

Postural Analysis Through RULA, REBA And QEC Of Vendors Selling Edible Items At Railway Stations And In The Trains

Iqbal Ahmed Khan, Rupak Kumar Deb

Abstract: An ergonomic study is conducted on postural analysis of the vendors selling edible items at various railway stations and in trains in Northern India. It has been observed that they attain a definite posture infinite number of times to perform a particular task for whole life. It depends upon the number of passengers whom they interact for selling edible products in the trains and at the railway stations. It has been observed that about 20-25 vendors are working at one railway station and +7000 railway stations in Indian railway network therefore at national level these are large in numbers. The RULA and REBA analysis are performed on the eight different vendors who were selling various types of eatable products at the railway stations and in the trains. The results of RULA analysis score is 100% score (7-high risk) was obtained for each vendor which indicates that there is a very high risk and further investigation is required on their working postures and implement change soon. On the other hand REBA analysis showed that 50% score (5- has medium risk, further investigate and change soon and remaining 50% score (8-9), pointed out that these postures have high risk, further investigate and implement change. The average of REBA score of all 8 vendors is 6.75 which showed that the working postures have high risk, further investigate and implement change soon. Further, QEC analysis also revealed that there is a high risk as per the assessment scores. Almost every vendor's shoulder score lies (31-40) which means high risk, also back score, wrist score and neck score showed high risk in QEC assessment scores. On the basis of results and succeeding discussions conclusions has been drawn.

Index Terms: WMSDs .RULA .REBA . QEC.

I. INTRODUCTION

India has the largest train network in Asia. Daily 7000 trains including Gatimaan, Shatabdi, Super-Fast, Rajdhani, Duranti, Mails, Express, Passenger trains and special trains are plying at different routes. Train journey is considered to be safest, comfortable and economic journey and approximately one crore passengers used this facility on regular basis throughout the India. At the time of journey their eatable needs are different throughout the day. To cater passengers eatable needs vendors carry various eatable things/products such as tea, coffee, soup, cold drinks, water bottles, milk bottles, samosas, bread pakodas, chips, and other edible products. Further through observations it is

noticed that working postures of vendors during selling of items is awkward. Few vendors (Figure 1 & 2) holding the bucket of weight of 18-20 kg (water bottles, milk bottles, cold drinks etc.) at their forearm and moved in different Boggies of trains and at railway stations. Some vendors (Figure 3) carry breadpakodas, samosas etc. in the tray on their head. Also some vendors keep containers weight at their shoulder (right/left) (Figure 4, 5, 6 and 7). Apart for this few vendors (Figure 8) had the weight of the tray support through belt on his neck. Also tea/coffee vendors carry container on their either shoulder or hand. Besides this all the vendors shift the load when they feel tired to other part of the body. Through observations it is also noticed that they usually carry eatable/liquid items in different containers like Bucket, tub (square/round), tray etc. Also they carry load at their head, shoulder (right/left), on hands and sometimes through belt on the neck and give support by stomach and hands to the tray.

The activities of vendors are repetitive in nature which enhances the work related musculoskeletal disorders (WMSDs)/ RSI (repeated strain injury)/ CTD (cumulative trauma disorder).The vendors work is repetition in nature and have not sufficient time for body tissues to recover themselves to overcome the strain which is producing during working on body tissues might be effect discomfort, pain and prolonged working subsequently results of disability to them. Further, no doubt repetitive nature of work is the major and important parameter for WMSDs but apart from this other factors such as working conditions, environment factors, individual capabilities and habits play a significant role in WMSDs in human beings.

The literature re-examine showed that a lot of researches were conducted in the past e.g Alireza Choobineh et.al. [1] found that there was very high score of RULA (action level 3 & 4). This score could be minimized by designing ergonomic workplace to the workers of an Iranian communication company. Another study conducted by Yasser Labbafinejad et.al. [2] found a relationship between Low Back Pain (LBP) and education of workers in RULA scores. Also they found relationship between neck pain, age, gender, and working posture (mostly sitting/standing or alternating between the two). LBP, neck pain, awkward posture increased abstentism in the workers of the company. Further, J Nieves Serratos-Pereza et. al. [3] performed the investigation and ergonomic assessment in camshaft production operations.

