Comparative Study of Ergonomic Assessment Tools on the Blue Collar Workers in a University

T. Ahmed Thanveer, Surendar Varadharajan, and P. A. Arun

1 Introduction

Due to the lack of time and the primary work entrusted, it is observed most of the workplaces are having reactive approaches [1]. It is disappointing to see that only a very few workplaces are taking proactive measure to prevent injuries. Work related musculoskeletal disorders can affect the smooth running of business due to the worker compensation, reduced productivity, absenteeism, worker turnover and poor quality [2]. Hence the industries should aim in reducing the musculoskeletal disorder and increase profit. While comparing with occupational diseases which are caused due to exposure of a particular agent, musculoskeletal disorders are mostly multi-factorial [3]. It's always a challenge for the epidemiologists and ergonomists who are conducting research to find the factors that contribute to WMSDs as musculoskeletal disorder are multi-factorial.

Different ergonomic tools are used to access the risk due to the exposure with WMSDs. The ergonomic hazards can be analyzed through different approaches, quantitative, qualitative and semi quantitative. The quantitative method requires numerical computation and expertise to do the study. NIOSH can be included in quantitative analysis and it requires more data and time for conducting the study [4]. The qualitative tool uses basic observation data and makes the work easy for the observer. Studies showed that certain ergonomic tools are flexible and easy to use but at the same time some require more resources and time.

The techniques to quantify the discomfort and stress due to awkward postures can be broadly classified to observational and instrument based. Instrument based technique uses devices to continuously monitor and record the posture of the worker during the work. Observation techniques are more preferred due to their low cost,

T. Ahmed Thanveer · S. Varadharajan · P. A. Arun (✉)
Department of HSE and Civil Engineering, School of Engineering, Unviersity of Petroleum and Energy Studies, Dehradun, Uttrakhand, India
e-mail: arun.pa@ddn.upes.ac.in

N. A. Siddiqui et al. (eds.), *Advances in Behavioral Based Safety*,
https://doi.org/10.1007/978-981-16-8270-4_17

ease of conducting and the non-interference with the work. It's unfortunate to say that despite of all these tools ergonomic hazards still exist uncontrolled. One of the reason being the analyst finds it difficult to choose between the tools for performing ergonomic analysis from the different options available.

The factors that have to be looked into during the study are, weight lifted, frequency, age, duration, movement and body part affected. Hence through this paper, the selection process is made easier by conducting study and suggesting the appropriate tool.

2 Methodology

For conducting the study on ergonomics, there are different tools which are already developed and in use. The techniques available were studied and foremost preferred techniques in use were selected for the project. The tools selected were RULA, REBA, NIOSH lifting equation and WISHA. The ergonomic assessment tools were applied on the blue-collar workers in the university to study the risk possessed by them. The workers are involved in different activities like cleaning floor, cutting bushes, carrying waste, watering plants etc. Observation and interview of the workers were done to get a clear idea of the work carried out.

Age of the worker and the duration of the work were noted to incorporate that into the study. An activity was chosen and the workers were observed for a considerable amount of time, and the most common posture was captured. The photographs captured were studied with the abovementioned tools. The observation included different activities; each activity was studied with the selected tools. The observations were compared in different aspect to suggest the pros and cons of the specific tools. The studies in the literature mainly focused on a specific work which was analyzed by different tools. Here more focus was given in suggesting the best suited tool for the activities selected. The factors which effect WMSD, which were looked upon by the individual tools were also found and compared (Fig. 1).

3 Ergonomic Risk Assessment Tools

Ergonomics is gaining widespread emphasis in recent times and we have different tools to study and measure ergonomic risk in the workplace. The increase in the long-term effects of repetitive motion injuries has brought light in the authorities to study the problem and find the solution to them [5]. The selected techniques for the study are the following.

