Safety Science 158 (2023) 106000

Contents lists available at ScienceDirect

Safety Science

journal homepage: www.elsevier.com/locate/safety

Online office ergonomics training programs: A scoping review examining design and user-related outcomes

Haroun Zerguine [a,*], Genevieve N. Healy [b,c,d], Ana D. Goode [b], Jason Zischke [e,f], Alison Abbott [g], Lynn Gunning [h], Venerina Johnston [a,i]

[a] The University of Queensland, School of Health and Rehabilitation Sciences, St Lucia, Brisbane, QLD, Australia
[b] The University of Queensland, School of School of Human Movement and Nutrition Sciences, St Lucia, Brisbane, QLD, Australia
[c] Baker IDI Heart and Diabetes Institute, Melbourne, VIC, Australia
[d] Curtin University, School of Physiotherapy and Exercise Science, Perth, WA, Australia
[e] Health Economics Group, QIMR Berghofer Medical Research Institute, Brisbane, QLD, Australia
[f] School of Public Health and Social Work, Queensland University of Technology, Brisbane, QLD, Australia
[g] Workplace Health and Safety Queensland, Office of Industrial Relations, Queensland Government, Brisbane, QLD, Australia
[h] Comcare, Canberra, ACT, Australia
[i] School of Health and Medical Sciences, University of Southern Queensland, Ipswich, QLD, Australia

ARTICLE INFO

Keywords:
Office ergonomics
Training
E-learning
OHS authorities
Health education
Health and safety

ABSTRACT

Online ergonomics training programs have emerged as an efficient way to support office workers' health, safety, and wellbeing. A scoping review was conducted to assess the design and user-related outcomes of current online office ergonomics training tested in the scientific literature and provided by Occupational Health and Safety (OHS) authorities.

A systematic search of five databases and eighteen OHS authorities' websites was conducted. Data on training details and content was extracted and tabulated. Design outcomes of satisfaction, usability and acceptability were recorded, as were user health-related and knowledge outcomes. A validated rubric for eLearning evaluation was used to assess the functional, technical, and pedagogical aspects of training programs provided by OHS authorities.

Five articles were included, and reported on user-related outcomes: musculoskeletal health, ergonomics knowledge, and/or posture. None of the studies reported on design-related outcomes. Eight online training programs were identified in six OHS authorities in Australia (2), the USA (2) and Canada (2). All eight programs included information on workstation set-up and physical hazards while two included information on psychosocial hazards. These programs scored high in the technical (12/12) and accessibility (10.5/12) aspects, but lower on teaching (4/9), social (5/9) and cognitive (5.5/9) aspects.

Online office ergonomics training tested in the literature seem to focus on user-related outcomes while OHS authorities training was more comprehensive and met design-related targets. Future collaboration between OHS authorities, the scientific community and end-users need to be considered to build robust evidence-based programs that address both the design and user-related outcomes.

1. Introduction

The workplace is a complex system with multiple factors (including environmental, physical, psychosocial, organisational, and individual) interacting with the worker (Carayon and Smith, 2000). Ergonomics is defined by the International Ergonomics Association (IEA) as "the scientific discipline concerned with the understanding of the interactions among humans and other elements of a system in order to optimize human well-being and overall system performance" (International Ergonomics Association, 2019). With the rapid increase in computer and desk-based work (Bailey, 2018; Victory and Cooper, 2002), and the associated impacts of prolonged sitting and prolonged computer screen viewing on health outcomes such as musculoskeletal disorders (MSDs) (Jun et al., 2017; Waersted et al., 2010), eye strain (Brewer et al., 2006),

* Corresponding author at: Level 3, Therapies Annexe (84A), The University of Queensland, St Lucia, QLD 4072, Australia.
E-mail address: h.zerguine@uq.edu.au (H. Zerguine).

https://doi.org/10.1016/j.ssci.2022.106000
Received 14 April 2022; Received in revised form 30 September 2022; Accepted 3 November 2022
Available online 16 November 2022

cardiovascular disease (Bailey et al., 2019), job strain and psychological distress (Jun et al., 2019), ergonomics and health promotion interventions, especially those delivered online have become important to prevent the occurrence of these health problems (Tchir and Szafron, 2020). Education and training are fundamental components of ergonomics interventions (Burton, 2010; Heidarimoghadam et al., 2022). Although there is no universally agreed definition of office ergonomics training, Hoe et al., (2012) claimed that ergonomics training should include educational activities for employees to identify risk factors for work-related MSDs, selection and use of appropriate work practices and equipment, and correct adjustment of their workstation to ensure it fits the user and facilitates a comfortable working environment. The effectiveness of office ergonomics training and educational programs has been inconsistent (Van Eerd et al., 2016). While benefits have been observed in increasing workers' knowledge, decreasing musculoskeletal discomfort, adopting healthy behaviour, and enhancing workers' performance (Dalkılınç and Kayihan, 2014; Robertson et al., 2009; Robertson et al., 2013; Robertson et al., 2017; Faisting and de Oliveira Sato, 2019), non-statistically impacts on these outcomes have also been observed (e.g., Amick et al., 2012; Krause et al., 2010). Further, the quality of the evidence from ergonomics educational interventions has been reported to be low (Hoe et al., 2018; Chen et al., 2018). Ergonomics training was most effective when combined with other strategies such as workstation redesign and participatory ergonomics interventions (Heidarimoghadam et al., 2022). Furthermore, from an instructional design perspective, the effectiveness of ergonomics training could be impacted by the way the training was developed and the use of instructional system design models, learning theories, and involvement of end-users for efficient training materials (Robertson and Maynard, 2005). Ergonomics training programs should also use a holistic approach in content development to address the interactions of the office worker with other elements of the system by considering the physical, organisational, and cognitive domains (International Ergonomics Association, 2019). Different methods have been used to deliver ergonomics training and education programs in the workplace. These methods include face-to-face individual instruction (Shariat et al., 2018) or group-based delivery such as workshops (Sohrabi and Babamiri, 2021), technology-based learning (PC, smartphones, tablets) through interactive multimedia (Robertson et al., 2009) or web-based programs (Dalkılınç and Kayihan, 2014; Meinert et al., 2013), or a combination of face-to-face and technology-based delivery (Robertson et al., 2009; Robertson et al., 2013; Robertson et al., 2017). Due to the advancement of technology and widespread access to the Internet and mobile devices, online (virtual/e-learning) tools have emerged as an effective way to manage and improve people's health (Boulos et al., 2014; Wicks et al., 2014). According to the Cambridge Dictionary (2020), 'virtual' refers to technologies using a computer and other electronic equipment, and not involving people physically going somewhere. Online training is growing in popularity and has emerged as an effective way of learning and professional development across many industry sectors, such as higher education (Castro and Tumibay 2021), healthcare (e.g., health professionals) (Vaona et al., 2018) and the business and administrative sector (e.g., office workers) (Noe et al., 2014). Online learning offers potential advantages over other training methods, including widespread access, personalised instruction, and regular updating of content (Wang, 2018). In 2012, technology-based learning, that includes e-learning, online learning, and mobile learning, was used on average in 39 % of organizations' formal learning hours in the United States (Miller et al., 2014). More recent data from the Australian Bureau of Statistics (2022) showed that work-related online learning has increased from 19 % in 2016–17 to 55 % in 2020–21, such that online learning is the most common delivery mode for workplace training. Virtual/e-learning has been considered the most suitable mode for training programs as they offer flexibility in time and location and the possibility of potential personalisation of instructions (Cook, 2007). The ability to learn and self-assess remotely is particularly pertinent given the increased proportion of office work occurring in the home environment resulting from the COVID-19 pandemic (Xiao et al, 2021; Reznik et al., 2021).

A preliminary and exploratory search for virtual or e-learning ergonomics training programs for office workers in the literature found no synthesis of evidence regarding the types of programs available, their content, or the usability, feasibility, acceptability, and users' satisfaction with these training programs. These elements linked to the design of training programs have been identified as key factors contributing to the success of the e-learning experience (Harrati et al., 2016; Yakit and Ismailova, 2018). Researchers have also emphasised the pedagogical aspects when developing e-learning, including the use of instructional design models and theories to identify the specific needs of users and achieve the desired outcomes (e.g., acquiring knowledge, developing skills or changing behaviour) (Khalil and Elkhider, 2016). It is possible that ergonomics training programs exist outside the traditional scientific literature such as by workplace safety and health authorities. These authorities provide services and resources to support industries to fulfil their legislative responsibilities to reduce the risk of workplace injuries and maintain employee safety and health. However, we are unaware if national and international Occupational Health and Safety (OHS) authorities and bodies offer office employees and workplaces online training programs with relevant content and the usability and functionality of such. Identifying any existing online training programs in the peer-reviewed literature or provided by OHS authorities, and summarising their content, usability and functionality features will be a valuable resource for future development of such programs.

To address these gaps, a scoping review has been conducted to (a) systematically identify and review the online ergonomics training programs that have been developed and tested in the scientific literature, specifically in terms of design and user-related outcomes; and, (b) provide an overview and evaluate the functional, technical, and pedagogical aspects of current online ergonomics training programs related to office workers promoted by OHS authorities and bodies.

By conducting this review, greater knowledge of the current online office ergonomics training available in peer-reviewed literature and OHS authorities will be achieved. Such knowledge will showcase the quality of current training, and identify gaps in content, usability, functionality, and accessibility to ensure future training meets the contemporary needs of the modern office worker with high-quality learning design and content and fulfils the requirement for safe workplaces.

