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Rapid Entire Body Assessment (REBA) based work posture analysis of small-scale dyeing unit in Bhadohi, Uttar Pradesh, India

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Abstract

Dyeing is one of the steps of carpet making process. In Bhadohi, the Carpet City of India and its neighbouring village areas, there still exists traditional manually operated dyeing units. Due to the weights of raw materials (Wool/Jute), poor workstation setups, usage of improper tools and lack of ergonomics awareness among workers, the tasks involved in these dyeing units are strenuous. Improper work methods performed by these workers lead to work-related Musculoskeletal disorders (MSD). As such, to understand the risk level of improper work-method practices, it becomes important to do work posture analysis of the workers. In this study, the Rapid Entire Body Assessment (REBA) method was being used to conduct a work posture analysis. The analysis was conducted on five workers working in a small dyeing unit in Bhadohi. The work activities were being observed and video recordings were being made. Lifting of raw materials from the ground, loading raw materials to the *Charkha* (spinning wheel) and spinning the loaded *Charkha* were the three major tasks selected for the assessment. The study based on the result manifests the need to investigate and implement changes in work methods in such dyeing units. Implementation of ergonomics design intervention is needed for prevention of Musculoskeletal disorder (MSD) risk among the workers of the unorganised small dyeing unit in Bhadohi.

Key words

REBA, dyeing, Posture analysis, unorganised small-scale unit, Ergonomics, work related Musculoskeletal Disorders (WMSDs).

Introduction

Bhadohi, a district in Uttar Pradesh is famous for carpet manufacturing, especially hand-knotted carpets. It is known as the carpet city of India. The carpets of the Uttar Pradesh region received the Geographical Indication (GI) tag in 2010(Punekar & Yadav, n.d). Dyeing raw materials is one of the steps of carpet making process. The small-scale dyeing units in Bhadohi mostly use the traditional *Kuda* (pot) dyeing method (Figure 1). But it has been observed that "the *Kuda* dyeing method has been largely replaced by machine dyeing in closed chambers"(Carpet Exporter promotion council India , 2022). Now-a-days carpet-making industries present in Bhadohi use modern machines and equipments in carpet making process but there still exists small-scale traditional *Kuda* dyeing units in unorganized sector. These dyeing units present in Bhadohi do washing and dyeing raw materials manually, in the sense that, many still use human-powered equipments and earn money for their family. These traditional dyeing units cannot afford boiler dyeing plants, which are machine powered, as they are expensive (Karimi, 2015).

Traditionally, the pots used for boiling water were used for dyeing raw material, locally called *Kuda*. Now-a-days such pots are replaced by concrete pots. There is a Charkha (spinning wheel) on the top of a *Kuda*, which now-a-days is fixed to an iron stand cemented to the *Kuda*. The *Kuda* and the *Charkha* are made by local masons and welders. The whole arrangement of the workstation is arranged by them. The dyeing process is done manually and it needs numbers of workers for dyeing raw

materials. The workers stack the raw materials on the *Charkha* and the *Charkha* is rotated using its handle by workers while the dyeing master supervises the coloured water in the *Kuda*, which is boiled using coal and wood underneath the *Kuda*. Both chemical and natural dyeing agents are used in the process. The *Charkha* is spinned until the raw materials are properly dyed (Karimi, 2015). The capacity of the *Kuda* is 150-180 kilograms of raw materials. It was observed that rings made of aluminium wires (Figure 2) were used to hold raw materials which were then stacked into the Charkha for dyeing of the raw materials. Lifting, loading, and spinning are the activities involved in the traditional manual dyeing process. Figure 3, Figure 4 and Figure 5 represents Activity-1(lifting of raw materials from the ground), Activity-2 (loading of raw materials on the Charkha) and Activity-3 (spinning of the *Charkha*) respectively.

Figure 1:Human powered Kuda dyeing machine ***Figure 2: Aluminum wire ring***

The workers practice awkward body postures while lifting of raw materials from the ground because of the weight of raw materials and also while loading raw materials to the *Charkha* due to poor workstation design. These factors negatively impact the work performance of the workers. These workers work for five to seven hours a day and their work involves lifting, loading and spinning of raw materials in repetitive motion in the Charkha. As the raw

materials absorb water, their weight increases making it difficult for the labourers in spinning the *Charkha*. All these factors which contribute towards the practice of awkward body postures can lead to work-related Musculoskeletal disorders (MSD) among workers (Godwin & Ndubueze, 2013). So, this study was conducted to examine the risk levels involved in practicing awkward body postures by analyzing the work postures of workers in a small scale *Kuda* dyeing unit of Bhadohi using the Rapid Entire Body Assessment (REBA) method.

