IN-SITU POSTURAL ANALYSIS OF WOMEN CONSTRUCTION WORKERS

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Absract

India is one of the largest and the most important developing countries of the world. In this country, public health emphasizes more on communicable diseases, malnutrition and reproductive healthcare. Majority of the population is working in industrial sector. Industrial revolution as well as globalization is increasing the burden of occupational hazards and changing occupational morbidity drastically. Still occupational health is seen as a secondary issue while formulating health policy and health-related programmes. In the construction industry heavy manual materials handling tasks are performed regularly and a large number of female labourers are engaged for these tasks. Almost no attention is paid to the health and safety aspects of these construction labourers. The common body components (body parts) such as the head, wrist, shoulders, lower back and knee, followed by upper and lower arm were afflicted with pain because of the activities performed by these women construction workers. The maintenance of posture and the support of load are particular examples of static work. It is evident that both the upper and lower extremities get affected (with pain/discomfort) due to the posture adopted while engaging in activities governing the construction industry. Hence an attempt on postural analysis of the workers was done in their working situation using Rapid Upper Limb Assessment (RULA), as RULA can be used to assess a particular task or posture for a single user or group of users and assess a number of different postures during a work cycle to establish a profile of the musculoskeletal loading.

Keywords: Construction Industry, Women Construction Workers, Postural Analysis, RULA

Introduction

There is complete negligence on the health and safety aspects of construction labourers opine Basu *et al.*, (2005) and Maiti, (2008). Census 2001 reported that the growth per cent for female workers was higher than that for male workers from 1991 to 2001. This increase rate led to certain concerns, such as, adverse effects on reproduction, exposure to toxic chemicals in the workplace and musculoskeletal disorders, because neither the tasks nor the equipment they used were adapted to their build and physiology.

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In India women workers constitute a major portion in the work force of the construction industry. Sad to say they remain not only unorganized but also unskilled as compared to male workers, who by virtue of their gender preference progress ahead in their career from an unskilled worker to a skilled one, specifically as a mason, carpenter, welder and electrician. Contrarily women construction workers start as unskilled helpers and remain unskilled throughout their life and evidently are victims of gender discrimination. Low wages, dependence on spouse, lack of opportunity for skills training and the unorganized nature of job leave them stagnant with no chances of promotion prospects in their job. In general they upgrade their skills through practice, observation and working under skilled masons and carpenters. Evidently being engaged only in soft skills, the gap between the skilled male workers and unskilled women workers placed them in a position of less empowerment economically and socially.

Need for the study

The study was done in construction sites in Coimbatore city. Construction is a physically demanding occupation. They often lift, stoop, kneel, twist, grip, stretch, reach overhead, or work in other awkward positions to do a job and are at risk of developing work and posture – related musculoskeletal disorders and ortho problems. Such problems among them is all the more prominent, but invisible. They include back (spinal) problems, carpal tunnel syndrome, tendinitis, rotator cuff tears, sprains and strains of various types. These problems do not surface but stay invisible as their socio-economic status demand them to earn. Preliminary studies conducted had shown a good number (91%) of workers to complain of pain in different body parts. The main complaints concerned low back pain (80%), neck pain (88%) and shoulder pain (89%), the causal factor being the awkward postures adopted and the heavy workload. Other hea complaints like gynaecological problems (56%), skin diseases (25%) and respiratory problems (32%) were also reported. The body mass index mostly for the migrated workers revealed that 48 per cent of them also to suffer from chronic energy deficiency. Hence the need to study the body discomfort experienced by the women.

With this backdrop Rapid Upper Limb Assessment (RULA) was chosen as the method and was administered on the 50 subjects (doing different tasks) chosen for the body discomfort study.

