Norms and Standards related to ergonomic risk assessment: a literature review

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Abstract: The advent of "Industry 5.0" marks a significant shift in industrial manufacturing, emphasizing sustainability and a human-centric approach. This transformative evolution highlights the pivotal role of ergonomics in ensuring worker well-being and safety, particularly in industries characterized by labor-intensive processes and cyclical tasks. Integrating ergonomic assessment practices becomes crucial for enhancing worker well-being, safety, and overall productivity. This study employs an integrative literature review to explore existing frameworks and methodologies in ergonomic risk assessment globally, incorporating various sources of information, not limited to purely academic sources, but also non-academic sources such as ISO standards. The objective is to explore the features, criteria, and guidelines provided by these tools to effectively assess and manage ergonomic risks. The research provides an overview of common norms and standards utilized internationally, facilitating a comparative analysis of ergonomic tools.

The key findings are summarized to demonstrate the operational mechanisms of existing ergonomic assessment methods. Addressing the urgent need for a digital ergonomic risk assessment tool in the context of Industry 5.0, this research enhances our understanding of the challenges and drivers for a successful ergonomic assessment. Through a comprehensive exploration of existing frameworks, the study aims to contribute insights into global methodologies, offering a comparative analysis that can contribute to the development of comprehensive and effective ergonomic assessment tool for the evolving industrial landscape, promoting industrial sustainability and advancing the well-being of workers within the manufacturing industry. The value of this work lies in its potential to inform the design and implementation of ergonomic practices aligned with the transformative goals of Industry 5.0, fostering a safer and more productive working environment.

Keywords: Ergonomic assessment, Ergonomics, Industry 5.0, Human-Centric.

1. Introduction

Musculoskeletal disorders (MSDs) remain the most common work-related health problem in the European Union (EU) (EU-OSHA, 2022; European Risk Observatory, 2019). MSDs concern workers in all sectors and occupations. Besides the effects on workers themselves, they result in high costs to enterprises and society (European Risk Observatory, 2019). In EU workplaces, over half of employees with work-related musculoskeletal disorders (WMSDs) are absent from work. Those with WMSDs tend to be absent for longer compared to those with other health issues. Additionally, WMSDs result in permanent disability in 60% of reported cases (Govaerts et al., 2021). The same situation is presented also in other industrialized countries. In the U.S., according to the United States Department of Labor (Bureau of Labor Statistics, 2023) over the 2021-2022 period, musculoskeletal disorders accounted for 33,9% (502,380 cases) of the total for nonfatal occupational injuries and illnesses with days away from work. In China, according to the Chinese Center for Disease Control and Prevention (Jia et al., 2021), the standardized prevalence rate of WMSDs was 41,2% among the population in key industries from January 2018 to June 2022. Analysis from Global Burden of Disease (GBD) 2019 data showed that, for many years, MSDs remain the leading contributor to workplace disability (Cieza et al., 2021).

WMSDs are associated with several factors, including working posture, manual force exertion, manual material handling, mechanical workloads, awkward posture, repetitive action, vibration, psychosocial factors and individual factors. Due to the complexity of WMSDs, it is essential to use comprehensive ergonomic assessment methods to effectively identify and mitigate workplace ergonomic risks. The availability of various assessment methods, from subjective judgments to direct measurements, highlights the importance of selecting approaches that align with the specific requirements of each workplace (Chiasson et al., 2012; Takala et al., 2010).

Comparative analyses of existing assessment tools reveal discrepancies in risk determination, highlighting the need for standardized approaches and informed decision-making in methodology selection (Chiasson et al., 2012). Understanding the strengths and limitations of each method is crucial for accurately assessing ergonomic risks and implementing targeted interventions to mitigate them (Chiasson et al., 2012; Takala et al., 2010).

Previous studies (Chiasson et al., 2012; G. C. David, 2005; "Handbook of Human Factors and Ergonomics Methods," 2004; Takala et al., 2010) have examined various aspects of ergonomic assessment methods for evaluating physical workload. However, there is a lack of updated comparisons of these methods aimed at assisting users in selecting the most suitable tool for specific purposes, as many of the methods have been revised and updated over time.

