

The Study of Human Behavior and Physical Ergonomics in the Workplace

Anuradha Kumari¹ and Ranganath M. Singari²

^{1,2} *Department of Design, Delhi Technological University, Delhi, India.*

Abstract: The workplace environment has become a consequential reason for hazards to employees' physical and behavioural well-being. This paper presents the analysis of physical ergonomics using RULA, and REBA methods and behaviour analysis using the ethnographic method. The data were collected from Professors, Heads of the Department of education institute. The results obtained from RULA analysis-the risk of MSDs is high for 40% of Participants, and from REBA analysis, 66.66% of Participants are at increased risk of MSDs. Finally, the study concludes that any person suffering from a physical work-related injury will also affect their behaviour, so physical and behavioural factors of any workplace have positive relations with Pearson's correlation coefficient (r) value of 0.5497.

Practical Implications: This study describes the analysis of Physical ergonomics and human behavior in the workplace. It gives concrete direction to interpret employees' problems related to physical posture and behavior at the workplace and eventually help to identify practical solutions.

Keywords: Human Behavior; Musculoskeletal Disorder; Physical Ergonomics; Workplace Environment.

1. Introduction

A working environment is an extensive term and includes all the environmental factors. Behavior and Physical are two significant factors in any typical working environment. In a physical climate, elements are connected to an employee's attitude toward physically engaging with the workplace environment (Sharma et al., 2016). While the employees' etiquette with one another is associated with behavioral and environmental factors, a poor workplace environment can lead to work-related injuries that affect employee productivity (Cash et al., 2020; Hafeez et al., 2019).

As per ILO (International Labor Organization), every year, 160 million people suffer from work-related injuries due to bad ergonomics at the workplace (Van Daele, 2008). IEA (International Ergonomics Association, 2003) describes "Ergonomics as the study of human interactions, data, and design methods to optimize human well-being and overall system performance" (Aburas & Shin, 2015). It helps to design assessments of job work, system and product, and environment so that they can be tailored to people's abilities, requirements, and limitations. Ergonomics promotes the comprehensive and human-centric approach to designing a product, process, and system that cater to behavioral, physical, organizational, social, and other relevant factors. Several ergonomic factors contribute to health, including improper furniture design, workspace design, lighting, tools, repetitive motion, and heavy lifting. These ergonomic factors can lead to problems and injuries associated with MSD (Musculoskeletal Disorders), like repetitive strain injury, carpal tunnel syndrome, and repeated motion injury (Al Shahry et al., 2018). Poor workplaces affect human behavior, which causes



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many problems, i.e., identity confusion, impaired judgment, loss of long and short-term memory, confusion, insomnia, anxiety, and anger (Lepri et al., 2011).

Although various academicians and researchers have undertaken a considerable amount of work in the field of evaluating physical ergonomics at work, there is very little literature that focuses on change in human behavior due to the workplace environment. This work aims to examine human behavior and physical ergonomics in the workplace and how physical ergonomics affects the behavior of employees at a workplace. How are physical and behavioral factors of any work related to each other. This study is based on quantitative and qualitative measures of the focused set of users.

2. Background

There is a brief overview provided of human behavior and physical ergonomics, along with various investigations, methods, and case studies that have been conducted for assessing human behavior and physical ergonomics.