2. Methods

2.1. Search and selection

2.1.1. Interdisciplinary search

A scoping review was selected as the most appropriate methodology given the limited research evidence base and the high likelihood of training programs existing outside the empirical literature. The six-stage methodological framework by Arksey and O'Malley (2005) was followed in conducting this review. To identify the main concepts for this review, the framework of Population, Concept and Context (PCC) recommended by the Joanna Briggs Institute (JBI) for scoping reviews was used (Appendix 1) (Peters et al., 2015). An interdisciplinary search was conducted in the following databases: PubMed, Embase, Web of Science, ERIC (Education Resources Information Center) and CINAHL (Cumulative Index to Nursing and Allied Health Literature). Synonyms and subject headings relating to the following concepts were applied in several combinations: office workers, ergonomic, training, and online. The search terms and search strategy are included as supplementary materials (Appendix 2).

EndNote (2013) was used for the collection of bibliographic references from the five databases, and duplicates were removed. Articles were then exported to Covidence (2022) for screening. Two reviewers (HZ and JZ) independently screened the titles and abstracts by applying

the following criteria:

- The study sample should be office/desk-based workers.
- The intervention should include a training or education program.
- The training program should be delivered online or involve multimedia content.
- The training program should target office ergonomics.
- The study should be published in peer-reviewed journals, conference proceedings or higher research degree theses between 2010 – Dec 2021. This timeline was chosen to capture the most recent online training developed and tested.
- The study should be published in the English language.

The reference list of articles that fulfilled our criteria after screening was searched for additional papers. Following the elimination of ineligible articles, the eligibility of the remaining articles was assessed independently through full-text reading by HZ and JZ. Disagreements on study eligibility were resolved by a third reviewer (VJ). Table 1 presents the inclusion and exclusion criteria for this review. Observational studies conducted without administering, developing, or testing any intervention, or those not providing details of the training, were excluded.

2.1.2. Electronic search

An electronic search on websites of Safety and Health authorities of five countries (Australia, Canada, New Zealand, UK, USA) was conducted. The selection of countries was based on the reputation for well-developed ergonomics and Occupational Health and Safety (OHS) systems, as well as the first language of the website (English). Responsible OHS authorities and bodies in each country were selected from the Occupational Safety and Health country profile (OSH Profile) available on the International Labour Organisation (ILO) website (International Labour Organization, 2015) (Table 2). To ensure complete coverage of websites, two researchers (HZ, LG) used different strategies to identify all information related to office/computer-based workers on each website. An initial search was based on topic/industry/hazard classification on each website. For example, Safe Work Australia classify their information based on "safety topic" or "safety by industry and business". The second strategy was to search the website using various combinations of keywords (e.g., ergonomics, ergonomic workstation, office ergonomics, office workstation, desk-based work, office workstations, computer ergonomics, and work from home). These key terms were identified as "top ten keywords" that employees use when looking for office ergonomics of a local OHS regulator website (Appendix 3). Using this approach, we aimed to identify and gain an overview of all types of information and training provided to desk-based workers or workplaces.

The interdisciplinary and electronic search strategies in databases and grey literature were developed and conducted with the assistance of an expert librarian at The University of Queensland, Australia.

2.2. Data extraction

Due to the differences in the information provided, and the structure of the peer-reviewed articles and the grey literature, the data extracted from each source focused on different outcomes.

Table 1
Inclusion and exclusion criteria.

Criteria	Inclusion criteria	Exclusion criteria
Population	Office workers	Other populations
Setting	Desk-based work	Other settings
Intervention	Intervention involving online training and/or digital technology (mobile or computer application, digital multimedia)	Intervention/ training program delivered face-to-face, group or not involving digital technologies
Language	English	Languages other than English
Time	2010 to Dec 2021	Before 2010

Table 2
List of Occupational Health and Safety authorities in each country identified from ILO website.

Country	OHS Authority	Website
Australia	Safe Work Australia	https://www.safeworkaustralia.gov.au/
	WorkSafe ACT	https://www.worksafe.act.gov.au/
	SafeWork NSW	https://www.safework.nsw.gov.au/
	Workplace Health and Safety Queensland	https://www.worksafe.qld.gov.au/
	SafeWork SA	https://www.safework.sa.gov.au/
	WorkSafe Tasmania	https://www.worksafe.tas.gov.au/
	WorkSafe Victoria	https://www.worksafe.vic.gov.au/
	WorkSafe WA	https://www.commerce.wa.gov.au/worksafe/
	The Commonwealth – Comcare	https://comcare.gov.au/
New Zealand	WorkSafe NZ	https://worksafe.govt.nz
Canada	Canadian Centre for Occupational Health and Safety (CCOHS)	https://www.ccohs.ca/
	Institut de recherche Robert-Sauvé en santé et en sécurité du travail (IRSST)	https://www.irsst.qc.ca/en/
	Commission de la santé et de la sécurité du travail du Québec (CSST)	https://www.csst.qc.ca/
The United States	Occupational Safety and Health Administration (OSHA)	https://www.osha.gov/
	National Institute for Occupational Safety and Health (NIOSH)	https://www.cdc.gov/niosh/
	Mine Safety and Health Administration (MSHA)	https://www.msha.gov/
United Kingdom	Health and Safety Executive (HSE)	https://www.hse.gov.uk/
	Institution of Occupational Safety and Health (IOSH)	https://www.iosh.co.uk/

Full articles of the selected studies were reviewed to extract the following information where possible: paper information (authors, year of publication, country where the study was conducted); study details and participants (study design, target population, eligibility, sample size, data collection instruments); intervention/training details (theoretical framework/model, content development, reliability/pilot test); and outcomes. The focus was placed on two types of outcomes: design-related outcomes (e.g., satisfaction, usability, feasibility, acceptability, and adherence); and user-related outcomes (e.g., knowledge, attitudes, behaviour, physical or psychological health). Studies were also categorised based on the UK Medical Research Council (MRC) framework for developing and evaluating complex interventions based on their research phases: development, feasibility and piloting, evaluation and implementation (Craig et al., 2011).

The virtual/e-learning office ergonomics programs identified from each OHS authority website were reviewed and checked in terms of content (workstation setup, physical hazards, psychosocial hazards, safety hazards), applicability to working from home, applicability to working from the office, language, time to completion, target audience (employee, employer), provision of a checklist, use of quizzes or assessment questions, and certificate of completion. These key features of the training content have been identified through discussion amongst the research team and advisors from the local OHS regulator.

2.3. Data synthesis and critical appraisal

Subsequent to data extraction, results of the systematic search of peer-reviewed literature were quantitatively summarised and presented using descriptive statistics. A narrative synthesis was also used to report the study details, intervention/training details, and outcomes. Further, a

critical appraisal was conducted by two researchers (HZ and GNH) to assess the methodological quality of the studies included in this review using the JBI Critical Appraisal tool (Tufanaru et al., 2017). Reviewers appraised each article independently, with consensus reached through discussion as required.

The online office ergonomics programs identified in the grey literature were evaluated using the Rubric for e-learning Tool Evaluation (Anstey and Watson, 2018) with a slight modification of item description wording (approved by the rubric authors) to ensure relevance to this topic and industry. This rubric is used to evaluate the functional, technical, and pedagogical aspects of e-learning tools in higher education (Anstey and Watson, 2018). The rubric contains 8 categories and 27 items distributed as follows: Functionality [4 items], Accessibility [4], Technical [4], Mobile Design [3], Privacy, Data Protection, and Rights [3], Social Presence [3], Teaching Presence [3], and Cognitive Presence [3] (Table 3). Two raters (HZ, VJ) independently assessed each online training program using the rubric. Inter-rater reliability was assessed using Cohen's kappa, with a strong level of agreement observed between the raters ($\kappa = 0.80$). A scoring system was used with each item of the rubric rated as "working well" (3 points), "minor concerns" (2 points), or "serious concerns" (1 point). Appendix 4 explains each item of the rubric in detail and how each of the e-learning tools was rated.

3. Results

The screening results and the summary findings from the peer-reviewed article search are reported in Fig. 1 and Table 4 respectively, while the findings from the grey literature search and training evaluation are reported in Tables 5 and 6, respectively.

3.1. Peer-reviewed articles:

A total of 6931 articles were originally identified. Following removal of duplicates, 4804 articles were assessed for eligibility through title and abstract and 50 articles went through a thorough full-text screening (Fig. 1). A total of five research articles, all published between 2012 and 2015, were included. These studies were conducted in Spain (del Pozo-Cruz et al., 2012; del Pozo-Cruz et al., 2013), Germany (Meinert et al., 2013), Turkey (Dalkılınç and Kayihan, 2014), and Iran (Habibi and Soury, 2015), and included a total of 291 office workers (183 Female, 108 Male, mean age = 41.4 years). An unbalanced sex sample was noted in two studies with 70 females and 32 males in the study by Dalkılınç and Kayihan, 2014, and 23 females and 52 males (Habibi and Soury, 2015). Two research articles (del Pozo-Cruz et al., 2012; del Pozo-Cruz et al., 2013) from the same research project included office workers with non-specific low back pain and used a randomized controlled trial design (9-month intervention duration), reporting separately on two different outcomes. The three other studies included asymptomatic office workers and used a pre- post-test design with durations of 1- (Meinert et al., 2013), 1.5- (Dalkılınç and Kayihan, 2014), and 2.5- (Habibi and Soury, 2015) month follow-up. All studies focused on seated position in a standard desk setting, with none using sit-stand desks. All research articles used questionnaires to assess knowledge of office ergonomics, working posture, and/or physical health. None of the studies reported using a theoretical model/framework to guide the development of the training program nor reported on any design-related outcomes. All training programs were developed by experts/clinicians, and all reported a pilot/usability phase prior to the intervention implementation except one (Habibi and Soury, 2015). None of the studies reported reviewing the literature before the development of the training program, and none reported using national/international guidelines or standards. The online training was delivered either in the form of an e-learning module (Dalkılınç and Kayihan, 2014), illustrative videos (Habibi and Soury, 2015), interactive website information (Dalkılınç and Kayihan, 2014) or a multimedia presentation (Habibi and Soury, 2015).

