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Review Article

A Systematic Review of Ergonomics Risk Assessment Methods for Pushing and Pulling Activities at Workplace

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ABSTRACT

It is vital to assess workplace pushing and pulling (PP) activities to manage musculoskeletal injuries among employees. However, there is still no clearly-suited risk assessment method. This systematic review aims to provide an overview of risk assessment methods for PP activities at the workplace. Thus, the review employed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA). Two primary journal databases were searched, namely Scopus and Science Direct. Furthermore, to ensure the robustness of the study, the searches were expended via handpicking, snowball identification, and consultation with ergonomics experts. Atlas.ti version 8 software was used to analyse the identified articles thematically. The search resulted in nine articles eligible for the systematic analysis. From the articles, six assessment methods used force measurement as the main indicators, while three assessment methods used the weight of the load as measurement indicators. The assessment tools did not cover all the risk factors for PP activities. Besides, there was a lack of evidence showing the assessment tools or methods' reliability, validity, and usability. This systematic review highlighted the advantages and limitations of existing assessment methods, and no one method fits all. The findings showed that the assessment methods for PP activities still needed a force measurement and did not cover all the significant risk factors associated with PP. In addition, no clarifications were presented regarding the assessment methods' reliability, validity, and applicability.

Keywords: Ergonomics tools, manual handling, pushing and pulling, risk assessment method

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INTRODUCTION

Lifting, lowering and carrying have been major manual handling activities (Todd, 2012), which resulted in ergonomics risk (Bennet et al., 2011). Thus, pushing and pulling (PP) has been introduced to mitigate the risk of other manual handling activities (Bennet et al., 2011). The PP can be explained as a horizontally applied force. The force is led afar from the body via pushing but towards the body via pulling (Hoozemans et al., 1998; Baril-Gingras & Lortie, 1995). Furthermore, pulling requires greater force (Castro et al., 2012) and maximal voluntary grip force (Chen et al., 2015) than pushing.

While lifting creates large compression forces on the spinal disc and other spinal structures, the act of PP usually creates shear forces (Waters et al., 2011) and back muscle loading (Chen et al., 2015; Kuijer et al., 2007; Frost et al., 2015; Hoozemans et al., 2002) reported that PP increase the risks of a shoulder injury but not necessarily lower back pain, and it is major cause for musculoskeletal injuries at the workplace (Lee, 2018).

One of the key elements for managing musculoskeletal disorders (MSDs) at the workplace is ergonomics management, which can be accessed via ergonomics risk assessment (Cohen et al., 1997; Rahman & Mohammad, 2017; Monaco et al., 2019; Gyemi et al., 2016). According to David (2005), three classes of ergonomics risk assessment include self-reporting, observation methods (basic and advanced techniques), and direct measurement.

Another important criterion of an assessment tool is the psychometric properties such as reliability, validity and usability (Jahrami et al., 2019). First, a reliable tool ensures consistent results are obtained from repeated assessments, which is necessary to identify ergonomic risk factors changes over time (Bannigan & Watson, 2009). Second, a valid tool provides accurate information about the ergonomic risk factors in a given work environment, which is necessary to develop effective interventions to reduce ergonomic risks (Cook & Beckman, 2006). Finally, a usable tool ensures that the assessment process is efficient and effective, which can increase the likelihood of the tool being adopted and used in the workplace (Occhipinti & Colombini, 2015).

Although there are many assessment tools for PP activities, such as KIM-PP (Steinberg, 2012), RAPP (Health and Safety Laboratory, 2013), PPAC (Ferreira et al., 2007) and et cetera, it is still unclear as to what is the best assessment method for PP at an industry level. Despite the different views surrounding PP assessment tools, there has been less published review in this area. Therefore, the present study addresses this research gap by reviewing the existing assessment tools for PP activities and highlights the directions for future research.

The research questions guiding this systematic review are:

(1) What risk factors are evaluated by the PP assessment tool?
(2) What is the assessment tool's reliability, validity and usability?

This article highlights a review of ergonomics risk assessment tools in relation to workplace PP.

MATERIAL AND METHODS

Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)

The review process employed the PRISMA (Moher et al., 2009). PRISMA is a published standard for performing the systematic literature review. PRIMA has been reported to guide authors to systematically evaluate and examine the quality of reviewed papers and be used for other types of research besides randomised trials (Moher et al., 2009). This methodology involves four stages, i.e., identification, screening, eligibility, and inclusion.