Figure 3: Activity-01

Figure 4: Activity-02

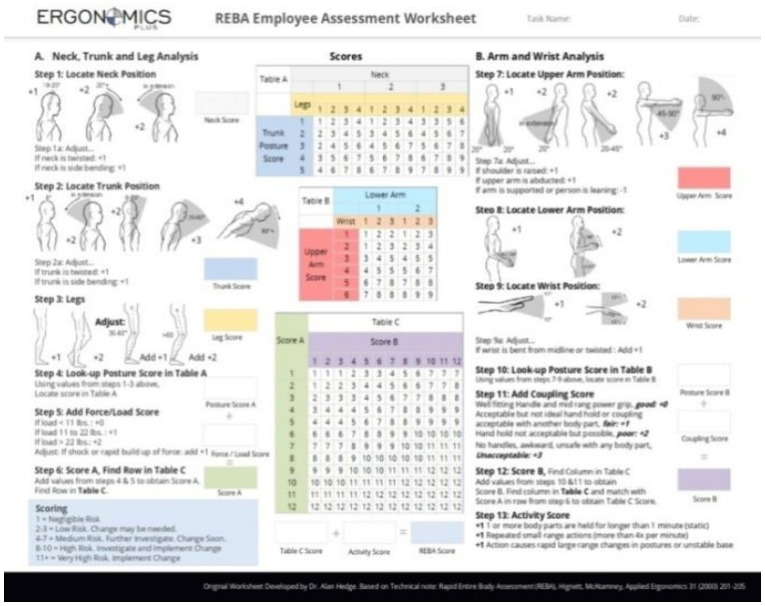
Figure 5: Activity-03

Method and materials

The research study was conducted on a small-scale *Kuda* dyeing unit present in Bhadohi in Uttar Pradesh, India. Prior to this visit a pilot study was conducted for 3 days at "Bhadohi Carpets", a carpet making industry located at Bhadohi. The owner of the industry gave an overview of the industry and the whole process of carpet making performed in the industry was observed. The owner of "Bhadohi Carpets" informed that they have a dyeing plant in their industry but some industries still do the dyeing process through small scale dyeing units. Taking this information and after going through secondary literatures on unorganised

dyeing units and dyeing processes the visit to the small scale *Kuda* dyeing unit was made. This dyeing unit is located at a distance of 12 to 15 kilometres from Bhadohi railway station. The owner of the dyeing unit was the resource person during this visit, who showed his dyeing unit and his workers were observed while they were carrying out the dyeing process manually.

The study was conducted on five workers selected for the study. It was done by observing the methods used by the workers during the process of dyeing and it was observed how the raw materials were handled by the workers. Video recordings were made throughout the observation process to capture the awkward postures of the workers while they were performing their work. After that different snapshots were taken of the awkward postures of the workers from the video footages to conduct posture analysis. The snapshots were mostly of the side views of the workers as it helps minimize errors while measuring the angles of different body parts. REBA analysis was then carried out by measuring the angles of awkward postures of the body parts using a protector. The selected postures were then analysed to fill the scores in the REBA worksheet. The REBA method, which was developed by Hignett and McAtamney in the year 2000 to assess the risk levels associated with work-related MSD is being used in this study, the worksheet of which is shown in Figure 6(Agarwaal, Nair, Kartik, Pardeshi, & Sarawadw, 2016).



