J Med Edu. 2026 December; 25(1): e163303 https://doi.org/10.5812/jme-163303

Published Online: 2026 November 15 **Research Article**

Design, Implementation, and Evaluation of a Virtual Modular Ergonomics Course for Improving Employees Work Environments

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Received: 4 November, 2025; **Revised:** 22 February, 2026; **Accepted:** 16 May, 2026

Abstract

Background: Work-related musculoskeletal disorders (WMSDs) are among the most common occupational health problems worldwide and often result from poor ergonomic conditions and limited awareness of ergonomic principles in the workplace. Educational interventions, particularly those based on modern instructional technologies, play a crucial role in improving ergonomic knowledge and promoting healthy work practices among employees.

Objectives: This study aimed to design, implement, and evaluate a virtual, modular ergonomics training course to enhance ergonomic awareness and improve the working conditions of administrative staff at medical universities in Iran.

Methods: A semi-experimental study with a pretest-posttest design was conducted among 170 registered participants from various medical universities; 120 completed the full course. The training was designed using the ASSURE instructional design model and delivered virtually through an e-learning platform. Data were collected using demographic and occupational questionnaires, a workplace ergonomic checklist, the Nordic Musculoskeletal Questionnaire (NOSACQ), and pretests and posttests. The validity and reliability of the tools were confirmed (Content Validity Ratio [CVR], Content Validity Index [CVI], Cronbach's $\alpha > 0.8$). Quantitative data were analyzed using descriptive and inferential statistics in SPSS version 21.

Results: The prevalence of musculoskeletal discomfort was highest in the neck (58.4%) and wrists/hands (44.2%). More than 53% of participants attributed their discomfort to workplace conditions. The mean knowledge score significantly improved from 10.77 at pretest to 17.76 at posttest ($P < 0.01$). Participants reported high satisfaction with the course content (mean = 4.69/5), instructor performance (mean = 4.68/5), and course delivery quality (mean = 4.60/5).

Conclusions: The virtual modular ergonomics training program effectively enhanced participants' ergonomic knowledge and awareness, and participants reported high levels of user satisfaction. These findings highlight the importance of integrating modular, technology-based ergonomic education into workplace training initiatives to reduce WMSDs and improve occupational health and productivity among administrative staff.

Keywords: Ergonomics, Musculoskeletal Diseases, Education, Distance, Occupational Health

1. Introduction

With the industrialization of developing countries, work-related injuries, diseases, and accidents have increased (1). Today, many occupations expose workers to various musculoskeletal disorders because of specific postures and failure to adhere to ergonomic principles in the workplace (2). According to findings from the National Institute for Occupational Safety and Health (NIOSH) in the United States, work-related musculoskeletal disorders (WMSDs) rank second among work-related illnesses and injuries, after respiratory occupational diseases (3).

These disorders are associated with work patterns, improper physical postures, frequent repetition, limited mobility, and insufficient rest, all of which are prevalent in service, construction, and office jobs (4).

WMSDs can lead to reduced strength, limited range of motion, pain, and swelling (5). Contrary to the common perception that office jobs are comfortable, occupational illnesses, particularly WMSDs that lead to absenteeism, are

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How to Cite: Ahmady S, Habibi A, Zandishafagh Y. Design, Implementation, and Evaluation of a Virtual Modular Ergonomics Course for Improving Employees Work Environments. J Med Edu. 2026;25(1):e163303. doi: https://doi.org/10.5812/jme-163303

notably prevalent. Research has demonstrated that WMSDs contribute to lost work time, increased costs, and workforce injuries (6). More than half of workplace absences are attributed to musculoskeletal diseases and injuries (7). The risk of developing WMSDs can be predicted based on individual, psychosocial, and ergonomic factors (8). In fact, the prevalence of WMSDs in work environments is directly linked to workplace ergonomic factors (9).

