Work-Related Risks and Hazards for Garment Making Workers at Sewing Workstations: A Review.

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Abstract
Awkwardly designed sewing workstations in garment manufacturing cause work-related risks and hazards that raise global health concerns for industrial sewing workers and the environment. In this review, therefore, most of the studies showed that work-related musculoskeletal disorders (WMSDs) are a major problem throughout the world. However, strategies to control this risk typically focus on redesigning sewing workstations to reduce the ergonomic hazards that workers experience during their work performance. Though the best way to have a safer workstation without any injuries during the work is to assess the risks and hazards of WMSD. The aim of this review study, therefore, is to assess work-related risks and hazards for garment-making workers at sewing workstations. Furthermore, there are three primary risk factors that are essentially physical in nature, such as forceful exertions, high task repetitions, and awkward postures. Besides, the most common hazards at the workstation are safety hazards, biological hazards, physical hazards, ergonomic hazards, chemical hazards, work and person hazards, fire hazards, and environmental hazards. In addition, there are many ways to reduce ergonomic risks and hazards that can help fit the sewing workstation to the worker. Additionally, solutions can be grouped into ten main categories, such as eliminating the risks and hazards, substituting the risks and hazards, engineering controls, visual and audible warnings, administrative controls, improving work policies and procedures, work practice controls, counteractive stretch breaks, a job rotation program, and providing personal protective equipment. This review therefore suggested a study on ergonomic hazards for making workers realize the importance of ergonomics for assessing potential ergonomic risks and hazards factors that existed around their sewing workstation. For ergonomic assessment methods, RULA and REBA are used to review studies from different researchers. In contrast, both survey-based methods show their significance and are suitable and accurate to assess the risk and hazards of ergonomics in the workers' working environment. This review study, therefore, suggested both methods as the most popular and widely used observational ergonomic assessment tools in various industries and services. It is hoped that the review and discussion can inspire more researchers to take part in this present review study.
Keywords: Garments industry, RULA, Ergonomic hazards, WMSD, REBA.

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1. Introduction

The garment sector is a sector that plays an important role in the economic development processes of countries. The most common problem is that almost every employee has musculoskeletal complaints due to non-adjustable and non-ergonomic work desks and chairs (Kaya, 2015). Moreover, in India, the most common occupational problem among workers is musculoskeletal disorder. Currently, the work is being carried out manually in most of the small scale manufacturing, and therefore the issues of MSD and injury in different body sites are of top priority (Ansari et al., 2014). Additionally, California is home to the largest garment manufacturing center in the United States of America, with the majority of the garment workshops (P. C. Wang et al., 2010).

Research shows that workers operating sewing machines face a substantially higher risk of muscle pain and injury than workers in other jobs (Patil et al., 2017). The early industrialization of both industrialized and developing nations was typified by the garment and textile industries, which only needed a modest degree of production technology and an abundance of inexpensive labor. In many developing nations, export-led industrial expansion has been sparked, particularly through the clothing industry (Natsuda et al., 2010). Operators of sewing machines for clothing are subject to dangers and discomfort that build up over time (Okareh et al., 2021). Besides, major manufacturing of clothing still happens in cramped, unfriendly settings where little care is given to the layout and environment of the workplace, putting workers in danger.

The garment sector, which primarily consists of small and medium sized enterprises, is one that requires a lot of labor. Large-scale organizations are typically the focus of occupational health and safety programs in developing countries (Ahmad et al., 2021). In addition, the most frequent occupational health risk among sewing workers is musculoskeletal pain (MSP), and it is unclear what drives their health-seeking behavior (Akinpelu et al., 2016). Moreover, the SMO executes repetitive, boring operations in a position that is similar to a static component of muscle load on the shoulders and neck (Lindh et al., 1991). Besides, in Bangladesh's garment industry, for example, many sewing machine workers are exposed to conditions that put their musculoskeletal health at risk (Habib, 2015).

Previous research by Patil et al., (2017) shows that workers operating sewing machines face a substantially higher risk of muscle pain and injury than workers in other jobs. Study by many researchers Akinpelu et al., (2016); Ansari & Sheikh, (2014); Biadgo et al., (2021); Habib, (2015); Norhidayah et al., (2016); Okareh et al., (2021); Parimalam et al., (2006) observed that poorly designed workstations, inappropriate furniture, inadequate ventilation, inappropriate lighting, excessive noise, and inadequate protection from dangerous chemicals, dust, poor housekeeping, and a lack of personal protective equipment. Furthermore, are a few examples of these hazards, which can make workers more vulnerable to pain and occupational diseases (Esmaeel, 2020; Esmaeel et al., 2022).

This review study, therefore, conducted in garment manufacturing, is aimed at assessing work-related risks and hazards for garments-making workers at sewing workstations in order to have a safer workstation without any injuries during the work.

2. Literature Review

Following are the literature review of some of the studies which gives more information about their share in field of work-related risks and hazards which are to be considered while designing the sewing workstation for garments making workers. However, the research done on the risks assessment and hazards by some of the scholars are described in subheading:

2.1 Ergonomic Risk Factors

There are three primary risk factors, which are essentially physical in nature as presented as well as seen in figure 1 (Cheng et al., 2016):

2.1.1 Forceful Exertions

Forceful exertions create greater demands on the muscles, tendons, and joints. Besides, increased force also signifies increased physical needs, such as higher muscular effort. In contrast, the amount of strain on the muscles and joints, however, is influenced by a number of parameters, including the height at which the load must be lifted and the frequency of lifts. There are no particular limitations, such as weight restrictions, in the regulations (Wang & Chen, 2012).

In addition, high force loads are applied to the human body throughout several work duties. Besides, high force demands cause muscles to work harder, which raises associated fatigue and can cause MSD (Middlesworth, n.d; Keir et al., 2021). Keir et al., (2021) found a high correlation between intense exertion and carpal tunnel syndrome (CTS), epicondylitis, and conditions involving the hand and wrist tendons. Relationships between epicondylitis and CTS's dose and response were discovered. The multiplicative impacts of risk variables on injury risk are also shown via interactions. A dosage response between risk variables and injury is further supported by animal models and laboratory research that show clear correlations between task demands and biomechanical measurements associated with mechanisms for upper extremity injuries.