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The tasks performed by the workers are; i) managing the camshaft components i.e loading and unloading to and from the lathe machine, ii) camshaft mechanism visual inspection and test of fulfilment to the required parameters, iii) alteration of the machinery iv) setting the complete components in the containers. The REBA results showed that the 3 operations are at a very high risk, 14 classify as high risk, 14 were found as medium risk and 4 operations classified as small risk level. The body parts such as trunk, neck, arm and wrist were found at risk for WMSDs.

Keeping this in mind the present study is conducted to explore the health risk assessment of the vendors through their working postures, when they are selling edible items at platforms and in the trains. Their postures are recorded in videos and at a standstill taking photographs and these images are used for postural examination. The postural analysis tools Rapid Upper Limb Assessment (RULA), Rapid Entire Body Assessment (REBA), and Quick Exposure Check (QEC) are used to evaluate the risk assessment concerned in the functioning postures of the vendors.

II. METHODOLOGY

The vendors working at railway stations and in the trains the following procedure is followed for postural analysis;

1. Filming (Video and still photography) the vendors' posture by Sony Camera
2. Take print of each vendors posture and measure the different angles of body parts as stated in RULA and REBA employee Assessment Worksheet (Table 1 and 2). Eventually, calculate the grand score of REBA and find out the associated risk through the Table 4.

3. The evaluation of this vendors' posture is to be carried out as per the procedure given in the RULA and REBA employee Assessment Worksheet. The outcome of the evaluation is **score** of RULA and REBA.
4. On the basis of these **scores** of RULA and REBA, determine the associated risk of posture of the vendor. This risk can be found in Table 3 & 4.
5. The similar analysis is to be carried for all the vendors' postures. The procedure of analysis for RULA, REBA and QEC is adopted from Iqbal Ahmed Khan and B.P Agarwal [4].

Further, The Rapid Upper Limb Assessment (RULA) employee assessment worksheet (Table 1) is used which was developed by McAtamney and Corlett [5] to compute the musculoskeletal risk caused by inactive tasks where upper body difficulty were high and work related upper extremity disorders are reported. The upper arm, lower arm, wrists, neck, trunk, legs postures are to be evaluated as procedure mentioned in Table 1. Finally, calculate the grand score of RULA and find out the associated risk through the Table 3. Similarly REBA (Rapid Entire Body Assessment) employee assessment worksheet (Table 2) is used, which was developed by Hignett.S. and Mc Atamney.L. [6] to give postural investigation of the worker for entire body activities i.e static and dynamic activities and give a REBA score.. The procedure of evaluation of posture is given in REBA employee assessment worksheet is to be followed for trunk, neck, and legs, upper and lower arms and wrists.

Table 1: RULA Employee Assessment Worksheet

A. Arm and Wrist Analysis

Step 1: Locate Upper Arm Position: +1, +2, +3, +4

Step 2: Locate Lower Arm Position: +1, +2, +3, +4

Step 3: Locate Wrist Position: +1, +2, +3, +4

Step 4: Wrist Twist: +1, +2, +3, +4

Step 5: Look-up Posture Score in Table A:

Step 6: Add Muscle Use Score

Step 7: Add Force/Load Score

Step 8: Find Row in Table C

Table A: Wrist Score

Upper Arm	Lower Arm	Wrist Twist	Wrist Twist	Wrist Twist	Wrist Twist
1	2	1	2	1	2
1	1	1	2	2	3
1	2	2	2	2	3
1	3	3	3	3	4
2	1	2	3	3	4
2	2	3	3	3	4
2	3	4	4	4	5
3	1	3	4	4	5
3	2	4	4	4	5
3	3	4	4	4	5
4	1	4	4	4	5
4	2	4	4	4	5
4	3	4	4	4	5
5	1	5	5	5	6
5	2	5	5	5	6
5	3	6	6	6	7
6	1	7	7	7	8
6	2	8	8	8	9
6	3	9	9	9	9

Table B: Neck, Trunk, Leg Score

Neck Posture Score	Trunk Posture Score	Legs Score	Legs Score	Legs Score	Legs Score
1	2	3	4	5	6
1	1	2	2	1	2
2	2	3	3	2	3
3	3	4	4	3	4
4	4	5	5	4	5
5	5	6	6	5	6
6	6	7	7	6	7
7	7	8	8	7	8
8	8	9	9	8	9
9	9	9	9	9	9

