
PUBLIC HEALTH RESEARCH

Modified Initial Era Checklist for Screening Ergonomics Risk Factors in Diagnosing Work-Related Musculoskeletal Disorders

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ABSTRACT

Introduction	Work-related musculoskeletal disorders (WRMSDs) are known to affect a diverse range of occupations around the world. One major factor for their occurrence is the presence of ergonomics risk factors in the workplace; as such, steps to minimise WRMSDs in Malaysia include the development of the Initial Ergonomics Risk Assessment (ERA) checklist for on-site assessors. The checklist, however, may not be useful for medical doctors who diagnose WRMSDs in hospitals or clinics. Moreover, there is no tool to assist medical doctors in considering the role of ergonomics risk factors when diagnosing WRMSDs, which can hamper the overall management of occupational diseases. This study was therefore carried out to modify the Initial ERA checklist so that medical doctors can use it to consider the role of ergonomics risk factors when diagnosing WRMSDs.
Methods	In Phase I, document analysis was performed to construct the tool by integrating elements that were relevant for use in hospitals or clinics from the Initial ERA checklist and similar tools published overseas. In Phase II, the tool was reviewed by medical doctors and nurses and was found to have excellent content validity (I-CVI = 1.00). In Phase III, the tool underwent further improvement after trailing its application in two role-play sessions involving various healthcare professionals.
Results	The resulting Modified Initial ERA Checklist can assist medical doctors screen for various ergonomics risk factors when diagnosing WRMSDs in hospitals or clinics.
Conclusions	Future studies could further examine its application in the field to validate its actual use in hospitals or clinics.
Keywords	Work-related Musculoskeletal Disorder; Occupational Health; Ergonomics

Article history:

Received: 8 September 2024

Accepted: 16 April 2024

INTRODUCTION

Work-related musculoskeletal disorders (WRMSDs) are a group of non-communicable occupational diseases that can afflict the muscles, tendons, ligaments and other components of the musculoskeletal system.¹⁻³ Besides physical discomfort, pain and disability, WRMSDs can affect a person's mental health and productivity, and therefore, in the long run, the economy.⁴ WRMSDs are global problems and can occur in various industries. For example, 37% of low back pain that occurs worldwide is likely work-related, and they affect workers such as clerks, service workers, tradespersons, farmers and operators.⁵

Ergonomics risk factors such as awkward posture and repetitive movement are believed to contribute towards WRMSDs.⁴⁻⁶ Thus, the reduction of occupational exposure to ergonomics risk factors can minimise or prevent WRMSDs. Because of that, tools such as the Concise Exposure Index (OCRA), Rapid Office Strain Assessment (ROSA) and Rapid Upper Limb Assessment (RULA) have been developed to identify and assess ergonomics risk factors in the workplace.⁷⁻⁹ In Malaysia, the Department of Occupational Safety and Health (DOSH) published a tool called the Initial Ergonomics Risk Assessment (ERA) checklist to improve the identification and assessment of ergonomics risk factors in the workplace (2017). Unlike tools such as OCRA, ROSA and RULA, the Initial ERA checklist can be used for various types of workplaces, tasks and ergonomics risk factors. On the other hand, the checklist may not be as comprehensive for certain tasks or ergonomics risk factors as other tools, and therefore, the checklist's use may need to be followed up with the use of tools such as OCRA, ROSA and RULA.