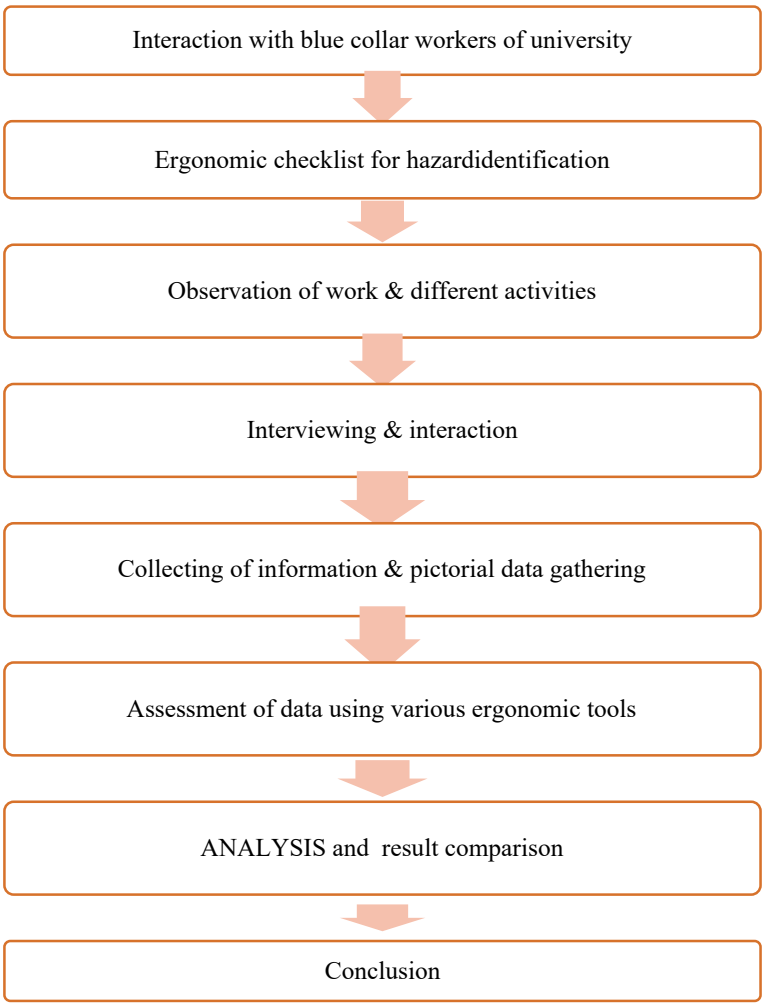

Fig. 1 Methodology

3.1 REBA

REBA helps to analyze various tasks in which systems are sensitive to musculoskeletal risks. REBA is logical and quick risk estimation for the whole body WMSDs of the workers [6]. A worksheet is used for the evaluation of the chosen posture in the particular job. It divides body to segments which are coded according to movement planes. Neck, legs and trunk come in group A. Wrist, upper and lower arm comes in group B. The scoring is done in a manner it increases with the deviation from neutral position by observing each body part. It is proved best for the static,

dynamic and places where change in position is frequent. It is similar to RULA and gives attention to external load acting on neck, legs and trunk.

3.2 RULA

E Nigel Corlett and Lynn McAtamney developed RULA and published in 1993. Rapid upper limb assessment is an ergonomic analysis tool for the investigation of work related upper limb disorder. It is a simple technique which does not need any special equipment for the investigation. This RULA uses diagram and score table for evaluating the risk of exposure [7]. It helps in screening a group of workers who are affected quickly. It needs only a clipboard and pen to do the investigation [8]. Muscular effort associated with force, number of movement, posture and static muscle work can help in identifying what contributes to muscle fatigue.

3.3 WISHA

WISHA is a direct observation technique where hazards are assessed using checklist based on the work. It uses verbal cues to guide user through evaluation criteria [9]. In accordance with duration, the risks are classified into hazard and caution. The checklist is of four body zones like hand and wrist, neck and shoulder, low back and knee [9]. If more than one hazard is checked in the checklist, there is high chance for WMSD and immediate action required [10].

3.4 NIOSH Lifting Equation

To use NIOSH lifting tool first we need to collect measures and information about the task performed and record the information for calculating the RWL. The data should be collected by direct observation and interviewing the employees involved in the work. The NIOSH equation is used to access manual handling in workplaces and handling risk in working places associated with tasks like lifting and lowering [11]. The Recommended Weight Limit (RWI) is calculated by multiplying different task variables.