Many workplace problems can be mitigated through ergonomics, which is considered a key factor in improving working conditions and maintaining health and satisfaction in the workplace (10). Ergonomics is defined as "the science of optimally utilizing work tools in the workplace to achieve maximum productivity while ensuring user satisfaction and safety, and creating a safe work environment" (11). It is a systems-oriented approach that focuses on the interaction of individuals with their work and the design of work processes.

Ergonomic assessment is the first step in managing WMSDs and provides a cost-effective means of preventing work stress injuries and repetitive fatigue (12). Numerous studies have emphasized the importance of specialized training programs to familiarize individuals with ergonomic principles in their workplaces. These studies highlight the positive impact of ergonomic education (3, 5, 8, 9, 13).

Most prior research in ergonomics has used face-to-face interventions, with limited emphasis on novel methods. For example, Bandahagh compared mobile learning via smartphone applications with traditional lecture-based learning to teach dental ergonomics.

The findings revealed that mobile learning significantly enhanced students' knowledge compared with conventional lectures, suggesting the potential of mobile-based training as a supplementary educational tool (14).

Other research has also used advanced technologies for ergonomic training. Aguilar et al. conducted a randomized clinical trial comparing virtual avatar-based ergonomic training with traditional lecture-based instruction for remote workers. Their results indicated that virtual avatars could effectively address the educational needs of remote workers on a large scale (15).

An alternative approach to ergonomic training involves modular educational programs, an integral part of workforce development aimed at increasing productivity, reducing professional errors, and improving organizational environments. Modular virtual programs represent a notable application of information and communication technology in continuing education, saving employees' time and energy (16).

This method delivers specialized job skills through independent, distinct modules, each of which offers specific skills while collectively providing comprehensive training. It allows learners to access extensive information rapidly without time or location constraints and reduces travel costs, time wasted, and conflicts between training hours and work schedules, thereby fostering motivation, enhancing experience, and promoting innovation.

Work-related musculoskeletal disorders are among the most common occupational health problems in the country, and numerous articles have addressed this issue. However, this research differs from previous studies in its implementation and evaluation of a modular online ergonomics training course to raise ergonomic awareness and improve working conditions for employees.

2. Objectives

Given the importance of ergonomic training in preventing WMSDs and the lack of prior studies in Iran on the design and implementation of modular ergonomic education, this study aimed to design, implement, and evaluate a virtual modular ergonomic training course to improve workplace conditions for administrative staff at medical universities. The researchers designed a modular ergonomic training program for administrative staff at medical universities that addressed human capabilities and limitations, environmental stressors, static and dynamic forces on the human body, and factors that induce fatigue. The program was made available to learners, and its effectiveness was subsequently evaluated.

3. Methods

This study employed a quasi-experimental research design with pretest and posttest assessments, using both qualitative and quantitative (continuous and discrete) data. Cluster random sampling was used, and the sample size was determined based on the number of participants who registered and expressed interest in the program. A total of 170 participants from various medical universities in Iran (including Tehran, Shahid Beheshti, Isfahan, Yazd, Shiraz, Tabriz, Hamedan, Ahvaz, Rasht, and Mashhad) registered for the course. Of these, 120 completed all stages of the program, and the analysis was conducted using the complete data sets.

After obtaining ethical approval and permission from the graduate studies department of the School of Medical Education and Learning Technologies at Shahid Beheshti University of Medical Sciences, the researchers introduced the study and its objectives to potential participants. Those who met the inclusion criteria and registered for the study participated in the modular training course.

The course was designed and implemented using the ASSURE model to improve the working conditions of administrative staff. The ASSURE model is a classroom-based instructional design framework that enhances educational experiences in the classroom. It is considered a macro-level model used to design entire programs rather than individual lectures or sessions. The model consists of six stages (17).