The methodological quality of these studies was appraised according to the JBI criteria for randomised controlled trials (RCT) and quasi-experimental designs (Tufanaru et al., 2017) – Table 5. Besides double blindness, the RCT study met all criteria (del Pozo-Cruz et al., 2012, del Pozo-Cruz et al., 2013). All three quasi-experimental studies did not have a control group and had unclear details about the reliability of the outcome measured (Dalkılınç and Kayihan, 2014; Habibi and Soury, 2015; Meinert et al., 2013). Further, assumptions for statistical tests were unclearly described in two studies (Dalkılınç and Kayihan, 2014; Meinert et al., 2013).

All studies reported user-related outcomes that included at least one health-related outcome (musculoskeletal complaints, headache complaints, functional health, and/or health-related quality of life (QoL)), while three also reported on working posture change (Dalkılınç and Kayihan, 2014; Habibi and Soury, 2015; Meinert et al., 2013) and one reported on changes in perceived knowledge (Dalkılınç and Kayihan, 2014). None of the studies reported on design-related outcomes. The three studies that assessed musculoskeletal discomfort reported a statistically significant decrease in complaints among participants that received the training program at the 1- (Meinert et al., 2013), 1.5- (Dalkılınç and Kayihan, 2014), and 2.5- (Habibi and Soury, 2015) month follow-up. A statistically significant improvement in office ergonomics knowledge was also found immediately after providing the e-learning training (Dalkılınç and Kayihan, 2014). Office workers with low back pain in the training group had a significant improvement in functional disability and health-related QoL, a decrease in the number of low back pain episodes (del Pozo-Cruz et al., 2012), and improvements in self-reported health status and self-reported functional disability (del Pozo-Cruz et al., 2013) compared to the control group who had access to standard care only. Standard care in this study was defined as all existing non–web-based information offered by the university to staff (e.g., annual medical examination). Significant improvement in self-reported (Dalkılınç and Kayihan, 2014; Habibi and Soury, 2015) and observed (using side view picture and geometrical analysis) (Meinert et al., 2013) working posture behaviour and computer workplace adjustment (Meinert et al., 2013) was also reported after the training intervention. Other aspects such as education, work level, time on the computer and physical activity were not reported in these studies.

Table 3
Rubric for e-learning Tool Evaluation (Anstey and Watson, 2018).

Category	Criteria
Functionality	Scale
	Ease of Use
	Tech Support / Help Availability
	Hypermediality
Accessibility	Accessibility standards
	User-focused participation
	Required Equipment
	Cost of Use
Technical	Integration/ Embedding within a Learning Management System (LMS)
	Desktop / Laptop Operating Systems
	Browser
	Additional Downloads
Mobile Design	Access
	Functionality
	Offline Access
Privacy, Data Protection, and Rights	Sign Up/ Sign In
	Data Privacy and Ownership
	Archiving, Saving, and Exporting Data
Social Presence	Collaboration
	User Accountability
	Diffusion
Teaching Presence	Facilitation
	Customization
	Learning Analytics
Cognitive Presence	Enhancement of Cognitive Task(s)
	Higher-Order Thinking
	Metacognitive Engagement

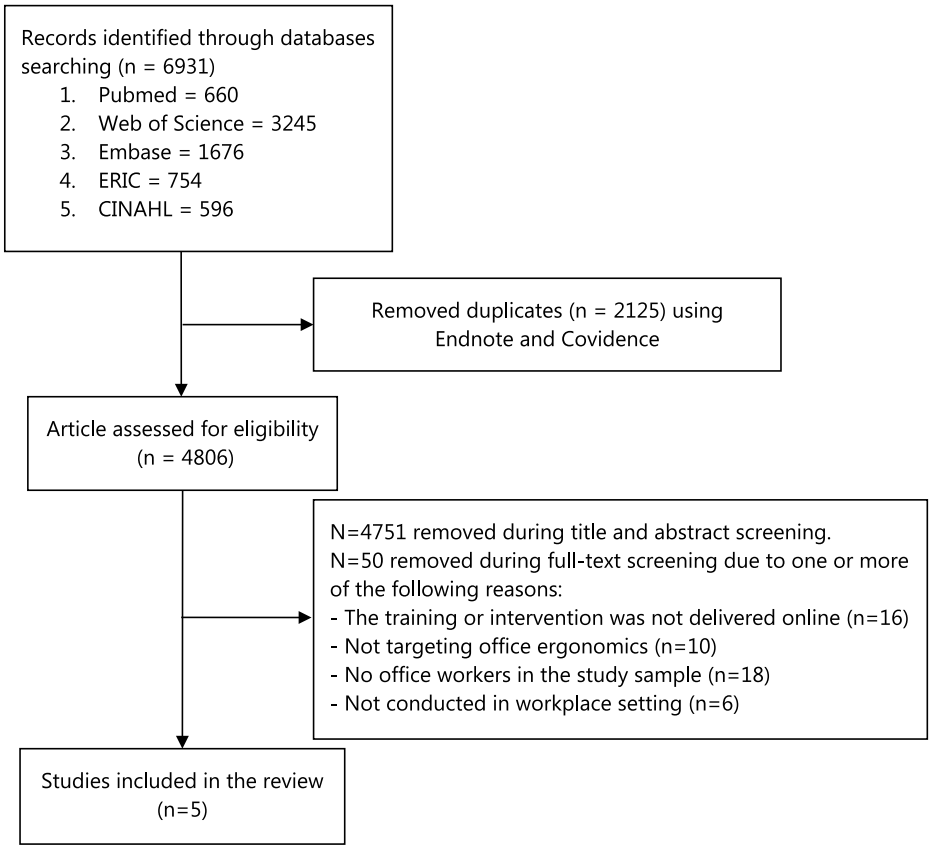

Fig. 1. Search and screening results of peer-reviewed articles.

3.2. Grey literature

Eight online training programs that included office ergonomics were identified from six of the 18 OHS authorities across three countries (2 in Australia, 2 in Canada and 4 in the USA), with no online training identified in the UK or New Zealand (Table 5). These online training programs were freely available, though one was only freely available during the COVID-19 pandemic (Canadian Centre for Occupational Health and Safety, 2020). All eight programs provided information on workstation set-up and physical hazards while two programs also included information on psychosocial hazards (Comcare, 2020; Workplace Health and Safety Queensland, 2020). Two programs were on sit-stand workstations for employees (Washington State Department of Labor and Industries, 2020c) and employers (Washington State Department of Labor and Industries, 2020b), with two others included information on sit-stand desks (Institute for Work and Health, 2015; Workplace Health and Safety Queensland, 2020). All programs were designed for workplace offices, with three including information on working from home (Comcare, 2020; Washington State Department of Labor and Industries, 2020a; Workplace Health and Safety Queensland, 2020). Of the eight programs, four included information for both employees and employers in the same training (Comcare, 2020; Institute for Work and Health, 2015; Occupational Safety and Health Administration, 2020; Workplace Health and Safety Queensland, 2020), while two provided a checklist for workstation assessment as a resource to support employees (Occupational Safety and Health Administration, 2020; Workplace Health and Safety Queensland, 2020). All programs were self-paced with three programs reporting a completion time ranging from 40 to 120 min (Canadian Centre for Occupational Health and Safety, 2020; Institute for Work and Health, 2015; Washington State Department of Labor and Industries, 2020a). Three programs used quizzes or questions to assess knowledge gained (Canadian Centre for Occupational Health and Safety, 2020; Institute for Work and Health, 2015; Workplace Health and Safety Queensland, 2020). Only one offered a certificate of completion (Canadian Centre for Occupational Health and Safety, 2020). As per the inclusion criteria, all programs were in English with three programs also providing either French (Canadian Centre for Occupational Health and Safety, 2020; Institute for Work and Health, 2015) or Spanish (Occupational Safety and Health Administration, 2020) versions (Table 6).

Using the e-learning evaluation rubric, the highest overall mean score of all training programs was recorded in the technical (11.9/12) and accessibility (10.4/12) aspects. The lowest scores were recorded in cognitive (5.4/9), social (5.1/9) and teaching (4/9) elements. The total scores varied between the training programs with the highest recorded for a program in the USA 67/81 (Washington State Department of Labor and Industries, 2020a) and the lowest for a Canadian program 57/81 (Canadian Centre for Occupational Health and Safety, 2020) (Table 7).

4. Discussion

This scoping review sought to provide an overview of the content, design and user-related outcomes of the current online office ergonomics training tested in the scientific literature and freely available on the websites of OHS authorities and bodies. This is the first summary of these elements, with findings intended to be used to identify research gaps and collaborative opportunities that could be further exploited in this area. Five peer-reviewed studies and eight virtual office ergonomics programs from six OHS authorities in Australia, Canada, and the USA were located, summarised, and synthesised.

4.1. Office ergonomics training content

This review found that OHS authorities and bodies in Australia,

Table 4
Characteristics of the five studies included in the review.