Materials and Methods

A video of 50 subjects doing various tasks in the construction sites like carrying different loads (bricks, cement, sand, mud mortar mixture, chips etc.), shoveling, filling mud in the foundation, sweeping and sieving sand showing different movements of the workers was recorded. After recording the video, it was cropped after every ten seconds to get snapshots for the analysis of posture of the workers. Thus snapshots of the workers performing different activities was obtained.

Posture Analysis Using RULA (Rapid Upper Limb Assessment)

Rapid Upper Limb Assessment (RULA) (McAtamney and Corlett, 1993) provides an easily calculated rating of musculoskeletal loads in tasks where people have a risk of neck and upper-limb loading. RULA was developed to require minimal training. Dismukes (1996) reported that people untrained in ergonomics could accurately assess upper-limb disorders using RULA. Hence this method was chosen. It assesses a working posture and the associated level of risk in a short time frame and with a need for equipment beyond pen and paper. The tool provides a single score as a snapshot of the task, which is a rating of the posture, force and movement required. The risk is calculated into a score of 1 (low) to 7 (high). These scores are grouped into four action levels that provide an indication of the time frame in which it is reasonable to expect risk control to be initiated.

The main applications of RULA considered for this study were to :

- Measure musculoskeletal risk usually as part of a broader ergonomic investigation
- Educate workers about musculo-skeletal risk created by different working postures

Procedure

The procedure of using RULA is explained in detail (Box 1) in three steps:

a. The posture or postures for assessment were selected.

b. The postures were scored using the scoring sheet, body-part diagrams and Tables.

c. Scores obtained were converted to one of the four action levels.

The maintenance of posture and the support of load are particular examples of static work. To analyze posture, measurement of the angles between the body parts, distribution of masses of body parts, the forces exerted on the environment during the posture, the length of the time during which specific posture is held, and the effect on the person should be taken into account (Ghosh *et al.,* 2010).

The RULA method evaluates the ergonomic risk factors by observation of the posture of workers while they are working at their workstation directly (McAtamney and Corlett, 1993). Fig: 1 presents a copy of the RULA sheet.

RULA (Rapid Upper Limb Assessment) helps in rapid assessment of the musculoskeletal loads on workers due to posture, repetitive action and force. It aids in evaluating jobs or tasks that expose workers to upper limb disorders (neck, shoulder, upper and lower arms and hand). RULA accomplishes these goals by providing a "Grand score" which can be compared to four action levels (http://www.nexgenergo.com/ergonomics/eergointuea.html).