Resources

Xiao and Watson (2019) suggested that no one database is complete, thus suggesting more than one database for the search process, and Younger (2010) mentioned that when using more than one database, it will cover each other's weaknesses. Thus, two databases have been employed for search purposes: the Scopus and Science Direct databases. One of the biggest databases of peer-reviewed literature abstracts and citations is Scopus, which has over 25,200 titles from 7000 publishers worldwide. Several academic disciplines are included in Scopus, including engineering, medicine, and health sciences. Science Direct is the second database used in the review. It has over 2,650 peer-reviewed journals with over 19 million articles and chapters.

The Systematic Review Process for Article Selection

Identification. At the first stage of identification, relevant keywords were determined. Then, a search was done to identify similar and related keywords based on a thesaurus, a dictionary, and previous research (Table 1). The search was done on the Scopus and Science Direct databases. This search yielded insufficient material, as few journal articles included studies on ergonomics assessment tools for PP activities. As stated by Younger (2010), the researcher should perform the search process in more databases to obtain more articles related to the topic; thus, the search was expanded via handpicking, snowball identification, and consultation with ergonomics experts. This step led to identifying publications in the form of government research papers, ISO standards, and book chapters. In the end, 41 publications related to the current topic were identified.

Table 1
Search strings

Database	Keyword used
Scopus	(TITLE-ABS-KEY ("manual handling") AND TITLE-ABS-KEY ("risk assessment") AND TITLE-ABS-KEY (pushing OR pulling)
Science Direct	Title, abstract, keywords: "manual handling" AND "risk assessment"

Screening. In this step, duplicate publications were first removed. As a result, three articles were excluded. Next, adhering to the inclusion and exclusion criteria presented in Table 2, 37 publications were filtered. Due to the limitations of the current topic under review, the accepted literature type was widened to cover research articles, government publications, and conference proceedings. Therefore, journal publications and meta-analyses were excluded. Moreover, it should be noted that this review only covered publications in the English language. Additionally, the timeline was expanded from 1970 to 2019 to increase the possibility of retrieving related publications. Thirty-four publications were finalised for the next stage of the review.

Table 2
Inclusion and exclusion criteria

Criterion	Inclusion	Exclusion
Literature type	Research articles; Government publications; Conference proceedings	Systematic literature review journals, Meta-analysis
Language	English	Non-English
Timeline	Between 1970-2019	<1970
Manual handling Type	Pushing and Pulling	Lifting, carrying, lowering
Assessment method	Self-report, observation methods (advanced and straightforward technique) and direct measurement	Biomechanical model

Eligibility. Thirty-four (34) publications were prepared at this stage. The publications' titles, abstracts, and content were screened thoroughly to ensure that the publications fulfilled the inclusion criteria for the current research. This step yielded 9 eligible publications. The remaining 25 publications did not match the inclusion criteria. Biomechanical models were excluded from the review due to the complexity of such assessments. Figure 1 illustrates the flow diagram for the review process.

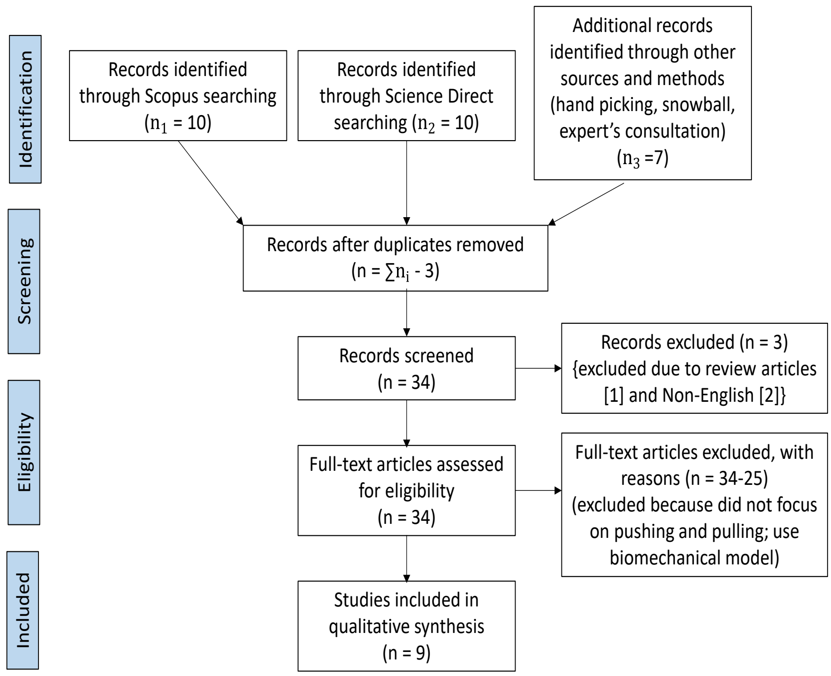

Figure 1. Flow diagram of the study (adapted from Moher et al., 2009)

Data Extraction and Analysis

Using Atlas.ti 8 software, a thematic analysis was carried out to develop appropriate themes and subthemes according to the data compilation. Then, the authors categorised the overall themes into two: (1) the variables measured by each tool and (2) the reliability, validity, and usability of the tool.