Given these considerations, this literature review seeks to explore the landscape of ergonomic assessment methods, highlighting the importance of selecting appropriate tools to enhance workplace safety and well-being. By delving into the features, criteria, and limitations associated with existing assessment methods, this research aims to contribute to the development of comprehensive and effective ergonomic assessment method tailored to the diverse needs of modern workplaces.

2. Method

In this review, Scopus was utilized for literature searches. Articles indexed by Scopus were used to evaluate the literature on ergonomics assessment methodologies. The specific search string used to query Scopus was as follows: TITLE-ABS-KEY ((ergonomic* AND (assessment OR evaluat* OR mapping OR "risk analysis")) OR (WMSD OR MSD OR "Musculoskeletal disorders") AND (assembl* OR manufactur*) AND (norm* OR standard* OR rule* OR regulation*)). Only studies published in English are being considered. Papers published after the year 2000 are selected because the main relevant methods have undergone significant revisions over the past 20 years. Methods that have not been updated since 2000 are at risk of being outdated and may not reflect current best practices or advancements in the field.

Based on the initial search record, 707 records were identified. Screening was carried out of the records on Title and Abstract to clarify whether the records were relevant to the research objectives. Among them, 591 were excluded because these articles were not related to our review, or they refer to commercial ergonomic evaluation products without public explanation. After that, full texts were screened for eligibility. Eventually, 69 articles were selected for further evaluation. Fig. 1 shows a flow chart of the standard PRISMA methodology for study identification, screening, eligibility, and inclusion.

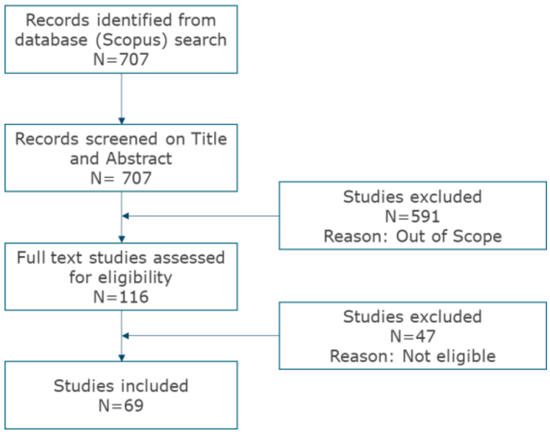

Figure 1. PRISMA flow diagram

A total of 23 methods were identified in the 69 selected papers. Some of the methods are mentioned in multiple papers, the most common ones are RULA (35 papers), REBA (21 papers), OCRA (19 papers) and NIOSH (11 papers). The selection of ergonomic assessment methods for inclusion in the study was then conducted. Some methods used only in a few specific studies were discarded due to inadequate description of the tool or poor adaptation rate. Only methods publicly available in scientific literature, reports, or common textbooks, ensuring systematic observation, described in a reproducible manner, and widely accepted and utilized, were included. After the selection, a total of 14 methods were considered in this study.

Following the initial assessment, several studies referenced in the selected papers were also incorporated, along with relevant studies not indexed in the Scopus database but pertinent to the topic. Additionally, studies that cited the original method proposal papers were screened to identify more recent research and advancements in methods.

Furthermore, other sources of information were incorporated (not only purely academic sources), those that are equally important but not equally searchable in a unique way, such as **ISO standards**. As a result, 2 additional methods suggested for risk assessment by ISO 11228-3:2007 (ISO 11228-3:2007, 2007) and ISO-TR 12295:2014 (ISO/TR 12295:2014, 2014) were also included.

3. Results

As result of the selection, 16 ergonomic assessment methods were considered. Table 1 listed the body segments each tool is focused on. Appendix A summarized the fundamental features of the methods and the limitations of each method.

Table 1: Focus on body segments.

