

# THE ERGONOMIC ASSESSMENT OF CYCLE RICKSHAW OPERATORS USING RAPID UPPER LIMB ASSESSMENT (RULA) TOOL AND RAPID ENTIRE BODY ASSESSMENT (REBA) TOOL

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**Abstract:** In India, the population of about eight lacks people who are engaged in riding cycle rickshaw as an occupation. It is an unorganized sector of India. A cycle rickshaw is a modified form of bicycle which is the cheapest mode of transportation for carrying passengers, luggage and goods. Many tasks connected with this occupation are associated with strenuous body postures, and some body movements typical for this job which, when combined with a heavy load, result in frequent work-related musculoskeletal disorders (WMSDs). Working postures were analyzed by means of Rapid Upper Limb Assessment (RULA) tool and Rapid Entire Body Assessment (REBA) tool in order to determine the area of discomfort. The outcome of the research is beneficial for manufactures of cycle rickshaws and similar products well as users of such products, including cycle rickshaw operators. Some suggestions were given to have increase the comfort and safety level.

**Keywords:** Ergonomics, RULA, REBA, cycle rickshaw, WMSDs

## 1. INTRODUCTION

A number of studies has been carried out concerning various aspects of a cycle rickshaw, such as energy expenditure of cycle rickshaw operators in different parts of India (Pradhan et al. 2004, Pradhan et al. 2008). A number of anthropometric studies has been conducted in India on agricultural workers (Dhara et al. 2005, Kar et al. 2003, Yadav et al. 1997, Gite et al. 1989, Gupta, et al. 2003, in which anthropometric data of various parts of the body have been reported for general population in India (Manna et al. 2001, Chakrabarti et al. 1997, Chakrabarti 1996, Fernandez 1992). These studies were carried out in order to collect the data anthropometric data for 34 body measurements especially for Eastern India (Pradhan et al. 2010).

The present analysis was performed for two operating postures that were found to be potentially harmful. Postures typical for the job were analyzed by means of Rapid Upper Limb Assessment (RULA) tool and Rapid Entire Body Assessment (REBA) tool

in order to assess the areas of discomfort. The outcome of the research is beneficial for manufactures of cycle rickshaws and similar products well as users of such products, including cycle rickshaw operators.

### 1.1. CYCLE RICKSHAW

A pedal-operated rickshaw is a modified bicycle, which is used extensively as a mode of transport for carrying passengers and luggage. Tricycle originates in Japan and dates back around 1868. At that time, such a manpower vehicle was called "Jinriksha". Tricycles, widely used in Asian countries, vary in style and may have different names such as Trishaw, Pedicab, Cyclo and Becaks. A cycle rickshaw is often perceived as an environment friendly and a less expensive mode of transportation. Since it is considered a traditional Indian traditional vehicle, it can be spotted in every part of India; in villages, small towns, metros, heritage sites etc. It is, however, an unorganized sector of transport in India. In metros, cycle rickshaws are used inside institutional areas, market places and, also, in narrow and crowded lanes where there is an accessibility problem for vehicles. A cycle rickshaw is available in various types depending on the their intended use i.e., for carrying passengers, luggage or merchandise.

### 1.2. RAPID UPPER LIMB ASSESSMENT (RULA) TOOL AND RAPID ENTIRE BODY ASSESSMENT (REBA) TOOL

Rapid Upper Limb Assessment (RULA) tool was proposed by McAtamney, L. & Corlett, E.N. in 1993 (Lynn McAtamney et al. 1993) and by Hignett and McAtamney in 2000 (Hignett, S. and McAtamney, L 2000) as a means of assessing a posture which poses a risk of work related musculoskeletal disorders (WRMSDs), and determining critical tasks in this occupation. For each task, it is supposed to assess posture factors by assigning a score to each area. The RULA and REBA tools use a systematic process to evaluate the whole body postural musculoskeletal disorders (MSD) and risks associated with tasks typical for this job. A one page worksheet is used to evaluate the required or selected body posture, forceful exertions, type of movement or action and repetition. The RULA and REBA were designed for an easy use without a need for an advanced degree in ergonomics or expensive equipment. Using the RULA and REBA worksheet, an evaluator can attribute a score to each of the following body regions: wrists, forearms, elbows, shoulders, neck, trunk, back, legs and knees. After the data for each region is collected and scored, Tables 1 and Table 2 are used to compile the risk factor variables, generating a single score that represents the level of work-related musculoskeletal disorders (WMSDs) risk.