Jung et al. (2005) pushing and pulling framework was improved by adding variables like hand grips (Ayoub & Dempsey, 1999), task duration (Rohani et al., 2018), and temperature (Snook & Ciriello, 1974). These variables were added to create variable and sub-variable categories corresponding to theme number 1 (Figure 2).

Theme number 2 was derived based on the past literature, which suggested that ergonomics risk assessment tool should be:

- Reliable when used in practical and research settings (Rohani et al., 2018; Zetterberg et al., 2019);
- Provides valid ergonomics measurement. The development stage should be emphasised (Sukadarin et al., 2015), and
- Ease of use (usability) is an important criterion that determines application among practitioners (Eliasson, 2017).

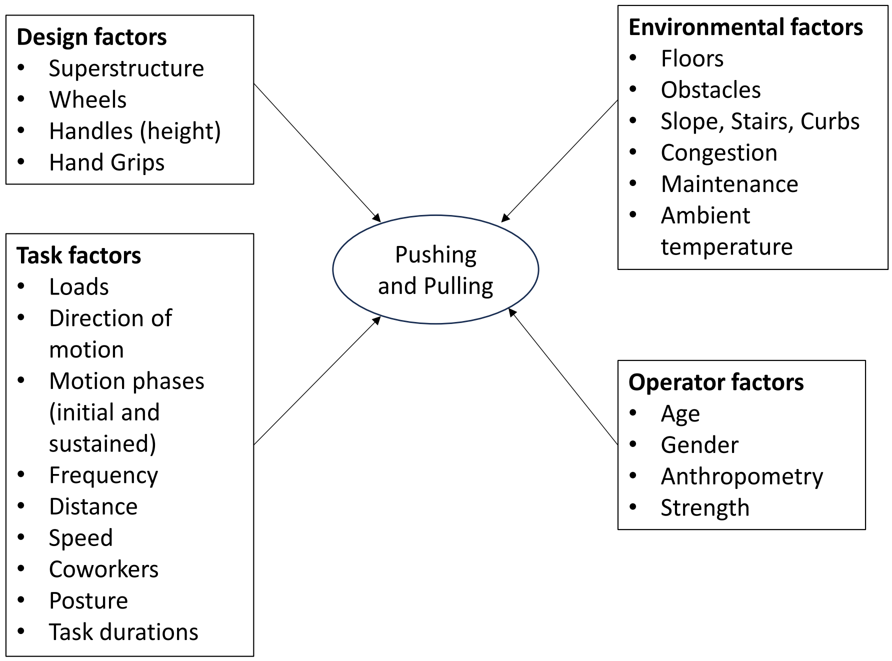

Figure 2. Factors determining pushing and pulling activities (Snook & Ciriello, 1974; Ayoub & Dempsey, 1999; Jung et al., 2005; Rohani et al., 2018)

RESULTS

General Study Findings and Background

The analysis identified nine risk assessment tools or methods for PP activities: four from journal articles (Snook, 1978; Snook & Ciriello, 1991; Steinberg, 2012; Lind, 2018), one from a book (Mital et al., 1997), one from ISO standards (International Organization for Standardization, 2007), two from government research reports (Ferreira et al., 2007; Health and Safety Laboratory, 2013), and one from a conference proceeding (International Organization for Standardization, 2007). Table 3 shows the included publications and the type of publication.

Table 3
Publication related to assessment tools for pushing and pulling activities

No	Title	Publication Type	Source
1	The design of Manual Handling Table	Journal Article (Ergonomics)	Snook (1978)
2	The Design of Manual Handling Tasks: Revised Tables of Maximum Acceptable Weights and Forces	Journal Article (Ergonomics)	Snook and Ciriello (1991)
3	A Guide to Manual Material Handling	Book	Mital et al. (1997)

Table 3 *(Continue)*

No	Title	Publication Type	Source
4	Key Indicator Method (Pushing and Pulling) KIM-PP	Journal Article (Work)	Steinberg (2012)
5	Pushing and Pulling Operations Assessment Charts Tool (PPAC)	Government Research Report	Ferreira et al. (2007)
6	ISO 11318-2: 2907 Ergonomics–Manual handling–Part 2: Pushing and Pulling	ISO Standard	International Organization for Standardization (2007)
7	Risk assessment of pushing and pulling (RAPP) tool	Government Research Report	Health and Safety Laboratory (2013)
8	Pushing and pulling: An assessment tool for OHS practitioners	Journal Article (International Journal of Occupational Safety and Ergonomics)	Lind (2018)
9	DUTCH: A New Tool for Practitioners for Risk Assessment of Push and Pull	Conference Proceeding	Douwes et al. (2019)