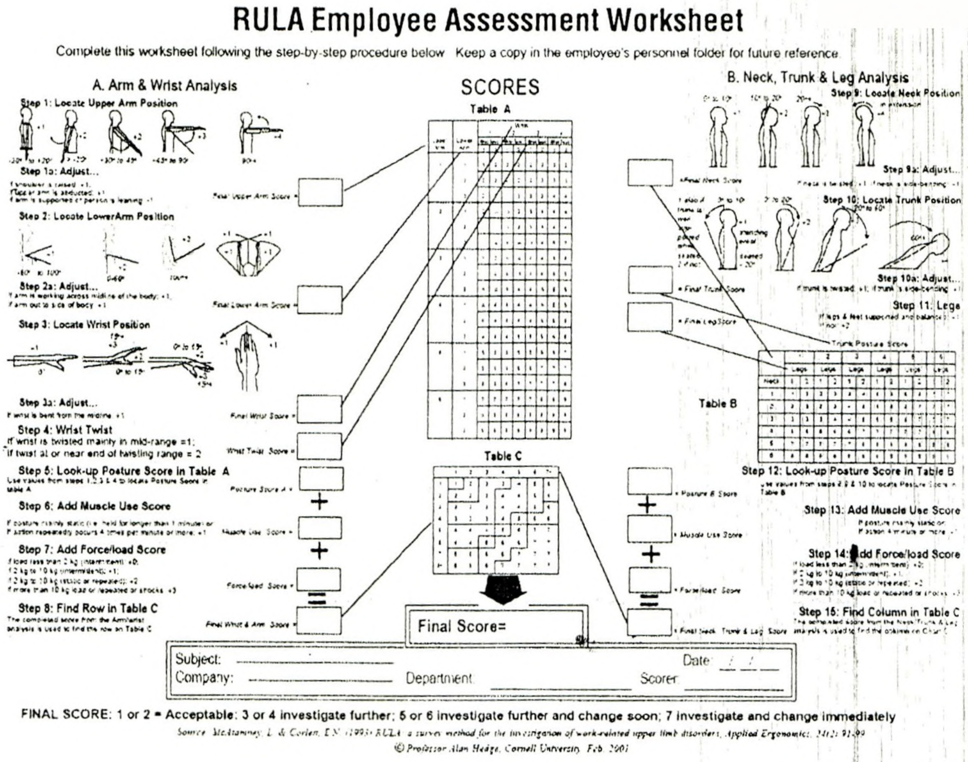

Figure 1 Box 1: Steps in RULA Assessment

Step 1 - Observing and selecting the posture(s) to assess: A RULA assessment represents a moment in th work cycle and it is important to observe the postures being adopted whilst undertaking the tas prior to selecting the posture(s) for assessment. Depending upon the type of study, selection may b made of the longest held posture or what appears to be the worst posture(s) adopted.

Step 2 - Scoring and recording the posture: Decide whether the left, right or both upper arms are to be assesse Score the posture of each body part.

Step 3 - Action level: The grand score can be compared to the Action Level list. However since the huma body is a complex and adaptive system, they provide a guide for further action (http://www.rula.co.uk

RULA Action Levels:

1. Action Level 1: Score of 1 or 2 indicates that the posture is acceptable if it is not maintained or repeate for long periods.
2. Action Level 2: Score of 3 or 4 indicates that further investigation is needed and changes may be require
3. Action Level 3: Score of 5 or 6 indicates that investigation and changes are required soon.
4. Action Level 4: Score of 7 indicates that investigation and changes are required immediately.

The given scores represent the information pertaining to the RULA analysis recorded for the selected subjects (50) doing different type of task in the construction industry. The study also focussed on the posture – induced effects on the upper and lower extremities, expressed as scores, based on angles of body bend caused in performance.

Salient Findings

The assessment was done based on the instructions given under Box (1) and the details obtained are analyzed and delineated under:

a. Arm and Wrist Analysis Vs Task
b. Neck, Trunk and Leg Score Analysis
c. Summation Score for the different body posts used in performances
d. Grand Scores for Investigating Upper Limb Disorders

a. Arm and Wrist Analysis Vs Task

The following Table (1) projects the details on how the subject's body parts were used beyond their normal positions while performing different tasks.

The arm and wrist score for the posture adopted during different tasks performed by the subjects is given in

Table 1. Arm and Wrist Analysis Vs Task

Type of task	Body parts affected	Position angle	Position score	Postural score in table A from fig.1 of RULA	Force / load score: Load 2kg to 10kg or more (intermittent, static, repeated)
Carrying Loads	Upper arm Lower arm Wrist	90° + 50° 15° +	6 3 4	9	3
Passingbricks manually	Upper arm Lower arm Wrist	45° 45° 15° +	6 3 4	9	2
Shoveling	Upper arm Lower arm Wrist	45° 45° 15° +	3 3 4	5	2
Filling mud in the foundation	Upper arm Lower arm Wrist	45° 45° 15° +	3 3 4	5	0
Sweeping	Upper arm Lower arm Wrist	45° 45° 15° +	3 3 4	5	0
Sieving sand	Upper arm Lower arm Wrist	90° + 50° 15° +	6 3 4	9	0

Table 1. They carried loads mainly on their head. A study on Indian women observed that when the same load was carried in the head, shoulder or waist mode, the least cardiac stress occurred when the load was carried on the head, followed by the shoulder and the waist mode (Roy and Atreya, 1997).