2.1.2 High Task Repetitions

These are repetitive job tasks and processes that call for performing the same actions repeatedly. As a result, they are usually managed through work procedures and hourly or daily production targets. Numerous job tasks and cycles are repeated in nature, and they are usually governed by work processes and hourly or daily production targets. When paired with other risk factors, including high force and/or uncomfortable postures, high task repetition might contribute to the development of MSD. If the cycle period is 30 seconds or fewer, the task is regarded as very repetitive (Middlesworth, n.d; Ghoual, 2019).

According to Pavlovic, (2013), WMSD diseases are becoming a significant issue for the global economy. The risk factors for their development are numerous and diverse. Additionally, one of the most significant risk factors is repeated work. Besides, the body's reaction to repetitive stress is discussed in this study, along with the methodologies now in use to assess repetition as a risk factor for musculoskeletal illnesses.

2.1.3 Awkward Postures

An awkward posture therefore, refers to positions of the body that deviate meaningfully from the neutral position while performing work activities (Yale & Safety, 2018). Besides, when lifting, lowering, or handling loads with the back bent or twisted as opposed to when the back is straight, additional stress is imposed on the spinal discs, which is determined by body postures. In the same way, tasks that require a lot of time spent working above shoulder height can be very stressful (Wang & Chen, 2012; Rupasinghe & Panuwatwanich, 2020; Hambali et al., (2019).

Although an awkward postures in construction operations, per Chen et al.,'s 2017), study, present significant risks for both short-term WMSDs and long-term injuries. According to Beiseds, avoiding and reducing the exposure of workers to uncomfortable postures is possible with the help of motion capture technologies for posture recognition. Addtionally, research by Ezugwu et al., (2020), despite the fact that the level of awareness varied within variables, it is evident that the level of awareness about awkward posture and repetitive motions as ergonomic factors related to MSD was positive.

Figure 1. Risk factors.

2.2 The Common Hazards in the Workstation

The most common hazards in the workstation are: Safety hazards, biological hazards, physical hazards, ergonomic hazards, chemical hazards, work and person hazards, fire hazards and environmental hazards as described in details as well as in the figure 2 (Guiochon, 1980; Loud Noise Vibration Electricity, n.d. Disorders, n.d; Vitharana et al., 2015):

Figure 2. The common hazards in the workstation.

2.2.1 Safety Hazards

Any worker could be exposed to safety hazards, however, those who use heavy equipment or work on construction sites are at a g higher hazards. Besides, safety hazards include event (Rupasinghe & Panuwatwanich, 2020): Spills on floors or tripping hazards, working from heights, guards removed parts that a worker can accidentally touch, electrical hazards as shown in figure 3.

Additionally, in many nations, companies must submit information about incidents involving health and safety at their workplaces to the appropriate authorities, including the department of labor and the occupational health and safety organization, through an investigating report that includes a detailed account of the accident event (Rupasinghe & Panuwatwanich, 2020).

Figure 3. Safety hazards.

2.2.2 Biological Hazards

Biological hazards are dangerous, because they include to expose to dangerous substances and diseases. Similarly, associated with working with animals, people, or infectious plant materials. Work in schools, day care facilities, colleges and universities, hospitals, laboratories, emergency response, nursing homes and outdoor occupations. These may expose biological hazards (Rim & Lim, 2014; Xavier et al., 2019; Russi, 2017). In addition, types of biological hazards may be exposed to include: Blood and other body fluids, mold, bacteria and viruses as shown in figure 4.

According to research by Xavier et al., 2019), hospital workers may be exposed to occupational biological hazards if they come into contact with hospital waste either directly or indirectly. In addtion, because information on biological agents in the workstation is lacking, biological hazard analyses at the workstation to securely recognize the harmful factors with biological basis are desperately needed (Rim & Lim, 2014).

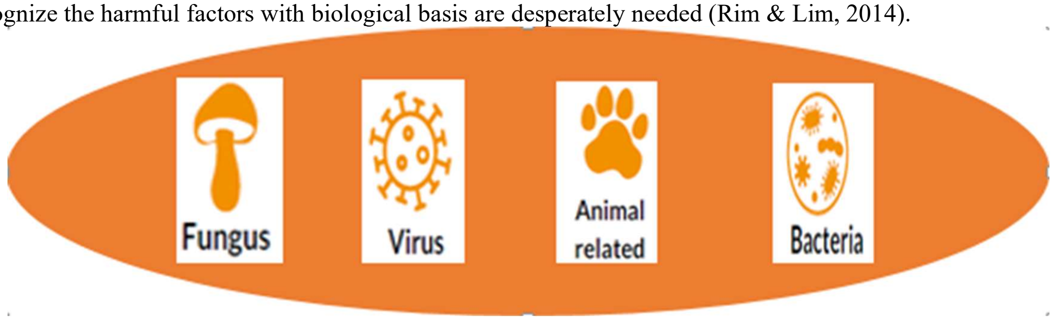

Figure 4. Biological hazards.

2.2.3 Physical Hazards

Physical hazards are dangers that are brought on by energy, matter, and their interactions. Conceptually, workplace physical hazards can be further broken down into energy and electromagnetic fields, physical work environments, and worker-material interfaces (Bartram et al., 2000).

Besides, the protection of workers and various human factors can alter the effects of exposure to these dangers. Additionally, physics is the study of matter and energy as well as how they interact. Further, physical hazards are often associated to the release of stored energy, i.e. the energy stored in a pressure or vacuum vessel, electrical energy or the energy in moving mechanical parts as seen in figure 5.

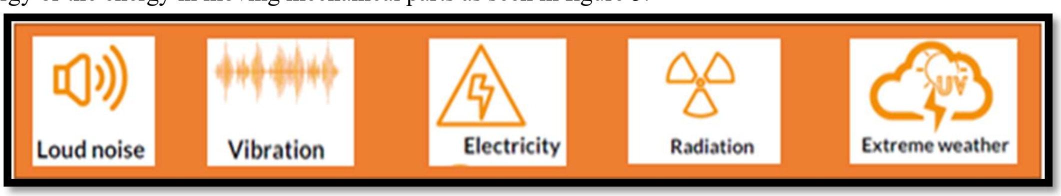

Figure 5. Physical hazards.