Main Findings

The description of each method and the output type/rating score are described in Table 4. Basically, the output/rating score of the assessment methods can be divided into three types: recommendation force limit (Snook, 1978; Snook & Ciriello, 1991; Mital et al., 1997; International Organization for Standardization, 2007), risk range category (Steinberg, 2012), and traffic light grading system (Lind, 2018; Ferreira et al., 2007; Health and Safety Laboratory, 2013; Douwes et al., 2019). It is important to note that the risk range category and traffic light grading system are similar in that both illustrate low to high-risk levels. Table 5 displays the variables evaluated using all the assessment methods, while Table 6 summarises the methods' reliability, validity, and usability. Six assessment methods used force measurement as one of the risk assessment components (Snook, 1978; Snook & Ciriello, 1991; Lind, 2018; Mital et al., 1997; International Organization for Standardization, 2007; Ferreira et al., 2007), which contradict the recommendations of Steinberg (2012), the Health and Safety Laboratory (2013), and Douwes et al. (2019), all of which used the weight of the load as measurement indicators.

Table 4
Description of assessment method for pushing and pulling

Method	Description	Strength	Limiation	Rating Score
The design of Manual Handling Table (Snook, 1978)	• Based on experimental design • A total number of 28 male industrial workers. • Need to perform 54 tasks that varied in frequency, travelling distance, and height.	Stringent experimental methodology has been used for the development	• The data is based on the US population. It may not be appropriate to be used in different population • Need to use force gauge	Force limit information/ recommendation
The Design of Manual Handling Tasks: Revised Tables of Maximum Acceptable Weights and Forces (Snook and Ciriello, 1991)	• Used a much bigger sample size for PP activities (128 subjects: 68 males and 51 females) compared to the previous research (57 subjects: 42 males and 15 females). • Similar methodology and simulation with previous research • The maximum acceptable initial force for the pulling task was 13% lower than the pushing task, whereas it was 29% lower for the maximum acceptable sustained force. • In the revised table, there were six distances for pulling tasks compared to only one pulling distance in the previous table, which used a similar frequency for PP for both males and females. • Mean forces in the revised table were lower than the original tables for female workers: initial push, 2.72 kg lower; sustained push, 0.90 kg lower; initial pull, 1.76 kg lower; and sustained pull, 3.39 kg lower. • However, the opposite trend was reported for male workers: initial push, 1.36 kg higher; sustained push, 1.27 kg higher; initial pull, 1.53 kg higher; sustained pull, 1.11 kg higher.	Stringent experimental methodology has been used for the development	• The data is based on the US population. It may not be appropriate to be used in different population • Need to use force gauge	Force limit information/ recommendation

Table 4 *(Continue)*

Method	Description	Strength	Limiation	Rating Score
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Table 4 *(Continue)*

Method	Description	Strength	Limiation	Rating Score
A Guide to Manual Material Handling (Mital et al., 1997)	• Used data from Snook and Ciriello tables and suggested maximum acceptable force limits adjusted for various biomechanical, physiological, and epidemiological criteria.	Based on a large body of research on ergonomics and manual material handling, it gives it a strong scientific foundation.	• The data is based on the US population. It may not be appropriate to be used in different population • Need to use force gauge	Force limit information/ recommendation
Key Indicator Method (Pushing and Pulling) KIM-PP (Steinberg, 2012)	• KIM for pushing and pulling (KIM-PP) was developed from the year 2898 until 2901 by the Federal Institute for Occupational Safety and Health (BAuA) and the Committee of the German States for Occupational Safety and Health (LASI)	• Simple and easy-to-use method • It does not require any special equipment or training	It relies on subjective ratings of the magnitude of pushing and pulling forces, which individual perceptions and biases can influence.	Risk Score and Risk Range
Pushing and Pulling Operations Assessment Charts Tool (PPAC) (Ferreira et al., 2007)	• By UK HSE • Developed to complement Manual handling Assessment Charts (MAC), which focused on lifting, lowering, carrying, and team handling operations.	• Relatively easy to use and requires minimal training • A quantitative measure of the risk of MSDs associated with PP tasks, which can help prioritise interventions and track progress over time	• Need to use force gauge	Traffic light grading system