For all the samples irrespective of the task they do, upper arm was used in an angle 45-90^0 or more than that while carrying and lower arm was used in an angle 50^0 it was flexed up to 95^0. In the entire task the wrist was found to be 15^{0}but bending upwards and downwards varying with the task. All these body parts were twisted to varied angles from their normal position. Wrist naturally showed a bent from midline as the construction workers twisted them while working. While abduction adjustment was found for upper arm, lower arm was found to work across midline or out to side of body but they differed with the type of task they performed.

Evidently individual body part position score recorded was to the tune of 6, 3 and 4 for upper, lower arm and wrist respectively for carrying different load, passing bricks manually and sieving sand. But for shoveling, filling mud in the foundation and sweeping it was 3, 3 and 4 for the same body parts respectively. For years the construction industry has been associated with increased rates of work related musculoskeletal disorders (WMSDs), a condition involving the soft tissues of the body, including muscles, tendons, nerves, cartilage and other supporting structures, that is caused by exposure to work-related factors (U.S. Department of Health and Human Services 2000 and Healthy people 2010).

The posture of the arm was not maintained static in all the cases. As the action of performing different tasks was repeated more than four times per minute the muscle use score recorded was +1 for all. The location of the hands when performing a task can be almost anywl within the forward or sideways reach, (Ayoub and Mittal, 1989) while the worker is obliged both to bend and to twist in order to reach, making it clear that strength is affected by body posture.

Posture score from Table A in Fig: 1 of RULA was 9 for carrying different load, passing bricks manually and sieving sand whereas for shoveling, filling mud in the foundation and sweeping it was five respectively that are due to the posture they adopt while performing these tasks. Thus the workers are under moderate to high risk of Musculoskeletal disorders (MSDs) as there is a clear relationship of heavy repetitive work and awkward postures.

b. Neck, Trunk and Leg Score Analysis

The following Table 2 depicts the posture deviations noticed in th construction workers, while performin different task in the construction indust with respect to the position of neck, tru and leg.

Table 2. Neck, Trunk and Leg Analysis Vs Task

Type of task	Body parts affected	Position angle	Position score	Postural score in table B from fig.1 of RULA	Force / load score: Load 2kg to 10kg or more (intermittent, static, repeated)
Carrying loads	Neck	10 - 20	3		
	Trunk	60°+	6	7	3
	Leg	-	2		
Passing bricks manually	Neck	20°+	4		
	Trunk	60°+	5	7	2
	Leg	-	2		
Shoveling	Neck	20°+	3		
	Trunk	60°+	6	7	2
	Leg	-	2		
Filling mud in the foundation	Neck	20°+	3		
	Trunk	60°+	6	7	2
	Leg	-	2		
Sweeping	Neck	20°+	3		
	Trunk	60°+	6	7	0
	Leg	-	2		
Sieving sand	Neck	20°+	4		
	Trunk	20° – 60°	5	7	0
	Leg	-	2		

The workers were found to carry load on their head without any mechanical aids which varied from 10 to 50 kg, walking almost 30-50ft again (unloading the pan and returning back to load the pan for the next round) and the number of times these tasks (average 800 times in a day or more as required) were repeated. The loads lifted and carried by these workers are much heavier than the weight limit recommended by the NIOSH Committee (Basu *et al.,* 2005). These processes thus were found to involve rapid, repetitive motions of the wrist, hand and arms which could provoke repetitive trauma disorders and other musculo-skeletal health impairments. The action may not sound actually strenuous but weakened the muscles, tendons and joints due to repetitive conditions and non ergonomi work pattern leading to work relate musculoskeletal disorders (WMSDs).

