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A Systematic Review on the Effectiveness of Ergonomic Training Intervention in Reducing the Risk of Musculoskeletal Disorder

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Abstract

Background: Ergonomic training is the most widely used intervention in addressing the issue of musculoskeletal disorder (MSD). However, its effectiveness is uncertain. This systematic review provides a narrative synthesis of up-to-date randomised controlled trials (RCTs) of already conducted ergonomic training interventions at workplaces to reduce the risk of MSD among computer users with a view to provide evidence on its effectiveness and thus inform policy on improvement of work practises.

Methods: Searches for RCTs were conducted on 15 databases, journals and grey literatures between March and September 2014 and retrieved studies were exported to Refworks. After application of the inclusion and exclusion criteria, out of 33 studies appraised, 13 studies ranging from average to high quality based on the methodology and results were included in the review. Included studies were critically screened and extracted data were narratively synthesized.

Results: The synthesis of included studies showed statistically significant reduction in MSDs in the neck, shoulder, fingers, wrist, elbow/forearm, lower back, upper back, foot and trunk. One study recorded a reduction in symptoms such as cervico-thoracic myalgia, numbness, weakness and nocturnal exacerbation, though not statistically significant. While reduced effects were widely reported across studies, it was not maintained at long-term follow-up in some studies. Findings suggest that the method of training delivery influenced the duration of effects across the studies.

Conclusion: Findings suggest that ergonomic training interventions are effective in reducing the risk of MSDs. However, across the studies, the method of training delivery influenced the long-term and short-term effects. Computer users who experience MSDs may benefit on a long-term basis from ergonomic training interventions designed to visually engage, instigate participation and offer application assistance/supervision. However, this review identified areas for further research into the impact of ergonomic training interventions on absence from work and productivity.

Keywords: Ergonomic training; Musculoskeletal disorders; Computer users

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Introduction

Musculoskeletal disorder (MSD) commonly referred to as repetitive strain injury is a term used to describe a variety of conditions affecting the muscles, bones and joints in the back, lower and upper limbs and the neck [1,2]. The European Agency for Safety and Health at Work [3] defines MSDs as impairment of the body structure such as muscles, joints, tendons, ligaments, nerves, bones or a localised blood circulation system caused or aggravated by the performance of work and by the effects of the immediate environment where the work is carried out. These injuries cause pain, ache, weakness, discomfort, and numbness, tingling and swelling [4].

Since the 1980s, MSDs have been considered one of the fastest growing occupational injuries [5]. According to Robinson [5], the Occupational Safety and Health Administration (OSHA) [6] attributed the disorder to changes in process and technology. They concluded that these changes in process and technology poses risk factors such as; prolonged exposure to repetitive tasks, awkward and improper posture, excessive use of force or pressure, lack of adequate rest and inappropriately designed workstations, thus resulting in MSDs.

In a survey carried out by the Institution of Occupational Health and Safety in 2011/2012, it was estimated that 439,000 workers suffered from MDSs caused or made worse by their current or past work [7]. Approximately 176,000 of these workers suffered from back pain, 177,000 suffered from upper limbs and neck problems while 86,000 suffered from lower limb problems [7]. Between 2011/2012 and 2013/2014 the number of new cases with MSDs increased from 141,000 to 184,000 [8], suggesting that attempts at addressing the issue is unsuccessful. According to Lewis et al. [9], studies suggest that incident of MSD is of higher prevalence among computer users compared to non-computer users. The major causes of musculoskeletal issues among computer users are generally thought complex and controversial. However, authorities believe that environmental, organizational and individual factors contribute to its onset [10]. Workers who have high work strain, lengthier mouse and keyboard use, perceived high muscle tension and previous musculoskeletal disorders in the neck and shoulder are at risk of developing MSDs [11]. While Norman et al. [12] suggests that disorder of the hand and wrist is associated with long term use of keyboard; the mechanism involves a repetitive finger motion and sustained muscle activity in the forearm. Which agrees with Kryger et al.'s [13] findings that intensive keyboard task alongside job demands and postural stress are associated with MSDs among computer users. All these factors contribute to the onset of MSD among computer users and when not properly treated for, condition gets worse and eventually affects worker's ability to work.

