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Work posture load evaluation in medium size metal processing enterprise in Latvia

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Abstract. The aim of this study was to evaluate the exposure of individual workers to ergonomic risk factors associated with upper, lower extremities and trunk WRMSDs and to assess entire body posture for risk of WRMSDs. The company that produces finished metal products (ironing boards) was chosen for the research. Rapid Entire Body Assessment (REBA) was used to assess the entire body posture for risk of WRMSDs. Rapid Upper Limb Assessment (RULA) method was used for ironing boards employees to evaluate exposure of the neck, trunk, arms and legs in relation to physical load. Our study proved that employees are subjected to WRMSDs due to the load on certain body parts during the work: shoulder and neck area, lower back, legs and arms. Forced work postures are an essential risk factor at work. Assemblers and packers are subdued to high risk level, but inspectors – to medium risk level, which corresponds to evaluation with RULA and REBA methods.

Key words: ergonomics, RULA, REBA, work posture, physical load.

INTRODUCTION

In Latvia manufacturing industry, which employs approximately 14% of the total population, has been rapidly developing over the past 10 years. At the same time, the number of work-related musculoskeletal disorders (WRMSD) has increased. The literature analysis shows that employees in many industries, including manufacturing industry, are exposed to manual handling and forced labour positions. Forced labour positions are the most common ergonomic risk factor in this branch (Huisstede et al., 2006; Hoy, 2012).

Forced labour positions can be very different – standing, sitting, squatting, bending down, and stretching. They can be awkward or strained, particularly when performing precise tasks which require application of strength as well (Guidelines for Manual Handling at Workplace, 2018).

In such cases, the spinal column in the area of the neck and chest is bent, shoulders are slightly raised and expanded, which in a long-term period unfavourably affect health of the workers. Due to it, disability, sick leave, and early retirement are increasing (Keogh et al., 2000; Costa-Black et al., 2010). Performing assembling in metal-working

processes, moving of heavy loads is rather often associated with their holding. WRMSDs, such as lower back pain, neck pain, and pain in the lower and upper extremities are the most common health disorders among those employed in the industry (Muggleton et al., 1999; Leclerc et al., 2001; Costa &Vieira, 2010; Hoy et al., 2012). Many authors in their research have proved that in the origin of WRMSDs not only ergonomic risks, but also psycho-social risks at work are of essential significance, which include employee's present health condition, mood, worries about somatic symptoms (Vargas-Prada et al., 2013), sleep disturbances, perception of pain, their age, gender, stress, support at work and work/life imbalance (Okunribido & Wynn, 2010; Eatough et al., 2012).

Ergonomic assessment of Work-Related Musculoskeletal Disorders involves the evaluation of the risk of developing a range of disorders in muscles, nerves and joints, primarily in the upper and lower limbs and lower back, associated with occupational tasks.

The aim of this study was to evaluate the exposure of individual workers to ergonomic risk factors associated with the upper and lower extremities and trunk, and to assess entire body posture for the risk of WRMSDs. The company that produces finished metal products (ironing boards) was chosen for the research. The study was approved by the Human Ethics and Institutional Review Board of University of Latvia in 2018.

MATERIALS AND METHODS

The objective research involved 7 workers, all females, employed in assembly of ironing boards, 7 workers from packaging of ironing boards and 7- from inspection staff for ironing boards. All workers did not have acute musculoskeletal disorders, all agreed to participate in the survey and in research. Demographic factors are shown in Table 1.

Table 1. Demographic factors of the research groups: mean age and range, mean height, mean weight, mean body mass index (BMI), standard deviation (SD).

Profession/Length of service (years)	n	Mean age ± SD	Range	Mean height, cm ± SD	Mean weight, kg ± SD	Mean BMI, kg m^{-1} ± SD
Assembly of ironing boards workers	7					
0–5	3	36.0 ± 14.1	23–54	170.3 ± 2.5	73.0 ± 4.6	25.2 ± 2.3
6–15	3	41.7 ± 5.7		175.0 ± 7.9	82.7 ± 6.7	27.8 ± 4.0
> 16	1	54		178	87	27.5
Packaging of ironing boards workers	7					
0–5	4	32.0 ± 10.7	22–53	170.8 ± 8.6	76.5 ± 10.1	26.2 ± 1.5
6–15	1	53		168	81	28.7
> 16	2	41.5 ± 3.5		167.5 ± 3.5	72.5 ± 6.4	25.9 ± 3.4
Inspection staff for ironing boards	7					
0–5	3	50.3 ± 7.1	39–58	171.0 ± 3.6	73.0 ± 4.6	24.9 ± 0.5
6–15	2	47.0 ± 11.3		166.5 ± 3.5	75.0 ± 7.1	27.1 ± 3.7
> 16	2	52.0 ± 4.2		170 ± 2.8	81.5 ± 6.4	28.2 ± 1.3

Work cycles contains various operations for each chosen profession in the research. Hence such work operations were analysed due to the fact that management and workers of the company indicated main uncomfortable and painful postures, fatigue levels and load on various body parts in the long term in assembly, packaging and inspection operations. Duties of assemblers of ironing boards are related with assembling of boards. Within a shift workers lift and move the assembled boards averagely 150 times. One board weighs 7.8 kg. During the work mainly arms, legs and back receive the load. Operations analysed for workers in packaging of ironing boards were: to take ironing boards of different size and weight off the platform, put them on the table and attach markers to them. Within a shift 380 ironing boards are lifted with hands taking them from platforms and placing them onto the working table. The average weight of an ironing board is 7.8 kg, the lightest being 5.8 kg, but the heaviest – 9.8 kg. Lifting and placing of ironing boards require the load on the muscles of legs, back and arms. Ironing board inspection staff operations involved visual assessment of the quality of the packed ironing boards. Slightly bending forwards with stretched arms the worker has to turn round the ironing board whose average weight is 5.8–9.8 kg. The work process involves arms, legs and back.

