Effects of an ergonomic intervention program based on the PRECEDE-PROCEED Model for reducing work-related health problems and exposure risks among Emergency Medical Dispatchers

Susan Barkhordarzadeh[1], Alireza Choobineh[2], Mohsen Razeghi[3], Rosanna Cousins[4], Hamidreza Mokarami[5*]

[1] Department of Ergonomics, School of Health, Shiraz University of Medical Sciences, Shiraz, Iran

[2]Research Center for Health Sciences, Institute of Health, Shiraz University of Medical Sciences, Shiraz, Iran

[3] Department of Physiotherapy, School of Rehabilitation Sciences, Shiraz University of Medical Sciences, Shiraz, Iran.

[4] Department of Psychology, Liverpool Hope University, Liverpool, UK.

[5] Department of Ergonomics, School of Health, Shiraz University of Medical Sciences, Shiraz, Iran.

*Corresponding author: Hamidreza Mokarami, Department of Ergonomics, School of Health, Shiraz University of Medical Sciences, PO Box 71645-111, Shiraz, Iran. Email: hamidreza.mokarami@yahoo.com

Abstract

Objective: To evaluate the effectiveness of an ergonomic intervention program based on the PRECEDE-PROCEED model in terms of improving exposure risks and work-related health problems in emergency medical dispatchers.

Methods: This quasi-experimental study used an interrupted time series design. Participants were 55 employees working in an Emergency Medical Communications Center in Iran. The intervention program was based on the PRECEDE-PROCEED model and included five face-to-face training sessions and installing auxiliary equipment according to best ergonomic principles. Direct observations of the emergency medical dispatchers' working postures using the Rapid Office Strain Assessment, and a survey which included a modified Nordic Questionnaire, Work Ability Score, Visual Fatigue Questionnaire, and a Behavioral Factors questionnaire were used at three time points: baseline, one-month post-intervention, and three months post-intervention.

Results: The modified Nordic questionnaire showed significant reductions in pain intensity scores for neck, lower back, knee and ankle after the ergonomic intervention program. In addition, there were considerable post-training improvements in behavioral factors (knowledge and enabling factors) and working postures. No significant changes were observed in Work Ability Scores, or visual symptoms.

Conclusions: An ergonomic intervention program based on a systematic framework such as the PRECEDE-PROCEED model and on-site interventions can be effective in improving and enhancing the working conditions of emergency medical dispatchers. Therefore, it is suggested that ergonomic interventions be implemented based on standard and valid behavioral change models such as PRECEDE-PROCEED model in other work environments in which musculoskeletal pain and digital eye strain are common.

Keywords: Computer vision syndrome (CVS); Musculoskeletal disorders (MSDs); Eye fatigue, Ergonomic risk assessment; Behavioral change models

Introduction

Emergency medical dispatchers (EMD) are typically the first line of communication between witnesses or casualties who perceive the need for urgent medical attention (Castrén et al. 2008; Torlén et al. 2017). EMDs work in Emergency Medical Communications Centers (EMCC) whose purpose is to support people who request emergency support remotely, and dispatch the appropriate response to the caller in terms of emergency medical services, 24 hours a day (Golding et al. 2017). The duties of EMD are: (A) To direct special emergency operations, including taking and recording correct and complete reports from an accident, such as the exact address where the accident took place, the number and characteristics of the injured patients' problems, controlling traffic routes and sending the nearest ambulance to the address of the accident. EMD may also give training to the caller to assist the injured or sick patients in terms of vital first aid until the ambulance and paramedics arrive at the scene; (B) To oversee the gathering of relevant statistics and any critical history or special circumstances that will support triaging communications, appropriate treatment, and any legal consequences; and (C) To monitor an event until the mission ends (Dunford 2002; Golding et al. 2017).

During the course of fulfilling their urgent, sensitive and precise duties, EMD are dependent upon telecommunications and computers for long periods. Outside of the busy, noisy and highly stressful working environment of an EMCC, there is a significant literature to indicate EMD are at risk of harm to health that can be caused by working at a computer station under high stress conditions – and conversely that health can be improved by an appropriate and timely intervention. Digital eye strain, which can escalate to computer vision syndrome (CVS), and awkward body postures which can promote musculoskeletal disorders (MSDs) are the most important health problems among computer users (Jomoah 2014). In their sample of Serbian computer operators, Blagojević et al. (2012) showed a high prevalence of MSDs and CVS – 55.8% and 27.3% respectively. Similarly, Ali et al. (2020) and Janwantanakul et al. (2008) found evidence of high rates of MSDs, and the studies of Boadi-Kusi et al. (2021), Derbew et al. (2021) and Ranasinghe et al. (2016) all reported very high prevalence of CVS among those working at computers for long periods of time. The duties of EMD include all the elements of general visual display terminal users, but in addition, working in urgent conditions, sometimes with life-or-death outcomes, contributes to the demands of the job beyond what is generally seen in other office workers. Notably, there are reports which indicate that stressful working conditions mediate the development of MSDs in call-center employees in the UK (Sprigg et al 2007), and that there is a role for ergonomics to reduce MSDs in call-center workers (Khattak, 2019). Similarly, Skřehot et al. (2016) discuss how the implementation of ergonomic best practice can improve working conditions and performance of those working in control centers.