In the first stage, the instructional design phases were analyzed and evaluated based on the initial four steps of the ASSURE model: 1) targeted needs assessment and learner analysis, 2) setting standards and objectives, 3) selecting media and educational content, and 4) utilizing media and educational content. This stage involved collecting comprehensive and accurate information to plan and deliver the course effectively. The educational content was created in the production facilities of the School of Medical Education at Shahid Beheshti University of Medical Sciences. The content was recorded and filmed with the participation of an expert faculty member specializing in occupational health and safety. The materials were then developed into SCORM-compliant multimedia files using advanced instructional strategies.

In the second stage, which aligned with the fifth step of the ASSURE model, the produced content was made available to participants after they were notified. The content was delivered over a 1.5-month period through the e-learning platform of the School of Medical Education and Learning Technologies at Shahid Beheshti University of Medical Sciences. The course consisted of eight instructional sessions, totaling 137 minutes of video content, during which the instructor presented ergonomic principles using PowerPoint and educational slides.

Before starting the course, participants completed demographic and occupational questionnaires and the Nordic Musculoskeletal Questionnaire (NOSACQ), which included information about workplace conditions, personal work situations, the incidence of musculoskeletal problems, and occupational injuries. The validity and reliability of these questionnaires had been established previously in related studies (18-20). Participants were also asked to complete a checklist assessing the ergonomic conditions of their workplaces. The researcher and research team developed this checklist based on a review of relevant literature and studies. Content validity was assessed using Lawshe's Content Validity Ratio (CVR) and Content Validity Index (CVI) (21). Ten experts reviewed the questions to ensure that the items were essential and appropriate. Reliability was evaluated using a Cronbach's alpha coefficient of 91%, indicating excellent reliability.

Participants also completed a 20-question pretest covering topics such as ergonomic principles, ergonomic risk factors, occupational causes of musculoskeletal disorders, symptoms of such disorders, proper sitting postures, correct back positioning, and body mechanics. The same questions were used in a posttest at the end of the course. The questions were multiple-choice; correct answers received one point, and incorrect answers received no penalty. The effectiveness of the training was evaluated by comparing pretest and posttest scores.

In the third stage, following the sixth step of the ASSURE model, a summative evaluation of the course was conducted after its completion. The researchers assessed participants' learning outcomes and satisfaction using a 25-question evaluation questionnaire. This researcher-designed questionnaire included three sections: course content (8 questions), instructor evaluation (9 questions), and course delivery quality (8 questions). Responses were measured on a scale from 1 (lowest) to 5 (highest). The questionnaire's content validity and reliability were confirmed using the same methods described above, with a reliability coefficient of 82%, indicating good reliability.

Descriptive and analytical statistics were used to analyze the data. After data collection and coding, the information was entered into SPSS software version 21. Descriptive statistics included absolute and relative frequency distributions for qualitative variables and means and standard deviations for quantitative variables. The independent t-test was used to analyze quantitative demographic data.

4. Results

Of the 170 individuals who registered for the course, 120 participants completed all stages of the modular ergonomic training program. Among these participants, 78 were female (65%), and 42 were male (35%). Most participants were university staff (87.5%), while 12.5% were university faculty members. Participants aged 37 to 42 years had the highest representation (48%), followed by those aged 31 to 36 years (26%). Most participants were from the universities of Tehran, Shahid Beheshti, and Isfahan, whereas the lowest participation was recorded at the universities of Rasht, Mashhad, and Ahvaz.

The following tables summarize the study results (Tables 1 - 4):

- Over 92.5% reported light-colored walls, and 91.7% reported light-colored ceilings in their work environments.
- However, 86.6% stated that they lacked a typing holder, and 75% noted the absence of a keyboard pad.
- Additionally, 77.5% indicated the absence of a designated rest area at their workplace (Table 1).

Table 1. Results of the Workplace Ergonomic Checklist [a]

Item	Question	Yes	No
1	Do you work in a similar role elsewhere?	25 (20.8)	95 (79.2)
2	Are short breaks scheduled during work hours?	61 (50.8)	59 (49.2)
3	Is there a designated rest area for employees?	27 (22.5)	93 (77.5)
4	Do you leave your workplace for rest during the day?	51 (42.5)	69 (57.5)
5	Do you stop working for rest during the day?	27 (22.5)	93 (77.5)

[a] Values are expressed as No. (%); n = 120.