ABURAS & SHIN, 2014, Conducted an ergonomic study on the school's seating area in three different locations 1) Student union building, 2) Science building 3) the Student's lounge. The survey was conducted on 45 students. The study found that the Student Union building has the highest comfortable seating area with the highest student satisfaction rate. (Graudenz et al., 2005), An average individual invests 70-80% of their time in their workplace. The elements influencing indoor climate incorporate temperature, relative moistness, indoor air quality, and light. (Houtman et al., 2008) Expressed thermal comfort is affected by numerous factors that incorporate air moistness, air temperature, human garments, and mean radiant temperature. The broad utilization of air conditioning causes health problems but helps to maintain thermal comfort. (Qutubuddin et al., 2013) investigated the safety risk factors and work-related health of sawmill workers. The workers at sawmills suffering from MSD (Musculoskeletal Disorder) RULA and REBA posture analysis shows that they are working over the safe limit as far as possible. (Trevelyan & Haslam, 2001) studied musculoskeletal problems in a handcrafted brick processing plant, focusing on the shaping office, where bricks are formed from clay. Strategies have incorporated an audit of clinical records, semi-organized meetings, video recording to empower tasks, pastoral and power examination, emotional inconvenience review, demeanor overview, working environment investigation, and correlations with a comparable manufacturing plant. The outcomes have shown that both upper appendage and back issues exist among the workers. (Neumann et al, 2002) Conducted a study assessing partial automation techniques' effect on ergonomics and profitability. Partial automation of gadget gathering has brought about a decrease in repetitive assembly work by 34%. (Joseph, 2003) summarized Ford Motors Company's efforts in maintaining and executing its corporate ergonomics program. The work draws out the idea of 'Design for Ergonomics,' which combines individual vehicle habitats and manufacturing engineering to impact the production process. (Burdoff & Duuren, 1993) Have surveyed the woodworking industry among operators to consider the impact of 10 attributes of the machine on disclosure to mechanical burden. Ovaco Kama Asana Analysis System (OKAAS) was used to analyze the workplace's body posture and external load. An investigation has demonstrated the beneficial impact accomplished by different ergonomic improvements. (Bao et al., 1996) assessed the effect of attributes of workplace physical workload on operators. The physical workload has been evaluated with the help of an expert's observation before and after the change. It indicated that the physical workplace workload was less after the change. (Feyen et al., 2000) Examined the PC-based program that allows engineers and designers to measure the worker's MSD injuries at the workplace. (Severs et al., 2016) Conducted a web-based survey of 405 ergonomics practitioners. RULA, RULA analysis was used for postural assessment.

3. Methods and Materials

An essential objective of this research is to study human behavior in the workplace and physical ergonomics. It was conducted at Delhi Technological University, Delhi. All participants participated in the study, which was decisive. Two different methods, RULA (Rapid Upper Limb Analysis), and REBA(Rapid Entire Body Analysis), was used for postural analysis, and the ethnography method is used for behavior analysis. Correlation analysis was performed between physical ergonomics and human behavior factors, and **Figure 1** shows that.

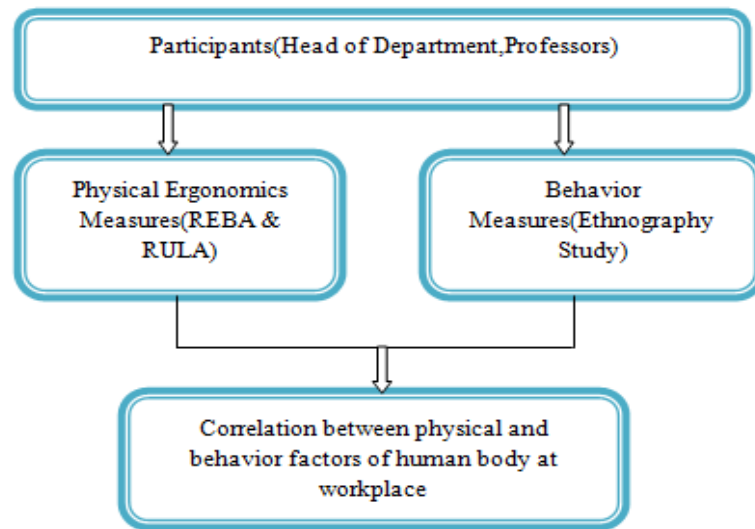


Figure 1: Flowchart of Research Methodology.

3.1. Physical Ergonomics Measures

Two methods have been selected RULA (Rapid upper limb analysis) and REBA(Rapid Entire Body analysis), from the literature study of Postural analysis.