Table 4 *(Continue)*

Method	Description	Strength	Limiation	Rating Score
ISO 11318-2: 2907 Ergonomics– Manual handling– Part 2: Pushing and Pulling (International Organization for Standardization, 2007)	• Detailed out two methods for identifying the risk associated with PP • Method 1: Generalised risk estimation and risk evaluation • Examined six risk categories: the task, load characteristics, working environment, individual capability, work organisation, and other factors presented in manual handling. • The psychophysical tables illustrated the acceptable initial and sustained forces by considering handle height, distance travelled, and frequency of push/pull tasks for both genders: males and females. *Note: Method 2 is beyond the scope of the study since it involves a biomechanical method*	Used data from Snook and Ciriello (empirical data)	Need to use force gauge	Force limit information/ recommendation
Risk assessment of pushing and pulling (RAPP) tool (Health and Safety Laboratory, 2013)	• By UK HSE • RAPP was mainly developed to address this concern where the assessor can assess without force gauge and by the observational method • The tool is divided into two types of assessment, which are: ◊ Moving loads on wheeled equipment and ◊ Moving load without wheeled equipment.	• Relatively easy to use and requires minimal training • A quantitative measure of the risk of MSDs associated with PP tasks, which can help prioritise interventions and track progress over time	Did not consider task frequency and handle height in the assessment chart	Traffic light grading system

Table 4 *(Continue)*

Method	Description	Strength	Limiation	Rating Score
Pushing and pulling: An assessment tool for OHS practitioners (Lind, 2018)	• Used nine multiplier equations in decision-making for the risk of PP and subsequently to determine the priority level score.	Based on psychophysical, physiological and biomechanical studies in combination with judgments from an expert group consisting of senior researchers and ergonomists.	Need to use force gauge	Risk Score based on traffic light system
DUTCH: A New Tool for Practitioners for Risk Assessment of Push and Pull (Douwes et al., 2019)	• DUTCH is a web-based tool for quick evaluation of push and pull activities	• Web-based • Relatively easy to use and requires minimal training	Need to have an active internet connection and device for the assessment	Risk Score based on traffic light system

Table 5
Publications and the assessed variables

Variable Category and Variable	Publication								
	1	2	3	4	5	6	7	8	9
Design Factors									
Superstructure				▲			▲		
Wheels					▲				
Handles height	▲	▲	▲		▲	▲		▲	▲
Handgrip							▲	▲	
Task Factors									
Loads				▲			▲		▲
Direction of motion	▲	▲	▲			▲			
Motion Phases (initial and sustained)						▲			
Frequency	▲	▲	▲	▲	▲	▲	▲	▲	▲
Distance	▲	▲	▲	▲		▲	▲		▲
Speed				▲					
Co-workers									
Posture				▲	▲		▲	▲	
Task Duration				▲	▲				
Environment Factors									
Floors				▲	▲		▲	▲	
Obstacles				▲	▲		▲		
Slope, stairs, and curbs				▲					
Congestion					▲				
Maintenance				▲	▲		▲		
Ambient temperature					▲		▲	▲	
Operator Factors									
Age									
Gender	▲	▲		▲		▲			▲
Anthropometry									
Strength									
Others	▲[a]	▲[a]	▲[a]	▲[b]	▲[a]	▲[a]	▲[c]	▲[a,d]	

Note (Table 5):
[a]*force*
[b]*positioning accuracy*
[c]*unstable load; the load is large and obstructs view; the load is sharp and hot and could damage touch; poor lighting conditions; strong air movements; personal protective equipment obstructs the work.*
[d]*one hand pushing/pulling; pushing/pulling in a lateral direction; team pushing*

Publications:

1. The design of Manual Handling Table (Snook, 1978)
2. The Design of Manual Handling Tasks: Revised Tables of Maximum Acceptable Weights and Forces (Snook & Ciriello, 1991)
3. A Guide to Manual Material Handling (Mital et al., 1997)
4. Key Indicator Method (Pushing and Pulling) KIM-PP (Steinberg, 2012)
5. Pushing and Pulling Operations Assessment Charts Tool (PPAC) (Ferreira et al., 2007)
6. ISO 11318-2: 2907 Ergonomics – Manual handling – Part 2: Pushing and Pulling (International Organization for Standardization, 2007)
7. Risk assessment of pushing and pulling (RAPP) tool (Health and Safety Laboratory, 2013)
8. Pushing and pulling: An assessment tool for OHS practitioners (Lind, 2018)
9. DUTCH: A New Tool for Practitioners for Risk Assessment of Push and Pull (Douwes et al., 2019)

Table 6
Reliability, validity, and usability for the assessment methods

Method	Source	Reliability	Validity	Usability
The design of Manual Handling Table	Snook (1978)	-	-	-
The Design of Manual Handling Tasks: Revised Tables of Maximum Acceptable Weights and Forces	Snook and Ciriello (1991)	-	-	-
A Guide to Manual Material Handling	Mital et al. (1997)	-	-	-
Key Indicator Method (Pushing and Pulling) KIM-PP	Steinberg (2012)	IRR=81% Kappa Score=0.705 (Douwes et al., 2019)	6/10 Moderate (Douwes et al., 2019)	-
Pushing and Pulling Operations Assessment Charts Tool (PPAC)	Ferreira et al. (2007)	-	-	-

