INVESTIGATION OF THE NEED OF ERGONOMIC INTERVENTION IN THE ENGINEERING DESIGN OF SPADE USING RULA/REBA TECHNIQUE

Sandeep Singh Kharb[1*], R.M. Belokar[2], Suman Kant[3]

[1, 2, 3]*Production and Industrial Engineering Department*

Punjab Engineering College (Deemed to be University),Chandigarh, 160012, India)

[*]Corresponding author

ABSTRACT

Agriculture consists of high labour intensive activities and use of manual tools make it even more tough and complex for the farmers. hence, musculoskeletal disorders (MSDs) are very common occupational issues in India. in the present study, postural analysis tools rapid upper limb assessment (RULA) was implemented to study level of discomfort while performing the different activities in the agricultural field using manual farm tool (spade) i.e. preparation of water channel for irrigation, seed bed preparation etc. Hence, it was concluded from the study that workers perform these activities under very high risk of postural discomfort which may lead to musculoskeletal ailments to the workers. Study indicated the immediate need of ergonomic intervention to improve the design of spade for the safety of workers and also to enhance the working efficiency of the workers.

Key Words: *RULA, MSDs, ergonomics, agricultural activities.*

1. INTRODUCTION

Agriculture sector plays crucial role in development of country. Agriculture employs majority of workforce all over the world [1]. In India, agriculture provides the employment to 225 million workers to cover the 140 million hectare of total available cultivating land [2], whereas all over the world agriculture employs the half world's entire working population [3]. In recent past decades, mechanization increased substantially in the agricultural sector in north India. But still so many agricultural activities are performed with the help of manual farm hand tools (Spade and sickle etc.). Small agricultural land owner are also not able to afford the highly automatic and developed agricultural machinery, which compels the workers to perform the rigours activities manually such as weeding and planting etc. Still in India, hoe (spade or locally known as Kodali or Phaora) is a basic manual farm hand tool, which has a predominant place in farming, civil construction and forestry work. This versatile is useful to perform many farm activities, e.g., seedbed preparation, ridge making, bund trimming and making drainage for irrigation. It is also helpful to remove plant roots, cutting turf and harvesting root crops [4]. Farmers indulged in highly laborious activities (agricultural activities) are exposed to multitude risky factors of MSDs. Researchers prioritized various factors to cause MSDs such as lifting, carrying heavy load (exceeding 50 lbs), sustained/repeated body bending (stooping) and highly repetitive activities (hand or leg work) [5; 6; 7; 8]. Many researchers have consistently identified and reported a number of injuries and illness in agriculture

through epidemiological and community based- researches. These included musculoskeletal disorders, respiratory diseases, noise-induced hearing loss, pesticides related issue and enhanced cases of cancer [9; 10; 11; 12; 13; 14].

2. METHODS

2.1 SUBJECT SELECTION

For the present study, volunteer participants were informed about the goal of research. Then, participants were observed not having any injury & musculoskeletal issue. After receiving of written consent from the participant for the participation, then only the worker was selected as the subject.

2.2 PROCEDURE

Before starting the land preparation activity using spade by the subject, subject was asked to be normal and not to feel any compulsion or stress to perform the task. Complete process was explained to the subject about the performance of activity and its video capturing for the further analysis. Subject was asked to start the activity and two minute video clip was capture in the sagittal plane as shown in Fig. 1.