RULA (Rapid Upper Limb Analysis): It is employed to evaluate the exposure to the risk factors for upper limb disease in the workplace. It is used for the rapid evaluation of the trunk and neck area. It indicates “(1-7, a number score), Where “1-2” implies that the posture at work is acceptable. “An investigation and change are needed at 3-4. “4-5” indicates an investigation and change are required at 4-. “7” indicates an investigation and immediate change are needed. (McAtamney & Corlett, 1993).

REBA (Rapid Entire Body Analysis): It is employed for the assessment of the posture of the neck, upper limb (forearm, arm, wrist), trunk, and lower extremities. It indicates “5” levels from negligible risk level to very high-risk level (Hignett & McAtamney, 2000).

3.2. Behavior Measures

The ethnographic research method was used to analyze the workplace participants’ behavior. It is a detailed and in-depth analysis method in which researchers observe and interact (Interview & survey), combining them with participants in their real-life working environment (Srivastava, 2004). Observation and interview methodology were used for data collection. Participants were approached to fill out the survey questionnaire as given in the appendix. The survey questionnaire is prepared with the help of Designers and experts in this particular field. 5-point Likert scale is used to get the survey data (Joshi et al., 2015). Every statement is tailored by choices of responses that compare to how you feel about that statement.

3.3. Sample Collection

Sample: The study was conducted at Delhi Technological University, Delhi. The study involved 15 (Head of Department, Professors) participants with an average age of 51.46 years, an average height of 168.99cm, an Average weight of 78.26 kg, and an average work experience of 26.86 years. The head of the Department was chosen as a sample because they are the most responsible person and simultaneously performs both the responsibilities as a professor (Teaching, Academic) and as a HOD (Administrative work).

Attainment of Data: Data was collected in a real-life working environment in the same temperature and light conditions. The following steps were followed for the attainment of Data:

Step 1: Inform the participants about the research. This study aims to build confidence and trust between them before beginning the ethnographic study and physical data collection for the quality and credibility of the data.

Step 2: For collecting the physical data, the video was recorded at their workplace during working hours to record their body posture and how much time participants spent at one body posture and one workplace, as shown in **Figures 2, Figure 3 and Figure 4.**

Step 3: The Whole video was clipped into screenshots to analyze participants' posture at the workplace. These clipped images were used to analyze to fill RULA and REBA scores.

Step 4: Full body posture assessment (neck, upper limbs (forearm, arm, and wrist), trunk, and lower extremities) REBA method and for upper limb assessment RULA method used as shown in **appendix 2 and appendix 3.**

Step 5: Ethnographic (Observation and interview) methods were conducted to explore the issues related to the workplace and how it affects participants' behavior. Every participant was asked to fill out the survey questionnaire, as shown in **appendix 1.**

Step 6: Correlation analysis was performed between physical ergonomics and human behavior factors to find the relationship between them to find how human behavior changes due to poor physical posture at the workplace.

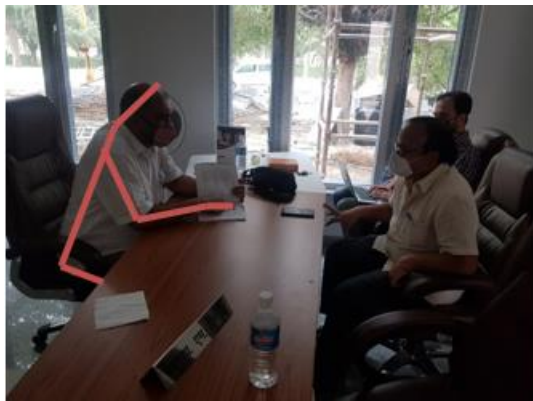


Figure 2: Adopted Body posture during discussion with colleague.



Figure 3: Adopted body posture during taking online classes.