The position score was 3 and and a twist score of +1 and bending respectively. As the legs and feet even w not supported balanced while working

Table 3. Summation Score for the Different Body Parts used in Performance

Activities performed	Body parts analyzed									
	Arm and wrist					Neck, trunk and leg				
	Σscore			Final score	Cumulative of Grand score	Σscore			Final score	Cumulative of Grand score
	Postural score	Muscle use score	Force load score			Postural score	Muscle use score	Force load score		
Carrying different load	9	1	3	**13**		7	1	2	**10**	
Passing bricks manually	9	1	2	**12**		7	1	2	**10**	
Shoveling	5	1	2	**8**		7	1	2	**10**	
Filling mud in the foundation	5	1	2	**8**	**8+**	7	1	2	**10**	7+
Sweeping	5	1	2	**8**		7	1	2	**10**	
Sieving sand	9	1	0	**10**		7	1	0	**8**	

was offered a score of 2. Therefore the posture score from Table B in Fig: 1 of RULA was 7 for the entire tasks.

Now for passing bricks manually and sieving sand the neck and trunk was twisted to an angle 20^0+ and 20-60^0 respectively. Hence the position score was 4 and 5 and a twist score of +1 and the leg score 2 as it was not supported or balanced. So the posture scores from Table B in Fig: 1 of RULA was 7 for the above tasks. It was found that, if the workers continued to work in the same posture they will suffer from musculoskeletal disorders related to neck, trunk and wrist in the near future. It was recommended to take the corrective action as soon as possible.

c. Summation Score and Grand Score

Table 3 presents details on the final score awarded for the arm and wrist and neck, trunk and leg while performing different type of tasks in the construction sites.

Comparative tallying of the individual upper and lower arm scores to wrist position scores, the mean posture scores for arm and wrist after adding muscle use score and force load score aided in fixing the posture and muscle score for the concerned arm in action. The score was computed as 13 for carrying different load, 12 for passing bricks manually and for shoveling and filling mud in the foundation. Sweeping was computed as 8 whereas for sieving sand it was 10.

Computed as per the instructions, the combined posture score for neck, trunk and leg adding muscle score and force/load to the mean posture was found to be 10 for all the tasks except sieving sand for which the score was 8.

d. Grand Scores for Investigating Upper Limb Disorders

The cumulative scores for arm and wrist analysis for all the tasks such as carrying different load, passing bricks manually, shoveling, filling mud in the foundation, sweeping and sieving sand was 8+, again for the neck, trunk and leg analysis the grand score was 7+ from Table C in Figure:1

The interpretation of the fitment table for score (value) 7 recommends further investigation of the posture and to implement changes soon, as the posture is not acceptable and tolerable.

So the final score for all the tasks recorded 'above 7' which directs one to interpret that the postures need further investigation and it is inevitable and has to be implemented soon as all the tasks range from above the shoulder work, to below the knees work and a variety in between. The surfaces that workers work kept on changing all the time and throughout the day.

Conclusion

This study presented is an ergonomic assessment of the female construction workers in action. The results showed that the workers were working with awkward postures and high motion repetitiveness.

Such prolonged bending and twisting may cause musculoskeletal disorders to them. Thus the workers were under moderate to high risk of work related musculoskeletal disorders (WMSDs). Manual tasks include both static (holding tasks) and dynamic (repetitive movement) components. Static work components deprive the muscles of essential oxygen, making such work very strenuous. Sustained sedentary work in a non-erect position has been associated with lower backache. Body posture changes when work is strenuous, more specifically, while undertaking static work. Turning, bending and twisting while handling materials have been associated with an increased incidence of lower back disorders such as pain, aches and discomfort (Smallwood and Deacon, 2003). To overcome these problems Practical Ergonomics can play an important role because the goal of the science of Ergonomics is to find a "best fit" between the workers and the job conditions. Ergonomics tries to come up with solutions to make sure workers stay safe, comfortable and productive. Hence the study highlights the dire need for implementation of ergonomic interventions with proper awareness among workers giving thrust on work-rest schedules and the working conditions of the female workers to reduce their work stress, by mechanization of certain aspects of the work procedure.

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