Application of ergonomic principles is essential for providing a good work environment which takes into account all the devices and equipment used 'on-the-job', and the required posture and comfort of the person while doing the work, towards preventing occupational injuries (Salvendy 2012). The science of ergonomics has a wide scope and computer ergonomics has increased in importance since the reliance on computers in many workplaces (Albin 2015). The reason for the emergence of this branch of ergonomics is that lifestyle and work changes are associated with improper posture during prolonged sitting and chronic computer use, and this leads to physical injury and in turn, MSDs (Woo et al. 2016).

Intervention studies to reduce work-related musculoskeletal disorders in office workers have indicated that teaching the principles of ergonomics, making ergonomic workplace corrections to workstation layouts, standardization of work methods and physical activity while working can all have a significant influence on reducing musculoskeletal complaints, reducing and preventing vision problems, and reducing absenteeism days (Aarås et al. 2005; Heidarimoghadam et al. 2020; Robertson et al. 2009; Shariat et al. 2018). It has also been argued that ergonomic intervention programs are much more successful if they are designed and implemented using a model-based approach (Baumann et al. 2012; Sanaeinasab et al. 2018; Sezgin and Esin 2018). One of the most widely used and effective models that has been utilized in various fields to promote health is the PRECEDE-PROCEED model (Nazari et al. 2020). The model was originally developed by Green et al. in the 1970s as a roadmap for designing and implementing health promotion programs in eight steps (Green and Kreuter 2005). As such, it is a participatory model, and has remained so through various revisions. It provides an efficient framework that has been used in health promotion programs for changing behaviors in a variety of applied settings, and its predictive power and validity as a design tool and as a framework for organizing and designing health promotion has been confirmed (Gielen et al. 2008). This model enables evaluation in epidemiological, social, behavioral, and environmental contexts for designing and assessing a systematic program for users (Nazari et al. 2020).

The discussion above indicates that working conditions in an EMCC provide both psychological and health problems for EMD. Health problems were considered in this study due to the high risk of MSDs and CVS, and considering that an ergonomic intervention based on a systematic model such as the PRECEDE-PROCEED model lead to correct workstation behaviors and ameliorate this risk. Thus, the aim of this study was to evaluate the effectiveness of an ergonomic intervention program based on the PRECEDE-PROCEED model towards improving reported work-related health problems of EMD.

Method

Study Design and Participants

This quasi-experimental study used an interrupted time series design. Data was collected using an anonymous survey at three time points: Baseline (a pre-intervention measurement), one month after the intervention, and three months after the intervention. Participants were EMD working in the EMCC of Shiraz University of Medical Sciences, Iran in 2020. A total of 59 people worked in the EMCC at the time of the study. Inclusion criteria were having more than one year of work experience, and no history of surgery or any accidents affecting the musculoskeletal area. The exclusion criterion was the occurrence of an accident during the study that made it impossible for the person to cooperate in the various phases of the study. Fifty-five EMD were eligible to participate and provided written consent to join the study.

The research project was approved by the Scientific and Ethical Committee of Shiraz University of Medical Sciences (IR.SUMS.REC.1399.578).

Data Collection Tools

Demographic Information

The survey included a section to collect data regarding the participant's age, sex, weight, height, marital status, education level, job tenure (years employed as an EMD), and average working hours per week.

Nordic Questionnaire

A modified version of the Nordic questionnaire was used to assess pain and discomfort indicative of MSDs (Kuorinka et al. 1987; Namnik et al. 2016). This questionnaire has been used in a wide range of occupations. The section used consisted of two parts. The first was a general questionnaire to identify musculoskeletal symptoms that EMDs experienced that prevented normal activity in nine sites of the body – neck, upper back, shoulders, elbows, knees, thighs, legs, wrists, and lower back – with the help of a body map (Kuorinka et al. 1987).

The second part asked participants to rate their pain or discomfort in the nine areas during the preceding month based a scale that ranged from 0 = no pain to 10 = very severe pain.

Work Ability Score

Work ability was measured using the Work Ability Score (WAS) (Mokarami et al. (2021). This variable is the first item of the work ability index and as a measurement tool is valid, simple, and convenient (Mokarami et al. 2021). The WAS assesses employees' ability to work using a visual scale of 0 (completely incapable of doing work) to 10 (fully capable of doing work).

Visual Fatigue Questionnaire.

The visual fatigue questionnaire (Habibi et al. 2011) was used to assess CVS. This questionnaire includes 15 questions in four main areas of asthenopic symptoms (4 items), visual symptoms (5 items), ocular surface-related symptoms (3 items), and extraocular symptoms (3 items). For each question, participants rated symptom impact from 1 (no fatigue) to 10 (severe fatigue).

Rapid Office Strain Assessment

The Rapid Office Strain Assessment (ROSA) (Sonne et al. 2012). is a picture-based checklist that can be used to determine the level of discomfort from computer use and evaluate potential risks factors related to MSDs for EMD at work whilst sitting on chair (chair height, seat pan depth, armrest and back support), using a computer (monitor, keyboard, and mouse), and telephone, in a matrix and offers a total score using a scoring chart.