Tool	Body Segments									
	Neck	Upper Limb	Whole Body	Shoulder	Forearm	Elbow	Hand	Wrist	Knee	Lower Back
ART-Tool (Assessment of Repetitive Tasks)		x								
EAWS (Ergonomic Assessment WorkSheet)		x	x							
HARM (Hand Arm Risk assessment Method)		x								
KIM-MHO (Key Indicator Method for Manual Handling Operations)		x								
LUBA (Loading on the upper body assessment)			x							
OCRA Checklist (Occupational Repetitive Actions)		x								
PLIBEL	x		x	x	x	x	x		x	x
QEC (Quick Exposure Check)			x							
HAL/TLV (Hand Activity Level/Threshold Limit Values)							x			
OCRA Index (Occupational Repetitive Actions)		x								
OWAS (Ovako Working Posture Analysing System)			x							
REBA (rapid entire body assessment)			x							
Revised NIOSH Lifting Equation			x							
Revised SI (Strain Index)					x	x	x	x		
RULA (rapid upper limb assessment)		x								
Snook & Ciriello			x							

The methods are presented first according to their method level and then in alphabetic order. The method level of each methods takes as reference ISO 11228-3:2007:

- **Method 1: Simple risk assessment**, that provide a simple and quick evaluation of ergonomic risks associated with manual tasks. They are intended to give a general indication of the potential risks, enabling practitioners to identify areas that may need more detailed investigation. Risk estimation using Method 1 should allow the classification of the risk by the three-zone approach (green, yellow and red) and determine the consequent action to be taken (ISO 11228-3:2007, 2007).
- **Method 2: Detailed risk assessment**, that involve a more detailed analysis of ergonomic risks. Detailed assessments are intended for situations where a higher level of precision is needed to understand the specific risks associated with manual tasks. These methods often provide a more thorough evaluation of risk factors. If the risk estimated using Method 1 is considered to be YELLOW or RED, or if the job is composed of two or more repetitive tasks (multitask job), the performing of a more detailed risk assessment is recommended. This will also allow a better determination of the remedial measures to be taken(ISO 11228-3:2007, 2007)

Description of each tool and the main findings of the method is provided below. Detailed information about the original paper and/or latest development of each method can be found in the reference.

Method 1: Simple risk assessment

ART (Assessment of Repetitive Tasks)

ART (Ferreira et al., 2009) is a method aimed at evaluating repetitive tasks involving the upper limbs, such as those in multitask repetitive jobs. Its purpose is to identify common risk factors contributing to upper limb disorders and aid in their assessment, management, and reduction. Using a numerical scoring system and a traffic light approach, ART assesses the level of risk associated with various factors in repetitive work situations. The main goal of ART is to pinpoint tasks with significant risks and prioritize measures to reduce these risks. Specifically, ART focuses on tasks requiring repetitive movements of the arms and hands, helping to identify and mitigate factors leading to Upper Limb Disorders.

EAWS (Ergonomic Assessment WorkSheet)

EAWS (Lavatelli et al., 2012) is a comprehensive tool to reduce fatigue caused by repetitive manual tasks. It focuses on four key areas of risk in cyclical industrial work: body postures, force exertion, manual handling of materials, and repetitive upper limb motions. It is considered to be one of the most sophisticated methods due to its precise evaluation of task details and its integration with Methods-Time Measurement (MTM) work analysis system, designed to be an engineered tool designed suitable for even the most complex industrial operations. The final score from EAWS indicates the overall risk of MSDs.

HARM (Hand Arm Risk assessment Method)

HARM (Douwes et al., 2014) is a method designed to evaluate the likelihood of experiencing arm, neck, or shoulder discomfort during tasks primarily involving hand or arm use. It is a semi-detailed method tailored for occupational health officers to assess pain risks related to hand-arm tasks. HARM aids in identifying solutions for risk reduction and estimating their impact on risk levels. It is user-friendly, requiring minimal training for occupational health and safety practitioners, as risks are identified using scores. It is versatile and can be applied to various work scenarios.

KIM-MHO (Key Indicator Method for Manual Handling Operations)

The KIM-MHO (Klussmann et al., 2017) method evaluates various factors such as exertion, cycle times, hand/arm postures, overall posture, work organization, and working conditions to determine the risk of upper limb overload. This method focuses on tasks involving consistent, repetitive movements and force exertion by the arms and hands. It typically applies to stationary positions, either sitting or standing, where workers use tools or machines to handle objects, usually weighing up to around 3 kg. By using this method, potential health consequences and necessary actions to prevent them can be identified.