Table 2. Prevalence of Musculoskeletal Disorders in Participants (Nordic Questionnaire) [a]

Body Part	Prevalence, %
Neck	58.4
Shoulders	30.8
Wrists/hands	44.2
Lower back	43.4
Upper back	12.5
Knees	34.2

[a] Values are expressed as the percentage of the 120 participants reporting pain or discomfort in that body part.

- All participants reported pain or discomfort in at least one of the six evaluated body areas.
- The highest prevalence was observed in the neck (58.4%) and wrists/hands (44.2%), whereas the lowest was observed in the upper back (12.5%) (Table 2).

Table 3. Work Environment as a Contributing Factor to Musculoskeletal Disorders [a]

Body Part	Attributed to the Work Environment, %
Neck	54.3
Shoulders	54.0
Wrists/hands	49.0
Lower back	55.8
Upper back	66.7
Knees	39.0

[a] Values are expressed as the percentage of participants with symptoms in that body part who attributed them to their work environment.

- The upper back showed the highest association with workplace factors (66.7%), whereas the lowest association was observed in the knees (39%).
- On average, over 53% of participants considered their work environment a contributing factor to musculoskeletal issues (Table 3).

Table 4. Participant Test Scores (Pre-Test and Post-Test) [a]

Score Range	Pre-Test	Post-Test
0 – 10	64 (53.4)	6 (5.0)
11 – 15	31 (25.8)	16 (13.3)
16 – 20	25 (20.8)	98 (81.7)

[a] Values are expressed as No. (%); n = 120. The test carried 20 single-answer questions, each scoring one point.

- The average score increased significantly from 10.77 on the pre-test to 17.76 on the post-test.
- The t-test results confirmed that the difference in mean scores was statistically significant ($P < 0.01$) (Table 4).

4.1. Effectiveness of the Modular Ergonomic Training Program

The evaluation of the modular ergonomic training course focused on three main aspects: content, instructor performance, and course delivery quality. The summarized results are presented in Tables 5 - 7:

- The highest-rated aspect was the coherence and integration of the content, which 96 participants (80%) rated as excellent.
- The mean overall effectiveness score for content was 4.69 out of 5, indicating high satisfaction with the course materials (Table 5).
- The highest-rated aspect was the instructor's expertise and mastery of the subject, rated highly by 94 participants (78.3%).
- The mean overall score for instructor performance was 4.68, reflecting high satisfaction with the instructor's abilities (Table 6).
- Participants gave the highest rating to their overall satisfaction with the course, with 98 participants (81.6%) rating it as excellent.
- The mean overall score for course delivery quality was 4.60, indicating a successful program (Table 7).

Table 5. Effectiveness of Course Content [a]

Item	Excellent (5)	Good (4)	Average (3)	Poor (2)	Very Poor (1)	Mean Score
Relevance to work	91 (75.8)	26 (21.7)	1 (0.84)	2 (1.66)	0 (0)	4.69
Scientific level and innovation	85 (70.8)	31 (25.8)	3 (2.5)	1 (0.84)	0 (0)	4.67
Knowledge and awareness improvement	77 (64.2)	40 (33.3)	3 (2.5)	0 (0)	0 (0)	4.61
Skill enhancement	74 (61.7)	39 (32.5)	7 (5.8)	0 (0)	0 (0)	4.56
Coherence and integration of content	96 (80.0)	21 (17.5)	3 (2.5)	0 (0)	0 (0)	4.77
Alignment with announced topics	88 (73.3)	31 (25.8)	1 (0.84)	0 (0)	0 (0)	4.72
Duration and content balance	91 (75.8)	26 (21.7)	3 (2.5)	0 (0)	0 (0)	4.69
Attractiveness for continued learning	92 (76.6)	23 (19.2)	3 (2.5)	2 (1.66)	0 (0)	4.70

[a] Values are expressed as No. (%) unless otherwise indicated; n = 120. Items were rated from 1 (very poor) to 5 (excellent).