EMD Behavioral Factors Questionnaire

A questionnaire was developed for this study to evaluate the behavioral factors affecting MSDs and CVS in EMD based on the educational recognition phase of the PRECEDE-PROCEED model. The questionnaire consisted of 20 items in three areas: attitude (9 items), knowledge (7 items), and enabling factors (4 items). The knowledge area included items about employees' knowledge of the appropriate distance of their eyes from the computer screen, the most appropriate posture of the head and neck when working at a computer, the most appropriate posture of the legs when working at a computer, the most appropriate position of the computer screen relative to the workplace window, factors affecting the occurrence of MSDs, the time period one should be step away from the computer screen in each hour of work, and the time period of rest. The knowledge questions had a multiple-choice format. For each of the seven items there were four options with only one correct answer. Scoring was 1 = correct and 0 = incorrect. The attitude area included items about an EMD's attitudes towards the workstation layout, the importance of a standing-sitting work cycle, duration of sitting, correct sitting posture, ergonomic assistive equipment, stretching movements, eye exercises, and eye problems caused by working with computers. Each of the attitude items was scored using a 5-point Likert scale, where 1 = strongly disagree and 5 = strongly agree. The enabling factors area included four items related to awareness of musculoskeletal injuries and their causes and influential factors: exercises to prevent MSDs, proper posture when sitting, eye exercises to prevent eye strain, and headaches caused by computer work. The four items were each scored on a 4-point scale where 1 = not aware, 2 = slightly aware, 3 = aware, 4 = fully aware. The psychometric properties of the EMD Behavioral Factors Questionnaire were confirmed (content validity index =.89; content validity ratio =.77; and internal consistency as measured by Cronbach's Alpha coefficient =.83).

Implementation of the Ergonomic Intervention Program

Coordination was made with the EMCC of Shiraz University of Medical Sciences and the necessary permission was obtained. The EMD ergonomic intervention program explicitly followed the phases of the PRECEDE–PROCEED planning model. Application of the model to the program is shown in Figure 1. In Phase 1 (social assessment) and Phase 2 (epidemiological assessment) field observations, face-to-face interviews and a literature review were undertaken to identify work-related health problems and factors that hindered improvement of participants' quality of life. Health problems included MSDs, CVS, non-ergonomic workstations and having to work using awkward postures, limited physical activity, and insufficient rest breaks. These issues were selected as educational priorities to support improvement of the quality of life of participants.

Phase 3 (educational and ecological assessment) was conducted using the EMD Behavioral Factors Questionnaire (developed in this study). Predisposing factors, enabling factors and reinforcing factors were identified and evaluated. Then in Phase 4, the administrative and policy diagnosis (budgets and resources, rules, regulations, goals and objectives of the organization; organizational barriers; organizational structure; and the external organizational factors), was amalgamated with outcomes from Phases 1, 2 and 3, to design the intervention program. Phase 5 then proceeded with operationalizing the program as follows:

Education

Five face-to-face educational sessions were held for EMD. The duration of each the five weekly sessions was 2-2.5 hours. The teaching included both theoretical and practical components. The first session was an introduction to the concepts of predisposing-knowledge factors including the following topics: What is ergonomics? What is workplace syndrome? What are MSDs? What is CVS? In the second session, the predisposing-attitude factors were discussed and people's attitudes towards the factors affecting musculoskeletal disorders and the effectiveness of preventive behaviors were presented. In the third and fourth sessions, the enabling factors were introduced. These were: using educational programs for preventing the MSDs; teaching appropriate exercises to prevent MSDs and reduce CVS; principles of ergonomics in purchasing ergonomic assistive devices for the workplace (introducing the equipment, application, importance of use and target limbs); and the principles of correct posture during work. The fifth session was a review of the material presented in the previous sessions. During the course, the research team kept in touch with the EMD to find out how much they were following the advice and correct behaviors, and to remind them if necessary. Once every two days photos, short videos, animations, and messages containing short educational texts were also sent to the employees to consolidate the training sessions. In total, 91 photos, 15 videos and animations and 20 messages were sent to participants. Any ambiguities that were raised were resolved, and several complaints about workstations were also dealt with.

Assistive Equipment

According to the range of enabling factors of the PRECEDE-PROCEED model, ergonomic assistive equipment was prepared for the employees and installed in the workstations of the EMD. The equipment included ergonomic elbow rests, ergonomic mousepads, footrests, and monitor stands. Regarding mousepads, the literature is somewhat divided on the benefit of ergonomic mousepads, perhaps because many different types have been used in studies. Noting the evidence of Gustafsson and Hagberg (2003) that forearm muscles loads of inclined mice are lower than those of conventional ones, and the results of a study which revealed that 25° or 30° slanted mice caused lower muscle activity and more neutral working postures for Extensor Carpi Ulnaris, Trapezius and Pronator Tres muscles (Chen and Leung 2007), in this study we used a slanted mousepad with an adjustable angle. Our previous study indicated that a slanted mousepad caused more neutral forearm and wrist postures and less forearm muscles activities compared with a non-slanted one (unpublished data).

Installing Posters and Distributing Pamphlets

In order to make the face-to-face teaching effective, educational posters were also fixed to the walls in the EMCC. The content of these posters included the design of a standard ergonomic workstation, appropriate workplace exercises, and eye exercises. Brochures on the principles of ergonomics in computer installation and use, stretching and sports exercises at work, ergonomic chair specifications in the workplace, tips for preventing musculoskeletal disorders and eye exercises to prevent vision problems caused by working with a computer were designed, prepared, and made available to the employees.