While ergonomics risk assessment tools like the Initial ERA checklist have the potential to improve ergonomics risk identification and assessment in the workplace, there may still be gaps in other aspects of the ergonomics risk management process, particularly in medical examination of workers. Despite medical doctors' roles in reporting occupational diseases to DOSH and consulting patients and sometimes employers about occupational diseases, there is still no tool to assist them in screening ergonomics risk factors in diagnosing WRMSDs, as tools such as the Initial ERA checklist were meant to be used by trained persons at the workplace. There is also little evidence in the literature that such a tool has been developed for medical doctors elsewhere. Even though a patient risk assessment system was developed for primary care, but it did not include a specific tool for ergonomics risk assessment.¹⁰ This gap needs to be addressed because medical doctors should be facilitated in managing WRMSDs.¹¹ Therefore, this study was conducted to examine the validity of a modified Initial ERA checklist. The

intention behind its development was to assist medical doctors in screening ergonomics risk factors for diagnosing WRMSDs in clinics or hospitals in the future. The Initial ERA checklist was chosen for modification because the checklist serves as the main reference for ergonomics risk assessment by regulators and practitioners in Malaysia.

METHODS

In Phase I, a document analysis was carried out to determine the sections of the Initial ERA checklist that could be used by medical doctors in clinics or hospitals.^{12,13} For example, the section on awkward postures in the Initial ERA was considered suitable because these could be discussed with patients using pictures of various awkward postures. Conversely, the section on weight limit for lifting or lowering task would require observation of the task and workstation to be completed, and therefore was considered unsuitable.

The sections from the Initial ERA checklist considered suitable for use in clinics or hospitals were then compared to the following tools from other countries: 1) Checklist for the Prevention of Manual Handling Risks,¹⁴ 2) Ergonomics Guidelines for Manual Handling,¹⁵ 3) Ergonomic Guidelines for Manual Material Handling,¹⁶ 4) MSD Prevention Toolbox,¹⁷ 5) Hazardous Manual Handling Risk Assessment Form,¹⁸ 6) Manual Task Risk Management Form,¹⁹ 7) Manual Handling Operations Regulations 1992,²⁰ and 8) Ergonomics Checkpoints.²¹ Contents from these tools considered suitable for use in clinics or hospitals were merged with the selected sections of the Initial ERA checklist. For example, 'crawling' and 'standing imbalance' were listed as awkward postures in the Hazardous Manual Handling Risk Assessment Form and Manual Task Risk Management Form; these were merged with the selected sections from the Initial ERA checklist. The outcome of this merger was the Modified Initial ERA Checklist version 1.

In Phase II, eight participants were recruited in focus-group discussions to determine the content validity index (CVI) of the modified checklist. Six of the participants were medical doctors and two were nurses. The participants were briefed about the checklist for half an hour before they provided feedback about its design. Four of the medical doctors then rated the checklist's CVI, which was measured according to item-level content validity index (I-CVI), where an I-CVI > 0.79 means the checklist is relevant, while an I-CVI = 1.00 would indicate the checklist has excellent content validity.²²⁻²⁴ The participants' feedback was then used to improve the checklist, the outcome of which was the Modified Initial ERA Checklist version 2.

In Phase III, 36 participants were recruited to trial the second iteration of the modified checklist. 17 of the participants were medical doctors, four were nurses, eight were occupational health

practitioners, five were academicians, and two were research and science officers. The participants were briefed about the checklist for one hour and were handed a manual on using the checklist. This was followed by two role-play sessions,²⁵ where the first involved a worker experiencing musculoskeletal pain due to occupational exposure to static posture. The second role-play involved a worker experiencing musculoskeletal pain due to lifestyle factors. In both role-play sessions, the participants were given opportunity to ask the role-players questions and use the checklist to determine if the musculoskeletal pain experienced by the workers was associated with occupational exposure to any ergonomics risk factors. After the role-play sessions were completed, the participants were required to provide feedback about the checklist's design to improve its usability and future adoption rate. This led to the third and final version of the Modified Initial ERA Checklist.

This study obtained ethical approval from the International Islamic University Malaysia (IIUM) Research Ethics Committee (IREC 2020-035). Among others, participants voluntarily took part in this study and could withdraw at any point during the study without any repercussion. The participants' information was stored in a secure location to maintain confidentiality.