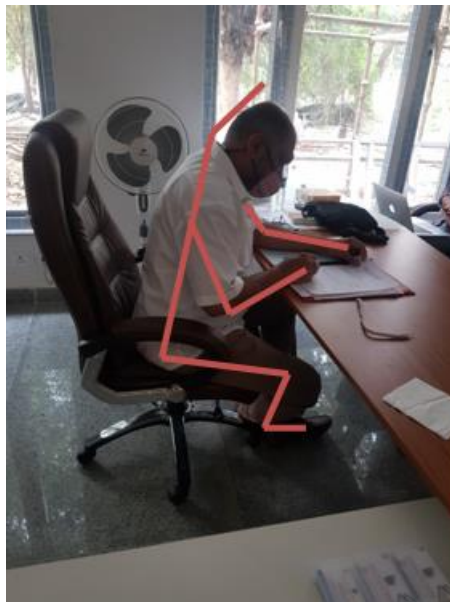


Figure 4: Adopted body posture during administrative work.

4. Result and discussion

As a result of using the methods described previously, the following results were obtained.

4.1. Physical Ergonomic Analysis

RULA method was utilized for upper limb assessment; Table 1 shows the RULA level, RULA score, and level of MSD risk. If RULA score is between 1-2, then level of risk is negligible if the score is between 3-4, Low-risk level. If the score is between 5-6, medium risk level, and if the score is 7, High-risk level (McAtamney & Corlett, 1993).

Table 1: Classification of level of risk under RULA Levels and score (McAtamney, L., & Corlett, E. N. (1993).

RULA Level	RULA Score	Level of MSD risk	Action
0	1-2	Negligible Risk	Acceptable
1	3-4	Low Risk	Investigate further
2	5-6	Medium Risk	Investigate further and change soon
3	7	High Risk	Investigate and change immediately

Figure 5 shows that none of the participants had negligible and low MSD risk levels. 40% of participants are at the high-risk level and urgently need an investigation and change immediately, while 60% of participants at a medium level of risk need further research and change soon.

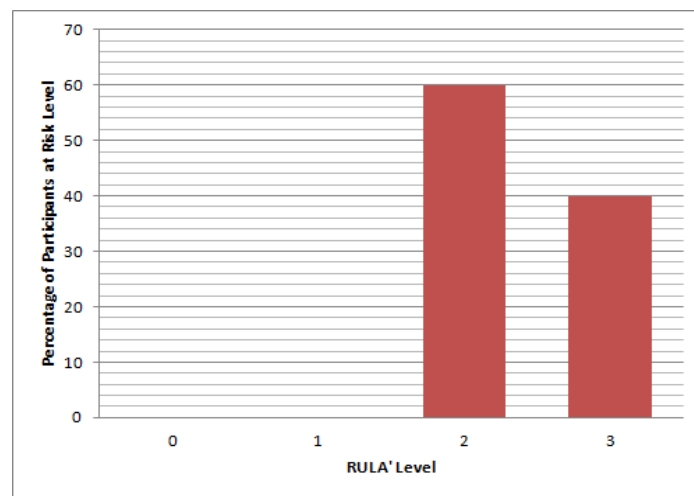


Figure 5: Participant's percentage under RULA level.

REBA method was utilized for upper limb assessment. Table 2 shows REBA levels, scores, and the level of MSD risk. If REBA score is lying at 1, then the level of risk is negligible; if the score is between 2-3, then Low-risk level. If the score is between 4-7, medium risk level, and if the score is between 8-10, High-risk level. If the score is between 11-15, very high-risk level (Hignett & McAtamney, 2000).

Table 2: Classification of the level of risk under REBA Levels and score (Hignett & McAtamney, 2000).

REBA Level	REBA Score	Level of MSD risk	Required action
0	1	Negligible	None Necessary
1	2-3	Low	May be necessary
2	4-7	Medium	Necessary
3	8-10	High	Necessary soon
4	11-15	Very High	Necessary now

Figure 6 shows that none of the participants were at negligible, low, or Medium MSD risk levels. 33.33% of participants are at the level of high MSD risk and urgently need necessary action soon, while 66.66% of participants at a very high level of MSD risk need essential action now.