2.2.4 Ergonomic Hazards

Ergonomic hazards occur when the type of work, body positions and working conditions put strain on the body (Ramaganesh et al., 2021; Hamid et al., 2018). Additionally, ergonomic hazards include: Improperly adjusted workstations and chairs, frequent lifting, poor posture, awkward movements, repeating the same movements over and over, having to use too much force and Vibration as shown in figure 6.

Study by Hamid et al., (2018), identified ergonomic hazards, muscle aches/ sprains (76.5%), excessive stretching of muscles (67.5%), body posture issues (56.0%), elbow/ wrist/ neck pain (56.0%), and bending/ twisting at work (55.5%) were commonly encountered. Although workers awareness about occupational health hazards and implementation of control measures by healthcare facility to mitigate hazards (especially biological) prevalence of hazards was reported. Hence, there is a need to improve working standards and conditions to reduce the occurrence of ergonomic and psychosocial hazards.

Figure 6. Ergonomic hazards.

2.2.5 Chemical Hazards

Chemical hazards are present when a worker is exposed to any chemical preparation in the workplace in any form (solid, liquid or gas). Besides, some workers are safer than others, but to some workers who are more sensitive to chemicals, even common solutions can cause illness, skin irritation, or breathing problems (Occupational Safety and Health Administration, 2016).

Moreover, chemical hazards includes: Liquids like cleaning products, vapors and fumes that come from welding or exposure to solvents, gases like acetylene, flammable materials like gasoline and explosive chemicals and pesticides as shown in figure 7.

Furthermore, the Globally Harmonized System of Classification and Labeling of Chemicals (GHS), Revision 3, was adopted by the United Nations in March 2012, and the Occupational Safety and Health Administration (OSHA) updated its Hazard Communication Standard to reflect this change.

Figure 7. Chemical Hazards.

2.2.6 Work and Person Hazards

Work and person hazards are safety challenges that companies may experience through the course of traditional operations. In addition, hazards or stressors that cause stress (short term effects) and strain (long term effects). These are the hazards associated with workstation issues such as workload, lack of control and respect. Additionally, work and person hazards include: Workload demands, workstation violence, intensity, respect and flexibility as shown in figure 8.

Figure 8. Work organization hazards.

2.2.7 Fire Hazards

Workstation fire cause severe damage to people and property every year. However, more than a thousand workstation fire happened in the UK since 2013. While there could be an assortment of reasons cussed workstation fires, negligence and faulty wires are the most common.

In addition, one fire hazards is the buildup or readily combustible materials like paper and cardboard, especially in corporate offices. Beside, an untested fire alarm is also a hazards, as this does not serve its purposed to let people know that a fire has started somewhere in the building. There are common fire hazards in the workstation such as flammable gases, flammable liquids, electrical, general combustibles, oils and metals as shown in figure 9.

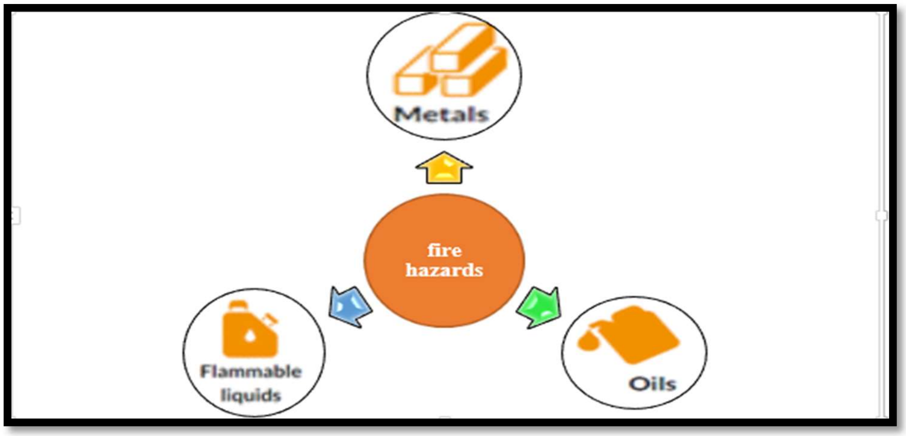

Figure 9. Fire hazards.

2.2.8 Environmental Hazards

Environmental health is a field that focuses on how the natural and human-built surroundings as well as behaviors affect human well-being. Therefore, the field is concerned with preventing disease, death, and disability by decreasing exposure to environmental hazards and promoting behavioral change. Furthermore, environmental hazards are threats to human health and well-being. In addition, environmental hazards are one of the most pressing and dynamic hazards constantly changing due to the more unpredictable and harsh weather and climate see figure 10 (Ha & Schleiger, n.d; Iderawumi, (2019).

The study by Iderawumi, (2019), states that the feasibility of brownfield rehabilitation is ultimately influenced more by the deal's underlying economics and other elements that aren't immediately tied to the risk of contamination. Additionally, environmental deterioration or liability issues won't be critically detrimental to the majority of worthwhile transactions. However, many individuals only recently came to the realization that the environment needs to be carefully controlled and shielded from harm and further deterioration.

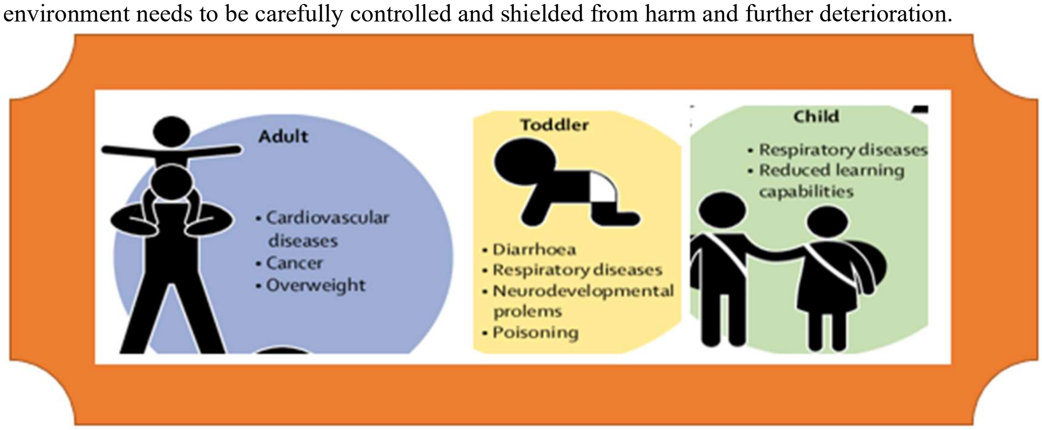

Figure 10. Environmental hazards.