RESULTS

The Modified Initial ERA Checklist developed in Phase I comprised of two main parts. The first part or Section A was for recording the worker's information such as name, occupation, industry, smoking status, existing conditions and complaints. The second part or Sections B-G was for recording the worker's occupational exposure to ergonomics risk factors. Section B consisted of pictures of various awkward postures so that the user and the

worker can discuss their workplace occurrence (see Figure 1 below). Sections C-G had statements pertaining to static posture, forceful exertion, repetitive motion, vibration and environment. In Sections B-G, the user can tick any of the picture or statement to indicate the possible presence of the ergonomics risk factors in the worker's workplace (see Figure 2 below).

Phase II showed that the modified checklist had excellent content validity, as the checklist's I-CVI = 1.00, where its relevance, clarity, simplicity, and ambiguity were all rated as 1.00. Despite this finding, participants in Phase I suggested the checklist could be improved by adding a body map illustration to ease the process of recording site of body pain in Section A.²⁶ Furthermore, the checklist was also modified to record the worker's occupational history and hobby in the same section. Another important change was the addition of Section H, which provided users with a guide for their next course of action (see Figure 3).

In Phase III, trial of the Modified Initial ERA checklist through role play sessions successfully collected feedback from participants on how to improve the checklist. These included suggestions to add more content and rearranging the layout for recording the worker's information in Section A so that it was more similar to the Guidelines on Medical Surveillance.²⁷ The additional content would enable the user to record ethnicity, marital status, number of cigarettes smoked, number of years as a smoker, BMI, heart rate and blood pressure of the worker. Another suggested improvement was for the body map illustration in Section A to only illustrate the anterior of the human body to decrease the risk of confusion to users (see Figure 4). All these suggestions were then incorporated in the final iteration of the Modified Initial ERA Checklist which had four pages in total.

Section B. Awkward Posture

Select any posture that was sustained cumulatively or continuously during work for a total of 2 hours or more a day.