LUBA (Loading on the Upper Body Assessment)

The LUBA (Kee et al., 2001) method relies on experimental data to create a combined index of discomfort for various joint movements like those in the hand, arm, neck, and back. It also considers the maximum time a person can hold a static posture without discomfort. In LUBA, postures are ranked based on discomfort levels measured in similar experiments. These discomfort ratings are added together to create a single score indicating the need for intervention. This overall score is then compared to experimental data on how long people can comfortably hold different postures. By comparing these scores, decision rules are established to prioritize necessary actions.

OCRA (Occupational Repetitive Actions) Checklist

The OCRA (Colombini et al., 2016) checklist is a tool used to assess workplace conditions and identify potential hazards. It considers factors like repetitive tasks, awkward postures, force exertion, and certain organizational aspects. OCRA checklist helps to identify and address factors that could harm workers' health. A questionnaire is often used alongside the checklist to gather information about the prevalence of musculoskeletal issues in various jobs, considering different factors. Its purpose is to pinpoint potential risks and create safer working conditions for employees, aligning with regulatory requirements and best practices in occupational safety and health.

PLIBEL (Plan för identifiering av belastningsfaktorer)

The PLIBEL (Kemmlert, 2004) checklist is designed to identify various risk factors affecting different parts of the body, such as awkward postures, movements, equipment, and organizational aspects. This qualitative study aims directly at prevention by addressing these risk factors through targeted questions that help find solutions. It is a straightforward and cost-effective tool with a broad range of risk factors, offering real opportunities for preventive measures and improvements. PLIBEL is intended for use by shopfloor personnel, making it accessible for practical application in various work settings.

QEC (Quick Exposure Check)

The QEC (G. David et al., 2008) is a method used to estimate exposure levels by considering various factors like posture, force, load handling, and task duration, with assigned scores for their combined impact. It is a questionnaire-based tool involving both practitioners and workers to assess workplace exposure to risk factors for WMSDs, encouraging collaboration to identify and implement changes aimed at eliminating or reducing exposure. Additionally, it serves to compare exposure levels before and after interventions. It assigns scores to measure exposure levels, aiding in the prioritization of interventions and their subsequent evaluation.

Method 2: Detailed risk assessment

HAL (Hand Activity Level)

The HAL (Franzblau et al., 2005) is a detailed method primarily focusing on handwork lasting 4 hours or more per shift, particularly analysing the frequency of actions and peak force exerted. HAL is designed to assess the risk factors associated with musculoskeletal disorders affecting the hand and wrist BY evaluating hand activity and effort level during typical tasks with short cycles. The method combines the average hand activity and normalized peak hand force, providing both a Threshold Limit Value (TLV) and a lower 'action limit' suggesting general controls for risk management.

OCRA (Occupational Repetitive Actions) Index

The OCRA (Colombini et al.; ISO 11228-3:2007, 2007) index is one of the most sophisticated quantifying methods aiming for precision by accumulating detailed assessments, that considers various risk factors such as the frequency of technical actions, repetitiveness, awkward postures, force exertion, additional factors, lack of recovery periods, and duration of repetitive tasks, including multitask repetitive jobs. The final score from the OCRA index determines the overall risk of MSDs. Its goal is to categorize work situations based on their exposure to MSDs and to quantify the level of exposure to tasks involving repetitive movements of the upper limbs.

OWAS (Ovako Working Posture Analysing System)

The OWAS (Karhu et al., 1977) method was developed to identify risky postures and evaluate the risk level based on the combined effect of different postures. Factors observed include load weight, postures of the back, arms, and lower extremities. The possible combinations are grouped into four action categories indicating a need for ergonomic change. Observations are typically quick "snapshots" taken at fixed intervals. OWAS ratings of postures correlate with perceived loading and discomfort. This method allows for evaluating physical strain caused by various work postures and provides a straightforward means to assess safety levels and implement corrective actions.

REBA (Rapid Entire Body Assessment)

The REBA (Hignett et al., 2000) method considers all body parts (trunk, legs, neck, shoulders, arms, and wrists) to provide an overall score. It incorporates factors like dynamic and static postural loading, human-load interface, and gravity-assisted upper limb positioning. Data on body posture, force usage, movement type, repetition, and coupling are collected to generate a final REBA score, indicating the level of risk and urgency for action. Its aim is to offer a comprehensive assessment of working postures, guiding decision-making regarding necessary interventions to reduce the risk of musculoskeletal issues.