Author, Year, Country	Study design	Sample	Intervention/ training	Developed by	Reliability/ pilot test	Instruments	Outcomes / Post-intervention Findings
Del Pozo-Cruz., et al. 2012 (Spain)	RCT (9-month intervention)	90 administrative university staff Criteria: subjects with nonspecific LBP. 46 Intervention Grp, 44 Control Grp. Mean age: 46.6 years (78F, 12 M)	Web-based postural and exercise program (2 and 7-Min videos) + email reminders.	Preventive medicine clinician and clinical exercise physiologist	Reliability study	LBP-Related Fitness Test The Roland-Morris Disability Questionnaire (RMDQ) The European Quality of Life (QoL) questionnaire Sociodemographic questionnaire	↑ Functional Disability ↑ Health-Related QoL ↑ Muscular Endurance ↓ Number of NLBP Episodes
Del Pozo-Cruz, B., et al., 2013 (Spain)						5-Q survey LBP-related exercise behaviour change. The Visual Analogue Scale (VAS) from the Euroquol-5D questionnaire (EQ-5D) The Oswestry Disability Index (ODI)	↑ Self-reported health status ↑ Functional health status
Meinert, M., et al., 2013 (Germany)	Quasi-experimental pre-post-test design T0 – Baseline T1 – 1 Week T2 – 4 Weeks	24 office workers in north German company. Mean Age: 40.7 years (12F, 12 M)	IfADo Ergonomic Vision website (Ergonomic Vision IfADo, 2013)	Leibniz Research Centre of Working Environment and Human Factors	Pilot study	Side view photo of the subject's natural working posture + geometrical analysis. Questionnaire on complaints at computer workplaces.	↑ Workplace adjustment changes. ↓ MSD complaints, - Headache complaints, ↓ Eye strain
Dalkılınç, M., & Kayihan, H., 2014 (Turkey)	Pre- post-design (immediate and 45 days post-training)	102 Employees in a telecom company. Criteria: subjects with MSD complaint and using a computer for > 4 h/day. Mean Age: 37.3 years (70F, 32 M)	e-learning interactive ergonomics training (~60Min) 6 Modules, 57 pages with audio recording at the background	Physiotherapists, Software designers and Illustrators	Pilot study Reviewed by an e-learning expert	Demographic questionnaire Knowledge assessment Questionnaire (10 Y/N) Workplace interaction questionnaire (10 Y/N) RULA questionnaire	↑ Office ergonomics knowledge ↑ Behaviour (workplace interactions and working posture) ↓ MSD Symptoms and complaints
Habibi, H., & Soury, S., 2015 (Iran)	Quasi-experimental (2- and 2.5-months post-assessment)	75 office workers (25*3Groups) in a gas company Criteria: no MSDs, working at least 6 h/day with at least 5 h sitting with computer work Mean Age: 41.2 years (23F, 52 M)	G1: 4 h-online training with a multimedia presentation on office ergonomics, chair adjustment and RULA, G2: Exercise software reminder, G3: Sports program 2–3 times/ week with a physiotherapist	Physiotherapist	None	RULA and Nordic Questionnaire for MSDs	↓ MSDs complaints ↑ Working posture

LBP (Low Back Pain), **MSD** (Musculoskeletal Discomfort), **NLBP** (Non-specific Low Back Pain), **RCT** (Randomized Controlled Trial), **RMDQ** (Roland Morris Disability Questionnaire), **RULA** (The Rapid Upper Limb Assessment). ↑ **(statistically significant increase/improvement),** ↓ **(statistically significant decrease),** - **(No statistically significant changes)**.

Canada and the USA provide comprehensive freely available online office ergonomics training programs for both employees and employers. All the ergonomics training programs identified and synthesised had a large focus on the physical domain, including workstation set-up, posture, musculoskeletal health, and physical hazards. Only two online training programs included information about psychosocial hazards at work (Comcare, 2020; Workplace Health and Safety Queensland, 2020). This finding was surprising, given the importance of psychosocial hazards for physical and mental health (Oakman et al., 2018). Similarly, a Cochrane review on workplace ergonomics interventions for office workers that included 15 RCTs (2165 workers) reported that all interventions have largely focused on physical ergonomics with no cognitive component identified (Hoe et al., 2018). Future ergonomics training programs should incorporate all aspects of ergonomics as defined by the IEA - the cognitive, social, organisational, and environmental (International Ergonomics Association, 2019). Further, although this review did not focus on the accuracy and consistency of the content of training programs, OHS authorities may be developing the content of training programs based on specific legislative requirements for office work rather than the scientific literature. A review of global office ergonomics standards and guidelines has found inconsistency and disagreement in recommendations on workstations design and set-up (Woo et al., 2016). Another review of 119 policy documents relevant to office workers found no policy focusing on sedentary behaviour (Coenen et al., 2017), that has been identified as an emergent health and safety issue leading to an increased risk of adverse health outcomes

Table 5
Critical appraisal of included studies.

Randomised Controlled Trials[1]	Randomisation for assignment to treatment groups	Allocation to concealment	Similar treatment groups at baseline	Participants blind to treatment assignment	Delivering treatment blind to treatment assignment	Outcome assessors blind to treatment assignment	Treatment groups treated identically	Follow-up complete or differences adequately analysed	Analysed in groups to which they were randomised	Outcomes measured in same way	Outcome measurement reliable	Appropriate statistical analysis used	Appropriate design
del Pozo-Cruz et al., 2012	✓	✓	✓	✗	✗	✓	✓	✓	✓	✓	✓	✓	✓
del Pozo-Cruz et al., 2013	✓	✓	✓	✗	✗	✓	✓	✓	✓	✓	✓	✓	✓

Quasi-experimental studies[2]	Are the 'cause' and the 'effect' clear	Participants included in comparisons similar	Receiving similar treatment other than intervention	Was there a control group?	Multiple measurements of the outcome pre- and post	Follow-up complete or differences described	Outcomes measured in the same way	Outcome measurement reliable	Appropriate statistical analysis used
Meinert et al., 2013	✓	✓	✓	✗	✓	✓	✓	?	?
Dalkılınç and Kayihan, 2014	✓	✓	✓	✗	✓	✓	✓	?	?
Habibi and Soury, 2015	✓	✓	✓	✗	✓	?	✓	?	✓

✓ = Yes, ✗ = No, ? = Unclear.
[1] measured with the JBI critical appraisal tool for randomised controlled trials, [2] measured with the JBI critical appraisal tool for quasi-experimental studies.

Table 6
Reported characteristics of online office ergonomics training programs provided by OHS authorities in Australia, Canada, and the USA.

Country	OHS Authority	Training name	Content	WFH	WFO	Language	Time to completion	Target audience	Checklist	Assessment/ Quizzes	Certificate of completion
Australia	Comcare	Office Safety tool	√Workstation setup √Physical hazards √Psychosocial hazards √Safety hazards	Yes	Yes	ENG	Unreported	√Employee √Employer	No	No	No
	Workplace Health and Safety Queensland	Work from home training module	√Workstation setup √Physical hazards √Psychosocial hazards √Safety hazards	Yes	Yes	ENG	Unreported	√Employee √Employer	Yes	Yes	No
Canada	Canadian Centre for Occupational Health and Safety (CCOHS)	Office ergonomics e-course	√Workstation setup √Physical hazards ×Psychosocial hazards ×Safety hazards	No	Yes	ENG + FR	40–60 min	√Employee ×Employer	No	Yes	Yes
	Institute for Work and Health (IWH) *accessed via* the CCOHS	eOfficeErgo: Ergonomics eLearning for office workers	√Workstation setup √Physical hazards ×Psychosocial hazards √Safety hazards	No	Yes	ENG + FR	90 min	√Employee √Employer	No	Yes	No
USA	Occupational Safety and Health Administration (OSHA)	Computer workstation eTool	√Workstation setup √Physical hazards ×Psychosocial hazards √Safety hazards	No	Yes	ENG + SPA	Unreported	√Employee √Employer	Yes	No	No
	Washington State Department of Labor and Industries *accessed via* the National Institute for Occupational Safety and Health (NIOSH)	Office Ergonomics	√Workstation setup √Physical hazards ×Psychosocial hazards ×Safety hazards	Yes	Yes	ENG	120 min	√Employee ×Employer	No	No	No
		Sit-Stand Computer Workstations, Help for Employers	√Workstation setup √Physical hazards ×Psychosocial hazards ×Safety hazards	No	Yes	ENG	Unreported	×Employee √Employer	No	No	No
		Sit-Stand Computer Workstations, Help for Workers	√Workstation setup √Physical hazards ×Psychosocial hazards √Safety hazards	No	Yes	ENG	Unreported	√Employee ×Employer	No	No	No

WFH (Working from Home), **WFO** (Working from Office), **ENG** (English), **FR** (French), **SPA** (Spanish).
Workstation setup (e.g., desk, chair, monitor, keyboard), **Physical hazards** (e.g., noise, lighting, ventilation), **Psychosocial hazards** (e.g., stress, fatigue, workload), **Safety hazards** (e.g., slips and trips). √ Available in the training, × Unavailable in the training.

(Straker et al., 2016). While only four training programs included information on sit-stand workstations as a way to address sedentary behaviour at work (Washington State Department of Labor and Industries, 2020c; Washington State Department of Labor and Industries, 2020b; Institute for Work and Health, 2015; Workplace Health and Safety Queensland, 2020), recent research showed that there is a large uptake of sit-stand workstations in workplaces (Zerguine et al., 2022), with an increased need of online training programs to support the appropriate usage of these desks (Zerguine et al., 2021). Future training programs need to ensure that the content is evidence-based using the most recent scientific research and address both workers' and workplace needs.