2.3 The Solutions/ Control Methods to Ergonomic Hazards/ Risks

There are many ways for reducing ergonomic risks and hazards factors that can help fit the sewing workstation to the worker. Additionally, solutions can be grouped into ten main categories such as eliminate the risks and hazards, substitution the risks and hazards, engineering controls, visual and audible warnings, administrative controls, improve work policies and procedures, work practice controls, counteractive stretch breaks, job rotation program, and provide personal protective equipment as described in details (Disorders, n.d; OSHAcademy, 2018).

2.3.1 Eliminate the Risks and Hazards

The most effective solution for the ergonomic risks and hazards at workstation is to eliminate the risks and hazards factors altogether. Occasionally, needs to change the tools, equipment, job design, or work area to remove the risks and hazards completely. This is called using "engineering controls". These are some examples of engineering controls such as redesign sewing workstations and work areas to eliminate reaching and provide adjustable tables and chairs that can be used by workers with a range of sizes that allow neutral postures. Improving the workstation is the heart of ergonomics and changing the work to fit the worker (Weaver & Astumian, 1990; Levels et al., n.d; Job et al., n.d.).

Additionally, the best strategy to safeguard workers from injuries is to eliminate hazards. However, a lot of companies or individuals fail to plan out their work tasks or to truly remove the threats they face. Millions of workers are exposed to dangers every day that are unnecessary. One of the first measures supervisors may take to start eliminating hazards is proper planning of the work, considering safer alternatives to completing a task, and allocating the required resources to finish the assignment. (Levels et al., n.d.).

2.3.2 Substitution the Risks and Hazards

The substitution principle could be communicated as taking steps to avoid products for which less hazardous substitutes are available (Bergkvist, 2007). Besides, substitution is the next-best solution for the ergonomic risks and hazards at workstation. For instance, the employer might replace large heavy containers with smaller containers (OSHAcademy, 2018; Oosterhuis, (2006).

Research by Oosterhuis, (2006), finds that public policy has become a main driver for innovation in chemicals hazards. However, a few countries apply a policy of mandatory substitution of hazardous chemicals on environmental lands. In addition, the limited evidence available suggests that such policies do not need to be conflicting with innovativeness in the chemical manufacturing.

2.3.3 Visual and Audible Warnings

Warnings can be either audible, visual, or both. Additionally, they could have a tactile quality. Signs, labels, tags, and lights are further examples of visual warnings. While audible alerts can be sent by announcement systems, alarms, bells, beepers, sirens, and bells. Vibration devices or air fans are examples of tactile alerts (OSHAcademy, 2018). Additionally, visual and audible warning signals need to be standardized and uncomplicated therefore that when the situation arises, workers be able to take prompt and proper act (DEA, 2010; Bruck & Thomas, 2007).

In contrast, many patients with less severe hearing loss might not feel a significant need for such specialized equipment, especially if their hearing aids are successful in improving their functional hearing of signals. Additionally, hearing healthcare specialists might not counsel clients with mild or moderate hearing loss regarding the alerting equipment they might need to purchase or if they would likely not wake up to smoke or carbon monoxide alarms (Bruck & Thomas, 2007).

2.3.4 Administrative Controls

Changing work procedures or the manner in which work is organized are examples of administrative improvements. Additionally, they might not deal with the causes of the contributing elements or other issues. Furthermore, to make sure the new procedures and regulations are successful, administrative enhancements frequently call for ongoing management and worker assessment (OSHAcademy, 2017; Ganaheh et al., 2018).

Additionally, any institutional frame of reference might be used to operationalize the administrative process with relative success. Besides a central government agency, a state university, or a global organization like the ILO, UNESCO, or the IMF/World Bank could serve as the frame of reference. Many of these scientists cite policy, organization, finance, personnel, procedures, and control as the six fundamental administrative categories (Marume et al., 2016).

2.3.5 Improve Work Policies and Procedures

The most effective solution for ergonomics risks and hazards is to develop work policies, procedures and practices that change how the job is done. This is called using "administrative controls". These are some examples of administrative controls such as rotate workers among different tasks to rest the various muscle groups of the body and improve work scheduling to minimize excessive overtime or shift work which can cause fatigue. However, it is not a substitute for reducing risks and hazards factors and should be used in combination with engineering and administrative controls (Disorders, n.d; california division of occupational safety and health, n.d; interagency coalition on aids and development, 2012).

Additionally, the core principles that have been formed for the workplace as well as the rules and procedures that have been created and put into place represent the organization's stance on human rights. Discussions about human rights and non-discriminatory business practices should occur at all organizational levels, especially with top managers, supervisors, and all employees (interagency coalition on aids and development, 2012).

2.3.6 Provide Personal Protective Equipment

The PPE can be used for equipment to eliminate risks and hazards at sewing workstation. The PPE that can help address ergonomic problems includes: Knee pads for kneeling tasks, shoulder pads to cushion loads carried on the shoulder and gloves to protect against cold and vibration (OSHAcademy, 2017; Utami & Sillehu, 2020).

In addition, employees used PPE while working because routine supervision was carried out by the person in charge of the ship. However, it is necessary to increase the awareness of employees in using PPE therefore that it becomes a requirement for workers by implementing a system of rewards and punishments, as well as a cooperation with the person in charge of ships and health employees at the port health office (Utami & Sillehu, (2020).

2.3.7 Work Practice Controls

The work practice control method is the use of workplace practices that take difficult postures into account and decrease them. Additionally, workers should receive adequate work technique instruction as well as encouragement to accept responsibility for using their bodies correctly and avoiding unpleasant postures whenever possible. In addition to workstation examples for work practice controls are require that heavy loads are only lifted by two people to limit force exertion, establish systems therefore, workers are rotated away from tasks to minimize the duration of continual exertion and awkward postures (Middlesworth, n.d; Safety, n.d.).

