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The Effectiveness of EIA Ergonomics Training Towards Individual Environmental Control, Musculoskeletal Pain, and Workplace Stress

Erna Faryza Mohd Poot [1], Mohd Suleiman Murad [1], Ghazali Masuri [1] Oinam Gokulchandra Singh [2]

[1] Faculty of Health Sciences, Universiti Teknologi MARA, Selangor Campus, 42300 Bandar Puncak Alam, Selangor, Malaysia
[2] College of Applied Medical Sciences, King Saud bin Abdulaziz University for Health Sciences, Riyadh, Saudi Arabia

ernafaryza@uitm.edu.my, sulaiman450@uitm.edu.my, mghazali@uitm.edu.my, oinamg@ksau-hs.edu.sa
Tel: +603 32584935

Abstract
Evidence on the effectiveness of office ergonomics training to overcome workers' musculoskeletal pain and workplace stress is still insufficient. Therefore, the quasi-experimental study was conducted to investigate the effectiveness of the integration of three models in ergonomics training; environmental control (E), instructional design (I), and adult learning (A), in reducing musculoskeletal pain and workplace stress among office workers. The findings indicated a significant difference ($p<0.05$) in reducing musculoskeletal pain and workplace stress by implementing EIA ergonomics training compared to conventional ergonomics training. Therefore, implementing EIA ergonomics training and enhancing the office policy are recommended to sustain workers' well-being.

Keywords: *musculoskeletal pain, workplace stress, office ergonomics, ergonomics training*

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Here, introduce the paper, and put a nomenclature if necessary, in a box with the same font size as the rest of the paper. The paragraphs

.0 Introduction

Musculoskeletal pain affects millions of computer office workers in developed countries (Kaliniene et al., 2016; Çelik et al., 2018). The prevalence of reported work-related musculoskeletal pain among office workers is seen to be on the rising side in Malaysia (Faryza, Murad, & Anwar, 2015). This increasing number of musculoskeletal pain cases is not solely due to the ergonomics factor but is associated with psychological stress commonly seen among office workers (Choobineh et al., 2011; Cho, Hwang, & Cherng, 2012). A combination of high demands in a job and low control over the situation can lead to stress (U.S Department of Health and Human Services, 2013). A survey has found that Malaysian employees are overworked and sleep-deprived, with 51% suffering from at least one dimension of work-related stress (Ram, 2019). Hence, it can be noted that the implication of musculoskeletal pain and workplace stress will cause occupational illness. Furthermore, it will lead to frequent absenteeism, reduced overall productivity, poor quality of life, and escalating medical expenses among office workers (Centers for Disease Control and Prevention, 2013).

1.1 Background of Study

The environmental control model has been identified as one concept of ergonomics models that emphasizes an individual's knowledge of how to adjust and effectively arrange one's workspace, which will lead to an individual's environmental satisfaction, communication,

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and psychological stress (Huang, Robertson, & Chang, 2004). The instructional design model is based on a systematic approach that emphasizes 4 phases in the learning process: knowledge acquisition, integration of knowledge and skills, practicing and rehearsing, and lastly, transferring training to the worksite (Gordon, 1994). This model successfully investigated training effects on office workers and other occupational settings (Salas et al., 1992; Huang, Robertson & Chang, 2004; Robertson, Ciriello & Garabet, 2013). The conventional ergonomics training conducted by the National Institute Occupational Safety and Health (NIOSH) organization in Malaysia used the didactic method, focusing on the acquisition of knowledge whereby the input of ergonomics implementation is by giving education via presentation, leaflet, and self-learning. To be compared with the instructional design model, the approach of ergonomic training implemented by Malaysian NIOSH covers two phases: the knowledge acquisition phase and the integration of knowledge and skills. The adult learning model is a set of ideas about how adults learn new skills or information. It focuses on the idea that adults know best when they talk to others about their life experiences and relate these experiences to the learning process. It emphasizes four concepts; engaged, relevant, active, and learned-centered (Merriam, 2001; Huang, Robertson & Chang, 2004). This model concept has been used in other studies as a method of delivery of their intervention and is effective in increasing ergonomics knowledge levels (Huang, Robertson & Chang, 2004; Robertson et al., 2008; Robertson, Ciriello, & Garabet, 2013). The previous study has shown that combining these three (3) models, environmental control, instructional design, and adult learning model, was a practical approach in ergonomics training to increase awareness of ergonomics in own workstation (Huang, Robertson & Chang, 2004). This study replicated a previous study that integrated these three models due to certain limitations. The previous study did not measure the effectiveness of the integration model with musculoskeletal pain. Moreover, there were no significant results in workplace stress due to the insensitivity of the workplace stress questionnaire.