4.2 Design related outcomes

The first aim of this scoping review was to review online ergonomics training programs in terms of design and user-related outcomes. Design-related outcomes such as satisfaction, usability and acceptability are important aspects in human–computer interaction and are considered one of the key factors for the uptake and success of any online learning (Harrati et al., 2016; Yakit and Ismailova, 2018). However, none of the published literature assessed any design-related outcomes. Although two studies reported conducting a pilot phase (Dalkılınç and Kayihan, 2014; Meinert et al., 2013), none of them reported if the usability, acceptability, or satisfaction was evaluated. Usability has been defined

Table 7
Evaluation of online office ergonomics training programs provided by OHS authorities in Australia, Canada, and the USA.

Category	Criteria	WHSQ	Comcare	CCOH	IWH	OSHA	OE	WA (L&I) SSWork	SSEmpl	MEAN SCORE
Functionality	Scale	★★☆	★★☆	★★☆	★★☆	★★☆	★★☆	★★☆	★★☆	
	Ease of Use	★★★	★★★	★★★	★★★	★★☆	★★★	★★★	★★★	
	Tech Support / Help Availability	★☆☆	★★☆	★★☆	★★☆	★☆☆	★★☆	★☆☆	★☆☆	
	Hypermediality	★★★	★★★	★★★	★★☆	★★☆	★★★	★★★	★★★	
	Functionality Score (.../12)	**9**	**10**	**10**	**9**	**7**	**10**	**9**	**9**	**9.12**
Accessibility	Accessibility standards	★☆☆	★★★	★★★	★★☆	★☆☆	★★☆	★★☆	★★☆	
	User-focused participation	★★☆	★★★	★★☆	★★★	★☆☆	★★★	★★★	★★★	
	Required Equipment	★★★	★★★	★★★	★★★	★★★	★★★	★★★	★★★	
	Cost of Use	★★★	★★★	★★☆	★★★	★★★	★★★	★★★	★★★	
	Accessibility Score (.../12)	**9**	**12**	**10**	**11**	**8**	**11**	**11**	**11**	**10.37**
Technical	Integration/ Embedding within a Learning Management System (LMS)	★★★	★★★	★★★	★★★	★★★	★★★	★★★	★★★	
	Desktop / Laptop Operating Systems	★★★	★★★	★★★	★★★	★★★	★★★	★★★	★★★	
	Browser	★★★	★★★	★★★	★★★	★★★	★★★	★★★	★★★	
	Additional Downloads	★★★	★★★	★★☆	★★★	★★★	★★★	★★★	★★★	
	Technical Score (.../12)	**12**	**12**	**11**	**12**	**12**	**12**	**12**	**12**	**11.87**
Mobile Design	Access	★★★	★★★	★★★	★★★	★★★	★★★	★★★	★★★	
	Functionality	★★★	★★★	★★★	★★★	★★★	★★★	★★★	★★★	
	Offline Access	★☆☆	★☆☆	★☆☆	★☆☆	★☆☆	★★★	★☆☆	★☆☆	
	Mobile Design Score (.../9)	**7**	**7**	**7**	**7**	**7**	**8**	**7**	**7**	**7.12**
Privacy, Data Protection, & Rights	Sign Up/ Sign In	★★★	★★★	★☆☆	★☆☆	★★★	★★★	★★★	★★★	
	Data Privacy and Ownership	★★★	★☆☆	★☆☆	★☆☆	★☆☆	★★★	★★★	★★★	
	Archiving, Saving, and Exporting Data	★☆☆	★☆☆	★★☆	★☆☆	★★☆	★★★	★☆☆	★☆☆	
	Privacy, Data Protection, & Rights Score (.../9)	**7**	**5**	**4**	**3**	**6**	**9**	**7**	**7**	**6.00**
Social	Collaboration	★☆☆	★☆☆	★☆☆	★☆☆	★☆☆	★☆☆	★☆☆	★☆☆	
Presence	User Accountability	★☆☆	★☆☆	★☆☆	★☆☆	★☆☆	★★★	★★★	★★★	
	Diffusion	★★☆	★★☆	★★☆	★★☆	★★☆	★★★	★★★	★★★	
	Social Presence Score (.../9)	**4**	**4**	**4**	**4**	**4**	**7**	**7**	**7**	**5.12**
Teaching Presence	Facilitation	★★☆	★★☆	★☆☆	★☆☆	★☆☆	★☆☆	★☆☆	★☆☆	
	Customization	★★☆	★★☆	★☆☆	★☆☆	★☆☆	★★☆	★★☆	★★☆	
	Learning Analytics	★☆☆	★☆☆	★★☆	★☆☆	★☆☆	★☆☆	★☆☆	★☆☆	
	Teaching Presence Score (.../9)	**5**	**5**	**4**	**3**	**3**	**4**	**4**	**4**	**4.00**
Cognitive Presence	Enhancement of Cognitive Task(s)	★★★	★☆☆	★★☆	★★☆	★☆☆	★★☆	★★☆	★★☆	
	Higher-Order Thinking	★★☆	★☆☆	★★☆	★★☆	★☆☆	★★☆	★★☆	★★☆	
	Metacognitive Engagement	★★☆	★☆☆	★★★	★★★	★☆☆	★★☆	★☆☆	★☆☆	
	Cognitive Presence Score (.../9)	**7**	**3**	**7**	**7**	**3**	**6**	**5**	**5**	**5.37**
	TOTAL SCORE (.../81)	**60**	**58**	**57**	**56**	**50**	**67**	**62**	**62**	**59.00**

★★★ Works well
★★☆ Minor concerns
★☆☆ Serious concerns

WHSQ (Workplace Health and Safety Queensland), **CCOH** (Canadian Centre for Occupational Health and Safety), **IWH** (Institute for Work and Health (IWH), **OSHA** (Occupational Safety and Health Administration, **WA (L&I)** (Washington State Department of Labour and Industries), **OE** (Office Ergonomics), **SSWork** (Sit-Stand Computer Workstations, Help for Workers), **SSEmpl** (Sit-Stand Computer Workstations, Help for Employers)

by The International Standardization Organization (ISO) as "the extent to which a product can be used by specified users to achieve specified goals with efficiency, effectiveness, and satisfaction in a specified context of use" (International Organization for Standardization, 1998). For e-learning programs, the usability has been directly linked with the quality, and end-users are increasingly demanding useable and high-quality programs (Oztekin et al., 2013; Oztekin et al., 2009). Therefore, future online training programs need to address the usability and acceptability aspects of e-learning programs to ensure meeting end-users' needs and satisfaction.

This review also found that all online training programs tested in the scientific literature were developed by experts/clinicians only and did not involve end-users or stakeholders such as staff, OHS providers, or workplace managers. OHS authorities did not provide information on how the training programs were developed, and if experts and end-users were consulted. Although experts may have the knowledge and expertise in the field, the involvement of multiple stakeholders in the design process is highly recommended (Robertson and Maynard, 2005). Codesign and participatory design approaches emphasise the importance of collaboration between end-users, stakeholders, experts and instructional designers when designing training programs, as these approaches bring together diverse perspectives to create high-quality and relevant training (Clemensen et al., 2017; Könings et al., 2017). Therefore, designing and developing training programs should actively engage end-users and stakeholders through an iterative process to generate ideas and build content and learning activities that help in developing skills and changing behaviour.

4.3 User-related outcomes – Health and knowledge

In contrast to design outcomes, the online training programs from the peer-reviewed articles all assessed user-related outcomes with a

focus on knowledge and physical health such as MSDs and posture. Although the focus might be due to testing specific research questions, these studies have not assessed any psychological health-related outcomes. Psychological disorders and MSDs have been identified as one of the most prevalent and costly occupational health problems in workplaces (Oakman et al., 2018). MSDs are considered multifactorial in origin with a combination of individual, psychosocial and workplace physical factors (David, 2005; Vinothini et al., 2018; Wahlström, 2005). The ergonomic systems model illustrated a large and diverse range of factors that influences MSDs and psychological health at work, this includes workers' individual characteristics, external factors, and workplace factors that involve task and equipment, work organisation and job design, and workplace environment (Macdonald et al., 2003; Oakman et al., 2018). Future ergonomics training/intervention programs should adopt a more holistic approach targeting both physical and psychological health and address all individual, physical, cognitive, and organisational factors to achieve optimal health.

Because of the nature of online learning systems, such as the lack of direct contact between instructors and learners, knowledge evaluation is considered a key component of any e-learning program (Ghatasheh, 2015). This review found only one online training program from the published literature that assessed perceived knowledge, while three out of the eight online training programs from OHS authorities used knowledge checks and assessment pieces within the training. Although e-learning assessments might not reflect the actual knowledge of learners, researchers found that the use of tests, quizzes and assessments in online training keeps learners engaged and motivated and help retention of information (Rosenberg, 2001). Furthermore, the data collected from assessments and quizzes could also be used to update or redesign content to enhance understanding and/or knowledge. Future evaluations of training programs might also consider evaluating the actual knowledge of users, which could be achieved with more comprehensive evaluation strategies, for example, the time that users spend reading the content and their progress which may indicate users' knowledge level (Ghatasheh, 2015).