In Phase 6, a process evaluation was undertaken to determine that the intervention program had been run according to the protocol. The program was evaluated through a panel discussion, and modifications were made to improve the program.

In Phase 7, the impact evaluation assessed the immediate effects of the intervention program, one month after the intervention was carried out. This was done by comparing the scores of the studied variables obtained before the intervention with those taken one month after the intervention program (i.e. follow-up 1). In Phase 8, an outcome evaluation of more long-term effects of the intervention program on the study variables three months after the intervention was carried out. This was done by comparing the scores of the studied variables obtained before the intervention and three months after the intervention (i.e. follow-up 2).

In the two evaluation phases, first histograms and Kolmogorov-Smirnov tests were used to check the normality of the data distribution and data skewness. The dependent variables were all normally distributed, therefore one-way repeated measures ANOVA were used to compare the changes in the evaluated data in the three different time periods. In this test, the sphericity of the covariance matrix was checked based on the Mauchly test, and if this assumption was not met, the Greenhouse Geisser test result was used to correct for the violation. Partial eta squared values were used to evaluate the effectiveness of the intervention. All analyses were done using SPSS software, version 24 (SPSS Inc., Chicago, IL, USA). A p-value $\leq .05$ represented statistical significance.

Results

Demographic Characteristics

Of the 55 participants, 50 were women (90.9%), 51 had a Bachelor degree (92.7%), and 41 were married (74.5%). The mean age, body mass index, and job tenure of participants were 33.18 ± 6.70 years (range 24–50 years), 24.44 ± 3.88 kg/m^2 (range 16–38 kg/m^2), and 6.76 ± 6.04 years (range 1–21 years). The average working hours per week was 45.09 ± 13.49 hours (range 20–89 hours).

ROSA Score

A one-way repeated measures ANOVA showed that there was a significant difference in the mean ROSA score in the three time periods ($p <.001$). As shown in Table 1, the comparison of baseline ROSA with follow-up 1 ROSA were significantly different ($p<.001$), and similarly, the comparison of baseline results with follow-up 2 showed a significant difference in the mean ROSA score.

MSDs

All nine areas were associated with work-related discomfort and pain for EMD at baseline although to a differing extent. The lower back (89.1%), neck (72.7%), knees (69.1%), shoulders (61.8%) and upper back (61.8%) were most problematic. The elbow was least painful, nevertheless, almost one third of the EMD (32%) noted a potential for MSD in this body part. Ankles (47.3%), wrists (43.6%), hips (40%) were also indicated as areas for improvement. A one-way repeated measures ANOVA showed a significant difference in the mean scores of pain intensity in the neck, lower back, knee and ankle in both the impact and outcome evaluations (see Table 1). There was an insignificant decrease in pain ratings in the other five areas one month after the intervention, but some rebound towards original levels after three months in these body parts. The change in pain intensity in the nine areas in the three time periods are also shown in Figure 2.

CVS

With respect to visual symptoms, although test scores for asthenopic symptoms, ocular surface-related symptoms, extraocular symptoms, and total eye fatigue, in follow-up 2 had decreased by 1.98, 0.09, 1.58, and 2.4 respectively when measured against baseline scores (Figure 3), these improvements were not significant (see Table 1).

WAS

The results of the one-way repeated measures ANOVA showed that there was no statistically significant difference in the average score of WAS in the three time periods (see Table 1).

EMD Behavior Factors

There was a significant difference in the mean scores of enabling factors and knowledge at both one-month and three-month assessments, but no significant difference was observed in the mean scores of Attitude (see Table 1 and Figure 4).

Discussion

This study aimed to determine the effect of an ergonomic intervention program on employees' work-related health problems based on the PRECEDE-PROCEED model using a sample of EMD. The results of the present study showed that the implementation of ergonomic interventions in the form of a systematic model can have a positive effect on reducing musculoskeletal pain. Lower back, neck and knee were the body areas with the greatest incidence of pain at baseline, and the intervention was successful in reducing pain ratings in these areas, and also the ankle. This is encouraging as these are common areas in which musculoskeletal pain occurs among office workers (Jomoah 2014; Shariat et al. 2018). The results of this quasi-experimental intervention study are also in line with the findings of three other MSD intervention studies (Choobineh et al. 2011, Shariat et al. 2018; Sohrabi and Babamiri 2021), although none of these other studies used a model-based approach.

Whilst the ergonomic intervention worked very well in the most important areas, in relation to incidence of musculoskeletal pain, we also found some body areas where there was no significant decrease in pain ratings at either follow-up time point. Although a lack of an increase in pain scores in the upper back, elbow and hip could be considered as a positive point, there may be a need to continue to follow the principles of the ergonomic program, including exercise, and using ergonomic assistive equipment, for longer before a significant difference in pain scores in these areas can be observed. With respect to wrist pain for EMD from computer mouse work, there was no obvious benefit at all of the ergonomic intervention. As nearly half of participants indicated musculoskeletal pain in the wrist area, this remains a challenge, if not a new one (Trillos-Chacón et al. 2021; Jovanović and Šimunič 2021). Despite the attraction of ergonomic mousepads, evidence of their physical benefit is tenuous at best (Schmidt et al. 2015; Trillos-Chacón et al. 2021). In this research we used a slanted mousepad with an adjustable angle, following the physiological evidence that such mousepads relieve some of the strain of mouse work (Chen and Leung 2007; Gustafsson and Hagberg 2003), but we did not find an improvement in ratings of pain. It has recently been asserted that to reduce the risk of wrist MSDs, the most effective strategy involves taking short breaks in work to perform physical exercises to increase blood and lymph circulation, as well as to relax the muscles of the hand (Berezutsky 2018). This recommendation endorses assertions short break periods and exercise in four of the papers in the review of Trillos-Chacón et al. (2021). This may be a challenge in the EMD context, nevertheless, it is important to promote such exercises if mousepads do not mitigate wrist MSDs.