1.2 Objective of Study

This study was conducted to investigate the effectiveness of the EIA ergonomics training by integrating three models; environmental control (E), instructional design (I), and adult learning (A). Furthermore, compared the EIA ergonomics training with the conventional ergonomic approach to reducing the occurence frequency of musculoskeletal pain and workplace stress among office workers after one week (post-intervention 1) and after three months (post-intervention 2) of ergonomics training implemented.

1.3 Significant of Study

The finding of this study could be used to improve the existing ergonomics training approach to reduce the occurrence frequency of musculoskeletal pain and workplace stress. In addition, more strategies could be implemented to obtain a healthy and conducive workstation environment.

2.0 Literature Review

As musculoskeletal pain and workplace stress caused among office workers are associated with ergonomics, ergonomics has been seen as an essential medium to overcome this problem (Mahmud et al., 2011; Hoe et al., 2018). Hence the rest of the literature will discuss the terminologies of musculoskeletal pain, workplace stress, and ergonomics training among office workers.

2.1 Musculoskeletal Pain and Workplace Stress among Office Workers

The causes that lead to musculoskeletal pain among office workers has been widely discussed, and the studies demonstrated that musculoskeletal pain could be derived from these three factors: individual, ergonomics, and psychosocial factor (Kaliniene et al., 2016; Çelik et al., 2018; Noorhashirin et al., 2018). First, individual factors can be arises from the individual him or herself by having poor posture, longer duration using a computer, and low level of ergonomic awareness. Next, poor workstation design can be described as a lack of ergonomics approach and no suitable equipment at her workplace. Meanwhile, the psychosocial factor can be within them psychology-social aspects such as work strain, stress, high job demand, and poor social support among colleagues are the ergonomics factors that lead to musculoskeletal pain. Finally, workplace stress is a harmful physical and emotional response when job requirements do not equal the worker's capabilities, resources, or needs (UNISON, 2009). It can happen when there is a conflict between job demands on the employee and the amount of control an employee has.

2.2 Office Ergonomics Training

Ergonomics training aims to increase office workers' knowledge regarding their workstation configuration, change inappropriate behavior, and control their workstation environment (Robertson, Ciriello & Garabet, 2013; Çelik et al., 2018). Even though many studies have been done regarding ergonomics for musculoskeletal pain among office workers, there is still a low quality of evidence. For instance, due to the ergonomics approach usage and duration for the outcome measures, most studies measure only in the short term (less than one month) (Hoe et al., 2018). Moreover, there is a lack of studies that tailor ergonomics intervention to individuals' participation, motivation, and readiness to change. Most ergonomics training studies used a concept of adaptation and equipment adjustment approach only without assessing or implementing the ergonomics approach in a holistic way that includes individual attribution in ergonomics implementation. Most approach seems to be emphasizing environment manipulation only, and the approach being implemented is based on the didactic approach.

3.0 Methodology

3.1 Scope of the Study

This study's scope was office workers with a similar job description of clerical work. Three organizations around Selangor were identified with similarities in office work tasks and workstation setup.

3.2 Data Collection

The quasi-experimental study design was conducted for seven months. The participants were divided into thirty-four office workers (n=34) in the conventional group and 34 office workers (n=34) in the intervention group. Inclusion criteria have been set for this study, where the participants must be office workers that use a computer for more than 1 hour per day and their job demands require them to use computers to complete the job tasks. In addition, the participants must have more than one year of experience working in the office and did not have other diseases that affect their musculoskeletal system. Research Ethics Committee approved this study, Faculty of Health Sciences, University Teknologi MARA, No. 600-FSK (PT.5/2), and approval from each organization was obtained for this study. Only the organization management and superior were well informed regarding the research study as this study was single-blinded.