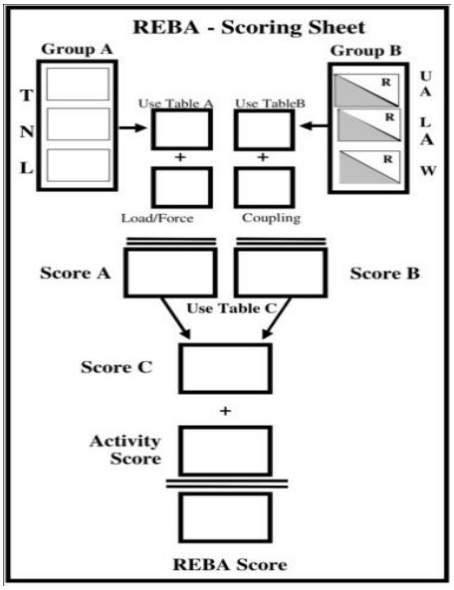


Figure 6: REBA Worksheet ***Figure 7: REBA calculation system***

This REBA method is based on observational technique used on workers to observe their postures while work activities are performed. The REBA calculation system is shown in Figure 7(Stanton, Hedge, Brookhuis, Salas, & Hendrick, 2005),where the body parts are divided into two groups, that is, Group-A (Trunk, Neck, and Legs) and Group-B (Upper arms, Lower arms and Wrist). The posture scores of Group A are tabulated in Table A in REBA worksheet and the Posture Score A is evaluated from scores of Group A using co-ordinate straight line. The posture scores of Group B are tabulated in Table B and the Posture Score B is evaluated from scores of Group B using co-ordinate straight line. Load/Force score and Coupling score are added to Posture Score A and Posture Score B respectively. The value of the Posture Score C is obtained by combining Posture Score A and Posture Score B, as tabulated in Table C, using co-ordinate straight line. The final REBA Score is obtained by adding Posture Score C with Activity Score.

Score Group	Level of MSD's Risk	Action level
1	Negligible risk, no action required	0
2-3	low risk, change may be needed	1
4-7	Medium risk, further investigation, change soon	2
8-10	High risk, investigate and implement change	3
11+	Very high risk, implement change	4

Table 1: REBA score groups, MSD's risk level, Action level

The final REBA score indicates Musculoskeletal Disorder's risk level due to awkward postures. The risk level of MSD is divided into five groups, which are 1, (2-3), (4-7), (8-10) and (11+) that is, Negligible risk, Low risk, Medium risk, High and Very High risk respectively. The REBA score is also divided into five Action level categories, which are, 0, 1, 2, 3 and 4 as shown in Table 1. If the Action level obtained is 0 then it indicates that there is 'No action required' and if the Action Level is 5 then it indicates' Very high risk of Musculoskeletal Disorder' and there is need to implement immediate changes.

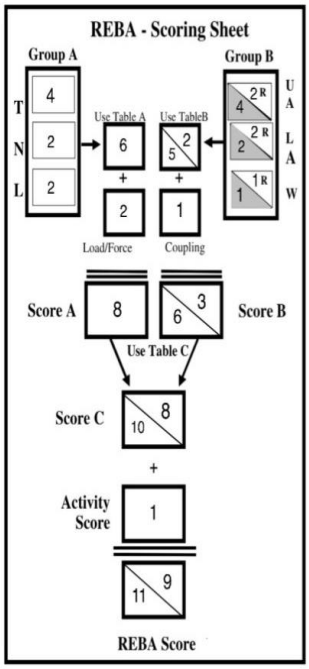
Result and Discussion

The personal characteristics of the five workers selected for the study are given in Table 2.

Characteristics	Male workers
Age	38.5 years ± 2.05
Weight	67 kg ± 5.50 SD
Stature	1.673m ± 0.30
Years of involvement	12 years ± 3
Working hours per day	5-7 hrs
Literacy	100%

Table 2: Personal characteristics of workers

For the study REBA Employee Assessment worksheet was used to analyse the awkward postures of the workers in the dyeing unit. According to the REBA worksheet result it is observed that in Activity-1 risk of getting MSD is 'very high' on the left side of the body and 'high' on the right side. The calculation of REBA on Activity-1 is shown in Table 3. In this activity the worker used to lean down towards the ground to lift the raw materials. As such the left upper arms and shoulders were raised above the normal position. The weight of the raw materials was more than 10 kilograms. The workers used aluminium rings to hold raw materials together and also to lift raw materials from the ground. Due to the thinness of the aluminium rings, it puts repetitive pressure on fingers of the workers at one particular point. Therefore, this handholding is acceptable but not ideal. The final REBA score is 9 for right side and 11 for left side of the body. The final REBA score indicates that the action level of Activity-01 is 4 for left side of the body and 3 for right side of the body.