Varying primary researches has been carried out to address the issue of MSD among computer users. However, to date there does not appear to be a systematic review on specifically the effectiveness of ergonomic training in reducing the risk of musculoskeletal disorder among computer users. Although Hoe et al.'s [14] study attempted to consider its effect, training was not evaluated as a single intervention. Hence, the inability to draw a conclusion on its effectiveness from such findings. The study sought to ascertain whether ergonomically designing work environment as well as training staff was effective in preventing work-related musculoskeletal disorders especially in the upper limb and neck in adults. His findings yielded supporting evidence that providing computer users with arm support and alternative keyboards may reduce the incidence of neck and shoulder musculoskeletal disorders. These findings however did not draw conclusions on how training impacted on the observed effect.

Over the years, the issue of work-related injuries/illnesses has resulted to significant cost to employers. According to Shapiro [15], the total cost of chronic musculoskeletal disorders in the United States was estimated at $200 billion and two-thirds of this cost was attributed to compensating the injured. While in Britain, 2012 recorded a total of £813 and £516 million cost on work-related injuries and illnesses for both known and unknown industries respectively [16]. In a case study reported by the Health and Safety Authority [17] a judge ruled in favour of an employee against the employer. The employee was awarded damages of £243,792 after employee developed musculoskeletal disorder as a result of working at a poorly designed computer workstation. Evidence showed that employer failed to carry out necessary risk assessment on the work and the workstation thereby failing to put in place preventive and protective measures to guard against injury. The employer also failed to train the employee, which heightened the exposure to risk factors working on a computer workstation poses. This case highlighted the implication of not implementing necessary risk management systems for workers who work at the computer workstations in order to prevent the incident of musculoskeletal disorders.

Considering the goal of every employer is to make profits and it would take the efforts of healthy, skilled and knowledgeable employees to achieve this. It is therefore imperative to conduct this systematic review with a view to ascertain findings that would improve the health and safety of employees reduce cost on claims and boost productivity. According to the Health and Safety Authority [17], though there is strong evidence of the effectiveness of ergonomic interventions in general, there is little proof of the effectiveness of ergonomic training interventions. Therefore it is important to gather evidence to support its effectiveness, which may inform policy and encourage further study into the subject area.

Objectives

The objectives of this review include:

1. To identify factors that act as either barriers or facilitators in the use of ergonomic training interventions.
2. To observe the varying changes that occurs in the different body areas before and after applying the ergonomic intervention.
3. To determine if differences exist between studies in method of intervention dissemination which may influence duration of outcome?
4. To determine if a significant difference exists between results in the intervention groups and the control groups (Where the control groups refer to computer users that will either receive or not receive alternative interventions).

Literature Review

The systematic review was conducted in line with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.

Inclusion criteria and search strategy

A search strategy based on PICOS strategy was formulated.

According to Khan et al., [18] the inclusion and exclusion criteria should follow on logically from the review question defined in terms of the population, intervention, outcome and study design of interest. Only studies that ultimately met all of the inclusion criteria were included in the review. This was to ensure that decisions made on selection of studies were free of bias, transparent and reproducible.

The inclusion criteria were thus designed as shown in **Table 1.** In identifying relevant literatures for a systematic review, it is crucial that search must be sensitive, specific, thorough and driven by the desire to capture as many relevant studies as possible [18,19]. This ensures that the search strategy is unbiased and reproducible. Based on this, a comprehensive search of relevant electronic databases including published and unpublished research, grey literature and reference list of both primary studies and reviews was conducted. With help from the University of the West of England (UWE) librarian, a preliminary initial search to ensure relevant databases were fully utilized was carried out. Varying search techniques, which were **Supplementary Table 1** constantly modified with a view to retrieve available literatures meeting the eligibility criteria, were applied. See for the search terms that were adopted during the course of the search.

Search was conducted on between March 2014 and May 2014 and subsequently between June 2014 and September 2014 on 15 databases: Business Source Premier, Cinahl, Cochrane Library, Ebosco Host, Embase, Google Scholar, Medline, Pedro, Psyc Info, Pubmed, Sage Journals, Science Direct, Sport Discus, Web of Knowledge and Wiley Online Library.