2.3.8 Job Rotation

The job rotation method will reduce frequent and persistent uncomfortable postures that can cause MSD by rotating jobs and expanding occupational tasks. Besides, job rotation increases the variety of hazards required as the employee takes on more duties, enlarging the physical demands and adding variety to the task (Evans, 2021; Oparanma & Nwaeke, 2015; Middlesworth, 2022).

According to Evans, (2021), there are many studies published in related literature investigating the relationship between employees' motivation and job design. Therefore, the common points of these studies is that the application of job design has a significant on the specifics of job performance, like flexibility, motivation, job satisfaction.

2.3.9 Counteractive Stretch Breaks

The counteractive stretch break method will implement rest or stretching breaks to give employees a chance to correct any repeated or continuous problematic postures and to give them enough time to recuperate (Middlesworth, n.d; Prevention, n.d; De et al., (2015).

According to De et al., (2015), the stretch break program (SBP) enhanced cervical, trunk and left shoulder flexibility in the complaints of storage group and improved cervical and shoulder flexibility and grip strength in the administrative group. Therefore, the SBP contribute to increase flexibility and musculoskeletal disorders in the regions that are affected by higher rates of work-related risks and hazards.

2.3.10 Engineering Controls

The engineering control method will eliminate the need for excessive force and unnatural postures, which will lessen worker fatigue and enable high repetition jobs to be carried out without significantly raising the risk of MSD for the majority of workers.

In addition the workstation examples for engineering controls are use a device to lift and reposition heavy objects to limit force exertion, reduce the weight of a load to limit fore exertion, reposition a work table to eliminate a long/excessive reach and enable working in neutral postures, use diverging conveyors off a main line consequently that tasks are less repetitive, install diverters on conveyors to direct materials toward the worker to eliminate excessive learning or reaching and redesign tools to enable neutral postures (Exertions, n.d.). In addition to the some of the basic research that is being used for the present review study could be summarized as shown in Table 1.

Table 1. Summary of the research studies particularly applicable for the present review study.

Author and Year	Title	Objectives	Methods / Tools	Findings	Comments / Gaps
Ahmad et al., (2021).	Investigation of ergonomic working conditions of sewing and cutting machine operators of clothing industry.	Examining the working conditions of sewing and cutting machines' operators of the garment industry.	Work through, interviews and focus group.	Understanding of working conditions of sewing activities at garment industry.	Comments: These could help in the design of ergonomics interventions for reducing musculoskeletal discords.
Talapatra & Mohsin, (2020).	An assessment of hazards and risks in the sewing section of the readymade garment industry in Bangladesh.	Identify and evaluate hazardous events and accidents list for sewing section of a readymade garment industry.	Interview session was completed with questionnaire.	Personal effort of each worker are essential for overall safety of sewing section.	Comments: Proper precautions are needed to take to save life of the workers as well as money and investment.
Abid et al., (2017).	Ergonomic Hazard Identification and Assessment of a Garment Factory in KSA—An Exploratory Study.	Identify and assess the risk of WMSDs among the workers who are working in sewing area of garment factory in KSA.	A survey was developed on the observed risks of WMSDs.	The results were analyzed, which showed that 84.6% of workers reported pain in their body parts.	Gaps: To prevent these hazards, suggestions were given to management which includes workplace re-designing and providing comfortable chairs/tables.
Habib, (2015).	Ergonomic risk factor identification for sewing machine operators through supervised occupational Therapy Fieldwork.	Identify the physical risk factors among sewing machine operators in a Bangladeshi garments factory.	Six ergonomic risk factors were determined using the Musculoskeletal Disorders risk assessment.	The results of this case study demonstrate that sewing machine operators work with high ergonomic risk.	Comments: One aspect of improving worker health in garment factories includes addressing musculoskeletal risk factors through ergonomic interventions.

3. Methodology

Ergonomic assessment techniques are vital to determining and evaluating the risk and hazard levels of ergonomics in the working environment. In this section, therefore, two types of ergonomic assessment methods have been chosen to be reviewed.

The methods chosen are REBA and RULA. These two methods are popular techniques that are often mentioned by researchers in the study of ergonomic assessment tools.

3.1 Ergonomic Assessment Methods

3.1.1 Rapid Entire Body Assessment

McAtamney & Hignett., (2000) developed REBA in the year 2000. In this method, therefore, the body segments are divided into 2 groups, namely group A and group B. Furthermore, group A consists of the back, neck, and legs, while group B consists of the upper arms, forearms, and wrists. Additionally, the determination of the REBA score, which indicates the risk level of the work posture, starts with determining the A score for group A postures plus the load score and the B score for group B postures plus the coupling score. Besides, the 2 scores A and B were used to determine the C score.

Moreover, the REBA score is obtained by adding the activity score to the C score. Also, from the REBA score, it can be seen the level of risk that exists. Table 2 and figure 11 show the important steps of REBA assessment by mentioning the REBA employee assessment worksheet. In addition, the final score of the REBA assessment, which is divided into 5 degrees of severity of the risk of ergonomics, such as score 1 represents negligible risk, score 2 to 3 represents low risk and suggests change may be needed, score 4 to 7 represents medium risk, which changes soon, score 8 to 10 represents high risk and requires investigation and implementation, and score 11 represents very high risk and implements change as shown in Tables 2 and 3 (Tee et al., 2017).

Table 2. Steps of REBA ergonomics assessment tool

Analysis	Step	Description
Neck, Trunk and leg	1	Locate Neck Position
	2	Locate Trunk Position
	3	Locate Legs Position
	4	Determine Posture Score A
	5	Add Force/Load Score
	6	Find Row in Posture Score C
Arm and Wrist	7	Locate Upper Arm Position
	8	Locate Lower Arm Position
	9	Locate Wrist Position
	10	Determine Posture Score B
	11	Add Coupling Score
	12	Find Colum in Posture Score C
	13	Add Activity Score
	14	Determine Final Score (1 to 11)

Table 3. REBA Score

REBA level	REBA score	Risk level	Action description	References
0	1	Negligible	Acceptable.	(Beatrix, 2021; Fan et al., 2022; Hignett & McAtamney, 2000; Kusuma, 2020; McAtamney & Hignett, 2000, 1995; Sheba Hepsiba Darius et al., 2009).
1	2 – 3	Low	Change may be needed.	
2	4 – 7	Medium	Further investigation, change soon.	
3	8 – 10	High	Investigation and implement required soon.	
4	11+	Very high	Implement required immediately.	