4.4 Theoretical model/framework

None of the published studies used a theoretical model/framework when designing and developing the training program. From a pedagogical perspective, the use of instructional design models to guide the development of any educational program is considered critical to the success of training programs (Khalil and Elkhider, 2016). Instructional models such as ADDIE (Analyse, Design, Develop, Implement and Evaluate), SAM (Successive Approximation Model), or Dick and Carey Systems Approach Model, provide a systematic approach to organise appropriate educational scenarios through learning theories to achieve instructional goals (Khalil and Elkhider, 2016; McIver et al., 2015). ADDIE, for example, uses a behavioural approach that focuses on achieving specific learning outcomes and behavioural change by considering the different learning theories, and the learner's needs and environment (Allen, 2006). These models are being increasingly adopted for e-learning programs and are shown to be effective in creating efficient and high-quality e-learning programs (Khalil and Elkhider, 2016; Patel et al., 2018). Correspondingly, the development of future training programs should incorporate the use of such models.

4.5 Working from home

All of the training programs developed by OHS authorities were designed for workplace offices, with only three including information on working from home (Comcare, 2020; Washington State Department of Labor and Industries, 2020a; Workplace Health and Safety Queensland, 2020). Recent research has shown that a substantial number of employees working from home had a poor ergonomic set-up of their workstation, with 43 % having a less than optimal seating position, and 50 % an inappropriate monitor position (Davis et al., 2020). As working from home is expected to continue, recommendations to address this issue could be achieved through the provision of online training and resources to support self-assessment (Reznik et al., 2021), or even by developing separate programs to address the specific needs of employees to support their physical and mental health when working from home.

4.6 Functional, technical, and pedagogical aspects

The second aim of this scoping review was to outline the functional, technical, and pedagogical aspects of current online ergonomics training programs promoted by OHS authorities and bodies. Using the e-learning evaluation rubric, it was found that online training programs provided by OHS authorities had high scores in both technical and accessibility aspects. The technical aspect reflects the basic technologies that make the e-learning system work. For example, most of the online training was embedded within a learning management system and all of the programs could be delivered across different operating systems and browsers. These elements have been identified in the e-learning readiness model as integral to the success of e-learning implementation (Mosa et al., 2016). Most training programs met the accessibility standards and requirements of training programs by addressing the needs of diverse users and their learning abilities (Kelly et al., 2009). All training programs had free access with minimal equipment and technology (computer, speakers and internet) requirements, which increases their accessibility by users. Low scores were identified in the social, teaching, and cognitive presence aspects. These categories support the design of the online learning environment to best create and sustain a sense of community among the learners based on the Communities of Inquiry model (Garrison, 2016). Social presence could be strengthened when designing online training by developing learning activities that foster collaboration and teamwork among learners. Although this might be challenging in practice if the training is relatively short in nature or individuals are completing the training in their own time, however, where possible, social presence could be achieved by providing learners with opportunities to interact with their peers and collaborate on activities to build a sense of community. Furthermore, when designing online courses, learning analytics could be integrated to support teaching presence. Learning analytics could be integrated via different tools and applications to help connect users, instructors and institutions and collect data to better understand the learners' capabilities, track their performance and provide feedback on their learning (Becker et al., 2018). Cognitive presence in e-learning could be enhanced by incorporating cognitive and higher order thinking tasks to assist learners in integrating, rearranging, or extending new and existing information in order to attain a goal or find solutions to a complex problem (Beckmann and Weber, 2016).

4.7. Strengths and limitations

A strength of this review was the inclusion of online office ergonomics training programs from both peer-reviewed and grey literature, which helped in providing a comprehensive perspective of available programs, including in practice. This comprehensive approach allowed a broader understanding of the distinctive features, content and focus of training programs. The use of a standardized tool for evaluating e-learning programs by two raters enabled an understanding of the key strengths and limitations of current office ergonomics programs. We recommend that future evaluations of existing e-learning programs

consider also including end-users during this process to gain their perspective of the functionality, usability, and overall experience with the training programs.

The aim of this review was to scope the recent research and OHS authorities and bodies' websites to provide an overview of the design and user-related outcomes of online training programs, as such we did not intend to compare or synthesize the changes in outcomes across research studies, nor to assess the accuracy and consistency of the content. This review identified five peer-reviewed articles (2010 – 2021) and followed the six-stage methodological framework for scoping reviews by Arksey and O'Malley (2005). To complement the findings from this framework, we also assessed the methodological quality of the included articles, with limitations found in the quasi-experimental studies including the absence of a control group and reliability of the outcome measured. The small number of articles identified, and the limitations in terms of their methodological quality, highlight the need for further high-quality studies evaluating the effectiveness of online office ergonomics training programs. Furthermore, the specific aim and user-related outcomes of each research paper included in this review did not allow for a direct comparison of the content of the online training programs or with those available on the OHS authority website. In addition, our grey literature search focussed only on online/interactive training programs available on the websites of specific OHS authorities and bodies in English-speaking countries, which may have excluded relevant information provided by other OHS bodies internationally and in documents or in written content in their websites. Further, this review did not include online training programs from other industry providers, including those commercially available.

5. Conclusion and future directions

This review found that online office ergonomics training tested in the literature tends to focus on user-related outcomes such as posture, musculoskeletal health, and knowledge, while training provided through OHS authorities provides more comprehensive programs with a high technological design that supports users through their learning experience. Further work could be undertaken to ensure that the content of training programs from peer-reviewed literature and OHS authorities is well designed, aligns with the evidence base, and supports the fulfilment of legislative responsibilities of workplaces. Future partnerships between OHS authorities, the scientific community and end-users need to be considered to build robust evidence-based programs that address both the design and user-related outcomes. These programs should follow an instructional system design approach for systematic planning and development of instructions and learning activities. This approach will help in increasing instructional efficiency, facilitating users' learning, and creating an environment for successful learning outcomes. Key stakeholders and end-users (consumers) should also be involved through the design, development, and evaluation phases to ensure the training program contains content and instructional strategies developed to achieve learners' needs.

Funding

HZ is supported by The University of Queensland Research Training Scholarship. GNH is supported by the Australian Medical Research Future Fund (MRFF) Emerging Leadership Fellowship (#1193815). Open access was supported by Medibank Better Health Foundation (R14-0984).

CRediT authorship contribution statement

Haroun Zerguine: Writing – original draft, Project administration, Methodology, Conceptualization. **Genevieve N. Healy:** Writing – review & editing, Supervision, Conceptualization. **Ana D. Goode:** Writing – review & editing, Supervision, Conceptualization. **Jason Zischke:** Investigation. **Alison Abbott:** Writing – review & editing, Resources. **Lynn Gunning:** Writing – review & editing, Resources. **Venerina Johnston:** Writing – review & editing, Supervision, Conceptualization.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ssci.2022.106000.

References

Allen, W.C., 2006. Overview and Evolution of the ADDIE Training System. Adv. Develop. Human Resour. 8 (4), 430–441. https://doi.org/10.1177/1523422306292942.

Amick III, B.C., Menéndez, C.C., Bazzani, L., Robertson, M., DeRango, K., Rooney, T., Moore, A., 2012. A field intervention examining the impact of an office ergonomics training and a highly adjustable chair on visual symptoms in a public sector organization. Appl. Ergon. 43 (3), 625–631. https://doi.org/10.1016/j.apergo.2011.09.006.

Anstey LM, Watson GP., 2018. Rubric for Evaluating E-Learning Tools. Western University. Available from: https://er.educause.edu/articles/2018/9/a-rubric-for-evaluating-e-learning-tools-in-higher-education.

Arksey, H., O'Malley, L., 2005. Scoping studies: towards a methodological framework. Int. J. Soc. Res. Methodol. 8 (1), 19–32. https://doi.org/10.1080/1364557032000119616.

Australian Bureau of Statistics, 2022. Work-Related Training and Adult Learning, Australia (No. 4234.0). https://www.abs.gov.au/statistics/people/education/work-related-training-and-adult-learning-australia/latest-release.

Bailey G., 2018. Office workers spend 1,700 hours a year in front of a computer screen. CBC News Los Angeles. Available from: https://www.independent.co.uk/news/uk/home-news/office-workers-screen-headaches-a8459896.html.

Bailey, D.P., Hewson, D.J., Champion, R.B., Sayegh, S.M., 2019. Sitting Time and Risk of Cardiovascular Disease and Diabetes: A Systematic Review and Meta-Analysis. Am. J. Prev. Med. 57 (3), 408–416. https://doi.org/10.1016/j.amepre.2019.04.015.

Becker SA, Brown M, Dahlstrom E, Davis A, DePaul K, Diaz V, Pomerantz J., 2018. NMC horizon report: 2018 higher education edition. Louisville, CO: Educause. Available from: https://www.learntechlib.org/p/184633/.

Beckmann, J., Weber, P., 2016. Cognitive presence in virtual collaborative learning: Assessing and improving critical thinking in online discussion forums. Interactive Technology and Smart Education 13 (1), 52–70. https://doi.org/10.1108/ITSE-12-2015-0034.

Boulos, M.N.K., Brewer, A.C., Karimkhani, C., Buller, D.B., Dellavalle, R.P., 2014. Mobile medical and health apps: state of the art, concerns, regulatory control and certification. Online journal of public health informatics 5 (3), 229. https://doi.org/10.5210/ojphi.v5i3.4814.

Brewer, S., Van Eerd, D., Amick, B.C., Irvin, E., Daum, K.M., Gerr, F., Moore, J.S., Cullen, K., Rempel, D., 2006. Workplace interventions to prevent musculoskeletal and visual symptoms and disorders among computer users: a systematic review. J. Occup. Rehabil. 16 (3), 325–358. https://doi.org/10.1007/s10926-006-9031-6.