Table C: Neck, Trunk, Leg Score

Wrist / Arm Score	Neck, Trunk, Leg Score	1	2	3	4	5	6	7
1	1	2	3	4	5	5	5	5
2	2	2	3	4	4	5	5	5
3	3	3	3	4	4	5	5	5
4	4	3	3	4	4	5	5	5
5	4	4	4	4	5	6	7	7
6	4	4	5	6	6	7	7	7
7	5	5	6	6	7	7	7	7
8	5	5	6	7	7	7	7	7

B. Neck, Trunk and Leg Analysis

Step 9: Locate Neck Position: +1, +2, +3, +4

Step 10: Locate Trunk Position: +1, +2, +3, +4

Step 11: Legs: +1, +2

Step 12: Look-up Posture Score in Table B:

Step 13: Add Muscle Use Score

Step 14: Add Force/Load Score

Step 15: Find Column in Table C

Scoring: (Final score from Table C)

1-2 = acceptable posture
3-4 = further investigation, change may be needed
5-6 = further investigation, change soon
7 = investigate and implement change

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Table 2: REBA Employee Assessment Worksheet

A. Neck, Trunk and Leg Analysis

Step 1: Locate Neck Position
 Diagrams showing neck positions with scores: +1 (twisted), +2 (side bending).
 Step 1a: Adjust...
 If neck is twisted: +1
 If neck is side bending: +1

Table A: Neck

	Neck											
Table A												
	1			2			3			4		
Neck Score	1	2	3	4	1	2	3	4	3	3	5	4
Trunk Posture	2	2	3	4	5	3	4	5	6	4	5	7
Score	3	2	4	3	6	4	5	6	7	5	6	7
	4	3	5	6	7	5	6	7	8	6	7	8
	5	4	6	7	8	6	7	8	9	7	8	9

Step 2: Locate Trunk Position
 Diagrams showing trunk positions with scores: +2 (twisted), +3 (side bending), +4 (bent).
 Step 2a: Adjust...
 If trunk is twisted: +1
 If trunk is side bending: +1

Table B: Lower Arm

	Lower Arm					
Table B						
	1		2		3	
Wrist	1	2	3	1	2	3
Upper Arm	1	1	2	2	1	2
Score	2	1	2	3	2	3
	3	3	4	5	4	5
	4	4	5	6	5	6
	5	5	6	7	6	7
	6	6	7	8	7	8
	7	7	8	9	8	9

Step 3: Legs
 Diagrams showing leg positions with scores: +1 (bent), +2 (twisted), +3 (bent), +4 (twisted).
 Adjust: +1 (bent), +2 (twisted).
 Add +1, Add +2.

Table C: Score A and Score B

	Score A												Score B																							
Score A																																				
	1			2			3			4			5			6			7			8			9			10			11			12		
1	1	1	1	2	2	2	3	3	3	4	4	4	5	5	5	6	6	6	7	7	7	8	8	8	9	9	9	10	10	10						
2	1	2	2	3	3	4	4	5	5	6	6	7	7	8	8	9	9	10	10	11	11	11	12	12	12	13	13	13	14							
3	2	3	3	4	5	5	6	7	7	8	9	9	10	11	11	12	13	13	14	14	15	15	16	16	17	17	18	18	19							
4	3	4	4	5	6	6	7	8	9	9	10	11	12	12	13	14	15	16	17	18	18	19	20	20	21	22	22	23	24							
5	4	4	5	6	7	8	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	28	29							
6	5	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32							
7	6	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33							
8	7	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34							
9	8	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35							
10	9	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36							
11	10	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37							
12	11	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38							
13	12	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39							

Step 4: Look-up Posture Score in Table A
 Using values from steps 1-3 above, locate score in Table A.

Step 5: Add Force/Load Score
 If load < 11 lbs.: +0
 If load 11 to 22 lbs.: +1
 If load > 22 lbs.: +2
 Adjust: if shock or rapid build up of force: add +1

Step 6: Score A, Find Row in Table C
 Add values from steps 4 & 5 to obtain Score A. Find row in Table C.