Table 6 *(Continue)*

Method	Source	Reliability	Validity	Usability
ISO 11318-2: 2907 Ergonomics–Manual handling–Part 2: Pushing and Pulling	International Organization for Standardization (2007)	-	-	-
Risk assessment of pushing and pulling (RAPP) tool	Health and Safety Laboratory (2013)	-	-	+[a]
Pushing and pulling: An assessment tool for OHS practitioners	Lind (2018)	-	-	+[b]
DUTCH: A New Tool for Practitioners for Risk Assessment of Push and Pull	Douwes et al. (2019)	-	-	+[c]

Note:
+ Tests were done with the assessment methods during the development process
- Tests were not done with the assessment methods during the development process
[a]Tool was easy to use: 70% by duty holders and 67% by regulatory inspectors (Health and Safety Laboratory, 2013)
[b]Majority (2/3) of respondents claimed that it is easy or fairly easy to do an assessment (Lind, 2017)
[c]No detail provided (Lind, 2018)

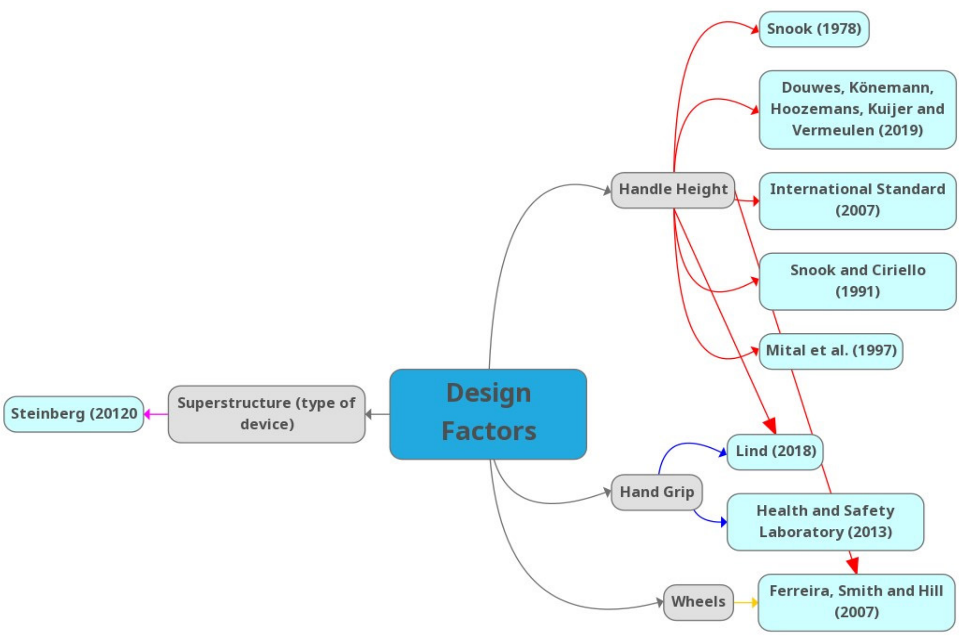

Figure 3. Schematic diagram of variables in the design factor and the associated assessment method

A schematic diagram of the variables for each factor category [design (Figure 3), task (Figure 4), environment (Figure 5) and operator (Figure 6)] and the associated assessment method are shown. The schematic diagram shows that most assessment methods emphasised the measurement of task factors, while the operator factor was given the least consideration. As for the design factor, the essential variable seemed to be handled height since all the assessment methods, except the Health and Safety Laboratory (2013) and Steinberg (2012), measured this factor.