Table 1

For finalising conclusion on RELA analysis

Analysis Score	WMSDs risk level	Action Required
1-2	Ignorable	No action required
3-4	Low risk	Change may be needed
5-6	Medium risk	Further investigation, Change soon
6+	Very high risk	Immediate change to be implemented

Table 2  
For finalising conclusion on RULA analysis

Analysis Score	WMSDs risk level	Action Required
1	Ignorable risk	No action required
2-3	Low risk	Change may be needed
4-7	Medium risk	Further investigation, change soon
8-10	High risk	Investigate and implement change
11+	Very high risk	Immediate change to be implemented

### 1.3. WORK-RELATED MUSCULOSKELETAL DISORDERS

Work-related musculoskeletal disorders is a term given to a group of disorders involving the muscles, joints, nerves and vascular compartment of the body, where certain jobs or work-related factors are associated with an increased risk of developing such disorders. Musculoskeletal disorders (MSDs) are the most common type of work-related health problem in India. Disorders of neck, chest, thigh, back, foot are common problems among the general population as well as cycle rickshaw riders in India.

### 2. RESEARCH OBJECTIVES

This paper deals with the ergonomic assessment of cycle rickshaw operators. The research was done in India to identify high risk working postures while riding a cycle rickshaw, and to suggest improvement in which can prevent work-related musculoskeletal disorders. Rapid Upper Limb Assessment (RULA) and Rapid Entire Body Assessment (REBA) were carried out to assess the risk zone of a cycle rickshaw rider. The main objective of the research work is to determine the risk zone of cycle rickshaw riding.

### 3. WORKING POSTURE ANALYSIS USING RULA AND REBA TOOL

Two main body positions on Cycle rickshaws riding were examined in the research:

1. Pedalling while standing position.
2. Pedalling while sitting position.

Those who were potentially at ergonomic risk of entire body injuries, were investigated in an analytical-descriptive study. Participants of the research were male cycle rickshaw operators between the age of 23 and 55, with mean age of 42.6 (SD = 36.30 years) being the average age of a participant. All of them underwent a preliminary interview, as information about their job characterization had to be obtained. Rapid Upper Limb Assessment (RULA) tool and Rapid Entire Body Assessment (REBA) tool were applied for assessing a rider entire body musculoskeletal risk factors associated with various tasks.

#### 3.1. PEDALLING IN A STANDING POSITION

Two pedal cranks are mounted on a crank shaft to make pedalling a cycle rickshaw possible. A circular pedalling motion is achieved with an oscillatory movement of powerful thigh muscles of a rider. To accelerate a cycle rickshaw from a rest condition or very low speed required more torque is required, so a cycle rickshaw rider adopts a stand-up position, as shown in Figure 1, in order to exert higher force on pedals.



Fig. 1. A cycle rickshaw operator pedalling in a standing position

The Rapid Upper Limb Assessment (RULA) analysis of a cycle rickshaw operator in a standing position are shown in Table 3, where the arm and wrist analysis as well as neck, trunk and leg analysis is carried out according to the guidelines (Lynn McAtamney et al, 1993). The Rapid Entire Body Assessment (REBA) analysis of a cycle rickshaw operator in a standing position is also carried out as shown in Table 4, where trunk, neck and legs' analysis and upper arms (shoulders), lower arms (elbows) and wrists' analysis are carried out according to the guidelines (Hignett, S. and McAtamney, L., 2000).

Table 3  
RULA analysis of a cycle rickshaw operator pedalling in a standing position

RULA	Working position	Score
Arm & wrist analysis	Upper arm position ( $20^{\circ}$ - $45^{\circ}$ )	2
	Lower arm position ( $60^{\circ}$ - $100^{\circ}$ )	1
	Wrist position ( $\pm 15^{\circ}$ )	3
	Wrist twist	2
	<b>Posture Score A</b>	<b>4</b>
	Muscle use score (action repeated)	1
	Force/load score (more than 22 lbs.)	2
	<b>Wrist and arm score</b>	<b>7</b>
Neck, trunk and leg analysis	Neck position ( $20^{\circ}$ )	3
	Trunk position ( $20^{\circ}$ - $60^{\circ}$ )	3
	Legs (not supported)	2
	<b>Posture score B</b>	<b>5</b>
	Muscle use score (action repeated)	1
	Force/load score (more than 22 lbs.)	2
		<b>Neck, trunk and leg score</b>
<b>Final score</b>		<b>7</b>

Table 4  
REBA analysis of a cycle rickshaw operator pedalling in a standing position

REBA	Working position	Score
Trunk, neck and legs analysis	Trunk ( $20^{\circ}$ - $60^{\circ}$ )	3
	Neck (Extension > $20^{\circ}$ and twist)	3
	Legs unilateral load bearing	2
	<b>Posture score A</b>	<b>5</b>
	Load/ force (> 10 kg)	2
	Activity (Rapid changes in posture)	1
		<b>Trunk, neck and legs score</b>

Upper arms (Shoulders), lower arms (elbows) and wrists	Upper arms (Flexion $45^{\circ}$ - $90^{\circ}$ )	3
	Lower arms (Flexion $60^{\circ}$ - $100^{\circ}$ )	1
	Wrists (Flexion $> 15^{\circ}$ )	2
	Posture score B	4
	Coupling (Poor)	2
	<b>Upper arms, lower arms and wrists score</b>	<b>6</b>
<b>Final score</b>		<b>10</b>

### 3.2. PEDALLING IN A SITTING POSITION

To accelerate a cycle rickshaw from a rest position or a very low speed more torque is required, so a cycle rickshaw rider adopts a stand-up position. After getting a standard uniform speed or desired speed, a cycle rickshaw operator adopts another position i.e. a sitting position, as shown in Figure 2, which is analysed by means of RULA and REBA.