Task variables include

H-Horizontal distance between the object and the body

V-Vertical distance between the object to the floor

D-Distance vertically moved by the object

A-Twisting or asymmetric angle

F-Frequency

C-Coupling

The NIOSH Lifting Equation,
(1) RWL = LC × HM × VM × DM × FM × CM × AM (1)
(2) Lifting Index (LI) LI = Weight/RWL (2)

The RWI gives the acceptable load that an employee who is fit and healthy could lift (8-h shift). To find out relative level of MSDS risk and physical stress. We calculate the lifting index (LI).

The LI if < 1 shows low risk to employees who are healthy. If LI ≥ 1 it denotes high risk to some amount of population [12]. Hence higher the LI higher the risk for back injury and MSDS. Along with RWL, Lifting Index (LI) is also calculated to provide a relative level of MSD risk and physical stress. The risk levels are categorized into three; (a) LI < 1, as Safe (b) 1 < LI < 3, as Increased risk and (c) LI > 3, as Not safe.

4 Result and Discussion

4.1 Tools Applicable for Activities

The blue-collar works in the university were observed and 20 work activities were selected for the study. RULA and REBA were used to evaluate all the activities because they were primarily based on posture evaluation. NIOSH was applied to only works which involved lifting weight and hence could only be applied to 5 activities. The WISHA checklist included different work situations, so the selected activities were compared with them and only 11 activities could be evaluated. By analyzing the results, it showed RULA and REBA are universal tools. NIOSH is confined to a particular activity lifting. WISHA checklist can be improved by adding more work conditions to increase the range of applicability (Fig. 2).

4.2 The Techniques and the Factors Considered

It was found that the exposures like awkward posture, load or force, movement frequency, duration and vibration have to be considered for measuring, the risk possess due to ergonomic hazards. All the factors were considered in WISHA checklist risk assessment. Duration and Vibration were not included in RULA and REBA. WISHA is a preliminary risk assessment tool and gave only qualitative output, it couldn't be relied completely as it doesn't generate a numeric value. Duration is a major component missing in RULA and REBA because most of the ergonomic risk arise due to long repeated work activities (Table 1).

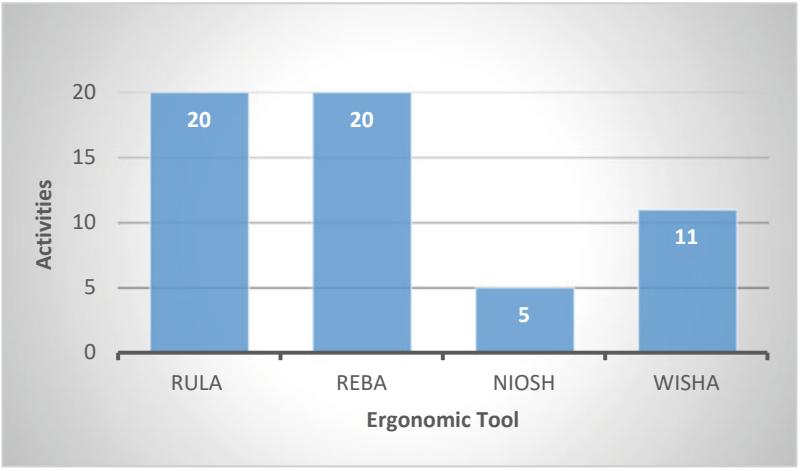

Fig. 2 Ergonomic tools applicable

Table 1 Exposure considered in each technique

SL. NO	Technique	Posture	Load/force	Movement frequency	Duration	Vibration
1	RULA	Y	Y	Y	–	–
2	REBA	Y	Y	Y	–	–
3	NIOSH	Y	Y	Y	Y	–
4	WISHA	Y	Y	Y	Y	Y

RULA

Rapid upper limb assessment is an ergonomic analysis tool for the investigation of work related upper limb disorder. The risk was categorized to four namely negligible, low, medium and high. The results showed all the activities contained at least a small amount of risk. The result showed 25% of the work activities under high risk, 35% under medium risk and 40% in low risk. Most of the activities which were having high risk came under gardening works. Both hands cannot be examined separately and lack of means to combine them is a weakness of RULA.

REBA

REBA is logical and quick risk estimation for the whole body WMSDs of the workers. REBA classified risk into 5 categories namely negligible, low, medium, high and very high. The results showed all the activities contained at least a small amount of risk. The result showed 30% of the work activities under high risk, 60% under medium risk and 10% in low risk. Most of the activities which were having high risk came under weight lifting and gardening works.