3.1.1.1 REBA Procedure Methodology

The assessment procedure using REBA method has been implemented by Dr. Hignett and Dr. Mcatamney by conducting several stages, as follows (Kusuma, 2020; Mcatamney & Hignett, 2000;; Wibowo & Mawadati, 2021):

1. Collecting the workers' posture data by using documentation (video or photo).
2. Determination of the angles of workers' body part.
3. Calculation of the REBA score for the posture.

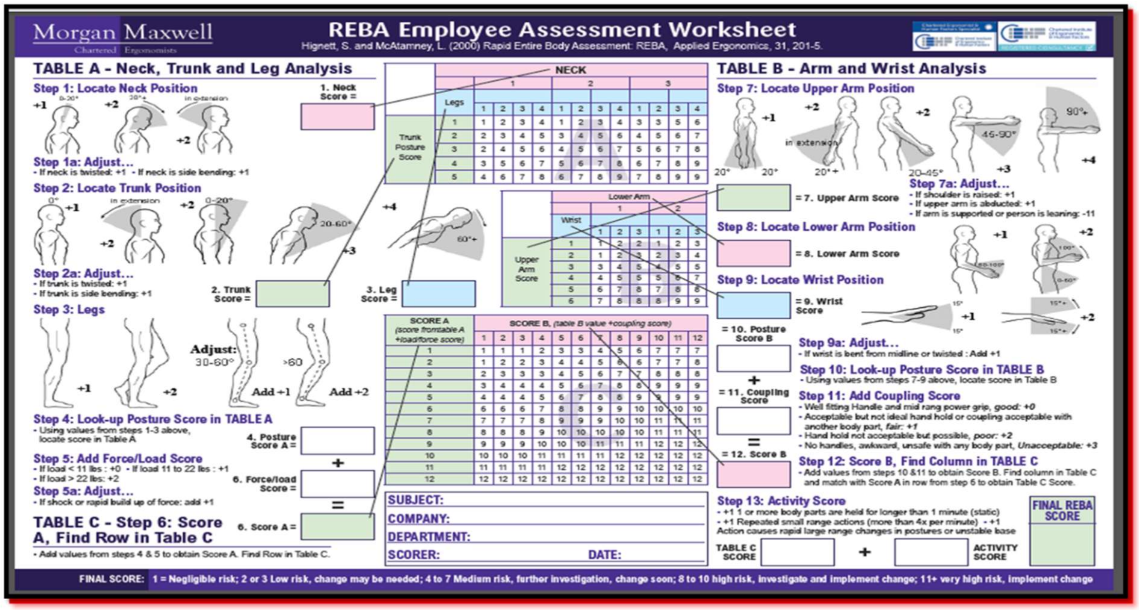

Figure 11. REBA employee assessment worksheet

3.1.2 Rapid Upper Limb Assessment

McAtamney & Corlett, (1993) have introduced RULA at the year 1993. This tool is a survey-based method which evaluates the risk of ergonomics affiliate with WMSDs at different workplaces. It does not require any instrumentation for ergonomics assessment which makes it simple, quick and observational. In addition, the important steps of the RULA ergonomics assessment are listed in Table 4 and figure 12.

The final score of the ergonomics assessment is distributed into 4 degrees of severity of the risk of ergonomics such as score 1 to 2 represents acceptable posture; score 3 to 4 represents further investigation, change may be needed; score 5 to 6 represents further investigation, change soon and score 7 represents investigation and implement change as shown in Tables 4 and 5 (Tee et al., 2017).

Table 4. Steps of RULA ergonomics assessment tool.

Analysis	Step	Description
Arm and Wrist	1	Locate Upper Arm Position
	2	Locate Lower Arm Position
	3	Locate Wrist Position
	4	Locate Wrist Twist Position
	5	Determine Posture Score A
	6	Add Muscle Use Score
	7	Add Force/Load Score
	8	Find Row in Posture Score C
Neck, Trunk and leg	9	Locate Neck Position
	10	Locate Trunk Position
	11	Determine Legs Condition
	12	Determine Posture Score B
	13	Add Muscle Use Score
	14	Add Force/Load Score
	15	Find Colum in Posture Score C
	16	Determine Final Score (1 to 7)

Table 5. RULA score

RULA level	RULA score	Risk level	Action description	References
0	1 - 2	Negligible risk	No action required	(Beatrix, 2021; Fan et al., 2022; Kusuma, 2020).
1	3 – 4	Low risk	Change may be needed.	
2	5 – 6	Medium risk	Further investigation, change soon.	
3	6+	Very high risk	Implement change soon.	