Scoring
 1 = Negligible Risk
 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, Implement Change

B. Arm and Wrist Analysis

Step 7: Locate Upper Arm Position
 Diagrams showing upper arm positions with scores: +1 (abducted), +2 (abducted), +3 (abducted), +4 (abducted).
 Step 7a: Adjust...
 If shoulder is abducted: +1
 If upper arm is abducted: +1
 If arm is supported or person is leaning: -1

Step 8: Locate Lower Arm Position
 Diagrams showing lower arm positions with scores: +1 (flexed), +2 (flexed).

Step 9: Locate Wrist Position
 Diagrams showing wrist positions with scores: +1 (bent), +2 (bent).

Step 10: Look-up Posture Score in Table B
 Using values from steps 7-9 above, locate score in Table B.

Step 11: Add Coupling Score
 Well fitting handle and mid range power grip: good: +0
 Acceptable but not ideal hand held or coupling acceptable with another body part: fair: +1
 Hand held not acceptable but possible: poor: +2
 No handles, awkward, unstable with any body part, unacceptable: +3

Step 12: Score B, Find Column in Table C
 Add value from steps 10 & 11 to obtain Score B. Find column in Table C and match with Score A in row from step 6 to obtain Table C Score.

Step 13: Activity Score
 +1 1 or more body parts are held for longer than 1 minute (static)
 +1 Repeated small range actions (more than 4x per minute)
 +1 Action causes rapid large range changes in postures or unstable base

Score	Intensity of MSD Hazard
1-2	Insignificant Risk, No Action Required
3-4	Low Risk, Change may be needed
5-6	Medium Risk, Further Investigation, Change Soon
6+	Very High Risk, Implement Change Now

Score	Intensity of MSD Hazard
1	Insignificant 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, Implement Change Now

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Figure 1: Vendor holding bucket at forearm selling water bottles at a railway platform



Figure 2: Vendor holding bucket at forearm selling water and milk bottles at a railway platform



Figure 3: Vendor Selling breadpakoda at head at railway station



Figure 4: Vendor Selling breadpakodaat his shoulder a at railway station

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Figure5: Vendor Selling Kachaouriat his shoulder a at railway station



Figure 6: Vendor Selling cold drinks at his shoulder a at railway station



Figure 7: Vendor selling tea in a container at his shoulder a at railway station



Figure 8: Vendor selling samosas with neck and stomach support in a container a at railway station

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III. RESULTS

A. For Arm and Wrist Analysis: Vendor's upper arm and wrist position (figure 1 and figure 2) are measured in angles. And the corresponding scores are obtained from Table 1.

Step 1: Position of Upper Arm

Upper Arm Angle (26^0) Score = 2

Step 2: Position of Lower arm

Lower Arm Angle (46^0) Score = 2

Step 3: Position of Wrist

Wrist Angle (10^0) Score = 2

Step 4: Wrist Twist

Wrist Twist Score = 1

Step 5: Look up posture score in Table A; which exits in Table 1

Using values, from steps 1 to 4 above, position score in Table A, score = 4

Step 6: Add muscle score: It is repetitive, so score =1

Step 7: Add Force/Load Score: load > 4.4 lbs, so score =2

Add values from step 5 to 7 $4+ 1+ 2 = 7$

Step 8: Find Row in Table C which exits in Table 1

According to Table 1 (RULA Employee Assessment Worksheet), Steps 1-15 are given below;

B. Neck, Trunk and Leg Analysis:

Step 9: Neck Position

Neck Angle (24^0) Score = 3

Step 10: Trunk Position

Trunk Angle (0^0) Score = 1

Step 11: Legs Position

Leg Angle (0^0), Leg score =2, Now find these scores of neck, trunk and leg in Table B of Table 1.

Step 12: Look up posture in Table B of Table 1, Score = 4

Step 13: Add muscle score: It is repetitive, score = 1

Step 14: Add Force/Load Score: load > 4.4 lbs, to 2.2 lbs score =2

Step 15: Find Column in Table C of Table 1

In Table C of Table 1, position the step 8 (score = 7) in row and step 15 (score =7) in column and obtained score 7. This "7" is the RULA score. Further RULA score =7, is used to see the information in Table 3. The information obtained from Table 3 is, very high risk, implement change now. The similar process is repeated for eight vendors. The results of eight vendors are presented in Table 5.