Revised NIOSH Lifting Equation

The Revised NIOSH (ISO 11228-1:2021, 2021; Waters et al., 1993) method aims to standardize the assessment of manual lifting tasks to identify their potential to cause low back injuries. It employs the NIOSH lifting equation, assessing factors as the weight of the load, lifting distance, frequency, task duration, and worker posture. It is developed specifically for jobs involving repeated lifting, requiring six observed lifting conditions to calculate a recommended weight limit for the task. The resulting Lifting Index (LI) compares the actual weight lifted to the recommended limit, offering valuable insights into the risks associated with manual material handling by analysing load weight, lifting frequency, distances, and other task variables.

Revised SI (Strain Index)

The Revised Strain Index (Garg et al., 2017; Moore et al., 1995) is a comprehensive method that considers several risk factors, including the intensity and frequency of exertion, duration per exertion, hand/wrist posture, and daily task duration. This method focuses solely on MSDs affecting the wrists and hands, particularly conditions like carpal tunnel syndrome. It is commonly used to quantify risks and compare different work situations, offering a good benefit-cost ratio due to its ease of use and reliable risk scoring. The Strain Index provides a numerical score correlating with the risk of developing distal upper-extremity disorders, aiding professional and ergonomic teams in predicting MSDs risks associated with certain job tasks.

RULA (Rapid Upper Limb Assessment)

The RULA (McAtamney et al., 1993) is a survey method designed for ergonomic investigations in workplaces where upper limb disorders are prevalent. It offers a quick assessment of musculoskeletal loads in tasks where there's a risk of neck and upper limb strain. This tool generates a single score representing the task's posture, force, and required movement, aiding in identifying potential risks. The scores are categorized into four action levels, indicating when risk control measures should be implemented. During the assessment, individual body segments are observed considering the loading on various body parts, especially the neck, trunk, shoulders, arms, and wrists, factoring in posture duration, force exertion, and movement repetition and scored based on deviation from neutral posture, with scores ranging from 1 (low) to 7 (high) indicating the level of risk.

Snook & Ciriello

The Snook & Ciriello (ISO 11228-2:2007/Amd 1:2022, 2022; Snook & Ciriello, 1991) method offers a structured approach for evaluating the physical demands associated with pushing and pulling tasks across various job settings. This method enables the analysis of both pushing and pulling activities, providing benchmarks for the initial and sustainable forces required. Three parameters are assessed: handle height, covered distance, and pushing or pulling frequency, along with specific worker information. By utilizing this method, organizations can assess the risk factors linked to manual pushing and pulling, thereby evaluating potential health risks for workers engaged in these activities.

4. Discussion

The objective of this study is to contribute insights into global methodologies, offering a comparative analysis that can contribute to the development of comprehensive and effective ergonomic assessment tool for the evolving industrial landscape, promoting industrial sustainability and advancing the well-being of workers within the manufacturing industry.

The results of the literature review show that no single method has clear advantages over others. By looking at the features and limitations of existing methods, we have identified some main challenges and drivers for the development of a comprehensive digital ergonomic risk assessment tool:

- Comprehensiveness

Many existing methods have limited area of focus, mainly only on specific body parts (e.g., OCRA, HAL, HARM, RUAL, revised SI). The practitioners of these methods may miss critical risk factors outside the tool's focus, leading to incomplete assessments. This limitation could potentially hinder the application of such ergonomic assessment methods in complex working environment.

A robust tool should include all relevant body parts to provide a holistic analysis of the risks.

- Usability

Some methods on the other hand are designed to evaluate the whole body, to provide a more complete ergonomic evaluation. These methods consider various body postures, forces, movements, and other factors across different body parts (e.g., REBA, EAWS, PLIBEL), which offer a more complete analysis, but are often very time-consuming and requires intensive training or specialized knowledge to perform accurately. The practitioners of these methods may encounter difficulties in completing ergonomic assessment promptly, delaying assessments and updates, particularly in dynamic industrial settings where rapid response to production changes is critical. This could potentially hinder the application of such methods for fast-paced environments.