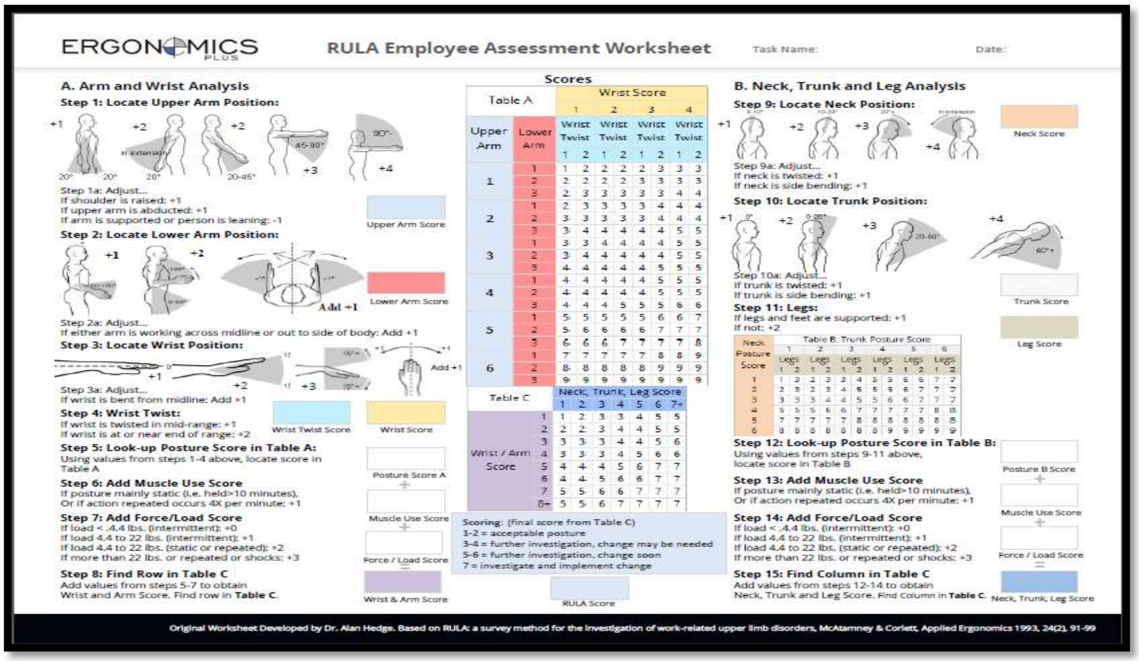

Figure 12. RULA employee assessment worksheet

3.1.2.1 RULA Procedure Methodology

The assessment procedure using RULA method has been implemented by Dr. Hignett and Dr. Mcatamney by conducting several stages, as follows (Kusuma, 2020, Mcatamney & Hignett, 2000, and Wibowo & Mawadati, 2021):

1. Development for recording and making note of the work postures.
2. Development of the scoring system.
3. Development of a scale for the level of action that provides a guide to the level of risk.

4. General Discussion

The findings of the review on the previous studies of the researchers on the work-related risks and hazards for making workers at sewing workstations using ergonomics assessment tools are presented and discussed in this section.

4.1 Rapid Entire Body Assessment Tool

Lasota, (2014) has conducted research on a company that sells books to analyse the ergonomics of the workers using REBA assessment. The tasks of the case study are order picking, carton sealing, and sorting parcels. All the tasks studied are assigned along the conveyer belt. The outcome of the assessment shows that 5 postures are at medium risk level, 7 postures are at high risk level, and 1 posture is at very high risk level. This concludes that the overall score of the workers postures is not acceptable. Besides, the main risk factor determined is the awkward posture of the worker.

Ansari et al., (2014) have done a case study on the posture analysis of the workers in a small factory using REBA assessments. From the results obtained, the REBA assessment shows that 13% of workers are at a low risk level, 33% are at a medium risk level, and 53% are at a high risk level. Furthermore, REBA assessment results indicate that most workers are exposed to a medium-to high- risk level at their workstation.

Fazi et al., (2016) have analysed the ergonomics of the workers in the food production industry using the REBA assessment tool. Furthermore, three workers with different genders and height ranges from 150 to 180 cm are selected for the case study, which are workers A, B, and C. The postures studied are divided into postures 1 and 2. Posture 1 involves products being lifted from one place to another, while posture 2 involves arranging products. According to the assessment, worker A scores the highest in the REBA assessment with different postures as compared to workers B and C. Therefore, the result shows that worker A needs to be transferred to a different workstation as his height is not suitable for the study area.

Wibowo & Mawadati, (2021) have analysed the work posture of employees by using REBA, based on the results of REBA, the grand score obtained is 11 and also categorized as action level 4. Moreover, based on the calculation of work posture using REBA methods, it revealed that the worker's work posture has a high level of risks and dangerous hazards. Therefore, the worker needs to immediately improve the work posture.

In addition, due to the lifting position that was started with no squatting position, it causes waist injures, since it becomes the lift's pedestal.

4.2 Rapid Upper Limb Assessment Tool

Öztürk & Esin, (2011) have done a study on the investigation of musculoskeletal symptoms and ergonomic risk factors among female sewing machine workers. RULA is a validated tool for the assessment of ergonomic risks. The results of the RULA scores were found to be quite high. Therefore, the final RULA scores of 7 indicate that the participants' postures at their work stations need to be investigated and implemented immediately.

Sharan & Ajeesh., (2012) have done a study on the relationship between ergonomic risk and the RULA ergonomic assessment in computer professions. Furthermore, from the results obtained, 65% of workers are at a low hazard level, 30% are at a medium hazard level, and 15% are at a high hazard level. This, therefore, shows that improvement in the ergonomics of information technology workers is needed in terms of the working environment, working hours, and sitting posture.

Norhidayah et al., (2016) have done an evaluation of the MSD risk among mining industry workers using the RULA method. In addition, the posture studied is the scenario of wet screening the raw mining material with a manual handling water hose. Likewise, the whole study is distributed into 3 assessment periods, such as morning, noon, and afternoon. According to the results, the mean scores for every assessment get a score of 7, which is the highest in the RULA assessment. This therefore, shows that immediate action is needed to improve the posture of the workers in the mining industry, as they are exposed to high MSD hazards.

Upasana & Vinay, (2017) have done an evaluation of the various tasks performed by tailors and the work posture adopted by them while operating the sewing machine. Additionally, the results of postural analysis using the RULA ergonomic assessment tool indicate that more than 58%, 60%, and 65% of the respondents were at high risk when performing ironing, stitching, and cutting activities at the sewing workstation. Furthermore, the majority of the respondents reported that a high rate of musculoskeletal discomfort was not avoided due to the job characteristics of tailors.

4.3 Comparison between REBA and RULA Ergonomic Assessment Methods

From the above findings therefore, the methodologies of REBA and RULA are well-known survey-based approaches. Additionally, both systems use the same scoring methodologies that assign various risk categories to the subject's postures and exertion forces. Furthermore, the REBA performs better in ergonomic evaluations, and it is a good tool for assessing the entire body. While the RULA is more suited to measuring static postures with repetitive use of the same activity and it is excellent for assessing the upper body.

4.4 Observations of the Risks and Hazard Identification

The main step in reducing risks at work and enhancing working conditions for employees is to identify various elements associated with WMSD risk. Identification of hazards and the provision of a suitable workspace help to improve safety and boost worker efficiency (Gade et al., 2015). Therefore, several methods of hazard detection and the risk of developing WMSDs are explored in this section, along with guidelines for employers to create a more comfortable workplace.

According to Abid et al., (2017), Table 6 shows the observed risk in the sewing section and how it reflects the main factors contributing to risk growth in WMSDs and poor working environments. Also, according to a study by Abid et al., (2017), operators spend a lot of time standing and sitting in uncomfortable positions, which creates cumulative stress on several body parts. The data also showed that 84.6% of the operators experienced generalized regional pain. Based on the distributed body map provided in the survey, the findings further revealed that these challenging postures cause restricted discomfort (Abid et al., 2017).