WISHA

WISHA is a preliminary risk identification technique that of qualitative in nature. The activities were classified into caution and hazard according to the nature of the work. Caution indicates risk exists which is not of serious nature but can be improved and Hazard indicates fast action has to be taken to protect the workers from ergonomic hazards. 64% of the activities came under caution and 36% under hazard. Due to the limitation of number of activities that could be included in the checklist, all observations could not be analyzed using the tool.

NIOSH Lifting Equation

The NIOSH is used to assess the risk in lifting and lowering the materials. The Recommended Weight Limit (RWL) is the weight an employee can lift for 8 h without the risk of musculoskeletal disorders. NIOSH equation is tested in many laboratories and well-documented tool. It is having a sound scientific background and gives good result for the health risk related to back. The demerit of the technique increases skill and knowledge required [1]. Practical limitations also cannot be neglected. It is also observed that it is most useful for OHS ergonomists/Practitioners and researchers.

Out of 20 activities considered, NIOSH was applicable to only 5 activities that involved lifting or lowering operations. 60% of these activities were found safe and the remaining 40% were under the increased Risk category.

5 Discussion

By the comparative study of the results (Table 3) of 20 different activities with the four tools RULA, REBA, NIOSH Lifting Equation and WISHA results were gathered. The results of RULA and REBA agreed with each other for around 50% of activities. But for the other activities when compared it was found RULA underestimated the risk in many cases. As REBA considered whole body assessment it has a better understanding of the risk involved [13]. For two activities waste collecting and cleaning seats, RULA showed high risk and REBA medium risk, this indicates the lack of scope in RULA.

The lifting activities which showed safe using NIOSH lifting technique came under medium risk in REBA. And no common trend could be found among the techniques which involved lifting activity. It indicates the inefficiency of the other tools in finding risk involved in lifting activities. The factors like horizontal distance, vertical height, Asymmetric angle are not considered RULA and REBA. 90% of the results of WISHA agreed with that of REBA. Even though WISHA checklist is a qualitative tool, it was proved to be reliable and can be used as a good preliminary study tool. During various activities, the discomforts like low back pain, neck pain

Table 2 Risk chart

Color Indication	Risk
	Negligible
	Low
	Medium
	High

and wrist aches were identified with the workers. Aged workers were found to be more affected by ergonomic hazards.

Some of the general recommendations while selecting a tool include, the persons, who carry out the ergonomic studies, should have a clear idea about the aim and objective of study. If it is found, that one technique is insufficient, it is recommended to apply multiple techniques to achieve the goal. The hazards which have to be emphasized such techniques have to be adapted which gives quantitative outputs, which are like RULA, REBA and NIOSH. The observer has to be trained to avoid the methodological errors that can affect the result [14]. Works which involve bending, reaching, stooping and grasping for long time are causing wear out in the body. It is very clear to avoid body aches, workers need to maintain proper posture and use right tool. The work has to be maintained in the comfort zone by eliminating unwanted movements and following correct procedure. The risks are color coded according to Table 2 and are tabulated in the Comparative table of results (Table 3).

6 Conclusion

The biggest challenge faced by the professional would be the selection of the ergonomic assessment tool according to their need. General observation techniques appeared more helpful for the HSE practitioners to evaluate the risk with the limited time and resources. From this project, it was very clear that there is no universal tool to evaluate every work. Every tool had its own strength and weakness. It was also found that all the factors that affect the MSDs are not considered in every tool. So it comes to the responsibility of the user to select the most appropriate one by considering the data available, nature of work, the resource available, time duration, cost consideration and accuracy. The development of task-based specific ergonomic tool would help in cutting down using of multiple tools. In Korea, the tool ALLA was developed to assess the risk in agriculture when they were unable to identify the increasing skeletal diseases in the country [15]. Understanding other tools did not focus on the lower limb risks they developed a specific tool to address the problem.

Works which involve bending, reaching, stooping and grasping for long time were found to be the main cause of wear out in the body. To avoid body aches and various MSDs diseases, the workers need to maintain proper posture and use the suited tool. And thereby maintaining work in the comfort zone without much deviation from the neutral position.