Fig. 2. An Indian cycle rickshaw operator pedaling in a sitting position

The Rapid Upper Limb Assessment (RULA) analysis of a cycle rickshaw operator adopting a sitting position is shown in Table 5, where the arm and wrist analysis as well as neck, trunk and leg analysis is carried out according to the guidelines (Lynn McAtamney et al, 1993). The Rapid Entire Body Assessment (REBA) analysis of a cycle rickshaw operator in a standing position is also carried out as shown in Table 6, where trunk, neck and legs analysis and upper arms (shoulders), lower arms (elbows) and wrists analysis are carried out in accordance with the guidelines (Hignett, S. and McAtamney, L., 2000).

Table 5

RULA analysis of a cycle rickshaw operator pedaling in a sitting position

RULA	Working position	Score
Arm & wrist analysis	<b>Working position</b>	<b>Score</b>
	Upper arm position ( $45^{\circ}$ - $90^{\circ}$ )	3
	Lower arm position ( $60^{\circ}$ - $100^{\circ}$ )	1
	Wrist position ( $\pm 15^{\circ}$ )	3
	Wrist twist	2
	Posture score A	4
	Muscle use score	1
Force/load score (More than 22 lbs.)	2	
Neck, trunk and leg analysis	<b>Wrist and arm score</b>	<b>7</b>
	Neck position ( $10^{\circ}$ - $20^{\circ}$ )	2
	Trunk position ( $0^{\circ}$ - $20^{\circ}$ )	2

	Legs (Not supported)	2
	Posture score B	3
	Muscle use score (Action repeated)	1
	Force/Load score (More than 22 lbs.)	2
<b>Final score</b>		<b>7</b>

Table 6

REBA analysis of a cycle rickshaw operator pedaling in a sitting position

REBA	Working position	Score
Trunk, neck and legs analysis	Trunk ( $20^{\circ}$ - $60^{\circ}$ )	3
	Neck( $0^{\circ}$ - $20^{\circ}$ and twist)	2
	Legs unilateral load bearing and knees flexion > $60^{\circ}$	4
	Posture score A	7
	Load/ force (> 10 kg)	2
	Activity (Rapid changes in posture)	1
<b>Trunk, neck and legs score</b>		<b>10</b>
Upper Arms (shoulders), lower arms (elbows) and wrists	Upper arms (Flexion $20^{\circ}$ - $45^{\circ}$ )	2
	Lower arms (Flexion $60^{\circ}$ - $100^{\circ}$ )	1
	Wrists (Flexion> $15^{\circ}$ )	2
	Posture score B	2
	Coupling (Poor)	2
<b>Upper arms, lower arms and wrists score</b>		<b>4</b>
<b>Final score</b>		<b>11</b>

#### 4. RESULT ANALYSIS

After the examination of the two operating positions of a cycle rickshaw operator, it was discovered that the score of RULA analysis of a cycle rickshaw operator pedalling in a standing position is 7 (Table 3) and the score of REBA analysis of a cycle rickshaw operator pedalling while standing position is 10 (Table 4). In case of the second position that is pedalling while sitting condition the RULA score is 7 (Table 5) and REBA score is 11 (Table 6). These scores of RULA and REBA of operating position are compared with the value of Table 1 and Table 2 respectively.

The value of RULA i.e. is 7 and REBA i.e. is 10 scores for a standing position and the value of RULA i.e. is 7 and REBA i.e. is 11 scores for a sitting position, which indicates that the considered working posture under consideration is poses a very high risk. Therefore, an immediate change needs to be implemented in order to reduce risk factors (Table 1 and 2]. As the RULA and REBA score of both is in the high risk zone, the working posture needs an immediate investigation and changes are necessary in the design of a cycle rickshaw. Training for proper sitting as well as standing posture is required so as to reduce the work-related musculoskeletal disorders (WMSDs) and improve the health condition of cycle rickshaw operators in India.

#### 5. CONCLUSION

As the anthropometric characteristics of cycle rickshaw operators were different from those of the Indian population, a cycle rickshaw should be designed in accordance with local anthropometric data. Otherwise, the height of a rider's seat from a pedal (crotch height) and the distance between a rider's seat and a handle (Forward grip reach) should have structure with variable adjustments corresponding to an individual rickshaw operator. Owing to this research, one is able to identify the most hazardous operating posture that needs an immediate investigation and improvement.

Knowledge about risk factors in order to prevent disability is an essential issue for cycle rickshaw operators.

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