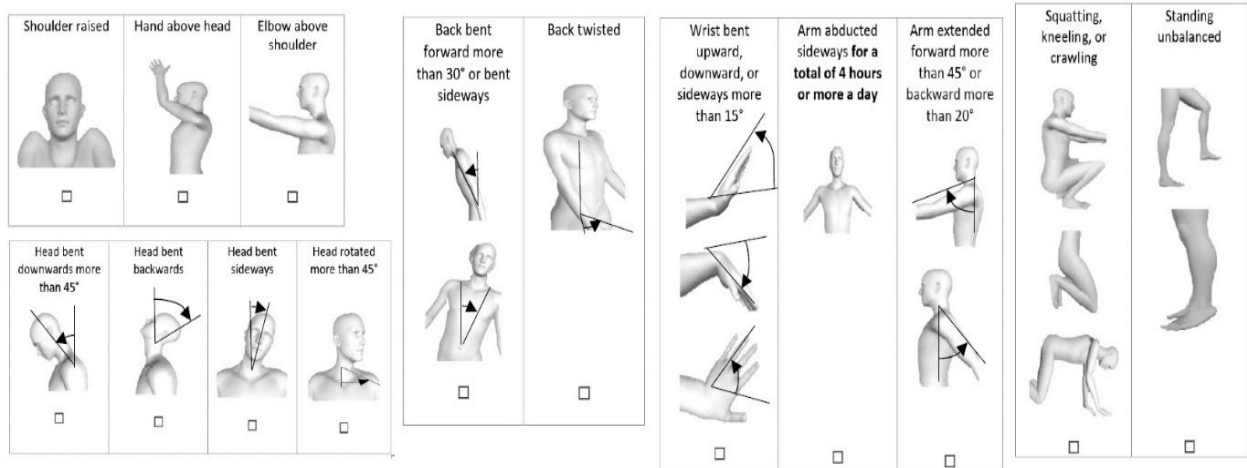


Figure 1 Examples of awkward postures illustrated in Section B

Section D. Forceful Exertion

Lifted or lowered object beyond the permissible weight limit (refer Appendix for weight limit)	<input type="checkbox"/>
Handled an object more than 5kg for male or 3kg for female while seated	<input type="checkbox"/>
Pushed or pulled to initiate or halt movement of wheeled object weighing over 1000kg for males and 750kg for females	<input type="checkbox"/>
Pushed or pulled wheeled object weighing over 100kg for males and 70kg for females to maintain motion	<input type="checkbox"/>
Pushed or pulled object for more than 20m	<input type="checkbox"/>
Pushed or pulled object using a poorly maintained handling aid such as trolley	<input type="checkbox"/>
Force applied with hands between shoulder and knuckle height	<input type="checkbox"/>
Carried object for more than 10m	<input type="checkbox"/>
Carried object along a steep slope, slippery floor, or obstacles	<input type="checkbox"/>
Environmental factors such as poor lighting present during carrying	<input type="checkbox"/>
Lifted/lowered/carried/pushed/pulled object was not easy to hold	<input type="checkbox"/>

Section E. Repetitive Motion

Repetitive action involving the neck, shoulders, elbows, wrists, hands, and knees occurring more than twice per minute for over an hour without breaks, or for three hours with breaks	<input type="checkbox"/>
Used the palm or knee as a hammer for more than 2 hours	<input type="checkbox"/>

Section F. Vibration

Used power tools without PPE for an hour	<input type="checkbox"/>
Used power tools with PPE for more than 5 hours	<input type="checkbox"/>
Experienced whole-body vibration	<input type="checkbox"/>

Section G. Environment

Inadequate lighting	<input type="checkbox"/>
Inadequate air ventilation	<input type="checkbox"/>
Extreme temperature (hot/cold)	<input type="checkbox"/>
Excessive noise	<input type="checkbox"/>

Figure 2 Statements in Sections D-G

Presence of body discomfort or pain?	Presence of Ergonomics Risk Factor(s)?	Suggested Action(s)
✓	✓	<ul style="list-style-type: none"> Possible occupational-related Submit report to DOSH Suggest Initial Ergonomics Risk Assessment to employer
✓	-	<ul style="list-style-type: none"> Possible non-occupational-related Suggest lifestyle modification to worker
-	✓	<ul style="list-style-type: none"> Suggest Initial ERA to employer

Figure 3 Guide for next course of action

Tick any body parts in the table below that the worker has complained of discomfort or pain and may come from work.

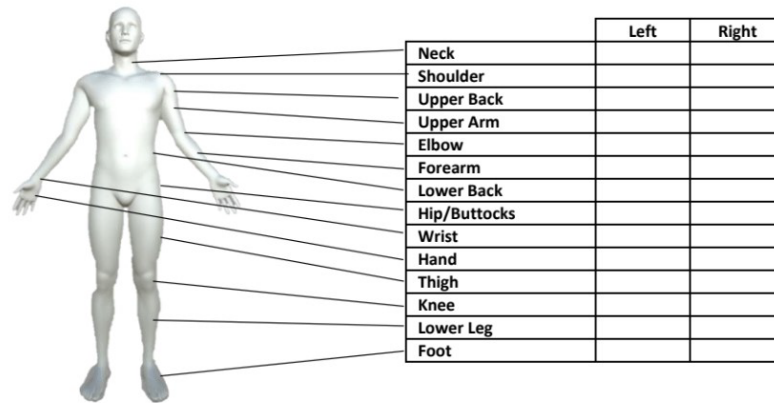


Figure 4 Body map illustration to indicate site of discomfort or pain

DISCUSSION

This study was carried out to modify the Initial ERA checklist so that it could be used by medical officers to screen work-related musculoskeletal disorders in patients. The resulting Modified Initial ERA Checklist can be used in clinics or hospitals without visiting the patient's workplace. The basis of this was the checklist's design that records information about the patient's symptoms, signs, and ergonomics risk factors reportedly present in the patient's workplace.²⁸ Using the checklist, a patient is suspected as experiencing work-related musculoskeletal disorders if the patient has musculoskeletal disorder and reported the presence of ergonomics risk factors in the patient's workplace.