Selection strategy

The initial search returned a total of 13,344 references related to ergonomic training and its impact on the risk of developing musculoskeletal disorders. However based on the relevance to the research aims, a total of 3,388 citations were eligible for potential inclusion and exported to Refworks (**Supplementary Table 2** for a summary of the search results on each database). Identified studies were initially screened according to the title and abstract which returned a total of 2,115 citations. On further full-text screening based on the inclusion and exclusion criteria, more reviews were excluded due to duplication and unsatisfactory outcomes in the results leaving a total of 33 studies for inclusion in the second stage of critical appraisal. **Supplementary Table 3** for a list of the included studies. A flow chart was developed to show the transparency of the selection strategy and a high degree of inter-rater reliability **(Figure 1).**

Table 1 Inclusion criteria.

Participants	Studies that report on computer users working for not less than 5 hrs in a week
Intervention	Studies that report on ergonomic interventions relating to computer workstation (Especially on training intervention)
Outcome	Studies that report on the reduced risk of MSD
Study Design	Randomized controlled trials

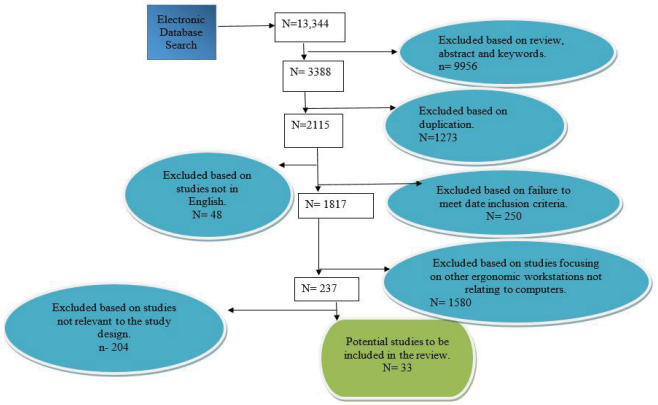

Figure 1 Flow chart showing search strategy.

Data extraction and evidence synthesis

To minimize the likely errors or biases that may occur at this stage, a simple standard data extraction sheet (**Supplementary Table 4**) was designed using the PIOS (Population, Intervention, Outcome and Study Design) strategy based on how the research question was formulated with a view to obtain all the relevant information from included studies [18]. This helped to gain a deeper understanding of the evidence in order to prevent error in interpretation as well as enhanced transparency of the method of analysis (*ibid*.). A test analysis was carried out on 2 papers with the aim of ascertaining variation in extraction which made for necessary adjustments. After the pilot extraction of data, on consultation with the supervisor it was agreed that the information was lengthy and difficult to read hence the need to modify and restructure it in a less complex manner and at the same time be careful to present relevant information. Therefore to achieve this, the extraction from included studies will be displayed in two tables with a view to include all necessary information **(Supplementary Tables 5 & 6).**

Analysis of findings can either be conducted quantitatively using statistical techniques such as meta-analysis or through a narrative approach [19]. For the reason that the research question is focussed on evaluating the effectiveness of an intervention in reducing the risk of musculoskeletal disorder and the included studies are all randomized controlled trials, the Meta-analysis technique would be the appropriate approach in combining the results [20]. However, after consultation with the supervisor and a supporting lecturer, it was agreed that rather than a meta-analysis, a narrative approach would be most efficient in combining results from individual studies since the individual studies are diverse in method and effects, hence combining them to produce an overall statistical outcome would be inappropriate and misleading. This was decided with a view to effectively prevent error in interpretation. The narrative approach provides more details on the strength and weaknesses of included studies. It allows for easy identification of similarities and differences in results.

Quality evaluation

The next stage of critical appraisal was aimed at assessing both the internal (design, conduct and analyses) and the external (population, exposure and outcome measure) validity of the study [18]. This was conducted using the Critical Appraisal Skill Programme (CASP) tool kit. Because the review is on intervention studies (Randomized Controlled Trials), the CASP tool kit was chosen as the most appropriate for the assessment as the questions were relevant to the research. However, two of the questions had to be modified with the aim of obtaining either a Yes, No or Can't Tell answer as was the initial concept of the structured response provided for most of the questions.

The CASP checklist for Randomised Controlled Trials comprises of 11 questions. 9 of which were structured with a Yes, No or Can't Tell response. However, the remaining 2 questions which did not have these structured responses were modified as thus:

- "How large was the treatment effect?" was modified to "Was the treatment effect large?"
- "How precise was the estimate of the treatment effect?" was modified to "Was the estimate of the treatment effect precise?"

These questions were all modified with a view to obtain either a Yes, No or Can't Tell response. Refer **Supplementary Table 7** for summary of quality assessment.