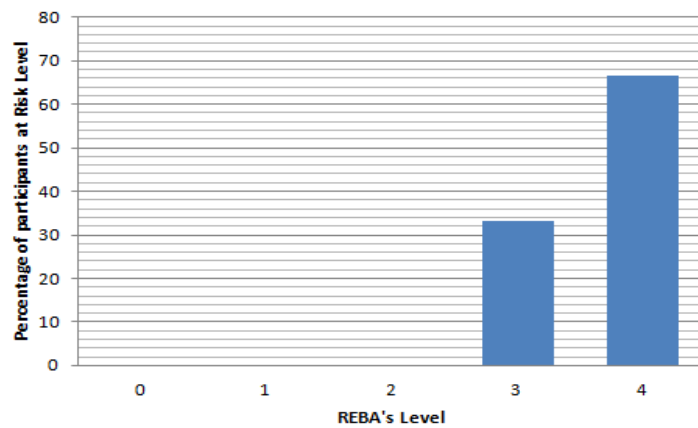


Figure 6: Participant’s percentage under REBA level.

4.2. Behavior Analysis

Ethnographic (Observation and interview) methods were conducted to explore the issues related to the workplace and how it affects participants’ behavior. A survey questionnaire consisting of 15 questions related to the workplace environment. Participants were suggested to rate on a Likert scale(1-5) (Joshi et at.,2015).

Table 3: Participant’s responses on 5 point Likert scale (Joshi et at., 2015).

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

4.3. Correlation between physical ergonomics and human behavior factors.

Correlation analysis was performed between physical ergonomics(RULA & REBA score) and human behavior (Survey response) factors to find the relationship between them. As shown in equation no 1, here r is Pearson’s correlation coefficient, and n is the sample size. x is the mean of physical ergonomics factors, and y is the mean of human behavior factors (Senthilnathan, 2019).

$$r_{xy} = \frac{n(\sum xy) - \sum x \sum y}{\sqrt{(n \sum x^2 - (\sum x)^2)(n \sum y^2 - (\sum y)^2)}} \dots \dots \dots (1)$$

Figure 7 shows the Linear Correlation between physical ergonomics (RULA & REBA) and human behavior (Survey Response) factors. Here X-dependent denotes the mean of physical ergonomics (RULA & REBA) factors, and Y-dependent denotes the mean of human behavior (Survey Response). The Pearson’s correlation coefficient (r) value is 0.5497. It shows that moderate positive relationship between the two factors.

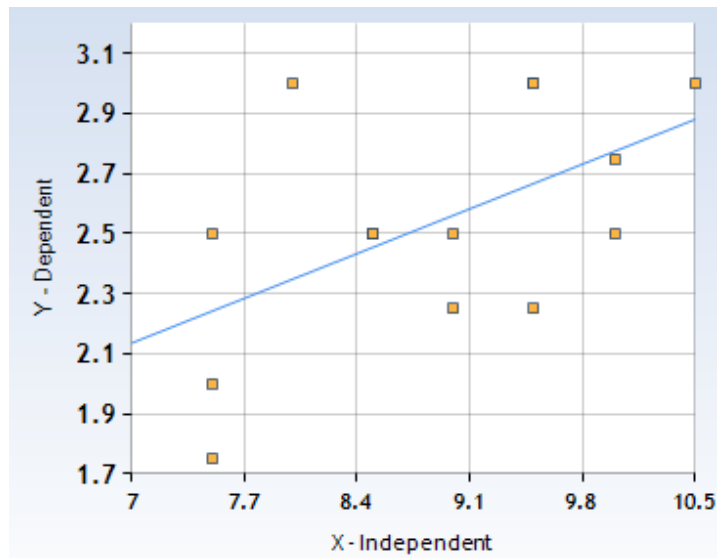


Figure 7: Linear Correlation physical ergonomics and human behavior variables.

It is found that workplace environment affects the physical ergonomics as well as the behavior of the employees those who are working under such environment conditions. There is a positive relation between Physical ergonomics and behavior, it means that if a person is physically not well in any workplace it will affect their behavior as well.