Table.5: RULA Scores for different Vendors

S.No.	Type of Vendors	RULA Score	Interpretation
Tea/ Coffee (Figure 7)			
1	Vendor 1	7	very high risk, implement change now
Samosas/Breadpakodas/ Kachodi (Figure 3, 4, 5 and 8)			
1	Vendor 2	7	very high risk, implement change now
2	Vendor 3	7	very high risk, implement change now
3	Vendor 4	7	very high risk, implement change now
4	Vendor 5	7	very high risk, implement change now
Cold Drinks/Water and Milk Bottles(Figure 1,2 and 6)			
1	Vendor 6	7	very high risk, implement change now
2	Vendor 7	7	very high risk, implement change now
3	Vendor 8	7	very high risk, implement change now

IV. REBA INVESTIGATION

According to Table 2 (REBA Employee Assessment Worksheet), steps 1-13 are given below;

Neck, Trunk and leg Analysis: For neck, trunk and leg positions (figure1) are measured in angles. And the subsequent scores are obtained from Table 2;

A. Neck, Trunk and leg Analysis

Step 1: Position of Neck:

Angle (24^0) Neck Score = 3

Step 2: Position of Trunk:

Angle (0^0) Trunk Score = 1

Step 3: Legs position

Angle (0^0), Leg Score = 2

Step 4: Look-up posture Score in Table: A of Table 2.

Using values from steps 1-3, Table: A of Table 2, **Score = 3**

Step 5: Load Score: Load > 22 lbs., score = 2

Step 6: Find row in Table C of Table 2. Score = 3 + 2 = 5

B. Arm and Wrist Analysis:

Step 7: Position of Upper Arm

Upper Arm (26^0) Upper Arm Score = 2

Step 8: Position of Lower Arm

Lower Arm (46^0) Lower Arm Score = 1

Step 9: Position of Wrist:

Wrist Angle (10^0) Wrist Score = 2

Step 10: Look up posture score in Table B of Table 2.

Score = 2

Step 11: Add coupling Score: Score = 2

Step 12: Find Column in Table C of Table 2. Add values From

Step 10 to 11: Score = 2 + 2= 4

Step 13: Activity Score, Score = 1

REBA Score = Score in Table C of Table 2 + Activity Score.

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REBA Score = 4 + 1 = 5

This REBA (score = 8) is seen in Table 4. The information obtained is, **Medium risk, further**

investigation, change soon. The similar process is repeated for eight vendors. The results of eight vendors are presented in Table 6.

Table.6: REBA Scores for different Vendors

S.No.	Type of Vendors	Figure No.	REBA Score	Interpretation
1	Vendor 1 Tea/Coffee	1	5	Intermediate risk, further investigate, modify soon
1	Vendor 2 Samosas/Breadpakodas/ Kachodi	2	8	High risk, investigate and implement change
2	Vendor 3	3	8	High risk, investigate and implement change
3	Vendor 4	4	5	Intermediate risk, further investigate, modify soon
4	Vendor 5	5	8	High risk, investigate and implement change
1	Vendor 6 Cold Drinks/ Water/Milk Bottles	6	6	Intermediate risk, further investigate, modify soon
2	Vendor 7	7	5	Intermediate risk, further investigate, modify soon
3	Vendor 8	8	9	High risk, investigate and implement change

V. QUICK EXPOSURE CHECK (QEC)

Through QEC spectator evaluation sheet calculator (website <http://www.qec.freiz.com>) give all answers and obtained the results as shown in Table 7 & 8. QEC was developed by [7], it has two sections. The first section is related to the risk factors in developing WMSDs, i.e. profound manual handling, Repetitive and dynamic actions, uncomfortable static postures that arise from poorly designed workstations, tools, equipment, working methods. The other factors are back, shoulder/arm, wrist/hand and neck.