The author chose to review only Randomised Controlled Trials because it was the most efficient way of measuring the effectiveness of an intervention as well as the fact that the comparison groups are usually balanced for known, unknown and unmeasured variables which minimizes the effects of bias on the results [18]. The author considered using the scoring system to grade the quality of the studies, but according to CRD [19], using quality scores is problematic, hence the recommendation to rather consider the individual aspects of the methodological quality in the quality assessment and synthesis. Therefore the author chose to grade each of the studies with justification based on three important criteria as shown below:

1. Studies that report statistical significance thus ensuring results obtained were not due to chance.
2. Studies that report appropriate statistical methods and tests used in the analysis to prevent misleading results. For example, looking out for studies where participants were selected from proper randomization and both participants and interviewers are blinded.
3. Findings from studies that were reported should be generalizable as this is characterized by how well the study performed on other appraisal questions in the checklist.

Based on these criteria, papers which passed the 3 selection measures were graded A (where A is a study that is well conducted and reported and about which, the author had no concerns), other papers which did not pass all the questions were graded B (where B is a study where the author had some concerns with the way study was conducted or reported but did not think they are severe enough to reduce the validity of the findings), while papers which did not pass up to two of the criteria were graded C (where C is a study where the author had concerns about the study design, conduct or reporting and ultimately believed the findings may not be valid).

At the end of this appraisal, 12 studies were graded A, 13 studies were graded B and 8 studies were graded C. On consultation with the supervisor, consent was given to include eight of the B graded studies as though flaws existed; it was properly controlled for and produced statistically significant outcomes. After conducting the critical appraisal process thrice using checklist to exclude errors, a total of 20 papers (12 A graded studies and 8 B graded studies) were selected as being eligible for the systematic review. However, on consultation with the supervisor 20 papers were considered too much for the review, bearing in mind the limited time frame required to analyse and synthesize these studies. Therefore with a view to minimize error in interpretation and avoid covering much materials in not very much depth, further critical analysis was thus conducted and 13 studies (7 A graded studies and 6 B graded studies) with specific focus on the varied significant outcomes from the training intervention was finally selected for the systematic review. Given the short time frame, this decision was considered best, as combining the results from a reasonable amount of studies in a clear and concise manner would be easy to achieve.

Results

Synthesis results

This section displays a detailed analysis of the health outcomes reported in the 13 individual studies. This was reported according to the intervention in review and its effect on the different body regions assessed. Refer **Supplementary Table 8** for a brief description of the participant's demographics (age, ethnicity and gender), their job type as well as duration of work time, which is likely to expose them to the risk of MSDs. Since evidence suggests that improper posture and non-ergonomic computer workstation is a major risk factor for the development of MSDs, this table also identifies other possible risk factors that may have contributed to the onset of MSDs and thus compounded or heighten the outcome from the studies.

From **Table 2,** 10 studies reported consistent reduction in musculoskeletal pains in the neck and shoulder, 5 on the upper back, 5 on the lower back, 6 on the elbow/forearm, 1 on the foot and 2 on the trunk. While **Table 3** reports improvement in musculoskeletal symptoms. Symptoms such as; cervico-thoracic myalgia (pain originating in the neck), numbness, weakness and nocturnal exacerbation cases. From these studies, it can be deduced that ergonomic training intervention does impact positively on the risk of musculoskeletal disorders.

Initial synthesis of themes on direct health outcomes

Health outcomes in the different body regions were considered based on the ergonomic interventions in review.

Table 2 Training outcomes.

S/N	Author/Year/Reference	Neck	Shoulder	Wrist	Elbow/ Forearm	Fingers	Upper Back	Lower Back	Foot	Trunk
1	Amick et al., 2003 [28]	√	√				√	√		
2	Bernaards et al., 2006 [30]	√	√							
3	De Vitta et al., 2008 [36]	√	√	√	√	√			√	√
4	Greene et al., 2005 [39]	√					√			
5	Ketola et al., 2002 [42]	√	√		√		√			
6	Mirmohammadi et al., 2009 [47]	√	√	√	√					√
7	Norashikin et al., 2011 [48]	√	√		√			√		
8	Rempel et al., 2006 [51]									
9	Taieb-Maimon et al., 2010 [56]	√	√	√	√	√	√	√		
10	Voerman et al., 2007 [59]	√	√							
11	Robertson et al., 2012 [54]	√	√					√		
12	Yafa et al., 2012 [60]	√	√	√	√		√	√		

Note: Where √ indicates improvement in musculoskeletal pains in the different body regions.