Burton J, 2010. WHO Healthy workplace framework and model: Background and supporting literature and practices: World Health Organization. https://apps.who.int/iris/handle/10665/113144.

Cambridge Dictionary, 2020. 'Virtual', in Online Cambridge Dictionary. https://dictionary.cambridge.org/.

Canadian Centre for Occupational Health and Safety 2020. Office ergonomics e-course: Government of Canada. Available from: https://www.ccohs.ca/products/courses/office_ergonomics/.

Carayon, P., Smith, M.J., 2000. Work organization and ergonomics. Appl. Ergon. 31 (6), 649–662. https://doi.org/10.1016/S0003-6870(00)00040-5.

Castro, M.D.B., Tumibay, G.M., 2021. A literature review: efficacy of online learning courses for higher education institution using meta-analysis. Education and Information Technologies 26, 1367–1385. https://doi.org/10.1007/s10639-019-10027-z.

Chen, X., Coombes, B.K., Sjøgaard, G., Jun, D., O'Leary, S., Johnston, V., 2018. Workplace-based interventions for neck pain in office workers: systematic review and meta-analysis. Phys. Ther. 98 (1), 40–62. https://doi.org/10.1093/ptj/pzx101.

Clemensen, J., Rothmann, M.J., Smith, A.C., Caffery, L.J., Danbjorg, D.B., 2017. Participatory design methods in telemedicine research. J. Telemed. Telecare 23 (9), 780–785. https://doi.org/10.1177/1357633X16686747.

Coenen, P., Gilson, N., Healy, G.N., Dunstan, D.W., Straker, L.M., 2017. A qualitative review of existing national and international occupational safety and health policies relating to occupational sedentary behaviour. Appl. Ergon. 60, 320–333. https://doi.org/10.1016/j.apergo.2016.12.010.

Comcare 2020. Office safety tool - Identify hazards and risks at your office: Australian Government Available from: https://www.comcare.gov.au/office-safety-tool.

Cook, D.A., 2007. Web-based learning: pros, cons and controversies. Clin. Med. 7 (1), 37–42. https://doi.org/10.7861/clinmedicine.7-1-37.
Covidence 2022. Covidence: better systematic review management. Available from: https://www.covidence.org/.
Craig, P., Dieppe, P., Macintyre, S., Michie, S., Nazareth, I., Petticrew, M., 2011. Developing and evaluating complex interventions: the new Medical Research Council guidance. BMJ 337, a1655. https://doi.org/10.1136/bmj.a1655.
Dalkılınç, M., Kayihan, H., 2014. Efficacy of Web-Based [E-Learning] Office Ergonomics Training: A Test Study. J. Musculoskeletal Pain 22 (3), 275–285. https://doi.org/10.3109/10582452.2014.907851.
David, G.C., 2005. Ergonomic methods for assessing exposure to risk factors for work-related musculoskeletal disorders. Occup. Med. 55 (3), 190–199. https://doi.org/10.1093/occmed/kqi082.
Davis, K.G., Kotowski, S.E., Daniel, D., Gerding, T., Naylor, J., Syck, M., 2020. The Home Office: Ergonomic Lessons From the "New Normal". Ergon. Des. 28 (4), 4–10. https://doi.org/10.1177/1064804620937907.
del Pozo-Cruz, B., Adsuar, J.C., Parraca, J., del Pozo-Cruz, J., Moreno, A., Gusi, N., 2012. A Web-Based Intervention to Improve and Prevent Low Back Pain Among Office Workers: A Randomized Controlled Trial. J. Orthop. Sports Phys. Ther. 42 (10), 831–D6.
del Pozo-Cruz, B., del Pozo-Cruz, J., Adsuar, J.C., Parraca, J., Gusi, N., 2013. Reanalysis of a tailored web-based exercise programme for office workers with sub-acute low back pain: Assessing the stage of change in behaviour. Psychol., Health Med. 18 (6), 687–697. https://doi.org/10.2519/jospt.2012.3980.
EndNote, 2013. EndNote X9 ed. Philadelphia, PA: Clarivate Analytics. Available from: https://endnote.com/.
Ergonomic Vision IfADo 2013. Better seeing and working at the computer. Available from: http://ergonomic-vision.ifado.de/en/.
Faisting, R.F.A.L., de Oliveira Sato, T., 2019. Effectiveness of ergonomic training to reduce physical demands and musculoskeletal symptoms - An overview of systematic reviews. Int. J. Ind. Ergon. 74, 102845 https://doi.org/10.1016/j.ergon.2019.102845.
Garrison, D.R., 2016. E-learning in the 21st century: A community of inquiry framework for research and practice: Routledge. https://doi.org/10.4324/9781315667263.
Ghatasheh, N., 2015. Knowledge level assessment in e-learning systems using machine learning and user activity analysis. Int. J. Adv. Comput. Sci. Appl. 6 (4), 107–113.
Habibi, E., Soury, S., 2015. The effect of three ergonomics interventions on body posture and musculoskeletal disorders among stuff of Isfahan Province Gas Company. J. Educ. Health Promotion 4, 65. https://doi.org/10.4103/2277-9531.162386.
Harrati, N., Bouchrika, I., Tari, A., Ladjailia, A., 2016. Exploring user satisfaction for e-learning systems via usage-based metrics and system usability scale analysis. Comput. Hum. Behav. 61, 463–471. https://doi.org/10.1016/j.chb.2016.03.051.
Heidarimoghadam, R., Mohammadfam, I., Babamiri, M., Soltanian, A.R., Khotanlou, H., Sohrabi, M.S., 2022. What do the different ergonomic interventions accomplish in the workplace? A systematic review. Int. J. Occup. Saf. Ergon. 28 (1), 600–624. https://doi.org/10.1080/10803548.2020.1811521.
Hoe, V.C.W., Urquhart, D.M., Kelsall, H.L., Sim, M.R., 2012. Ergonomic design and training for preventing work-related musculoskeletal disorders of the upper limb and neck in adults. Cochrane Database Syst. Rev. 8 https://doi.org/10.1002/14651858.CD008570.pub2.
Hoe, V.C.W., Urquhart, D.M., Kelsall, H.L., Zamri, E.N., Sim, M.R., 2018. Ergonomic interventions for preventing work-related musculoskeletal disorders of the upper limb and neck among office workers. Cochrane Database Syst. Rev. 10 https://doi.org/10.1002/14651858.CD008570.pub3.
Institute for Work and Health 2015. eOfficeErgo: Ergonomics e-learning for office workers: Toronto, Canada. Available from: https://www.iwh.on.ca/tools-and-guides/eofficeergo-ergonomics-e-learning-for-office-workers.
International Ergonomics Association, 2019. Definition and Domains of Ergonomics. Available from: https://www.iea.cc/whats/.
International Labour Organization 2015. ILO: National profiles on occupational safety and health Genève, Switzerland. Available from: https://www.ilo.org/safework/countries/lang–en/index.htm.
International Organization for Standardization 1998. Ergonomic requirements for office work with visual display terminals (VDTs) - Part 11: Guidance on Usability. ISO 9241-11.
Jun, D., Zoe, M., Johnston, V., O'Leary, S., 2017. Physical risk factors for developing non-specific neck pain in office workers: a systematic review and meta-analysis. Int. Arch. Occup. Environ. Health 90 (5), 373–410. https://doi.org/10.1007/s00420-017-1205-3.
Jun, D., O'Leary, S., McPhail, S.M., Johnston, V., 2019. Job strain and psychological distress in office workers: The role of coping. Work 64, 55–65. https://doi.org/10.3233/PWOR-192968.
Kelly, B., Sloan, D., Brown, S., Seale, J., Lauke, P., Ball, S., Smith, S., 2009. Accessibility 2.0: Next Steps for Web Accessibility. J. Access Serv. 6 (1–2), 265–294. https://doi.org/10.1080/15367960802301028.
Khalil, M.K., Elkhider, I.A., 2016. Applying learning theories and instructional design models for effective instruction. Adv. Physiol. Educ. 40 (2), 147–156. https://doi.org/10.1152/advan.00138.2015.
Könings, K.D., Bovill, C., Woolner, P., 2017. Towards an interdisciplinary model of practice for participatory building design in education. Eur. J. Educ. 52 (3), 306–317. https://doi.org/10.1111/ejed.12230.
Krause, N., Burgel, B., Rempel, D., 2010. Effort-reward imbalance and one-year change in neck-shoulder and upper-extremity pain among call center computer operators. Scand. J. Work Environ. Health 1, 42–53. https://doi.org/10.5271/sjweh.2881.
Macdonald, W., Munk, K., Evans, O., 2003. Ergonomics approaches to the prevention of work-related musculoskeletal disorders. An analysis and critical review of existing national, and regional standards and guidelines: A report prepared on behalf of the International Ergonomics Association for the International Labour Organisation.
McIver, D., Fitzsimmons, S., Flanagan, D., 2015. Instructional Design as Knowledge Management: A Knowledge-in-Practice Approach to Choosing Instructional Methods. J. Manage. Educ. 40 (1), 47–75. https://doi.org/10.1177/1052562915587583.
Meinert, M., König, M., Jaschinski, W., 2013. Web-based office ergonomics intervention on work-related complaints: a field study. Ergonomics 56 (11), 1658–1668. https://doi.org/10.1080/00140139.2013.835872.
Miller, L., Ho, M., Frankel, D., Jones, M., Bello, B., 2014. 2014 State of the Industry. Association for Talent Development (ATD), Alexandria, VA.
Mosa, A.A., Mahrin, M.N.rb., Ibrrahim, R., 2016. Technological Aspects of E-Learning Readiness in Higher Education: A Review of the Literature. Comput. Inf. Sci. 9 (1), 113–127. https://doi.org/10.5539/cis.v9n1p113.
Noe, R.A., Clarke, A.D., Klein, H.J., 2014. Learning in the twenty-first-century workplace. Annual review of organizational psychology and organizational behavior 21;1(1):245–75. https://doi.org/10.1146/annurev-orgpsych-031413-091321.
Oakman, J., Macdonald, W., Bartram, T., Keegel, T., Kinsman, N., 2018. Workplace risk management practices to prevent musculoskeletal and mental health disorders: What are the gaps? Saf. Sci. 101, 220–230. https://doi.org/10.1016/j.ssci.2017.09.004.
Occupational Safety and Health Administration 2020. Computer workstation eTool: Department of Labor, United States. Available from: https://www.osha.gov/SLTC/etools/computerworkstations/.
Oztekin, A., Nikov, A., Zaim, S., 2009. An assessment methodology for usability of web-based information systems. J. Syst. Softw. 82 (12), 2038–2050. https://doi.org/10.1016/j.jss.2009.06.047.
Oztekin, A., Delen, D., Turkyilmaz, A., Zaim, S., 2013. A machine learning-based usability evaluation method for eLearning systems. Decis. Support Syst. 56, 63–73. https://doi.org/10.1016/j.dss.2013.05.003.
Patel, S.R., Margolies, P.J., Covell, N.H., Lipscomb, C., Dixon, L.B., 2018. Using Instructional Design, Analyze, Design, Develop, Implement, and Evaluate, to Develop e-Learning Modules to Disseminate Supported Employment for Community Behavioral Health Treatment Programs in New York State. Front. Public Health 6, 113. https://doi.org/10.3389/fpubh.2018.00113.
Peters, M., Godfrey, C., McInerney, P., Soares, C., Khalil, H., Parker, D., 2015. The Joanna Briggs Institute reviewers' manual 2015: methodology for JBI scoping reviews. Available from.
Reznik, J., Hungerford, C., Kornhaber, R., Cleary, M., 2021. Home-Based Work and Ergonomics: Physical and Psychosocial Considerations. Issues in Mental Health Nursing 1–5. https://doi.org/10.1080/01612840.2021.1875276.
Robertson, M., Amick, B.C., DeRango, K., Rooney, T., Bazzani, L., Harrist, R., Moore, A., 2009. The effects of an office ergonomics training and chair intervention on worker knowledge, behavior and musculoskeletal risk. Appl. Ergon. 40 (1), 124–135. https://doi.org/10.1016/j.apergo.2007.12.009.
Robertson MM, Maynard WS., 2005. Office Ergonomics Training. Professional Safety 50 (7):22-30. Available from: https://www.proquest.com/scholarly-journals/office-ergonomics-training/docview/200372868/se-2?accountid=14723.
Robertson, M.M., Ciriello, V.M., Garabet, A.M., 2013. Office ergonomics training and a sit-stand workstation: Effects on musculoskeletal and visual symptoms and performance of office workers. Appl. Ergon. 44 (1), 73–85. https://doi.org/10.1016/j.apergo.2012.05.001.
Robertson, M.M., Huang, Y.H., Lee, J., 2017. Improvements in musculoskeletal health and computing behaviors: Effects of a macroergonomics office workplace and training intervention. Appl. Ergon. 62, 182–196. https://doi.org/10.1016/j.apergo.2017.02.017.
Rosenberg, M.J., 2001. E-learning: Strategies for Delivering Knowledge in the Digital. Mcgraw-Hill.
Shariat, A., Cleland, J.A., Danaee, M., Kargarfard, M., Sangelaji, B., Tamrin, S.B.M., 2018. Effects of stretching exercise training and ergonomic modifications on musculoskeletal discomforts of office workers: a randomized controlled trial. Brazilian Journal of Physical Therapy 22 (2), 144–153. https://doi.org/10.1016/j.bjpt.2017.09.003.
Sohrabi, M.S., Babamiri, M., 2021. Effectiveness of an ergonomics training program on musculoskeletal disorders, job stress, quality of work-life and productivity in office workers: a quasi-randomized control trial study. International Journal of Occupational Safety and Ergonomics 1–8. https://doi.org/10.1080/10803548.2021.1918930.
Straker L, Dunstan D, Gilson N, Healy G., 2016. Sedentary Work - Evidence on an Emergent Work Health and Safety Issue - Final Report. Report No.: 1760285897. Canberra: Safe Work Australia. Available from: https://www.safeworkaustralia.gov.au/resources-and-publications/reports/sedentary-work-evidence-emergent-work-health-and-safety-issue.
Tchir, D.R., Szafron, M.L., 2020. Occupational Health Needs and Predicted Well-Being in Office Workers Undergoing Web-Based Health Promotion Training: Cross-Sectional Study. J Med Internet Res 22 (5), e14093. https://doi.org/10.2196/14093.
Tufanaru C, Munn Z, Aromataris E, Campbell J, Hopp L., 2017. Systematic reviews of effectiveness. In: Aromataris E, Munn Z (Editors). JBI Manual for Evidence Synthesis. JBI, 2020. Available from https://synthesismanual.jbi.global.
Van Eerd, D., Munhall, C., Irvin, E., Rempel, D., Brewer, S., Van Der Beek, A.J., Dennerlein, J.T., Tullar, J., Skivington, K., Pinion, C., Amick, B., 2016. Effectiveness of workplace interventions in the prevention of upper extremity musculoskeletal disorders and symptoms: an update of the evidence. Occup Environ Med 73 (1), 62–70. https://doi.org/10.1136/oemed-2015-102992.
Vaona, A., Banzi, R., Kwag, K.H., Rigon, G., Cereda, D., Pecoraro, V., Tramacere, I., Moja, L., 2018. E-learning for health professionals. In: The Cochrane Database of