The second section involves the worker. Their responses are an important part of the evaluation. Care should be

taken that they respond the questions based on their understanding of performing the task. There are eight questions in this section pertaining to:

1. Maximum weight handled (this can be subjective, but should be verified with measurements of weights and forces)
2. Time spent on task
3. Maximum force level exerted by one hand (this can be subjective, but should be verified with measurements of forces)
4. Visual demand of the task
5. Vehicle use
6. Vibrating tools
7. Work pace
8. Stress level

Table 7: Risk Assessment of QEC for vendors

Risk evaluation	Low	Moderate	High	Very High
Back	10-20	21-30	31-40	41-56
Shoulder/Arm	10-20	21-30	31-40	41-56
Wrist/Hand	10-20	21-30	31-40	41-56
Neck	2-6	7-10	11-14	15-18
Stable Base	1	4	9	
Vibration	1	4	9	-
Work Pace	1	4	9	-
Environment	1	4	9	16

Table.8: QEC Scores for different Vendors

S.No	Type of Vendor	Figure No.	SCORES OF							
			Back	Shoulder /Arm	Wrist/ Hand	Neck	Drivin g	Vibration	Pace	Work Stress
1	Vendor 1 Tea/Coffee	1	32	40	42	16	1	1	4	9
	Samosas/ Breadpakodas									

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1	Vendor 2	2	32	42	38	16	1	1	9	9
2	Vendor 3	3	36	46	42	14	1	1	9	9
3	Vendor 4	4	32	28	38	16	1	1	9	4
4	Vendor 5	5	32	46	42	16	1	1	4	9
Cold Drinks/ Water Bottles										
1	Vendor 6	6	36	42	38	14	1	1	9	16
2	Vendor 7	7	36	38	42	14	1	1	9	9
3	Vendor 8	8	36	46	42	16	1	1	9	16

VI. DISCUSSIONS

RULA score = 7, is obtained which designates, very high risk, implement change now. From the observations it is also obvious that vendors' neck, upper arm, lower arm and trunk are in several time 's bents and twist to take explicit postures for performing a specific task. These precise uncomfortable postures of the vendors are repetitive infinite number of periods all over the day and produces job related musculoskeletal disorders in their upper extremity. The RULA results are matching with the past researchers such as D. N. Agrawal et.al. [8] observed that due to constant kneeling posture of the workforce got fatigued repeatedly and musculoskeletal nuisance were identified in them. A study of Chowdury M. L. Rahman [9] had found that most of the workers exposed to the upper extremity discomfort due to the awful working postures. Also, RULA revealed that no posture is risk free for all the workers working in ceramic industry. Therefore, various means and ways should be devised to obtain desired level of output from the workers.

Further, REBA analysis of the vendors showed that their working postures were either medium or at high risks so further investigate their working postures and modify soon. It is obvious from the photographs of the vendors that their functioning posture is awkward and could be injurious to them, if it continues for long duration. Further, over a period of time their age will also increases. Eventually working postures, ageing, work demand and their capability, needs extra efforts to complete the task successfully. Numerous studies were conducted in the past such as a study conducted

by Karthikeyan Mathesan et. al. [10] results of RULA and REBA were high (REBA 53.33% and RULA 85.71%) in manual feeding of workpieces by the operators during drilling operation has maximum risk for the operators. Therefore, the ergonomic aspects have to be considered for designing drilling workstation.

Farahnaz Abdollahzade et. al. [11] studied on room nurses and found a high score of REBA analysis which reflects urgent need to change the working postures of the nurses. Also they found in univariate analysis strong relationship between working posture and age, gender and regular daily exercise, work experience and number of shifts per month. QEC results (Table 7 and 8) also showed that back, shoulder/arm, wrist/hand, neck and work pace scores are high. These factors scores are high might be due to train

vendors carry food articles on their shoulders, arms and at head and also often bent their neck again and again to provide the food articles to the passengers by keeping bucket on the floor of the train or at railway stations due to weight of the bucket. Obviously when vendors repeated this posture in several times faces the pain in different body parts (at back, neck or shoulder etc.) which is the result of the working postures of the vendors. The QEC results are matching with the past researches such as Emre Ozgur Bulduk et. al. [12] QEC scores of 382 taxi drivers were establish very high risks for the shoulder/arm, wrist/hand and neck, whereas the scores for the back were found to be high for static use and moderate for moving. The results also showed that the work-related risk factors for WMSDs were connected with constrained postures, repetitive actions, vibration, work related stress. Essential ergonomic interventions are needed to reduce risk of exposures to WMSDs in taxi drivers.