The participants were being assessed using a self-report method three times during the survey done; baseline data (pre-intervention), after one week of ergonomics training (post-intervention 1), and after three months of ergonomics training (post-intervention 2). A set of questionnaires was used in this study consisting of 3 sections; Demographic Data (Section 1), Nordic Musculoskeletal Questionnaires Extended (NMQ-E) (Section 2), and Workplace Stress Scale (Section 3). The ergonomics training is implemented as a standard practice for the conventional group based on the existing didactic method. Participants were educated about ergonomics for office workers, musculoskeletal pain, and the meaning of workplace stress. Meanwhile, the participant received the EIA ergonomics training for the intervention group, which focuses on education, discussion, and self-evaluation.

3.3 Data Analysis

The McNemar's test was conducted to compare the frequency of occurrence of musculoskeletal pain before (baseline data) and after ergonomics training (after one week and after three months. In addition, the paired samples T-test test was used to test changes following the ergonomics training between the intervention and conventional groups. It was also used to compare the outcome before the ergonomics training was implemented with after one week and after three months of ergonomics training (post-intervention one and post-intervention 2) of Workplace Stress Scale score within the group.

4.0 Findings

4.1 Demographics Data

Demographic data illustrated in Table 1 shows participants' data such as gender, age, years of working, days of working per week, level of education, duration of working hours per day, and duration of hours working behind a computer. As indicated in Table 1, the two groups were similar in demographic variables percentage.

Table 1: Demographic data

Variables	Conventional Group (%)	P-value (chi-square test)	Intervention Group (%)	P-value (chi-square test)
Gender				
Female	21 (61.8)	0.17	30 (88.2)	0.00
Male	13 (38.2)		4 (11.8)	
Age				
20-29 years old	15 (44.1)		8 (23.5)	
30-39 years old	14 (41.2)	0.00	15 (44.1)	0.06
40-49 years old	4 (11.8)		7 (20.6)	
50-59 years old	1 (2.9)		4 (11.8)	
Years of working				
1-3 years	18 (52.9)		10 (29.4)	
4-6 years	4 (11.8)		7 (20.6)	
7-9 years	8 (23.5)	0.00	5 (14.7)	0.31
10-12 years	1 (2.9)		3 (8.8)	
More than 13 years	3 (12.5)		9 (26.5)	

Days of working per week 1-2 days 3-4 days 5-6 days Seven days	 0 (0) 0 (0) 34 (100) 0 (0)	-	 0 (0) 0 (0) 34 (100) 0 (0)	-
Level of education M Diploma Degree Master PhD	 11 (32.4) 13 (38.2) 8 (23.5) 2 (5.9) 0 (0)	0.04	 16 (47.0) 14 (41.2) 4 (11.8) 0 (0) 0 (0)	0.05
Working hours per day 1-3 hours 4-6 hours 7-9 hours 10-12 hours	 0 (0) 2 (5.9) 28 (82.3) 4 (11.8)	0.00	 0 (0) 2 (5.9) 31 (91.2) 1 (2.9)	0.00
Working hours behind a computer per day 1-3 hours 4-6 hours 7-9 hours 12 hours and more	 3 (8.8) 8 (23.6) 22 (64.7) 1 (2.9)	0.00	 4 (11.8) 16 (47.0) 14 (41.2) 0 (0)	0.00

4.2 Occurrence Frequency of Musculoskeletal Pain in Different Body Regions

As seen in Table 2 there was no significant difference in post-intervention 1 participant's occurrence frequency of musculoskeletal pain at neck, shoulders, upper back, elbows, wrist/hands, lower back, hip/thighs, knees and ankles/feet for conventional group where most of p-value of the body regions asked was $p > 0.05$. Meanwhile for occurrence frequency of musculoskeletal pain in post-intervention 2, there was significant difference only at upper back ($p= 0.00$) and lower back ($p= 0.00$) with $p < 0.05$. On the contrary, Table 3 noted a significant difference in post-intervention 1 participant's occurrence frequency of musculoskeletal pain at neck ($p=0.00$), shoulders ($p=0.00$), upper back ($p=0.00$), wrist/hands ($p=0.00$), lower back ($p=0.00$), hip/thighs ($p=0.00$) and knees ($p=0.01$) for intervention group, $p < 0.05$. Besides, for conventional group post-intervention 2, occurrence frequency of musculoskeletal pain noted significant differences at neck ($p= 0.00$), shoulders ($p= 0.00$), upper back ($p= 0.00$), wrist/hands ($p= 0.00$), lower back ($p=0.00$), hips/thighs ($p= 0.01$) and knees ($p=0.00$) with $p < 0.05$.