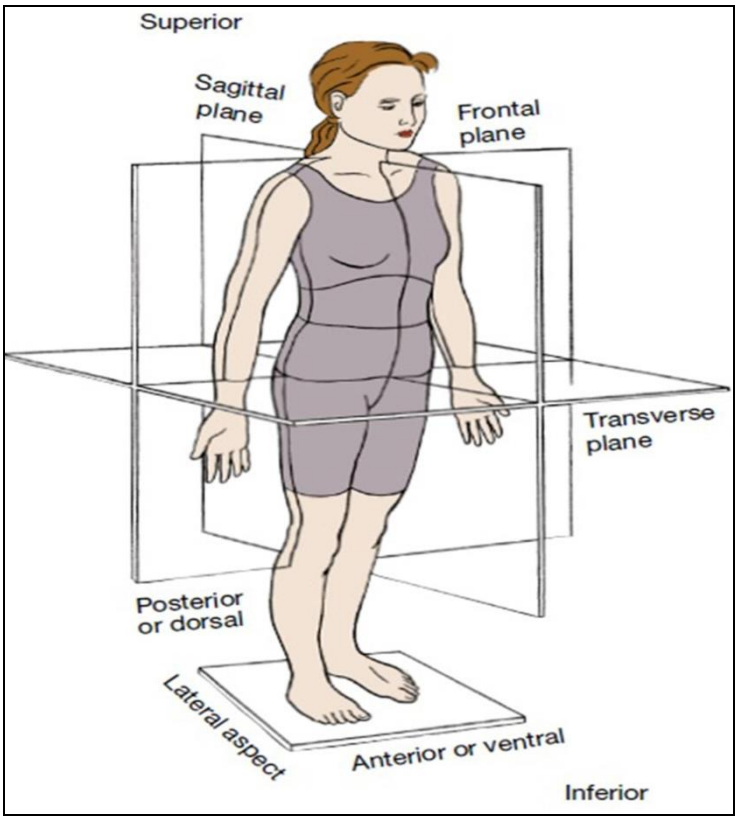


Figure 1 Different planes to present the postures of subject [Source: internet]

2.3 DATA ANALYSIS

Captured video was processed in the form of images and one image was selected to perform the analysis & to implement the RULA/REBA technique. All the procedural steps of RULA were followed and individual risk for

different body parts and risk score for the whole body was calculated to know the need of ergonomic intervention.

3. RESULTS AND DISCUSSION

RULA worksheet used to find the risk score in activity (to know the chances of incident of injury or MSDs) is shown in appendix. Process of RULA implementation to find the risk score consisted of 15 steps [15]. Three Tables (Table-A, Table-B, Table-C shown in worksheet) were used to reach the final risk score to conclude the risk of happenings of musculoskeletal disorders to the worker. Sections were classified as A & B to follow all the steps of RULA worksheet. The activity (land preparation using spade) shown in Fig. 2 was considered for the present study. Steps discussed below were used to reach the risk factor:

Section A: consisted of the analysis of arm and wrist

Step 1: +2 score was assigned to upper arm position (angle of upper arm lying at <45°)

Step 2: +2 score was given to the lower arm (position lying at < 60°).

Step 3: risk score for the wrist was given as +2 due to wrist flexion (< 15°) and +1 score was added due to ulnar deviation of wrist. So step 3 score became as +3 (+2 +1 = +3).

Step 4: +1 score added due to twisting of wrist.

Figure 2 Water channel preparation using spade for irrigation in the field

Step 5: in the Table A (shown in RULA worksheet) each score step 1 to step 4 was used to find the posture score-A. Which was found as 3.

Step 6: +1 muscle score was added to the posture score-A (Step 5 = +3), because activity occurs repeatedly in 4 times per minute. Hence, total wrist score reached to 4 (posture score-A 3 + 1 muscle score).

Step 7: weight of spade was measure as 2.2 to 2.5 kg (5.28-6 lbs). Hence load score for the repetitive activity was taken as +2 (Total score till step 7 = +4 + 2 = **+6**).

Step 8: the wrist and arm final risk score was calculated by Step 5 + step 6 + step 7, which was obtained as 6. This calculated score helped to observe the 6^{th} row in Table C.

Section B: consisted of the analysis of neck, trunk and leg.

Step 9: +4 risk was considered for the neck position (due to neck is extended in the posture Fig. 2).

Step 10: +4 score was assigned to trunk because trunk position lying at position greater than 60̊. Further +1 score was added due to the twisting of trunk while spading. Hence, score got +5.

Step 11: +1 score was assigned to legs, because worker can adjust the posture as per comfortability.

Step 12: By using the value of step 9 -11, located the calculated score in Table-B. Hence, from posture score from the Table-B was found as 7.

Step 13: muscle score (+1) is added to the posture score-B (+7).

Step 14: Load score was considered as +2, because of repetitive activity (more than 4 times per minute) is performed by spade (5.28-6 lbs).

Step 15: By adding the value of step 12-14 (7+1+2 = 10). Now this calculated score was used to locate the column in Table-C. Hence, step 8 and step 15 collectively used to identify final score from Table-C, Which was found as 7.