Table 6. Evaluation of Instructor Performance [a]

Item	Excellent (5)	Good (4)	Average (3)	Poor (2)	Very Poor (1)	Mean Score
Expertise and subject mastery	94 (78.3)	23 (19.2)	2 (1.66)	1 (0.84)	0 (0)	4.75
Communication and clarity	92 (76.6)	25 (20.8)	2 (1.66)	0 (0)	1 (0.84)	4.73
Up-to-date knowledge	93 (77.5)	22 (18.3)	5 (4.2)	0 (0)	0 (0)	4.73
Clear learning objectives	82 (68.3)	35 (29.2)	3 (2.5)	0 (0)	0 (0)	4.66
Organization of content	89 (74.1)	28 (23.4)	3 (2.5)	0 (0)	0 (0)	4.71
Appropriate teaching methods	78 (65.0)	34 (28.3)	5 (4.2)	2 (1.66)	1 (0.84)	4.55
Practical examples	83 (69.1)	30 (25.0)	5 (4.2)	2 (1.66)	0 (0)	4.63
Summarization at session end	85 (70.8)	32 (26.7)	1 (0.84)	2 (1.66)	0 (0)	4.66
Motivation and engagement	89 (74.1)	28 (23.4)	1 (0.84)	2 (1.66)	0 (0)	4.71

[a] Values are expressed as No. (%) unless otherwise indicated; n = 120. Items were rated from 1 (very poor) to 5 (excellent).

5. Discussion

The primary objective of this study was to design, implement, and evaluate a virtual modular ergonomic training course to improve the working conditions of administrative staff. Among the 120 participants who completed all stages of the program and requested a final certificate, 65% were women and 35% were men. The higher proportion of women may be attributable to the course's health-oriented and preventive approach, which aimed to raise awareness and prevent musculoskeletal disorders. Most participants were in the 35 – 40 age group, a demographic commonly associated with an increased prevalence of musculoskeletal disorders because of age and years of professional experience, as noted in prior studies (22-24).

Pretest and post-test results indicated that administrative staff at medical universities had insufficient knowledge of ergonomics. The average pretest score was 10.77, highlighting a lack of baseline ergonomic awareness. After completing the course, the score increased significantly to 17.76, demonstrating the program's success in enhancing participants' knowledge. Bandahagh reported similar findings, with dental students exhibiting substantial improvements in ergonomic knowledge after educational interventions (14).

The ergonomic workplace checklist revealed several deficiencies in workplace conditions. Key issues included the lack of morning exercises before work, the absence of regular breaks during the day, insufficient rest areas, inadequate physical activity during work hours, and limited ergonomic resources, such as typing holders and keyboard pads. These findings underscore the need for changes in management practices and structural adjustments to align workplaces with ergonomic principles. Chandwani et al. reported similar findings among office workers in Mumbai, including poor office furniture and equipment and frequent complaints about environmental noise causing stress and reduced concentration. Their study underscored the importance of training programs that empower administrative staff to

Table 7. Quality of Course Delivery [a]

Item	Excellent (5)	Good (4)	Average (3)	Poor (2)	Very Poor (1)	Mean Score
Quality of materials and slides	93 (77.5)	23 (19.1)	4 (3.34)	0 (0)	0 (0)	4.74
Quality of pre-test and post-test	86 (71.6)	26 (21.6)	8 (6.7)	0 (0)	0 (0)	4.65
Quality of questionnaires	88 (73.3)	27 (22.5)	5 (4.2)	0 (0)	0 (0)	4.69
Timing and organization	74 (61.6)	42 (35.0)	4 (3.34)	0 (0)	0 (0)	4.58
Platform usability	42 (35.0)	70 (58.3)	7 (5.8)	1 (0.84)	0 (0)	4.27
Overall satisfaction	98 (81.6)	18 (15.0)	4 (3.34)	0 (0)	0 (0)	4.78

[a] Values are expressed as No. (%) unless otherwise indicated; n = 120. Items were rated from 1 (very poor) to 5 (excellent).

mitigate the burden of musculoskeletal disorders on health systems (25).