Working with computer screens for extended periods of time can cause visual problems (Blagojević et al. 2012; Jomoah 2014). In the present study, after making the interventions – such as teaching the relevant principles of ergonomics and appropriate eye exercises, setting up and redesigning the workstation, and installing educational posters in the EMCC – the mean score of total eye fatigue was decreased compared to baseline, but the improvement was not statistically significant. According to our results and the intense working condition of the employees, we must recommend EMD use planned rest breaks during work for doing eye-related exercises, and that the relevant ergonomics principles of the intervention program are followed for longer to see if an improvement in vision variables and eye fatigue seen in EMD can be made. This is based on a previous report of a positive effect of ergonomic interventions in significantly reducing eye problems but only after 18-months, and again at 30 months (Aarås et al. 2005). In the present study the timing of the intervention outcome evaluation time may have been too short.

Similarly, in the present study, despite the interventions, there was no change in the WAS when the measure was repeated after the intervention. This was unexpected, although similarly workability was not improved in the six-month follow up of two ergonomic interventions to prevent MSDs in sample of construction workers (Visser et al. 2019). Here the follow-up was longer, but they still suggested that follow-up could be too short to establish improvements in work ability. Altogether, both results suggest that ergonomic interventions are not effective in changing the WAS. Nevertheless, we must also caution that in the present study, the intervention period of 3 months was likely to be insufficient to be able to achieve any significant changes in the WAS. Again, we must recommend adopting a long-term ergonomics intervention program to improve the work ability of EMD.

The ergonomic intervention program process, in terms of providing virtual and face-to-face teachings as well as sending regular photos, short videos, animations, and messages containing short educational texts to remind EMD of the teachings during the six weeks of the course was effective. An increase in the mean score of ergonomics knowledge and consequently an upward trend of change during the study were observed. These results are in line with those of Sezgin and Esin (2018) and Moshki et al. (2021) which showed that an educational intervention based on the PRECEDE-PROCEED model was able to increase the ergonomics knowledge of their samples of intensive care unit nurses and office workers, respectively.

Awkward and static postures are one most important ergonomic risk factors of MSDs among office workers (Moshki et al. 2021; Salvendy 2012; Sonne et al. 2012). In this regard, one of the management control strategies for reducing or eliminating the risk factors of MSDs in computer users is to give training and to provide a way to personalize each employee's workspace settings. The results of various studies have indicated that teaching ergonomics and designing ergonomic workstations and office buildings can be useful in preventing and reducing MSDs in office environments (Choobineh et al. 2011; Sanaeinasab et al. 2018; Shariat et al. 2018). The changes and corrections applied in the workstation of the EMD, as well as the teachings, were effective in improving their working posture and a clear downward trend in the mean ROSA score was observed. The mean ROSA score in follow-up 1 and follow-up 2 were very similar and both significantly different from the baseline. This sustainability of behavioral change in the employees can have a positive impact on control of the MSDs in the future. Consistent with these results, Sanaeinasab et al. (2018) showed the effectiveness of the model-based health education intervention on ROSA score.

This study was conducted in one EMCC and the number of its EMD employees was fairly low, and 91% women. Due to the limited number of employees and the possibility risk of contamination bias, a control group was not used to evaluate the interventions. Nevertheless, the use of an interrupted time series design in this study was a practical option, and provided some benefits. Using a single population for before and after intervention comparisons can eliminate selection bias and confounding due to between group differences. We accept that the study will benefit from replication using another sample of EMD, and additional longer follow-up time points. Further studies could also explore the influence of specific demographic variables which may impact on the success of the ergonomic intervention. This was not an objective in this study, but there remains potential for there to be thresholds in variables such as age and working hours that are relevant to outcomes.

Conclusion

This study was the first to implement an ergonomic intervention program based on a systematic approach to improving work-related health problems among EMD. The intervention program had an effect on improving the knowledge of and attitude to the use of ergonomic principles in EMD. This improvement in knowledge and attitude had a positive effect on the reducing employee's posture risk. In addition, using ergonomic assistive equipment and management support, in accordance with the requirements of PRECEDE-PROCEED model, the intervention had a beneficial effect in the reducing musculoskeletal pain. Altogether, these results suggest that an ergonomic intervention program based on a systematic framework – such as the PRECEDE-PROCEED model – and on-site interventions can be effective in improving and enhancing the working conditions of employees. Therefore, it is suggested that ergonomic interventions based on standard and valid behavioral change models such as PRECEDE-PROCEED model should be implemented in other work environments to manage exposure risks in employees.