Final RULA score is found as 7 indicated the very high risk which may cause the MSD ailments to the agricultural workers. Risk level and action needed is represented by Table 1 shown below.

Table 1 Risk level and intervention requirement classification under RULA sheet

RULA level	0	1	2	3
RULA score	1-2	3-4	5-6	7
Risk level	Negligible	Low	Medium	High
Intervention required	**Acceptable**	**Investigate further**	**Investigate & change soon**	**Investigate & change immediately**

4. CONCLUSION

The body posture of worker has been evaluated for the agricultural activity while using spade in the field. by RULA (ergonomics tool). It can be concluded from the above results (RULA score 7), workers are performing the activities in uncomfortable and hazardous posture. Which can cause the serious musculoskeletal ailments to the agricultural workers and also will reduce the productivity & performance of the workers. The RULA score is obtained at very high risk (Table 1). Hence, there is immediate need of an ergonomic intervention to improve the engineering design of spade with the proper knowledge and awareness of health issues on comfort posture to simplify the activity & to reduce the MSD ailments.

REFERENCES

[1] Mohan, D., Patel, R., 1992. "Design of safer agricultural equipment: Application of ergonomics and epidemiology". International Journal of Industrial Ergonomics 10, 301-309.

[2] Nag, P.K., Nag, A., 2004. "Drudgery, accidents and injuries in Indian agriculture". Industrial Health, 42, 149-162.

[3] ILO, 2003. "Facts on agriculture". Retrieved on August 25, 2007, from: http://www.ilo.org.

[4] Nag, P.K., Pradhan, C.K., 1992. "Ergonomics in the hoeing operation". International Journal of Industrial Ergonomics 10, 341-350.

[5] Meyers, J.M., Miles, J.A., Faucett, J., Janowitz, I., Tejeda, T.G., Duraj, V., et al., 2000. "High risk tasks for musculoskeletal disorders in agricultural field work". In: Paper Presented at the IEA 2000/HFES 2000 Congress, San Diego, CA.

[6] Meyers, J.M., Miles, J.A., Faucett, J., Janowitz, I., Tejeda, T.G., Kabashima, J.N., 1997. "Ergonomics in agriculture: workplace priority setting in the nursery industry". Am. Ind. Hyg. Assoc. J. 58 (2), 121-126.

[7] Meyers, J.M., Miles, J.A., Faucett, J., Janowitz, I., Tejeda, T.G., Weber, E., et al., 2001. "Priority risk factors for back injury in agricultural Field work: vineyard". Ergonomics. J. Agromed. 8 (1), 37-52.

[8] Fathallah, F.A, 2010. "Musculoskeletal disorders in labor-intensive agriculture". Applied Ergonomics, 41, 738-743.

[9] Arcury, T.A., Quandt, S.A., 2003. "Pesticides at work and at home: exposure of migrant farmworkers". Lancet 362 (9400), 2021.

[10] Arcury, T.A., Quandt, S.A., Russell, G.B., 2002. "Pesticide safety among farm workers: perceived risk and perceived control as factors reflecting environmental justice". Environ. Health Perspect. 110 (Suppl. 2), 233-240.

[11] Earle-Richardson, G., Jenkins, P.L., Slingerland, D.T., Mason, C., Miles, M., May, J.J., 2003. "Occupational injury and illness among migrant and seasonal farm workers in New York State and Pennsylvania, 1997-1999: pilot study of a new surveillance method". Am. J. Ind. Med. 44 (1), 37-45.

[12] Kirkhorn, S.R., Schenker, M.B., 2002. "Current health effects of agricultural work: respiratory disease, cancer, reproductive effects, musculoskeletal injuries, and pesticide-related illnesses". J. Agric. Saf. Health 8 (2), 199-214.