Table 3 Training outcomes continued.

Author/ Year/Reference	Cervico-Thoracic Myalgia	Tingling	Numbness	Weakness	Nocturnal Exacerbation
Joshi et al., 2011 [41]	√		√	√	√

Note: Where √ indicates improvement in musculoskeletal pains in the different body regions.

Training Intervention: The effect of training in **Table 2** show an improvement/reduction in musculoskeletal pains and symptoms especially in the neck and shoulder and in the elbow/forearm, lower back, upper back, and finally in the wrist, fingers, foot and trunk. While **Table 3** shows an improvement in symptoms such as cervico-thoracic myalgia, numbness, weakness and nocturnal exacerbation. However some of these results were not maintained at long-term follow up. Which supports Scheer et al.'s [21] position that though ergonomic training interventions is the most widely acceptable form of intervention, it generally produces short-term benefits. Evidence from one study suggests that results may not have been maintained at long-term follow up due to a wide range of factors which may include; the difference in training method across studies or participant's inability or refusal to continue with the proposed working posture/style or their inability to understand the content of the training sessions [3]. In one study, participants complained of too much information at the training program thus preventing ease of assimilation resulting in a high drop-out rate in the study [2].

Although different studies reported different outcomes in different body areas and outcomes maintained at either short-term or long-term time frame, results across studies suggest that ergonomic training intervention does contribute to reducing the risk of musculoskeletal disorders among computer users.

Discussion

Main findings

The main aim of the review was to evaluate the effectiveness of ergonomic training intervention on reducing the risk of musculoskeletal disorders among computer users. Thirty three randomized controlled trials met the inclusion criteria to be included in the final review, however at the quality appraisal stage, only thirty studies was added in the final review. The heterogeneity of the studies included in the review explains the decision to narratively synthesize data instead of a meta-analysis.

Findings from these studies suggests that the duration of outcome may be influenced by the style of training delivery. This agrees with the views of both Scheer et al.'s [21] and Ergonomic Tech Corp. [22] that both the quality of information and training methodology explains the failure in achieving long-term outcomes. 9 studies evaluated training interventions, which included instructional videos, power point presentations, posters, hand-outs, practise sessions and assistance from trainers on how to adjust workstations and adopt proper working posture [1,2,3,4,7,8,13,10,12]. The program focused on teaching participants the basics of office ergonomics, risk factors in computer work and workstations, appropriate working posture and proper usage of keyboards and mouse and proper positioning and adjustment of the chair, desk, monitor, keyboard and mouse. The practise sessions allowed participants to practise proper working styles on their workstation and properly adjust and position their work equipment as trained. Where participants found difficulty adjusting as required, trainers assisted and advised on proper work style. Participants were closely monitored and supervised until proper measures were fully adapted into their work style. At the end of the training program, results in 8 out of the studies showed a reduction in musculoskeletal issues in the neck, shoulder, wrist, elbow/forearm, fingers, upper back, lower back, foot and trunk and these outcome were maintained at long-term follow up in 7 studies. One month follow-up in one study showed outcome was maintained. However, a longer follow-up was suggested to accurately conclude on effects [7].

While 4 studies evaluated training interventions, which only involved oral/verbal presentation and advice on how to adjust workstations and adopt effective physical activities and correct postures with a view to reduce the incidence of MSDs

[5,6,9,11]. Participants were instructed concerning the principles of ergonomics in computer work and they were thus advised to adapt ergonomic measures into their working style and adjust workstations and equipment were necessary. Trainers encouraged participants to evaluate their workstation, work task and work method and implement changes on their own. Observations were recorded in the risk inventory checklist provided with a view to review progress and recommend possible improvement strategies based on the outcomes. After the training program, results showed a reduction in musculoskeletal issues in 3 studies, however these observed outcome were not maintained at long-term follow up, while one study after intervention showed no significant outcome at all in the different body regions evaluated. However, across the studies significant improvement in musculoskeletal issues were recorded among participants in the training group compared to the control group (alternative intervention).