The checklist underwent three developmental phases for different purposes. Phase I developed the initial version of the checklist by carrying out document analyses and merging different tools, Phase II determined the checklist's content validity by measuring its I-CVI, while Phase III simulated the checklist's use during role-play sessions to finalise its design. Although modifications were made to the checklist from versions 1-3, these were mostly confined to the patient information section. On the other hand, the ergonomics risk factors sections in all three versions remained largely the same. Six ergonomics risk factors were included in the checklist: awkward posture, static posture, forceful exertion, repeated motion, vibration and environment, all of which occur in different workplaces.^{29,30}

Potential use of modified checklist

Given its excellent content validity index (1.00), the Modified Initial ERA Checklist developed in this study has potential to assist medical officers in diagnosing work-related musculoskeletal disorders. The checklist's section for recording patient information would be familiar to medical officers due to its similarity with existing forms used by some medical doctors.³¹ The section would also

encourage medical doctors to collect information about the patient's current occupation and occupational history, which complied with quality indicators for clinical consultation.³² Moreover, medical doctors who use the checklist would not need to memorise ergonomics risk factors and would more likely consider them during clinical consultations because they are listed in the checklist.^{33,34}

Because the Modified Initial ERA Checklist can be used by medical doctors in clinics or hospitals, it could help to elevate the role of primary care in occupational health services. According to the World Health Organisation (WHO), the integration of occupational health into primary care services can enable occupational health services to reach more workers.³⁵ In Malaysia, for example, occupational health services are mostly offered by private and urban providers, and therefore may not be accessible to lower income patients.³⁶ Thus, a tool such as the Modified Initial ERA Checklist can alleviate this limitation by empowering the public and rural primary care providers to offer similar services. Furthermore, by increasing the likelihood of detecting work-related musculoskeletal disorders, more reports on such occupational diseases would be submitted to the Department of Occupational Safety and Health, which in turn would lead to more accurate statistics and better policy making.³⁷

The limitation of the checklist though lies in its dependence on the patient's memory and knowledge of ergonomics risk factors that are present in the patient's workplace to complete it. Hence, the checklist's use may be affected by recall bias that can underestimate or overestimate the ergonomics risk factors.³⁸⁻⁴⁰ One way of overcoming recall bias is to limit the recall to shorter recall periods as recall bias is associated with length of recall period.⁴¹ Thus, this checklist would be more beneficial when the patient encountered the ergonomics risk factors in the workplace recently, rather than months or years ago.

Ergonomics risk factors in the ergonomics checklist
Apart from the modified checklist, another outcome of this study was the comprehensive comparison of the content within Initial ERA with similar tools from abroad. The ergonomics risk factors included in the Initial ERA checklist were found to be similar to those in the other tools; that said, there were some differences between tools. The list of awkward postures in the Initial ERA checklist was more comprehensive than the Checklist for the Prevention of Manual Handling Risks, Ergonomics Guidelines for Manual Handling, Ergonomic Guidelines for Manual Material Handling, MSD Prevention Toolbox, Hazardous Manual Handling Risk Assessment Form and Manual Task Risk Management Form. Besides the Initial ERA checklist, only the MSD Prevention Toolbox and Manual Task Risk Management Form illustrated the awkward postures.

Most of the tools gave less emphasis on static posture than awkward posture. For example, static posture was indicated only once in the Ergonomic Guidelines for Manual Material Handling, but the same tool indicated awkward posture several times. By contrast, the MSD Prevention Toolbox indicated two types of static postures; both of which were also found in the Initial ERA checklist. Forceful exertion was evaluated by the tools in different ways. For example, in the Checklist for the Prevention of Manual Handling Risks, the level of exertion is determined in a subjective manner, whereas in the Manual Handling Operations Regulations 1992 and Ergonomics Guidelines for Manual Handling, users must determine the weight of the object being moved, which was similar to the approach in the Initial ERA checklist.