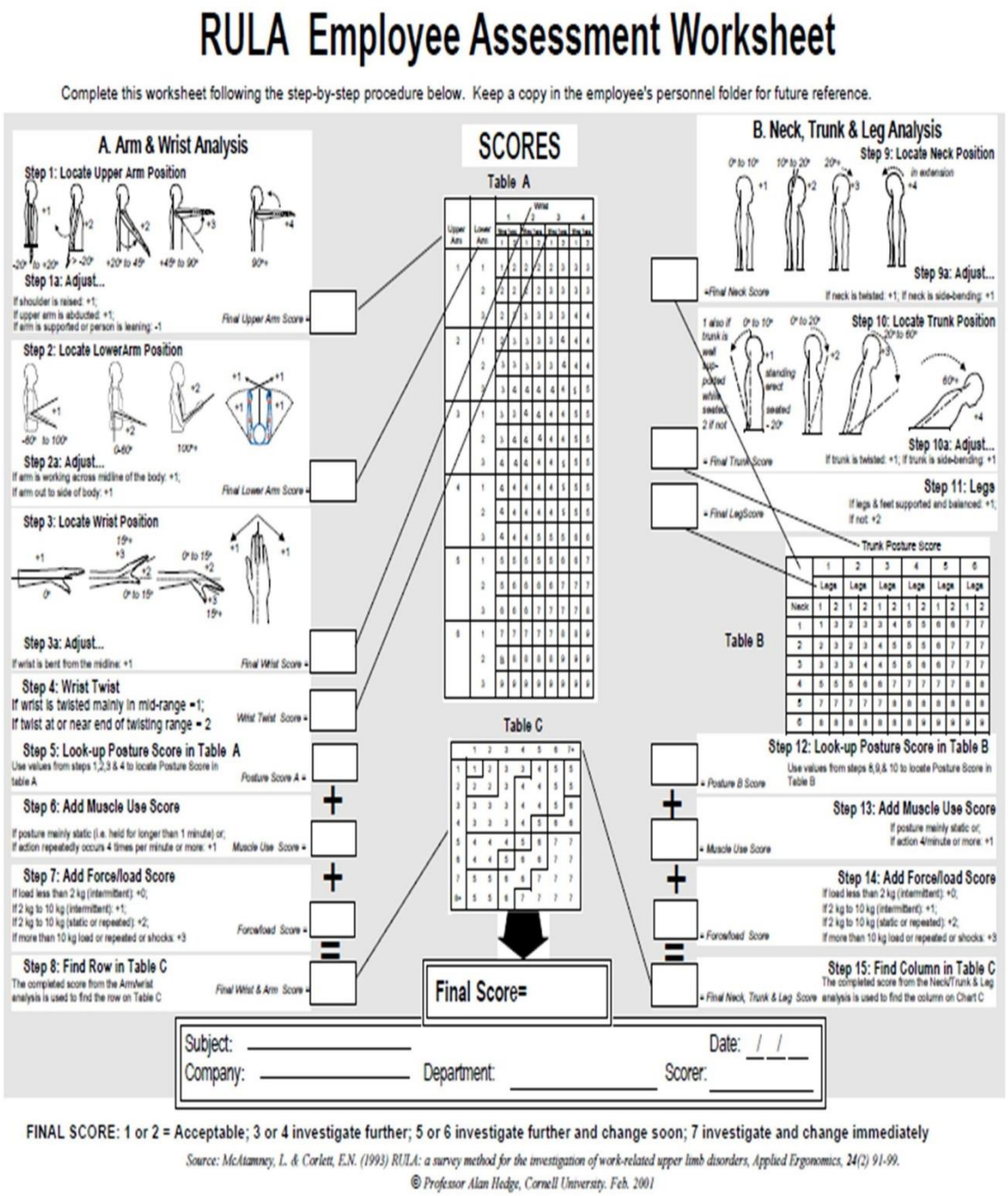
[13] McCurdy, S.A., Samuels, S.J., Carroll, D.J., Beaumont, J.J., Morrin, L.A., 2003. "Agricultural injury in California migrant Hispanic farm workers". Am. J. Ind. Med. 44 (3), 225-235.

[14] Rautiainen, R.H., Reynolds, S.J., 2002. "Mortality and morbidity in agriculture in the United States". J. Agric. Saf. Health 8 (3), 259-276.

[15] Ansari, N.A., Sheikh, M.J., 2014. "Evaluation of work posture by RULA & REBA: A case study". IOSR Journal of Mechanical and Civil Engineering (IOSR- JMCE), 4 (11), 18-23.

[16] Hignett, S., McAtamney, L., 2000. "REBA: A Survey Method for the Investigation of Work-Related Upper Limb Disorders". Applied Ergonomics, 2000.

APPENDIX



Source: [16]