The difference in effects in both training method may have been heightened due to the fact that participants who were only verbally trained and advised had no practical sessions or supervision from trainers. It is possible that participants only applied ergonomic measures to their working style for the duration of time they could remember what they were trained on. Over the course of time, this was forgotten and workers reverted back to normal working style especially as they were not monitored on compliance. Showing that participants were not effectively engaged, monitored and thus motivated in the training program to make long lasting changes in their work behaviour and workstation organisation which may have accounted for the short-term outcome. According to Greene et al. [10], this training approach generally does not facilitate active participation or problem-solving. Individual knowledge and skills were not increased as such participants were unable to integrate multiple preventive strategies that would impact on their condition.

As opposed to the other training category, where participants were fully engaged through visual aids and hands on practise sessions with assistance from the specialised trainers. This shows that workers were however motivated to learn, remember and apply what they learnt and practised thereby promoting behavioural changes which impacted on their musculoskeletal condition as observed. Agreeing with Karsh et al.'s [23] findings that participants will only make lasting changes to their work-style if they are able to see the intervention in use try it out and know how to access it. The training approach stimulated active participation and participants increased in their knowledge and skills on posture and workstation organization. This enabled them apply preventive strategies as advised in their work-style. In one study, participants reported that the training program was clear and helped them understand the effects of the seated posture and how to apply preventive measures which was effective in reducing musculoskeletal pains and symptoms [3]. This study also reported that the 84.37% of the participants in the training group attested to the fact that the program helped in changing organization of materials on the desk, correct positioning of the monitor, regulating of the height and position of the monitor and chair with objects such as books and others.

However, this raises concerns about the willingness of employers to invest in quality training programs that will achieve significant results. Are they willing to monitor employees with a view to ensure they are applying necessary safety measures to prevent injuries? Are they willing to offer support to employers by monitoring and supervising compliance to ergonomic based work behaviour? If Employers are keen about the health and safety of their employers and set on reducing the cost on compensation, quality training programs targeted at engaging and motivating workers will be effective in producing long-term reduction in musculoskeletal symptoms.

Notwithstanding the difference in methods and results across studies, results revealed a consistent reduction in musculoskeletal pains especially in the neck and shoulder. Thus indicating that computer users who experience musculoskeletal disorder may benefit from ergonomic training interventions. However this would require visually engaging workers, organising hands on practise sessions and monitoring their work to ensure proper application. This agrees with the findings from the work of Cole et al. [24] that interventions targeted at instigating participation from participants are effective in addressing musculoskeletal injuries. These findings are consistent with a number of other related studies on ergonomic training intervention as a the Liberty Mutual Research Institute for Safety [25] stated regarding one study that workers who receive training interventions are able to successfully translate knowledge from training into appropriate behaviours thereby resulting in reduced musculoskeletal issues [1]. Furthermore, Robertson et al. [26] observed that participants who received ergonomic training did not only demonstrate a significant increase in office ergonomic knowledge but they were given adequate time to practise these skills. These practise sessions as observed influenced the behaviour of participants positively resulting in minimal musculoskeletal discomfort. Consolidating the Health and Safety Authority's [17] conclusion that effective training programs include practise and supervisory sessions.

Strengths, limitation and gaps in evidences

Apart from the fact that a systematic review was the best method to answer the research question, this review focused on only randomised controlled trials (RCTs) which according to Pope et al. [27] is the best method for evaluating the effectiveness of an intervention. Making this a major strength of this review. The review process was thorough, transparent and reproducible and the critical appraisal method allowed for inclusion of high quality papers with minimal bias with no conflicting interest.

Though adequate precaution was taken at each step of the review to prevent any possible bias, it is still subject to limitations which could influence conclusions drawn upon.

According to Khan et al. [18], to minimise bias and error, a minimum of two researchers and a peer reviewer would be necessary. However this was not possible as this work required an independent effort. Considering databases searched was not exhaustive and due to technical issues some papers could not be accessed, relevant published and unpublished trials may have

been left out leading to publication bias. The decision not to include books, newspaper publications, magazines and articles may have also introduced some form of publication bias as well. The exclusion of studies not published in English as a result of cost in translation may also have introduced language bias. Out of 13 studies included, 7 studies were graded A, while 6 were graded B. Inclusion of B studies may have increased the risk of bias in the results. However, the risk in all studies were accounted and controlled for. It is important to note that findings may have been limited from imprecise estimates as a result of small sample size in some studies.