5. Conclusion

The workplace environment causes many physical and behavioral problems in the employees, which lead to a reduction in their performance due to MSD, repetitive strain injury, short-term memory, carpel tunnel syndrome, confusion, insomnia, anxiety, anger, etc. It is necessary for an institute/organization to measure the work-related physical and behavioral changes among their employees and should adopt necessary actions to prevent such problems due to the workplace environment. Previously a lot of work has been done in the evaluation of physical ergonomics in the workplace; however, very little literature focuses on change in human behavior due to the workplace environment. Physical ergonomics uses RULA, REBA, and behavior analysis uses the ethnographic method. The results from RULA showed that 40% of participants have a high level of MSD risk, and from REBA, 66.66% of participants are suffering from a very high level of MSD risk. Finally, it concluded that a poor workplace environment causes the physical health and behavior of the employees. Physical and behavioral factors in any workplace have a positive relationship among them. Using this study, the organization can reduce such problems and improve the performance of its employees.

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Conflict of Interest

There is no conflict of interest.

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Appendix

Appendix 1: Ethnographic survey questionnaire

General information

Name:

Gender: Male Female

Age :.....

Qualification: Matriculation Intermediate Bachelor Masters MPhil PhD

Designation:

Department:

Work Experience:.....

What is your brief job description?

.....

Question 1: Daily work experience at your workplace?

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
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Question 2: The working environment at your workplace is quiet?

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
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Question 3: The workspace has numerous noise interruptions?

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
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Question 4: Is the furniture adjustable, safe, and comfortable for long working hours?

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
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Question 5: The workspace has enough space for ordinary requirements(Body Movements, Storage, etc.)

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
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Question 6: What adequate measure of natural light comes at your workplace?

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
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Question 7: The workplace fulfills multi-functions for regular meetings.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
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Question 8: Does the workplace have sufficient windows to ensure fresh air and natural lighting?

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
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Question 9: Can light, security, and emergency controls be in easy reach and be operated without pinching or twisting of the wrist?

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
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Question 10: DO you feel overburdened with your responsibilities (Teaching + administrative) due to this COVID-19 pandemic?

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
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Question 11: Do you feel your work environment affects your health?

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
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Question 12:Do you feel that your staff and colleagues are well supportive?

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
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Question 13: Do you agree that you are getting a great career and professional growth opportunity?

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
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Question 14: Do you feel individual differences(Gender, designation, etc.) are well-valued at your workplace?

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
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Question 15: Are you satisfied with the work culture of your workplace?

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
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Appendix 2: RULA assessment worksheet

Arm & Wrist Analysis		Neck, Trunk & Leg Analysis	
Step 1: Locate Upper Arm Position: 	Upper Arm 2 Upper Arm Adjustment 2	Step 9: Locate Neck Position: 	Neck 3 Neck Adjustment 1
Step 2: Locate Lower Arm Position: 	Lower Arm 2 Lower Arm Adjustment 1	Step 10: Locate Trunk Position: 	Trunk 3 Trunk Adjustment 0
Step 3: Locate Wrist Position: 	Wrist 3 Wrist Adjustment 1	Wrist Twist 2	Legs 1
Arm Muscle Use 1	Force Load Score A 1	Upper Body Muscle Use 1	Force Load Score B 1
Final Score		7	

Appendix 3: REBA assessment worksheet

A. Neck, Trunk and Leg Analysis

REBA Assessment Worksheet

Trunk 2 + **Load/Force** 2 = **6**
Neck 1 + **Activity** 2 = **3**
Legs 3 + **Activity** 2 = **5**
Upper Arm 4 + **Lower Arm** 1 = **5**
Wrist 2 + **Activity** 2 = **4**
Table A 4 + **Table B** 5 = **9**
Table C 8 + **Activity** 2 = **10**
REBA Score 10

Adjust...
 If shoulder is raised: +1
 If upper arm is abducted: -1
 If arm is supported or person is leaning: -1