interventions within the two models. As such, comparing the final outputs of the two models using a single method is not feasible. Instead, the sub-scales of each model should be collectively analyzed using statistical methods.

Conclusion

Both models had a significant relationship between job stress dimensions and back pain among nurses, employee well-being, insomnia, smoking cessation, work-related burnout among lawyers, as well as musculoskeletal disorders of employees. In the present study, some aspects of both models were effective on predicting the effect of ergonomic interventions focused on musculoskeletal disorders. The final conclusion is that, in accordance with other studies, the combination of two models can also cover broader aspects of occupational stress.

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Conflict of interest

None declared.

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No specific financial source was used for this research.

Ethical Considerations

For the participants to enter the study, the objectives, process and conditions of the research were explained with informed consent obtained from them.

Code of Ethics

This study was carried out with the approval of the ethics committee of Hamedan University of Medical Sciences under number. IR.UMSHA.REC.1397.688.

Authors' Contributions

Mohammad Sadegh Sohrabi: Conceptualised the study, data collection, drafted, revised and reviewed the manuscript; Tayeb Mohammadi: Statistical analysis, Drawing and analyzing graphs.

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