The Nordic Musculoskeletal Questionnaire results revealed that all participants experienced pain or discomfort in at least one of six body regions. The neck, wrists/hands, and lower back were the most affected areas, whereas the upper back was the least frequently reported. More than 53% of respondents attributed their musculoskeletal issues to workplace conditions. These findings align with previous studies by Ebrahimi and by Abbasi et al., which identified similar issues among administrative staff at medical and educational institutions (26, 27).

Evaluation of the modular ergonomic training course showed high participant satisfaction across all three assessed dimensions: course content, instructor performance, and delivery quality. More than 75% of participants rated the content as highly relevant and practical, and the coherence and integration of the course material received particularly high marks (mean score of 4.69). The instructor received high ratings for expertise, clarity, and communication skills, with an average score of 4.68. Course delivery was also evaluated positively, with 81.6% of participants expressing high overall satisfaction.

The significant improvement in post-test scores further validated the program's effectiveness in enhancing participants' knowledge and awareness of workplace ergonomics. These findings are consistent with prior studies, including those by Bandahagh and Mathew et al., which demonstrated the effectiveness of innovative teaching methods, such as mobile-based learning and instructor-led PowerPoint presentations, in improving ergonomic awareness and reducing unhealthy work practices (14, 28). Aguilar et al. also highlighted the potential of virtual avatars to effectively address the ergonomic training needs of remote workers (15).

A key distinction of this study is its use of a modular educational framework based on the ASSURE model. By leveraging virtual modular programs, the study demonstrated the potential to deliver accessible, cost-effective, and highly practical training. This approach reduced travel costs, minimized conflicts with work schedules, and created a flexible learning environment, thereby motivating participants to engage with and benefit from the program.

5.1. Conclusions

The findings of this study highlight the need for increased awareness of ergonomic principles, changes in management practices, and structural adjustments informed by ergonomic principles in the work environments of administrative staff at medical universities. All participants reported experiencing pain or discomfort in at least one of the six assessed body areas, and the ergonomic status of their work environments was found to be moderate.

Comparison of the pre-test and post-test results revealed that participants had suboptimal knowledge of workplace ergonomics and improvement strategies. The significant improvement in post-test scores following the modular training course demonstrates the program's success in delivering practical and valuable content that enhanced participants' knowledge.

Participants rated the course's effectiveness highly in terms of content, instructor performance, and delivery quality. Overall satisfaction with the course encourages educational program designers to continue offering similar training initiatives. Such efforts can foster better working conditions for administrative staff at universities and other administrative centers, ultimately reducing musculoskeletal disorders and promoting workplace health.

In summary, this study indicates that administrative staff at medical universities had limited knowledge of ergonomics and required improvements in workplace conditions because of their history of musculoskeletal complaints. The overall positive reception of the course suggests its value in addressing these needs and provides a

foundation for further educational interventions aimed at enhancing workplace ergonomics.

Acknowledgements

This article is based on an MSc thesis conducted at the Department of Medical Education, Shahid Beheshti University of Medical Sciences. The authors wish to express their gratitude to all officials at the School of Medical Education and Learning Technologies.

Footnotes

AI Use Disclosure: The authors declare that no generative AI tools were used in the creation of this article.

Authors' Contribution: Study concept and design: S. A.; data analysis and interpretation: Y. Z. and A. H.; manuscript drafting: A. H.; critical revision for important intellectual content: Y. Z. and A. H.

Conflict of Interests Statement: The authors declare no conflicts of interest related to this study.

Data Availability: The dataset presented in this study is available from the corresponding author upon request, either during submission or after publication.