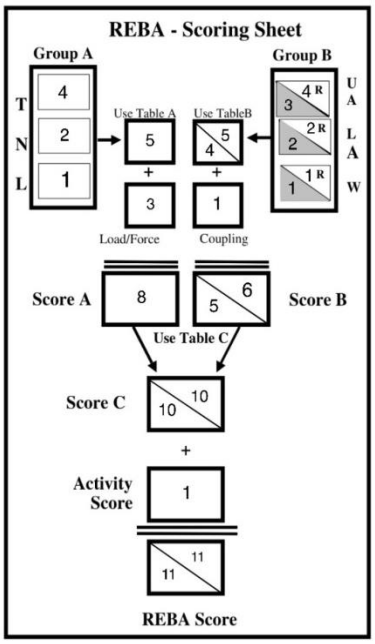


REBA				
Sl. No.	**The location of the**	**Description**	**Score**	
1	**Trunk**	20º-60º flexion=3, twisting and side bending=1	4	
2	**Neck**	0º-20º flexion=1, twisting and side bending=1	2	
3	**Leg**	Bilateral weight bearing=1, nee(s) between 30º-60º=1	2	
4	**Table-A from Table REBA**	The value of table-A taken from the coordinates a line from step REBA 1,2,3	6	
5	**Load & Force**	More than 10 kg	2	
6	**The value of A from table REBA**	The score A retrieved from the addition of the step-4 and step-5	8	
7	**Upper Arms (R)**	20º-45º flexion=2	2	
	UpperArms (L)	45º-90º flexion=3, arms is abducted =1	4	
8	**Lower Arms (R)**	<60º flexion >100º flexion	2	
	Lower Arms(L)	<60º flexion >100º flexion	2	
9	**Wrist(R)**	0º-15º flexion	1	
	Wrist (L)	0º-15º flexion	1	
10	**Table-B from Table REBA**	The value of table-A taken from the coordinates a line from step REBA 7,8,9	L 5	R 2
11	**Handle**	Handhold acceptable but not idea	1	
12	**The value of B from table RABA**	The score A retrieved from the addition of the step-10 and step-11	L 6	R 3
13	**The value of C**	The value of table-C taken from the coordinates of the straight line no.8 and 6 for left;8 and 3 right	L 10	R 8
14	**The value of the activities**	The action causes rapid large range changes in postures or unstable	1	
15	**Final REBA score**	Add table-C score and activity score	L 11	R 9

Table 3: Calculation of REBA on activity-1

The next activity, that is, Activity-2 was loading raw materials to the spinning wheel. The REBA score for this activity was 11 for both sides. The weight of the load of raw materials was more than 10 kilograms and the task involved rapid build -up of force. The right shoulder was in a raised position as compared to the left shoulder. It was due to the inaccessibility to the spinning wheel from the position where the worker stood, also creating an unstable base for the worker as his feet was not firmly fixed to the floor. There was not enough leg space for the worker, which can be seen in Figure 4. Here, handholding is acceptable but not

ideal because of the thin aluminium ring equipment they used. Due to the thinness of the equipment, it creates pressure on fingers, palms and wrist. The final REBA score indicates that the action level of Activity-02 is 4 for both side of the body.