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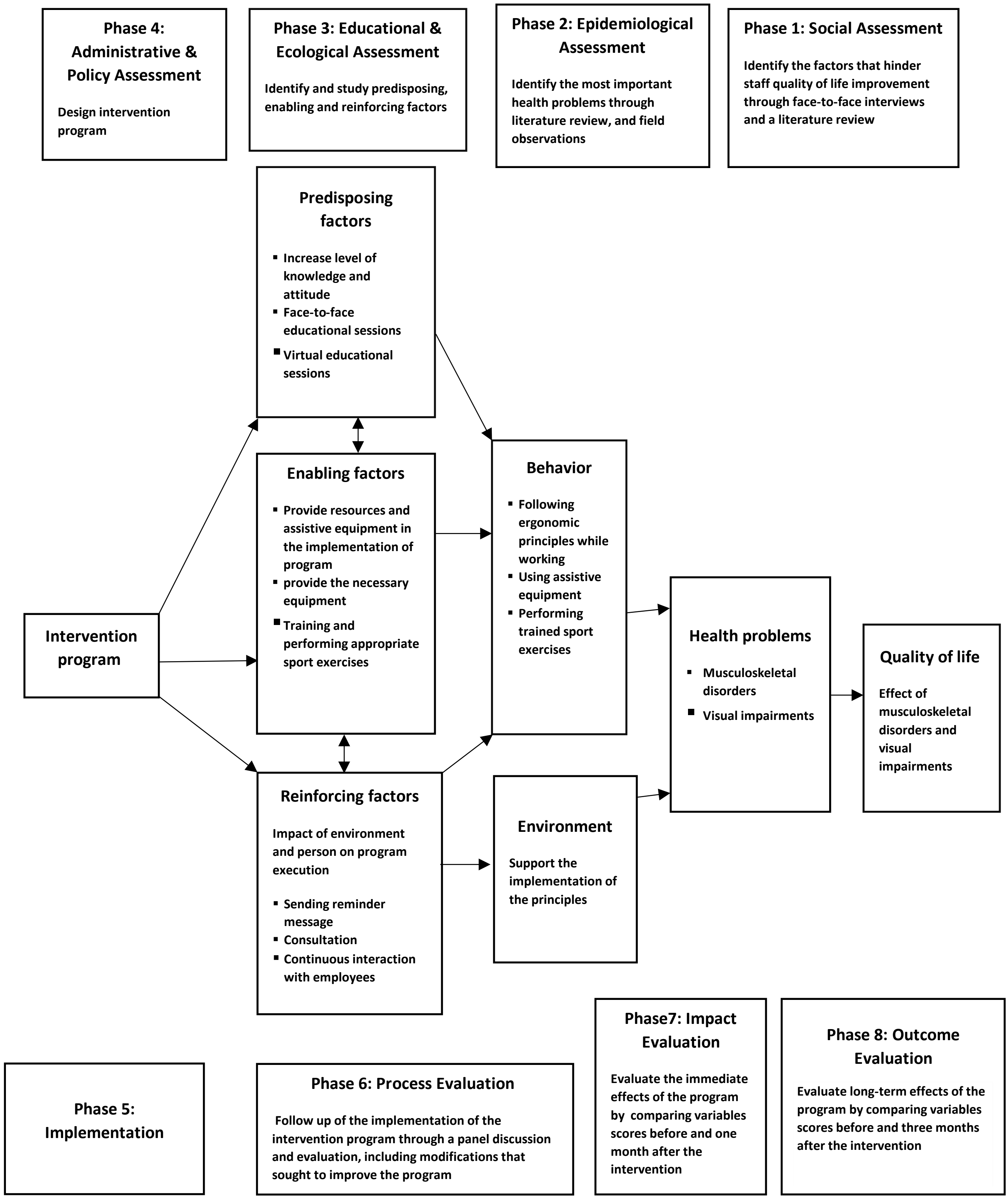

Figure 1. Application of PRECEDE-PROCEED Model to the EMD Ergonomic Intervention Program

Table 1. Comparison of mean scores of study variables at Baseline, follow-up 1 and follow-up 2 (N = 55)