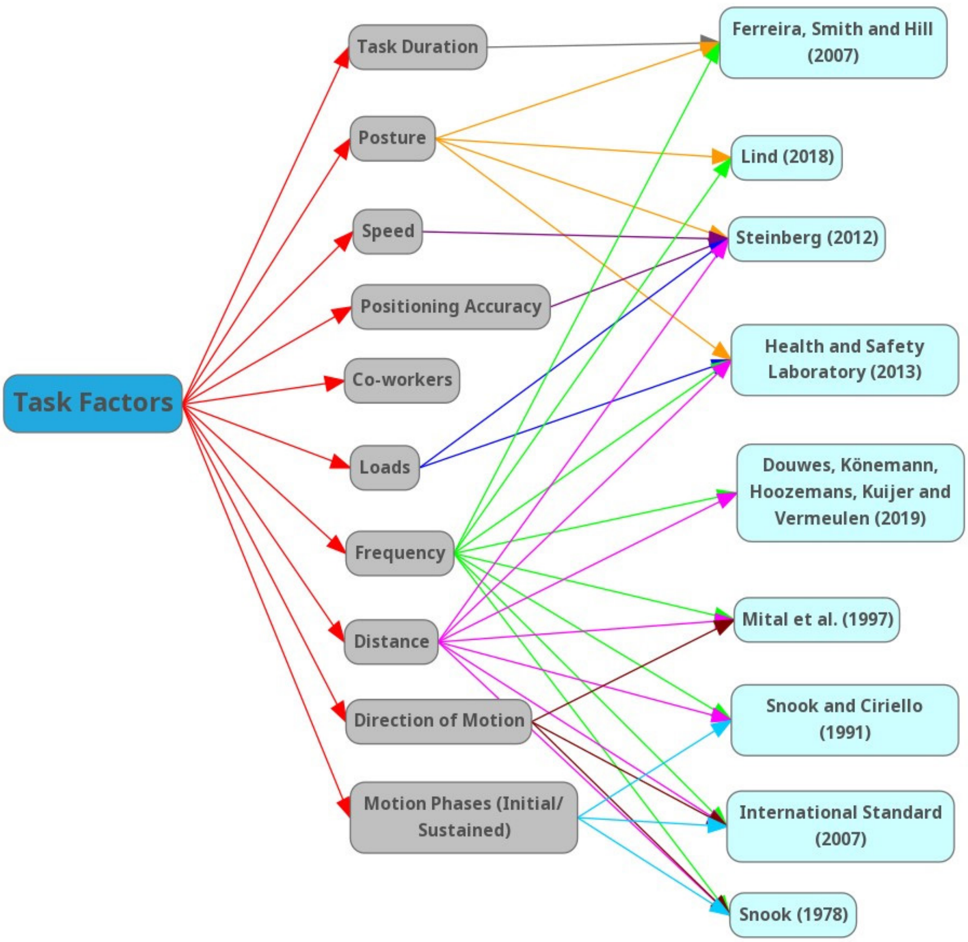

Figure 4. Schematic diagram of variables in task factor and the related assessment method

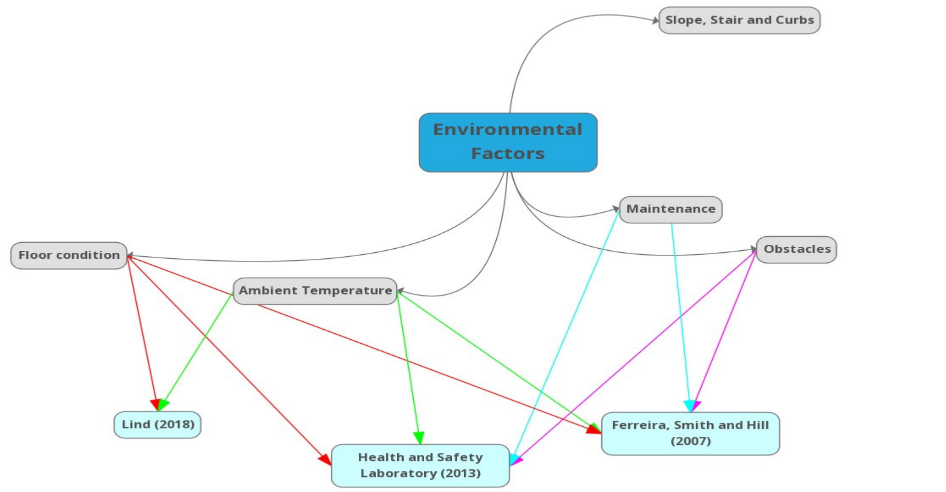

Figure 5. Schematic diagram of variables in environment factor and the related assessment method

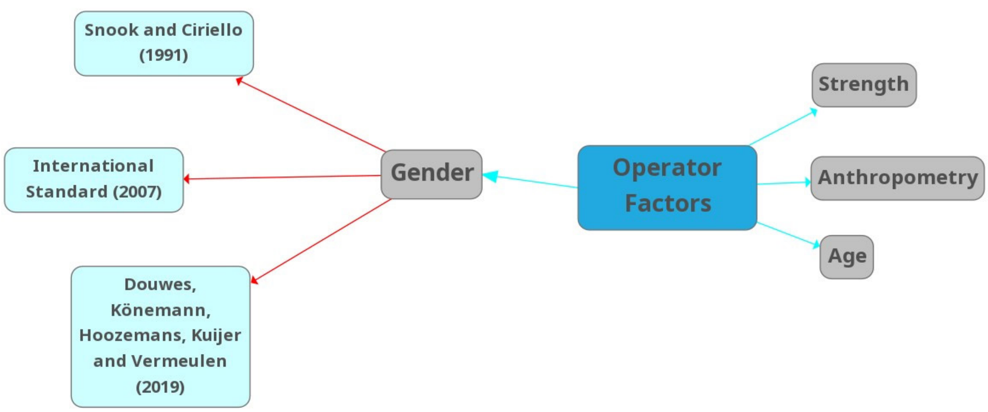

Figure 6. Schematic diagram of variables in the operator factor and the associated assessment method