Table 2. Occurrence frequency of musculoskeletal pain in different body regions for conventional group

Body regions	Before intervention		After intervention (1 week)		p-value	After intervention (3 months)		p-value
	Yes (%)	No (%)	Yes (%)	No (%)		Yes (%)	No (%)	
Neck	20 (58.8)	14 (41.2)	22(64.7)	12 (35.3)	0.69	20 (58.8)	14 (41.2)	1.00
Shoulders	18 (52.9)	16 (47.1)	15 (44.1)	19 (55.9)	0.51	14 (41.2)	20 (58.8)	0.34
Upper back	19 (55.9)	15 (44.1)	16 (47.1)	18 (52.9)	0.38	4 (11.8)	30 (88.2)	0.00
Elbows	2 (5.9)	32 (94.1)	4 (11.8)	30 (88.2)	0.63	4 (11.8)	30 (88.2)	0.63
Wrists/hands	12 (35.3)	22 (64.7)	10 (29.4)	24 (70.6)	0.73	6 (17.6)	28 (82.4)	0.15
Lower back	17 (50.0)	17 (50.0)	11 (32.4)	23 (67.6)	0.18	1 (2.9)	33 (97.1)	0.00
Hips/thighs	7 (20.6)	27 (79.4)	10 (29.4)	24 (70.6)	0.45	7 (20.6)	27 (79.4)	1.00
Knees	11 (32.4)	23 (67.6)	5 (14.7)	29 (85.3)	0.11	5 (14.7)	29 (85.3)	0.11
Ankles/feets	2 (5.9)	32 (94.1)	3 (8.8)	31 (91.2)	1.00	3(8.8)	31 (91.2)	1.00

Table 3. Occurrence frequency of musculoskeletal pain in different body regions for the intervention group

Body regions	Before intervention		After intervention (1 week)		p-value	After intervention (3 months)		p-value
	Yes (%)	No (%)	Yes (%)	No (%)		Yes (%)	No (%)	
Neck	28 (82.4)	6 (17.6)	5 (14.7)	29 (85.3)	0.00	10 (29.4)	24 (70.6)	0.00
Shoulders	25 (73.5)	9 (26.5)	4 (11.8)	30 (88.2)	0.00	3 (8.8)	31 (91.2)	0.00
Upper back	28 (82.4)	6 (17.6)	6 (17.6)	28 (82.4)	0.00	3 (8.8)	31 (91.2)	0.00
Elbows	3 (8.8)	31 (91.2)	3 (8.8)	31 (91.2)	1.00	2 (5.9)	32 (94.1)	1.00
Wrists/hands	21 (61.8)	13 (38.2)	2 (5.9)	32 (94.1)	0.00	2 (5.9)	32 (94.1)	0.00
Lower back	24 (70.6)	10 (29.4)	5 (14.7)	29 (85.3)	0.00	1 (2.9)	33 (97.1)	0.00
Hips/thighs	18 (52.9)	16 (47.1)	4 (11.8)	30 (88.2)	0.00	8 (23.5)	26 (76.5)	0.01
Knees	15 (44.1)	19 (55.9)	5 (14.7)	29 (85.3)	0.01	2 (5.9)	32 (94.1)	0.00
Ankles/feets	6 (17.6)	28 (82.4)	4 (11.8)	30 (88.2)	0.68	2 (5.9)	32 (94.1)	0.29

4.3 Workplace Stress

According to Table 4 there was a significant difference in decrease scores of Workplace Stress Scale after 1 week ergonomics training implemented (post-intervention 1) for intervention group (mean= 17.26, SD = 2.21, $p < 0.05$). Again, for Workplace Stress Scale scores after 3 months ergonomics training implemented (post-intervention 2), the results in Table 5 noted significant difference in decrease scores for intervention group (mean= 17.29, SD= 1.80, $p < 0.05$).