	Impact	Outcome		Baseline	follow-up 1	follow-up 2
	follow-up 1 vs Baseline	follow-up 2 vs Baseline	follow-up 2 vs follow-up 1			
Variable	p-value	p-value	p-value	Mean (SD)	Mean (SD)	Mean (SD)
Work Ability Score	.654	.895	.783	8.73 (1.02)	8.64 (1.23)	8.69 (1.27)
Neck (pain intensity)	<.001**	.012*	.963	4.04 (3.16)	2.91 (2.98)	2.93 (2.77)
Shoulder (pain intensity)	.093	.479	.501	3.02 (3.31)	2.51 (2.99)	2.76 (3.01)
Upper back (pain intensity)	.075	.611	.265	3.27 (3.54)	2.64 (2.94)	3.04 (3.20)
Elbow (pain intensity)	.794	.176	.105	.96 (1.94)	.91 (1.61)	1.36 (2.12)
Lower back (pain intensity)	.001**	<.001**	.258	5.8 (2.99)	4.44 (3.14)	3.91 (3.13)
Wrist (pain intensity)	.751	.454	.231	2.02 (2.88)	1.93 (2.55)	2.31 (2.74)
Hip (pain intensity)	.282	.424	.770	1.82 (2.98)	1.42 (2.38)	1.51 (2.21)
Knee (pain intensity)	.001**	<.001**	.269	4.13 (3.81)	2.95 (3.20)	2.60 (2.86)
Ankle (pain intensity)	<.001**	.007*	.269	2.53 (3.27)	1.07 (2.12)	1.42 (2.60)
Total eye fatigue	.527	.499	.063	63.34 (37.73)	65.65 (35.25)	60.94 (31.90)
Visual symptoms	.086	.357	.270	12.83 (13.33)	15.21 (11.51)	14.09 (11.83)
Ocular surface-related symptoms	.722	.922	.608	12.85 (8.40)	13.16 (7.62)	12.76 (7.74)
Extraocular symptoms	.825	.113	.020*	15.54 (9.26)	15.36 (9.04)	13.96 (7.75)
Asthenopic symptoms	.868	.078	.025*	22.1 (11.10)	21.9 (11.03)	20.12 (10.14)
Enabling factors	<.001**	<.001**	.792	4.6 (1.84)	6.6 (2.09)	6.67 (1.59)
Attitude	.579	.748	.724	16.37 (5.34)	16.83 (4.83)	16.59 (4.83)
Knowledge	<.001**	<.001**	.017*	2.89 (1.21)	5.09 (1.44)	5.78 (1.96)
Rapid Office Strain Assessment	<.001**	<.001**	.057	4.82 (0.54)	3.71 (0.56)	3.82 (0.54)