Ethical Approval: IR.SBMU.SME.REC.1401.044

Financial Disclosure: None declared.

Funding/Support: No funding was received for this study.

Informed Consent: Informed consent was obtained from all participants.

References

1. Kangar Louhr, Malekzadeh SH, Alizadeh K, Shamshiri B, Zareei S. [The prevalence of musculoskeletal cause of disability retirement among air force personnel during 1371-1382]. *Ann Mil Health Sci Res*. 2006;**4**(4):813-818. Persian.
2. EZ Aldini Ardakani F, Haerian Ardakani A, Akhavan Karbasi MH, Dehghan Tezerjani KH. [Assessment of musculoskeletal disorders prevalence among dentists]. *J Dent Med*. 2005;**17**(4):52-60. Persian.
3. Tayyari F, Smith JL. *Occupational ergonomics: Principles and applications*. London: Chapman & Hall; 1997.
4. Devereux JJ, Vlachonikolis IG, Buckle PW. Epidemiological study to investigate potential interaction between physical and psychosocial factors at work that may increase the risk of symptoms of musculoskeletal disorder of the neck and upper limb. *Occup Environ Med*. 2002;**59**(4):269-277. [PubMed ID: 11934955]. [PubMed Central ID: PMC1740269]. https://doi.org/10.1136/oem.59.4.269.
5. Gupta S. Ergonomic applications to dental practice. *Indian J Dent Res*. 2011;**22**(6):816-822. [PubMed ID: 22484877]. https://doi.org/10.4103/0970-9290.94677.
6. Barling J, Loughlin C, Kelloway EK. Development and test of a model linking safety-specific transformational leadership and occupational safety. *J Appl Psychol*. 2002;**87**(3):488-496. [PubMed ID: 12090606]. https://doi.org/10.1037/0021-9010.87.3.488.
7. Abdoli A. *[Body mechanics and principles of work station design]*. Tehran: Omid Publisher; 2009. Persian.
8. Mahmud N, Kenny DT, Zein RM, Hassan SN. Ergonomic training reduces musculoskeletal disorders among office workers: Results from the 6-month follow-up. *Malays J Med Sci*. 2011;**18**(2):16-26. [PubMed ID: 22135582]. [PubMed Central ID: PMC3216214].
9. Choobineh A, Tabatabaei SH, Mokhtarzadeh A, Salehi M. Musculoskeletal problems among workers of an Iranian rubber factory. *J Occup Health*. 2007;**49**(5):418-423. [PubMed ID: 17951976]. https://doi.org/10.1539/joh.49.418.
10. Das B, Sengupta AK. Industrial workstation design: A systematic ergonomics approach. *Appl Ergon*. 1996;**27**(3):157-163. [PubMed ID: 15677055]. https://doi.org/10.1016/0003-6870(96)00008-7.
11. Karzar Edivand R. *[The role of ergonomics and its impact on the production, production trends] [MS thesis]*. Tabriz: Islamic Azad University of Tabriz; 2000. Persian.
12. Ahmadi Asur A. *[Occupational diseases: General epidemiology, symptoms, prevention, treatment]*. Tehran: Andisheh Rafi; 2012. Persian.
13. Hendrick HW. Applying ergonomics to systems: Some documented "lessons learned". *Appl Ergon*. 2008;**39**(4):418-426. [PubMed ID: 18374303]. https://doi.org/10.1016/j.apergo.2008.02.006.
14. Bandeh-e-Haq A. *[Evaluation of the educational effects of smartphone based application mobile learning compared to verbal lecture-based method for learning of ergonomics in dentistry] [PhD thesis]*. Tehran: Shahid Beheshti University of Medical Sciences and Health Services; 2022. Persian.
15. Aguilar KN, Smith ML, Payne SC, Zhao H, Benden M. Digital human ergonomics training for remote office workers: Comparing a novel method to a traditional online format. *Appl Ergon*. 2024;**117**:104239. [PubMed ID: 38295672]. https://doi.org/10.1016/j.apergo.2024.104239.
16. Shahbeigi F, Nazari S. [Virtual education: Benefits and limitations]. *The Journal of Medical Education and Development*. 2012;**6**(1):47-54. Persian.
17. Ariefiani Z, Kustono D, Pathmantara S. Module development with project-based learning approach and assure development model. AIP Conference Proceedings. 2016. 30036 p.
18. Kines P, Lappalainen J, Mikkelsen KL, Olsen E, Pousette A, Tharaldsen J, et al. Nordic Safety Climate Questionnaire (NOSACQ-50): A new tool for diagnosing occupational safety climate. *Int J Ind Ergon*. 2011;**41**(6):634-646. https://doi.org/10.1016/j.ergon.2011.08.004.
19. Yousefi Y, Jahangiri M, Choobineh A, Tabatabaei H, Keshavarzi S, Shams A, et al. Validity assessment of the Persian version of the Nordic Safety Climate Questionnaire (NOSACQ-50): A case study in a steel company. *Saf Health Work*. 2016;**7**(4):326-330. [PubMed ID: 27924236]. [PubMed Central ID: PMC5127913]. https://doi.org/10.1016/j.shaw.2016.03.003.
20. Shirali G, Khademian F. [Analysis of workplace safety climate using the Nordic questionnaire: A case study in a metal industry]. *Iranian Journal of Occupational Health*. 2017;**13**(5):25-38. Persian.
21. Lawshe CH. A quantitative approach to content validity. *Pers Psychol*. 1975;**28**(4):563-575. https://doi.org/10.1111/j.1744-6570.1975.tb01393.x.
22. Morken T, Moen B, Riise T, Bergum O, Bua L, Vigeland Hauge S, et al. Prevalence of musculoskeletal symptoms among aluminium