Across the studies included, both male and female participants were recruited for the intervention. However, it was observed that a higher number of female participants were recruited which may have influenced the outcome. Further research would be necessary with either a balanced number of male and female participants or a higher number of male participants to observe whether effects were influenced by gender and therefore results cannot be generalised [28-59].

Considering the incident of musculoskeletal disorder impacts on days lost to work thus impeding productivity, a search across studies revealed that there are currently no studies reporting on the impact of ergonomic training interventions on days lost to work and productivity. Therefore, further studies would be relevant to observe whether a reduction in days lost to work will be attained, thus boosting productivity.

Recommendations

The aim of this research was to provide evidence suggesting that ergonomic training intervention is effective in reducing the risk of MSDs among computer users. Different studies reviewed have drawn upon the fact that working on a computer increases the likelihood of developing MSDs and statistics shows an increase in new cases of MSDs, thus increasing days lost to work, cost on compensation and possible decline in productivity. Making this a concern for employers.

Therefore, the following recommendations are proposed as possible means to address the issue of MSDs.

1. Findings from the study revealed that training programs targeted at visually engaging workers and allow for practice sessions were effective at achieving long-term reduction in musculoskeletal pains and symptoms. Therefore, employers must ensure regular quality training programs are invested in to adequately engage workers and provoke behavioural changes that will impact on their musculoskeletal scores.
2. Results from the research suggest that lack of monitoring/supervision of workers at work also contributed to the short-term health outcomes observed. Therefore, regular monitoring/supervision of worker's sitting posture and workstation organisation should be promoted to help reduce the risk of workers developing MSDs or worsening already existing conditions.
3. In line with the Management of Health and Safety at Work Regulation (28), employers must ensure adequate risk assessment of computer workstations have been carried out and necessary preventive and protective measures put in place to reduce the risk of musculoskeletal disorders to as low as is reasonably practicable.
4. Regular health surveillances should be advocated by employers to aid early detection of disorders/injury and thus necessitate provision of additional training. This would also aid occupational health and safety officers at workplaces monitor progress of health condition and determine if further training would be required.
5. Considering the issue of musculoskeletal disorder is a global issue, Public and Environmental health practitioners should be actively involved in the fight against the issue by advocating support visits to businesses both in the private and public sector targeted at offering advice and training sessions to both employers and employees on issues relating to musculoskeletal disorders.

Conclusion

To conclude this review, find below a summary of how this research has met its set objective.

1. To identify factors that act as barriers or facilitators in the use of ergonomic training interventions.

The result analyses revealed the varying barriers and facilitators of ergonomic training interventions which may include:

Facilitators: Availability of ergonomic experts; Availability of useful resources and materials to adequately engage participants; Active participation by both workers and their employers; Proper supervision/monitoring of participants at work.

Barriers: Lack of active participation by workers and their employers; Lack of adequate resources and materials to engage participants; Lack of proper supervision/monitoring of participants at work; Cost of training program.

2. To observe the varying changes that occurs in the different body areas before and after the intervention. Across the studies, result showed a reduction in musculoskeletal pain in the neck, shoulder, wrist, elbow/forearm, fingers, lower back, upper back, foot and trunk. Musculoskeletal symptoms such as cervico-thoracic myalgia, numbness, weakness and nocturnal exacerbation also reduced at the end of intervention compared to the baseline figures taken before intervention.
3. To determine if differences exist between studies in the method of intervention dissemination which may influence

outcome? Across the studies, training interventions were delivered either to include visual aids, practise sessions and assistance/supervision from trainers or as an oral presentation with a view to only offer advice. Results showed that training programs with visual aids, practise sessions and assistance/supervision from trainers was effective in maintaining long-term outcomes thus making it the most effective approach at achieving a reduction in risk of MDSs among computer users.

4. To determine if a significant difference exists between results in the intervention group and the control group.

Results across the studies showed significant reduction in MSDs among participants in the intervention group compared to participants in the control group.

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Conflicts of Interest

None declared.

Authors' Contributions

Abasiama Etuknwa was the lead author and contributed to the study design, screening process, eligibility process, data extraction, methodological quality evaluation, data analysis and write up (as a reviewer). Sharon Humphries was the study supervisor and contributed to the screening process, the eligibility process, data extraction, revised the paper critically and contributed to it intellectually. All the authors have read and approved the final version of the manuscript.

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