Table 7 lists the instances of pain in various body regions lasting at least seven days, along with a comparison of the findings from a study on musculoskeletal symptoms conducted on sewing operators by Schibye et al., (1995). The study thus showed that, in comparison to other body parts, the neck experienced the most pain. This may be because the head was tilted 60 degrees downward from neutral posture for extended periods of time, and the upper back region experienced pain at a rate that was second only to that of the lower back. This is very likely caused by the strain on the upper back brought on by unnatural postures brought on by unsupported and improperly fitted seats. As noted in observation 5 of Table 6, the incorrect height of the working table may also be a source of stress.

Additionally, holding these positions for nine hours a day for many years causes long-term issues for the pressured body parts. Similar to how the effect of such a posture grows over time in a physically demanding profession, the sewing vocation is no exception (Lin, 2016). According to research by Abid et al., (2017), 41% of sewing experts who have worked with the condition for more than five years have had consistent discomfort in the last three to six months, compared to 80% of those who have worked with it for a shorter time. Another study on sewing operators conducted by Kebede & Tafese, (2014) found that those who worked for more than 16 years were five times more likely to develop elbow and wrist musculoskeletal problems compared to those who worked for shorter periods (1–5 years).

Another significant finding was the operator's repetitive actions, which included a nearly constant slouched position established for the purpose of watching the job being done on the machine (Abid et al., 2017). The laborers' interview also made clear that a major factor contributing to eye stress was continual visual activity. This is consistent with survey data showing that 66.7% of workers experienced pain in their eyes. However, when workers worked exceptionally close to the take-up lever (a component of the sewing machine that pops up and down at a very rapid pace), investigations revealed additional hazards where the eye is extremely vulnerable to harm.

In the event that a worker made direct eye contact with the lever, this hazard was extremely dangerous. This is further discussed in Table 6's observation number 2. From the survey's findings about workplace design, it can be deduced that 54.4% of employees complained about uncomfortable seats that caused them to have ongoing pain in various body areas (Abid et al., 2017). According to (Asadi et al., 2015; Khan (2017; Sultana et al. 2020; Podgórski 2021; Sultana et al., 2020; Sultana et al. 2020; Okareh et al. 2021; Hasan et al. 2021; Macdonald & Oakman, 2013; Esmaeel et al., 2022; Esmaeel et al., 2020; Moradi & Barakat, 2021; Torres, 2021) MSDs are those which leave impacts on the musculoskeletal structures such as the nerves, muscle, tendon, and spine intervertebral discs (15. UBAK, 17 - 18 December 2022, Ankara, 2022).

Table 6. WMSDs and workplace design faulty observations

No.	Hazard	References
1	Table with sharp edges posing potential injuries and discomfort for forearms and elbow.	Abid et al., (2017).
	Awkward posture causing ergonomics stress to arms, shoulders, neck and back.	
	Treadle too close.	
2	Labor leaning on sharp edges.	
	Labor face too close to the sewing machine, exposing the eye to constantly moving take-up lever, posting a great risk to the eye and an injury at the slightest wrong move.	
	Awkward posture causing ergonomic stress on the eye, giving visually demanding task.	
3	Extreme attempts for self-adjustments on work chair for both back and setting region.	
	A very messy workplace that increase effort and time to find and carry out the work.	
	Variations in heights between platforms and sharp edges that both create awkward posture in reaching activities, and potential injuries to legs and arms.	
4	Awkward posture causing ergonomics stress on feet, legs and knee due to small space available to the legs and hand sewing machine table design structure.	
5	Awkward posture causing ergonomics stress on back, shoulders, upper back and lower back.	
6	Standing for long time.	
	Stress on the labor's shoulders.	
	Neck awkward posture.	
	Low working platform that creates stress on the eyes.	
	Absence of proper platform for the feet.	

Table 7. Comparison of work-related issues in sewing workstation

work-related issues	Frequency of occurrence	Percentage of occurrence %	References	Frequency of occurrence	Percentage of occurrence %	References
Neck	26	66.7	Abid et al., (2017).	37	48	Schibye et al., (1995).
Shoulders	7	17.9		32	41	
Elbows	7	17.9		5	6.5	
Wrists and hands	8	20.5		13	16.9	
Upper back	24	61.5		22	28.6	
Lower back	21	53.8		25	32.5	
Knees	12	30.7		11	14.3	

5.0 Conclusions

Based on the comprehensive information presented in the review studies above, the following conclusions can be drawn:

- In developing and developed countries, garment manufacturing is one of the major sources of the national economy, where large numbers of sewing workstation workers are involved. In this review, therefore, most of the studies showed that MSDs present a major problem throughout the world. However, strategies to control this risk typically focus on redesigning sewing workstations to reduce the ergonomic hazards that workers experience during their work performance.
- Furthermore, there are three primary risk factors that are essentially physical in nature, such as forceful exertions, high task repetitions, and awkward postures. Besides, the most common hazards at the workstation are safety hazards, biological hazards, physical hazards, ergonomic hazards, chemical hazards, work and person hazards, fire hazards, and environmental hazards.
- In addition, there are many ways to reduce ergonomic risks and hazards that can help fit the sewing workstation to the worker. Additionally, solutions can be grouped into ten main categories, such as eliminating the risks and hazards, substituting the risks and hazards, engineering controls, visual and audible warnings, administrative controls, improving work policies and procedures, work practice controls, counteractive stretch breaks, a job rotation program, and providing personal protective equipment.
- For ergonomic assessment methods, RULA and REBA are used to review studies from different researchers. In contrast, both survey-based methods show their significance and are suitable and accurate to assess the risk and hazards of ergonomics in the workers' working environment. This review study, therefore, suggested both methods as the most popular and widely used observational ergonomic assessment tools in various industries and services. In addition, several studies were reviewed in order to provide an overview of this method's development, applications, validation, and limitations so far.

It is hoped that the review and discussion can inspire more researchers to take part in this review study. Additionally, building a stronger platform for risks and hazards means meeting current and future challenges, in particular those related to situations of deep uncertainty.

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Conflict of interest
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