Developing a user-friendly and time-efficient tool with clear guidelines and efficient workflows is essential for their effective application.

- Objectiveness

Some methods are based on subjective input from workers, (e.g., QEC, HARM, LUBA), which may vary significantly between individuals, leading to variability and potential bias in results. This could potentially limit the applications of such methods only in rough screening of the ergonomic risks.

Some other methods rely on visual observation from practitioner (ex. REBA, OWAS, RULA, etc.), the accuracy of data rely largely on the training and expertise of the practitioners.

Incorporating objective measurements could mitigate variability and improve result accuracy and reliability.

- Digital readiness

Most existing methods are primarily paper-based limiting their accuracy, efficiency, and ability to capture real-time changes in the workplace.

Developing tools that leverage modern data collection technologies and are compatible with digital platforms can improve data management, analysis efficiency, and adaptability to evolving industrial demands.

5. Conclusion

Various methods are available for assessing ergonomic risks, each with its own approach and inherent limitations. While these methods mostly focus on similar risk factors, no single tool provides a comprehensive ergonomic risk evaluation. Users must choose the most suitable method for each situation, considering specific needs and often multiple methods should be used to evaluate the overall ergonomic risks. This often leads to spending considerable time analysing various risk factors using different methods, which may overlap in the risks covered. This highlights the urgent need for a comprehensive ergonomic risk assessment tool in the context of Industry 5.0.

This study offers valuable insights into the implications of choosing the appropriate ergonomic risk assessment method. Additionally, this study enhances our understanding of the challenges and drivers for a comprehensive digital ergonomic assessment method.

A comprehensive ergonomic assessment tool should encompass all body parts, ensuring holistic risk evaluation. It must be user-friendly, minimizing complexity with clear rules and guidelines. Objective data collection methods should be used to reduce subjectivity, and integration with digital technology should be implemented to enhance accuracy, efficiency, and adaptability to dynamic workplace environments.

Nevertheless, further study should be undertaken to investigate the evaluation studies of these methods in terms of validity, repeatability, and aspects related to their practical use.

Furthermore, the methods examined in this study could be further analysed to understand better how each variable affects the calculated risk level. This insight could greatly aid in developing a thorough ergonomic risk assessment method.

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Appendix A. Main Feature and Limitations