workers. *Occup Med (Lond)*. 2000;**50**(6):414-421. [PubMed ID: 10994244]. https://doi.org/10.1093/occmed/50.6.414.

23. Choubineh A, Soleimani A, Mohammadbeigi A. [Prevalence of musculoskeletal disorders symptoms in workers producing metal structures. Musculoskeletal Symptoms among Workers of Metal Structure Manufacturing Industry in Shiraz, 2005]. *Iran J Epidemiol*. 2009;**5**(3):35-43. Persian.
24. Zarei F, Mousavifard SA, Ardestani M. [Assessment of musculoskeletal disorder prevalence and associated risk factors of a metal structure manufacturing company in Tehran]. *J Environ Health Eng*. 2017;**4**(1):10-19. Persian. https://doi.org/10.18869/acadpub.jehe.4.1.10.
25. Chandwani A, Chauhan M, Bhatnagar A. Ergonomics assessment of office desk workers working in corporate offices. *Int J Health Sci Res*. 2019;**9**(8):367-375.
26. Ebrahimi H. [Investigation of the impact of ergonomic training programs on the prevalence of musculoskeletal disorders of administrative and support staff at Imam Reza Hospital in Mashhad, Iran]. *J Occup Hyg Eng*. 2023;**9**(4):222-229. Persian. https://doi.org/10.52547/johe.9.4.222.
27. Abbasi AM, Bahmanipour S, Rahimi M, Rashidi Z, Sayadi H. [Investigating the effect of ergonomic training in reducing musculoskeletal disorders among office workers]. *Specialized Quarterly Journal of Occupational Medicine*. 2023;**15**(2):29-37. Persian. https://doi.org/10.18502/tkj.v15i2.13376.
28. Mathew M, Doppalapudi R, Ravi J. A quantitative study on the impact of educational modules on the awareness of postural ergonomics among the dental clinical trainees of Jouf University: A north Saudi Arabian cohort. *Heliyon*. 2024;**10**(1). e24090. [PubMed ID: 38230236]. [PubMed Central ID: PMC10789623]. https://doi.org/10.1016/j.heliyon.2024.e24090.