Table 3 Comparative table of results

SL.NO	*ACTIVITY*	*RULA*	*REBA*	*NIOSH*	*WISHA*
1	Waste collecting	7	7	N/A	Caution
2	Cutting Branches	7	8	N/A	Caution
3	Sweeping Outdoor	4	5	N/A	N/A
4	Collecting Waste	6	8	N/A	Hazard
5	Lawnmowerl	4	5	1.5	N/A
6	Waste Handling	5	8	N/A	N/A
7	Weed Pulling	7	8	N/A	Hazard
8	Lawnmower pushing	4	3	N/A	N/A
9	Grass Cutting	7	9	N/A	Hazard
10	Weight Carrying	6	8	0.5	N/A
11	Lawnmower pulling	5	6	N/A	N/A
12	Bush Cutting	4	5	N/A	Caution
13	Arranging Chair	4	5	0.5	Caution
14	Cleaning Seats	7	6	N/A	Caution
15	Sweeping indoor	3	4	N/A	Hazard
16	Carrying	4	4	0.5	N/A
17	Waste collecting	6	7	1.1	N/A
18	Watering	4	3	N/A	N/A
19	Mopping	5	5	N/A	Caution
20	Table Cleaning	6	5	N/A	Caution

References

1. Pascual, S. A., & Naqvi, S. (2008). An investigation of ergonomics analysis tools used in industry in the identification of work-related musculoskeletal disorders. *International Journal of Occupational Safety and Ergonomics, 14*(2), 237–245.
2. Ross, P. (1994). Ergonomic hazards in the workplace: Assessment and prevention. *AAOHN Journal, 42*(4), 171–176.
3. David, G. (2005). Ergonomic methods for assessing exposure to risk factors for work-related musculoskeletal disorders. *Occupational Medicine, 55*(3), 190–199.
4. Dempsey, P. G. (2002). Usability of the revised NIOSH lifting equation. *Ergonomics, 45*(12), 817–828.
5. Schneider, S., & Susi, P. (1994). Ergonomics and construction: A review of potential hazards in new construction. *American Industrial Hygiene Association Journal, 55*(7), 635–649.
6. Ansari, N., & Sheikh, M. (2014). Evaluation of work Posture by RULA and REBA: A Case Study. *IOSR Journal of Mechanical and Civil Engineering, 11*(4), 18–23.
7. McAtamney, L., & Corlett, E. N. (1993). RULA: A survey method for the investigation of work-related upper limb disorders. *Applied Ergonomics, 24*(2), 91–99.

8. Lowe, B., et al. (2018). Assessment methods used by certified ergonomics professionals. In *Proceedings of the Human Factors and Ergonomics Society Annual Meeting*. Sage CA: SAGE Publications.
9. Rahman, M. N. A., and Zuhaidi, M. F. A. (2017). Musculoskeletal symptoms and ergonomic hazards among material handlers in grocery retail industries. In *IOP Conference Series: Materials Science and Engineering.* IOP Publishing.
10. McGaha, J., et al. (2014). Exploring physical exposures and identifying high-risk work tasks within the floor layer trade. *Applied Ergonomics, 45*(4), 857–864.
11. Asadi, N., et al. (2015). A comparative assessment of manual load lifting using NIOSH equation and WISHA index methods in industrial workers of Shiraz City. *Journal of Health Sciences and Surveillance System, 3*(1), 8–12.
12. Takala, E.-P., et al. (2010). Systematic evaluation of observational methods assessing biomechanical exposures at work. *Scandinavian Journal of Work, Environment & Health, 36*(1), 3–24.
13. Manavakun, N. (2004). A comparison of OWAS and REBA observational techniques for assessing postural loads in tree felling and processing. In *FEC–FORMEC–2004 conference.*
14. Kale, P., & Vyavahare, R. (2016). Ergonomic Analysis Tools: A Review. *International Journal of Current Engineering and Technology, 6*(4), 1271–1280.
15. Kong, Y.-K., et al. (2018). Comparisons of ergonomic evaluation tools (ALLA, RULA, REBA and OWAS) for farm work. *International Journal of Occupational Safety and Ergonomics, 24*(2), 218–223.