Table 4. Comparison of Workplace Stress Scale scores within the group before (baseline) and after one week (post-intervention)

Participant group (n)	Mean before intervention (SD)	Mean after 1-week intervention (SD)	Mean difference	Standard deviation	t	df	p-value	Effect size
Conventional group (n=34)	19.74 (3.83)	19.53 (3.54)	0.21	4.25	0.28	33	0.78	0.00085
Intervention group (n=34)	21.03 (2.73)	17.26 (2.21)	3.77	3.25	6.76	33	0.00	0.58

Table 5: Comparison of Workplace Stress Scale scores within the group before (baseline) and after three months (post- intervention 2)

Participant group (n)	Mean before intervention (SD)	Mean after three months of intervention (SD)	Mean difference	Standard deviation	t	df	p-value	Effect size
Conventional group (n=34)	19.74 (3.83)	19.38(3.38)	0.35	4.97	0.41	33	0.68	0.01
Intervention group (n=34)	21.03 (2.73)	17.29(1.80)	3.74	2.81	7.75	33	0.00	0.65

5.0 Discussion

Participants' occurrence frequency of musculoskeletal pain in the intervention group shows a significant difference. Furthermore, the intervention group reported less musculoskeletal pain before and after ergonomic training implementation at most of the body parts. The techniques applied in the intervention group are based on the adult learning model, where the knowledge delivery method is more adult-friendly and suitable for their age adaptability. The new ability to be taught to the adult must be best when they talk to others about their life experiences and relate these experiences to the learning process (Zmeyov, 1998; Fidishun, 2012). In addition, an instructional design model was implemented where it emphasizes 4 phases in a learning process: knowledge acquisition, integration of knowledge and skills, practicing and rehearsing, and lastly, transferring training to the worksite (Gordon, 1994). The effectiveness of the instructional design model with the adult learning model obtained in this study is similar to the previous research that implemented this model in their intervention (Robertson, Ciriello & Garabet, 2013). For instance, participants were asked to discuss, practice, and rehearse their

anthropometric calculation knowledge for their chair at the simulation workstation. Then, participants had to implement the learning into their workstations, supervised by the facilitator. In the meantime, the didactic approach emphasizes only acquiring and integrating knowledge and skills. Participants are taught anthropometric calculations for their chairs without a session to practice their understanding at their workstations.

Meanwhile, this study's Workplace Stress Scale result showed a significant difference in decreased workplace stress scores for the intervention group. This result has similar to the effect reported by other studies that workplace stress is associated with ergonomics (Cho, Hwang & Cherng, 2012; Çelik et al., 2018; Noorhashirin et al., 2018). Thus, workplace stress can be reduced by implementing proper ergonomics training. No significant difference was noted in Workplace Stress Scale scores in the conventional group. Due to the technique implemented in the didactic approach, participants have just been taught about the definition and steps to overcome workplace stress instead of executing the training to manage their stress level at the workplace. The technique applied in the intervention group is based on the environmental control model, which emphasizes more application specifically to the physical office work environment to increase participant's knowledge on how to adjust and effectively arrange one's workspace (Choobineh et al., 2011; Cho, Hwang & Cherng, 2012). Thus, it will lead to an individual's environmental satisfaction, communication, and psychological stress.

6.0 Conclusion and Recommendation

The ergonomics training that combines three models, which are environmental control (E), instructional design (I), and adult learning (A), are effective in decreasing the occurrence frequency of musculoskeletal pain and workplace stress among office workers. Therefore, occupational therapists, industrial training centers, and companies may use this EIA ergonomics training approach to reduce musculoskeletal pain and workplace stress among office workers. The findings of this study may improvise the existing guidelines and approaches used in implementing office ergonomics training. Furthermore, these approaches can be explored in another field of environment required in implementing ergonomics training. Therefore, it is recommended in future research to explore the EIA ergonomics training approach with the individuals' habits at their workstations. Using a daily diary or logbook and a closed-circuit television (CCTV) camera to monitor individuals' practice towards ergonomic knowledge they gained from the ergonomics training.

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Paper Contribution to Related Field of Study

This paper contributes to the field of occupational therapy and office ergonomics.

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