Tool	Kind of Output	Method Level	Feature	Limitation
ART-Tool (Assessment of Repetitive Tasks)	Quantitative	1	The ART tool is designed to help risk assess tasks that require repetitive movement of the upper limbs (arms and hands). It assists in assessing some of the common risk factors in repetitive work that contribute to the development of Upper Limb Disorders (ULDs).	The method is not intended for display screen equipment (DSE) assessments. Hand–arm vibration are not analyzed.
EAWS (Ergonomic Assessment WorkSheet)	Quantitative	1*	EAWS is a comprehensive ergonomic assessment tool for the Industrial Engineering to reduce the demand of fatigue generated by a manual cyclical task. The resulting EAWS score reflects the overall risk of Musculoskeletal Disorders (MSDs).	The method is quite time consuming. Left and right hand are only assessed separately for the upper limb assessment.
HARM (Hand Arm Risk assessment Method)	Quantitative	1	HARM is an instrument for determining the risk of arm, neck or shoulder complaints when performing tasks that predominately involve the use of the hands or arms. HARM offers a semi-detailed approach to evaluating pain risks.	The method is limited to tasks that take longer than 1 hour per day in total and tasks involving one handed force exertions of less than 6 kg/60 N.
KIM-MHO (Key Indicator Method for Manual Handling Operations)	Quantitative	1*	The method considers uniform, repetitive motion and force exerted by the upper extremities using instruments, small tools or hand-guided machines if necessary, usually in a stationary sitting or standing position. The work task is to process (modify) the working object or move (handle) small objects.	The method is based on average values and do not capture individual differences. The method takes into account of worker's perception, which might be biased. Hand–arm vibration are not analyzed.
LUBA (Loading on the upper body assessment)	Quantitative	1	The method is based on the experimental data for composite index of perceived discomfort (ratio values) for a set of joint motions, including the hand, arm, neck and back, and the corresponding maximum holding times in static postures.	The method considers only posture discomfort score, not including force, frequency and duration.
OCRA Checklist (Occupational Repetitive Actions)	Quantitative	1	The OCRA checklist is a procedure for monitoring existing conditions and makes it possible to map and identify hazardous work conditions based on OCRA Index.	The method takes into account of worker's perception, which might be biased.
PLIBEL	Qualitative	1	The study is qualitative and directly geared to prevention, targeting risk factors through questions that guide the search for solutions. It is a general, simple tool with a good benefit-cost ratio. The range of risk factors is wide, allowing real opportunities for preventive measures and improvements to be developed.	The method is intended only for general assessment and not intended for any specific occupations or tasks.
QEC (Quick Exposure Check)	Quantitative	1	The method was designed to assess exposure to WMSD risk factors in the workplace through a questionnaire involving the participation of both the practitioner and worker and encourages consideration of changes to eliminate, and limit exposure. It also provides a basis for comparing the level of exposure before and after an intervention	The method takes into account of worker's perception, which might be biased.
HAL/TLV (Hand Activity Level/Threshold Limit Values)	Quantitative	2	The HAL is a guideline to help assess and control the risk of musculoskeletal disorders related to hand-intensive work. This tool sets recommended exposure limits for various hand activities, such as repetitive motions, forceful gripping, and awkward postures, to prevent overexertion and potential injuries.	The method takes into account of worker's perception, which might be biased. The method covers only very limited number of risk factors.
OCRA Index (Occupational Repetitive Actions)	Quantitative	2	The OCRA index is one of the most sophisticated quantifying methods which claims to achieve precision by accumulating assessments of details. The final score defines the overall risk of MSD.	The method is quite time consuming. Time study is necessary for this method.
OWAS (Ovako Working Posture Analysing System)	Quantitative	2	The method aims to identify risky postures and evaluate overall risk by considering different postures and their effects. Factors such as load weight and postures of the back, arms, and lower extremities are observed, resulting in various combinations. OWAS ratings correlate with perceived discomfort, offering a way to assess safety and recommend corrective actions.	This method does not consider frequency and duration of the sequential postures.
REBA (rapid entire body assessment)	Quantitative	2	REBA has been developed as a tool incorporating dynamic and static postural loading factors, human-load interface (coupling). Data about the body posture, forces used, type of movement or action, repetition, and coupling are collected. A final REBA score is generated to give an indication of the level of risk.	The method does not provide a sub-score for different body regions. Left and right hand are only assessed separately. Duration and frequency are not considered.
Revised NIOSH Lifting Equation	Quantitative	2	The purpose of NIOSH Lifting Equation is to provide a standardized method for evaluating manual lifting tasks to determine if they pose a risk of causing low back injuries. It takes into account various factors such as the weight of the object being lifted, the distance it is lifted, the frequency of lifting, the duration of the task, and the posture of the worker during lifting.	The method is quite time consuming. The method is based on average values and do not capture individual differences.
Revised SI (Strain Index)	Quantitative	2	The Revised Strain Index is a method designed to evaluate the risk of MSDs of the wrists and hands. It considers factors like exertion intensity and frequency, duration per exertion, and hand/wrist posture. It offers a numerical score correlating with MSD risk, aiding professionals in predicting risks associated with certain job tasks.	The method limited to distal upper extremity. Localized compression or hand–arm vibration are not analyzed. Limited to assessment of the task to be carried out in a specific "work place", not suitable for determine risk of individual worker.
RULA (rapid upper limb assessment)	Qualitative	2	RULA is a survey method developed to assess work-related upper limb disorders. It generates a single score representing posture, force, and movement demands, identifying potential risks. These scores are grouped into four action levels that provide an indication of when risk control measures are necessary.	Duration and dynamic actions are not considered. The observers must decide which tasks to assess. Hand–arm vibration are not analyzed.
Snook & Ciriello	Quantitative	2	It provides guidelines and recommendations for assessing the physical demands placed on individuals engaged in pushing and pulling tasks in various occupational settings. This includes activities such as moving carts, handling wheeled equipment, or operating machinery that involves pushing or pulling motions.	The method takes into account of worker's perception, which might be biased. The method is based on average values and do not capture individual differences