Systematic Reviews 1:Cd011736. https://doi.org/10.1002/14651858.CD011736.pub2.
Victory, N.J., Cooper, K.B., 2002. A nation online: How Americans are expanding their use of the Internet. Economics and Statistics Administration and National Telecommunications and Information Administration 16, 17.
Vinothini, P., Halim, I., Umar, R.Z., Too, Y.W., 2018. A future framework for muskuloskeletal disorders symptoms among computer office workers International. Journal of Physiotherapy 5 (6). https://doi.org/10.15621/ijphy/2018/v5i6/178053.
Waersted, M., Hanvold, T.N., Veiersted, K.B., 2010. Computer work and musculoskeletal disorders of the neck and upper extremity: a systematic review. BMC Musculoskelet Disord 11, 79. https://doi.org/10.1186/1471-2474-11-79.
Wahlström, J., 2005. Ergonomics, musculoskeletal disorders and computer work. Occup. Med. 55 (3), 168–176. https://doi.org/10.1093/occmed/kqi083.
Wang, M., 2018. E-Learning in the Workplace – Part I. 3 Emerging technologies for workplace learning. Springer, Berlin, pp. 29–37.
Washington State Department of Labor and Industries 2020a. Office Ergonomics: Washington State Government. Available from: https://wisha-training.lni.wa.gov/training/articulate/officeergonomics/story_html5.html.
Washington State Department of Labor and Industries 2020b. Sit-Stand Computer Workstations, Help for Employers: Washington State Government. Available from: https://wisha-training.lni.wa.gov/Training/articulate/SitStandForEmployers/story_html5.html.
Washington State Department of Labor and Industries 2020c. Sit-Stand Computer Workstations, Help for Workers: Washington State Government. Available from: https://wisha-training.lni.wa.gov/Training/articulate/SitStandForWorkers/story_html5.html.
Wicks, P., Stamford, J., Grootenhuis, M.A., Haverman, L., Ahmed, S., 2014. Innovations in e-health. Qual. Life Res. 23 (1), 195–203. https://doi.org/10.1007/s11136-013-0458-x.
Woo, E.H., White, P., Lai, C.W., 2016. Ergonomics standards and guidelines for computer workstation design and the impact on users' health - a review. Ergonomics 59 (3), 464–475. https://doi.org/10.1080/00140139.2015.1076528.
Workplace Health and Safety Queensland 2020. Working from home online learning module: Queensland Government. Available from: https://fswqap.worksafe.qld.gov.au/elearning/wfh/.
Xiao, Y., Becerik-Gerber, B., Lucas, G., Roll, S.C., 2021. Impacts of working from home during COVID-19 pandemic on physical and mental well-being of office workstation users. J. Occup. Environ. Med. 63 (3), 181. https://doi.org/10.1097/JOM.0000000000002097.
Yakit O, Ismailova R., 2018. Learning Management System Implementation. Case Study on User Interface Configurations. MANAS Journal of Engineering 6(2):164-76. Available from: https://dergipark.org.tr/tr/download/article-file/604859.
Zerguine, H., Johnston, V., Healy, G.N., Abbott, A., Goode, A.D., 2021. Usage of sit-stand workstations: Benefits and barriers from decision makers' perspective in Australia. Appl. Ergon. 1 (94), 103426 https://doi.org/10.1016/j.apergo.2021.103426.
Zerguine, H., Goode, A.D., Abbott, A., Johnston, V., Healy, G.N., 2022. Factors impacting workplace investment in sit-stand workstations from the perspective of purchasing decision-makers. Appl. Ergon. 1 (98), 103558 https://doi.org/10.1016/j.apergo.2021.103558.