* $p \leq .05$; ** $p \leq .01$

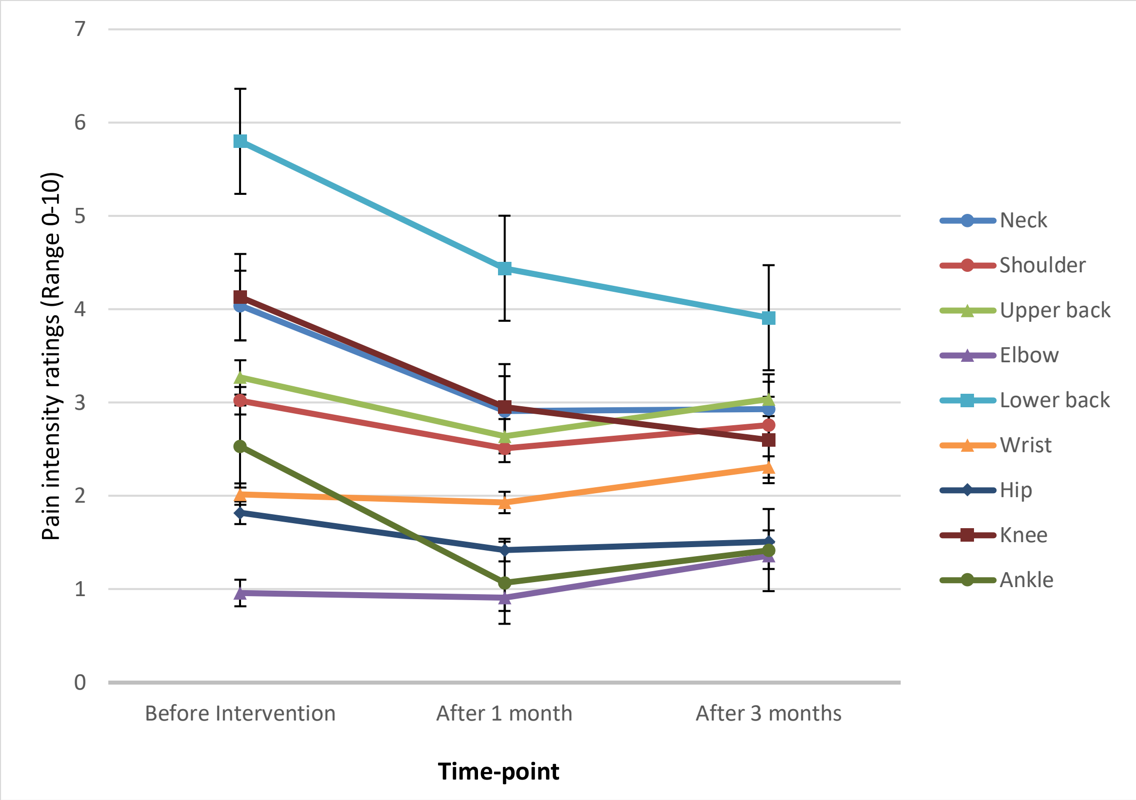

Figure 2. MSD scores according to body place and time-point

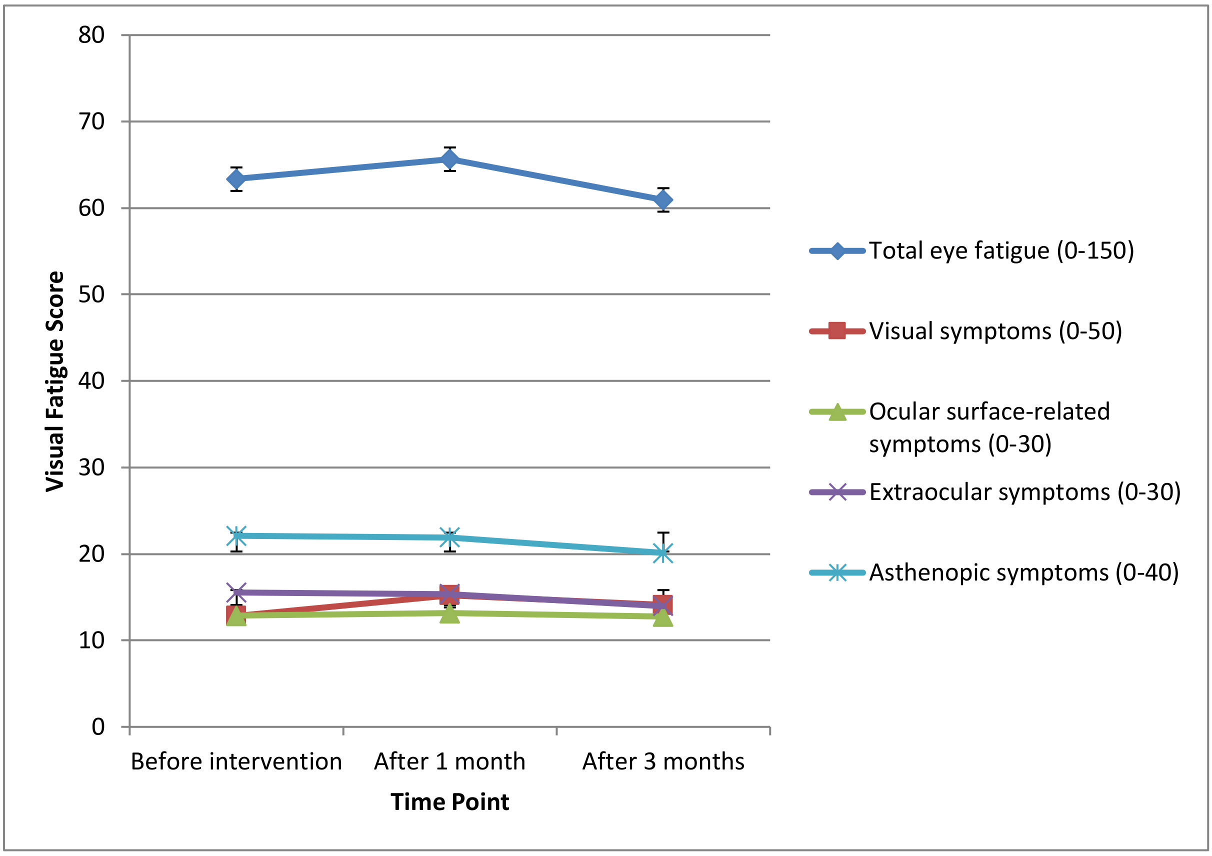

Figure 3. Eye and vision variables scores according to time-point

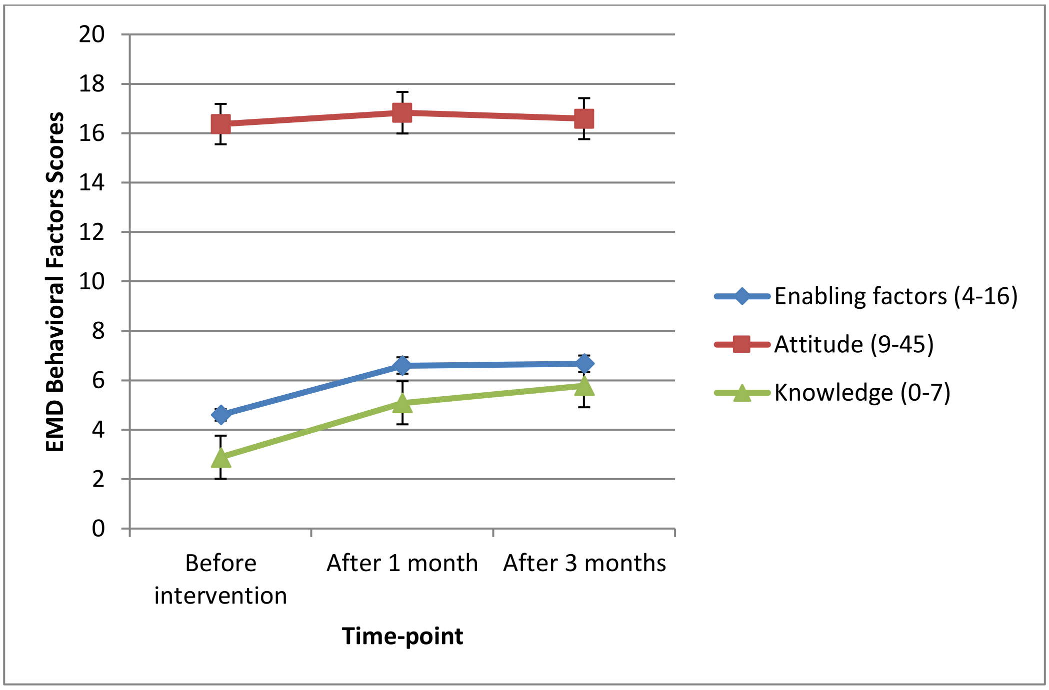

Figure 4. EMD Behavioral Factors scores according to time-point