VII. CONCLUSIONS AND FUTURE SCOPE

The present working postures of vendors are not appropriate so redesign the postures of the vendors considering ergonomic principles to reduce the WMSDs. Also, when they induct in this profession they have to aware about the posture affects in their life.

In each bogie install a machine/fix a place from where passengers purchase edible items from the vendors.

Further, work should be done on their postures to verify the present work by other postural analysis tools to reduce the WMSDs.

REFERENCES

1. Alireza Choobineh, Sayed Hamidreza Tabatabaei, Marzieh Tozihian, and Fatemeh Ghadami: Musculoskeletal problems among workers of an Iranian communication company. *Indian Journal of Occupational and Environmental Medicine*. Volume: 11, Issue: 1 Page: 32-36, (2007)
2. Yasser Labbafinejad, Zahra Imanizade, Hossein Danesh: Ergonomic Risk Factors and Their Association With Lower Back and Neck Pain Among Pharmaceutical Employees in Iran. *Workplace Health and Safety* <https://doi.org/10.1177/2165079916655807>
3. J Nieves Serratos-Pereza, Juan Luis Hernandez-Arellanob, M. Carmen Negrete-Garcia: Task analysis and ergonomic evaluation in camshaft production operations| 6th International Conference on Applied Human Factors and Ergonomics (AHFE 2015). *Procedia Manufacturing* 3 (2015) 4244 – 4251
4. Iqbal Ahmed Khan, B.P. Agrawal (2017) "Postural analysis of air filling operators working at petrol filling stations" *Industrial Engineering Journal*, Vol. X & Issue No. 5 May- 2017, pages 6-12.

Postural Analysis Through RULA, REBA And QEC Of Vendors Selling Edible Items At Railway Stations And In The Trains

5. McAtamney, L., E. N. Corlett (1993). RULA: A survey method for the investigation of work-related upper limb disorders. Applied Ergonomics. Vol. 24, No. 2, pages. 91-99
 6. Hignett S, McAtamney L. Rapid entire body assessment (REBA). Applied Ergonomics (2000), 31(2):201-205
 7. Li, G., and Buckle, P.: A Practical Method for the Assessment of Work-Related Musculoskeletal Risks - Quick Exposure Check (QEC), Human-System Interaction: The Sky's No Limit!, Proceedings of the Human Factors and Ergonomics Society 42nd Annual Meeting, Chicago, Illinois, October 5-9, 1998, the Human Factors and Ergonomics Society, Santa Monica, California, 2, 1351-1355
 8. D N. Agrawal, T. A. Madankar and M. S. Jibhakate: Study and Validation of Body Postures of Workers Working in Small Scale Industry through RULA. International Journal of Engineering Science and Technology, Vol. 3 No.10, ISSN: 0975-5462 (2011)
 9. Chowdury M. L. Rahman: Study and Analysis of Work Postures Of Workers Working In A Ceramic Industry Through Rapid Upper Limb Assessment (RULA). International Journal of Engineering and Applied Sciences, Aug. 2014. Vol. 5. No.03, Pages 14-20, ISSN2305-8269
 10. Karthikeyan Mathesan, Arun Mohan, Visagavel K, Deepakraja V, Balaji P, Selvakumar A: Study and Analysis of Body Postures Using Ergonomic Assessment Tools in Drilling Operations. Journal of Industrial Safety Engineering, Vol. 2, No 1, (2015).
 11. Farahnaz Abdollahzade, Fariba Mohammadi, Iman Dianat, Elnaz Asghari, Mohammad Asghari- Jafarabadi, Zahra Sokhanvar: Working posture and its predictors in hospital operating room nurses. Health Promot Perspect.; 6(1):17-22 (2016)
 12. Emre Ozgur Bulduk, Sidika Bulduk, Tufan Suren, Feride Ovali: Assessing exposure to risk factors for work-related musculoskeletal disorders using Quick Exposure Check (QEC) in taxi drivers. International Journal of Industrial Ergonomics, 44 (2014), pages 817-820
- patient named " Saksham Catalytic Converter" (2013) has already been published in Journal of patent by Govt. of India.



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