DISCUSSION

Ergonomics risk management is vital for reducing MSDs in the workplace (Cohen et al., 1997). Risk management is associated with occupational health and safety (Laws of Malaysia, 1994).

Thus, all potential main users of assessment methods will be health and safety practitioners in the workplace (Kadikon & Rahman, 2016). One of the strategies to ensure practical risk assessment at the workplace is to adopt simple, user-friendly observation methods. These methods should also reduce or eliminate the need to measure force and require minimal expert knowledge (Health and Safety Laboratory, 2013; Li & Buckle, 1999) without disrupting work activities (Kadikon & Rahman, 2016).

Based on the current review, six assessment methods (Snook, 1978; Snook & Ciriello, 1991; Lind, 2018; Mital et al., 1997; International Organization for Standardization, 2007; Ferreira et al., 2007) used a force gauge. However, as a force gauge is not readily available, assessments such as these will have limited application in the industry since organisations do not invest in the purchase of force gauges. Thus, assessing the risk of PP activities without a force gauge could present a significant challenge.

On the other hand, three methods, namely DUTCH, RAPP, and KIM-PP (Steinberg, 2012; Health and Safety Laboratory, 2013; Douwes et al., 2019), used the weight of the load as one of the variables for risk assessment. Nevertheless, for the risk assessment, RAPP and DUTCH did not take into account the handle height, disregarding the fact that previous studies showed a significant effect of handle height in PP activities on the MSDs' development (Hoozemans et al., 2004; Chaffin et al., 1983; Marras et al., 2009; Al-Eisawi et al., 1999). Furthermore, although the distance of the push and pull is considered to be a strong risk factor method (Snook, 1978; Snook and Ciriello, 1991; Cuervo et al., 2003), this variable was also not included (Lind, 2018; Ferreira et al., 2007).

There are four methods used to develop the assessment tools, namely, experimental design (Snook, 1978; Snook & Ciriello, 1991; Mital et al., 1997), literature review (Steinberg, 2012; Lind, 2018; Ferreira et al., 2007; Health and Safety Laboratory, 2013; Douwes et al., 2019), an adaptation from other assessment tools or resources (Steinberg, 2012; Lind, 2018; Mital et al., 1997; Douwes et al., 2019), and consultation with experts and expert opinions (Steinberg, 2012; Lind, 2018). However, although crucial, the testing for reliability, validity, and usability of the assessment tools in the reviewed studies during development was not clarified except for KIM-PP (Steinberg, 2012) and Douwes et al. (2019). The evidence showed that a usability test was carried out even then, only for RAPP (Health and Safety Laboratory, 2013), Pushing and Pulling: an assessment tool for OHS practitioners (Lind, 2018; Lind, 2017), and DUTCH (Lind, 2018).

This systematic review highlighted the advantages and limitations of existing assessment methods. No one method fits all. Measuring the forces associated with these activities is necessary to assess the PP activities. Also, the tools did not take into account every significant risk factor in relation to PP. There was also a lack of evidence proving the tools' reliability, validity, and usability.

CONCLUSION

The findings showed that the assessment methods for PP activities still needed a force measurement and did not cover all the significant risk factors associated with PP, while there was a lack of psychometric data to establish acceptable reliability, validity, and usability of the tool. In summary, the ergonomics risk assessment tool for workplace PP activities must take into account all major risk factors leading to the MSDs' development.

These tools must also be subjected to a rigorous development stage of reliability, validity, and usability testing.

FUTURE PROSPECT

This review recommends developing a new assessment tool for PP that includes all the main risk factors involved in the PP activities without making force measurement a requirement. The developed tool should fit the definition of a simple observation-based risk assessment guide to encourage usage among OSH practitioners. The newly developed assessment tool should be user friendly, self-explanatory and require minimal user training. During the development of the tool, selecting the critical risk factors in the assessment of PP shall consider the inputs from professional ergonomics experts and OSH practitioners, together with epidemiological evidence from the literature. It is also essential to consider the sensitivity analysis during development to determine which input variables are critical for the final risk level classification. The tool's reliability, validity, and usability testing should also be explained in detail to ensure that it can be practically applied in the industry and to dispel any doubts during the risk assessment.

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