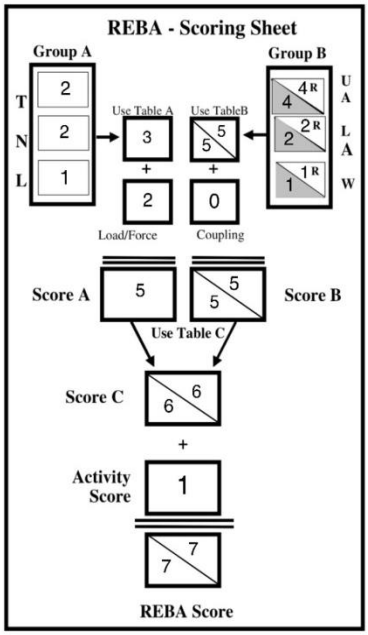


REBA				
Sl. No.	**The location of the**	**Description**	**Score**	
1	**Trunk**	20º-60º flexion=3, twisting and side bending=1	4	
2	**Neck**	0º-20º extension	2	
3	**Leg**	Bilateral weight bearing=1	1	
4	**Table-A from Table REBA**	The value of table-A taken from the coordinates a line from step REBA 1,2,3	5	
5	**Load & Force**	More than 10 kg=2 Rapid buildup force=1	3	
6	**The value of A from table REBA**	The score A retrieved from the addition of the step-4 and step-5	8	
7	**Upper Arms (R)**	>90º flexion=4, Shoulder is raised=+1,Person is leaning-1	4	
	UpperArms (L)	45º-90º flexion=3, Shoulder is raised=+1,Person is leaning-1	3	
8	**Lower Arms (R)**	<60º flexion >100º flexion	2	
	Lower Arms(L)	<60º flexion >100º flexion	2	
9	**Wrist(R)**	0º-15º flexion/extension	1	
	Wrist (L)	0º-15º flexion/extension	1	
10	**Table-B from Table REBA**	The value of table-A taken from the coordinates a line from step REBA 7,8,9	L 4	R 5
11	**Handle**	Handhold acceptable but not idea	1	
12	**The value of B from table RABA**	The score A retrieved from the addition of the step-10 and step-11	L 5	R 6
13	**The value of C**	The value of table-C taken from the coordinates of the straight line no.8 and 5 for left;8 and 6 right	L 10	R 10
14	**The value of the activities**	The action causes rapid large range changes in postures or unstable	1	
15	**Final REBA score**	Add table-C score and activity score	L 11	R 11

Table 4: Calculation of REBA on activity-2

The Activity-03 was spinning the *Charkha* (spinning wheel). The weight of the raw materials used to increase due to the absorption of boiled water from the *Kuda* while spinning the *Charkha*. Dyeing colour agents were mixed in the boiling water for the dyeing process. This task involved spinning the *Charkha* in repetitive motion (4x per minute or more) which made the task strenuous.

The final REBA score in this activity is 7, which indicates medium risk.



REBA				
Sl. No.	**The location of the**	**Description**	**Score**	
1	**Trunk**	0º-20º flexion=2	2	
2	**Neck**	0º-20º flexion=1, Twisted or side flexed=1	2	
3	**Leg**	Bilateral weight bearing=1	1	
4	**Table-A from Table REBA**	The value of table-A taken from the coordinates a line from step REBA 1,2,3	3	
5	**Load & Force**	More than 10 kg=2	2	
6	**The value of A from table REBA**	The score A retrieved from the addition of the step-4 and step-5	5	
7	**Upper Arms (R)**	>90º flexion=4	4	
	Upper Arms (L)	>90º flexion=4	4	
8	**Lower Arms (R)**	<60º flexion >100º flexion	2	
	Lower Arms (L)	<60º flexion >100º flexion	2	
9	**Wrist(R)**	0º-15º flexion/extension	1	
	Wrist (L)	0º-15º flexion/extension	1	
10	**Table-B from Table REBA**	The value of table-A taken from the coordinates a line from step REBA 7,8,9	L 5	R 5
11	**Handle**	Well fitting handle and midrange power grip	0	
12	**The value of B from table RABA**	The score A retrieved from the addition of the step-10 and step-11	L 5	R 5
13	**The value of C**	The value of table-C taken from the coordinates of the straight line no.5 and 5 for left;5 and 5 right	L 6	R 6
14	**The value of the activities**	Repeated small-range of actions occur, e.g., repeated more than 4 times per minute	1	
15	**Final REBA score**	Add table-C score and activity score	7	7

Table 5: Calculation of REBA on activity-3

Parameters	Activity No.01		Activity No.02		Activity No.03	
	L	R	L	R	L	R
REBA Score	11	9	11	11	7	7
Risk Level	Very High	High	Very High	Very High	Medium	medium
Action level	4	3	4	4	2	2

Table 6: REBA score, Risk level and Action level

In this study, the result presented in Table 6 indicates that the Action Level for Activity-01 is 4 and 3 for left and right side respectively. This shows that there is immediate need to implement change and investigate as recommended by action score of REBA. For Activity-02 the Action Level is 4 for both sides of the body, which according to REBA action score recommends immediate implementation of change. Again, for Activity-03, the Action level is 2 for both sides of the body, which indicates medium risk of getting MSD and for that further investigation is recommended.

Conclusion

The work method practiced by the workers in the unorganized *Kuda* traditional dyeing units needs ergonomic improvement. The ergonomic factors are not considered in these dyeing units due to lack of ergonomic awareness. Ignoring ergonomics in manually operated dyeing units will impact negatively on workers' health in long term and risk of getting work-related MSD would increase. Workstations and equipments in these dyeing units are not designed by keeping ergonomic factors in consideration. This study therefore suggests that while redesigning traditional *Kuda* dyeing units, there is need to keep ergonomics in consideration. There is also need of an ergonomic design intervention to improve

the awkward body postures of the workers to help minimize the risk of getting MSD. This study therefore can be vital in building knowledge base for future studies and comparisons based on this study could be made after design interventions are taken.

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