As for repetitive motion and vibration, most of the tools were less detailed than the Initial ERA checklist. For example, the Checklist for the Prevention of Manual Handling Risks included a general statement on whether an object would be moved very frequently or not. Similarly, the MSD Prevention Toolbox required users to subjectively determine if an object vibrated at a high frequency for more than 30 minutes. By contrast, the Initial ERA checklist required users to consider the body part, action and duration for the same purpose. Environment was the simplest section in the Initial ERA checklist as it required only a general assessment of the environment in terms of temperature, lighting and sound. Other tools, for example, the Hazardous Manual Handling Risk Assessment Form, adopted the same approach. Overall, it can be said that the Initial ERA checklist is very thorough. This may be by design as the checklist should be used by a trained person, whereas the other tools examined in this study did not have that requirement.

Strength and limitation of study

This study contributes to the advancement of occupational health by developing the Modified Initial ERA Checklist for diagnosing work-related musculoskeletal disorders (WRMSDs) in clinics in the future. It has done through a rigorous three-phase development process that ensures its practicality and reliability, as evidenced by its perfect content validity index (1.00). This, in turn, is expected to impact the management and prevention of WRMSD in various work environments.

However, the development of Ergonomics Checklist may have been exposed to biases when the document analyses were carried out in Phase I.¹³ For example, decisions on whether sections within the Initial ERA checklist could be filled in clinics or hospitals were subjective. Similarly, the other tools examined in this study were also analysed according to the researcher's personal judgement. Another limitation has to do with the I-CVI, which was determined in Phase II, and not after the last iteration of the Modified Initial ERA Checklist. It is possible the additions in Phase III may have reduced its content validity; however, since the additions were based on recommendations by the checklist's intended users, the content validity index would not have been greatly impacted.

Future study

Although the checklist showed promise during its simulated use in Phase III, questions remain on whether the Modified Initial ERA Checklist can be used as intended in actual practice. Among others, there is a need to examine its usability and the suitable amount of training that need to be undergone before users can complete the checklist in clinics or hospitals. For example, it is not known whether users with no experience or knowledge in ergonomics can fill in the checklist without any issue. Thus, a study could be carried out to examine how groups with different levels of training or experience use the checklist. Another aspect for further examination would be the concurrent validity of the ergonomics risk factors selected by the user during clinical consultation. A study can be performed to assess whether the medical doctor's selection accurately reflects the ergonomic conditions at the patient's workplace. This would involve comparing the completed checklist with observations made by an Ergonomics Trained Person at the patient's workplace. Another potential future study would involve investigating how the usage of modified checklist can impact patient reporting of WRMSDs. This could involve a comparative analysis of reporting rates before and after the checklist's adoption, as well as obtaining medical doctors' perspective on its impact on their diagnostic practices.

CONCLUSIONS

This study was carried out to modify the Initial ERA so that medical doctors can be assisted in diagnosing WRMSDs in hospitals or clinics. The objective was achieved after carrying out document analysis of the Initial ERA guideline published by DOSH and similar tools published overseas, as well as obtaining feedback from potential users among healthcare professionals. The Modified Initial ERA Checklist was found to have had excellent content validity, and therefore has potential for adoption by medical officers in the future. Being that said, the tool should first undergo further evaluation in the field, to account for practical issues not examined in this study.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest in this study.

ACKNOWLEDGEMENT

The National Institute of Occupational Safety and Health (NIOSH), Malaysia, provided support for this study under grant number NIOSH/NO.SH.18/2019-CRD. The authors would like to thank everyone who participated in and contributed to this study.

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