The work postures of assemblers, packers and inspection staff are represented in the Fig. 1.

Figure 1. Assemblers, packers and inspection staff in the working process.

Survey of the employees was carried out with a specially worked out questionnaire in order to find out their opinion about ergonomic risks at work, work load, and work postures. The following questions were included in this questionnaire: age, length of service, height, weight, smoking status, musculoskeletal disorders after work, physical activity in the leisure time, supervisor's support at work, colleagues' support, and work intensity. Smoking status was determined by the question: 'do you smoke or have you ever smoked?' with the four response alternatives: no, never (0); yes, but not anymore (1); yes, occasionally (2) and yes, every day (3). Musculoskeletal disorders after work in neck, shoulders, back, arms and legs were evaluated by assessing pain/discomfort intensity after the work. Pain/discomfort intensity was classified by participants as - no pain/discomfort, mild pain/discomfort, moderate pain/discomfort or severe pain/discomfort.

About leisure-time and physical activities the participants reported which of the following activity levels corresponded best to their own level: inactive (e.g., reading, watching TV, movies); some physical activity (e.g., bicycling, walking,); regular activity (e.g., running, gymnastics).

In order to evaluate the body posture and physical load on body parts both sides the Rapid Entire Body Assessment (REBA) was used to assess the entire body posture for risk of WRMSDs, but the Rapid Upper Limb Assessment (RULA) method was used for ironing boards employees to evaluate exposure of the neck, trunk, arms and legs in relation to physical load.

The Rapid Upper Limb Assessment (RULA) was developed earlier by Mc Atamney and Corlett (McAtamney & Corlett, 1993). The RULA ergonomic assessment tool considers biomechanical and postural load requirements of job tasks/demands on the neck, trunk, and upper extremities. This tool requires no special equipment in providing a quick assessment of postures of the neck, trunk and upper limbs along with muscle function and the external loads experienced by the body. After the data for each region was collected and scored, tables on the form were then used to compile the risk factor variables, generating a single score that represented the level of musculoskeletal disorders risk as outlined below (see Table 2).

Table 2. The classification of risks according to RULA

RULA Score	Risk level	Action (including further assessment)
1–2	(0) negligible risk	no action required
3–4	(1) low risk	change may be needed
5–6	(2) medium risk	further investigation, change soon
6+	(3) high	implement change now
	(4) very high risk	

REBA (Rapid Entire Body Assessment) was developed by Hignett and McAtamney (Hignett & McAtamney, 2000). REBA provides a quick and easy measure to assess a variety of working postures causing the risk of musculoskeletal disorders. It divides the body into sections to be coded independently, according to the movement planes and offers a scoring system for muscle activity throughout the entire body, stagnantly, dynamically, fast changing or in an unsteady way, and where manual handling may occur, which is referred to as a coupling score, as it is significant in the loads handling but may not always be using the hands. Postures of individual body parts are observed and postural scores increase when postures diverge from the neutral position. Group A includes trunk, neck, and legs, while group B includes upper and lower arms and wrists. Other items including the load handled, couplings with the load, and physical activity are specifically scored and then processed into a single combined risk score using a table provided. These scores are summed up to give one score for each observation, which can then be compared to tables stating the risk at five levels, leading to the necessity of actions.

REBA provides five action levels for estimating the risk level (Al Madani & Dababneh, 2016). These risk levels starting from 0 to 4 are corresponding to negligible, low, moderate, high and very high risk level respectively (see Table 3).

Table 3. The classification of risks according to REBA

Action level	REBA score	Risk level	Action (including further assessment)
0	1	(0) negligible	none necessary
1	2–3	(1) low	may be necessary
2	4–7	(2) medium	necessary
3	8–10	(3) high	necessary and soon
4	11–15	(4) very high	necessary and now

RESULTS AND DISCUSSION

The study involved 21 employees, all females, 16 of them having secondary education, but 5 – professional education. The younger employees recognised that they smoke averagely 10 cigarettes a day. They do it also during breaks. Fifteen of the employees were married, but 6 – single. None of the employees from the study do physical activities (swimming, gymnastics, etc.) after work. Only 57.1% of them recognised that they go to work by bicycle. As to feeling of pain/discomfort after work 66.7% of the employees pointed out that they felt pain/discomfort in the hands, legs and back, evaluating their level as moderate, but 33.3% of the employees of different age having length of service in the profession for 0–5 years, indicated that they did not feel pain/discomfort in individual parts of the body after work.

The acquired results assessing body postures with REBA method are shown in the Table 4.

Table 4. REBA method`s results, where count (n), standard deviation (SD)

Profession	n = 21	REBA score Mean ± SD	Risk level	Action
Assembly of ironing boards workers	7	4 = 8p 2 = 9p 1 = 7p 8.1 ± 0.7	3 high	necessary and soon
Packaging of ironing boards workers	7	3 = 9p 2 = 10p 2 = 10p 9.6 ± 0.5	3 high	necessary and soon
Inspection staff for ironing boards	7	5 = 6p 2 = 5 5.7 ± 0.5	2 medium	necessary

Assessing body conditions by REBA method it should be concluded that assemblers and packers are subdued to 3rd risk level, i.e. high risk level, but inspectors – to the medium risk.

Acquired results assessing the load of the upper parts of the body during work with RULA method are shown in the Table 5.

Table 5. RULA method`s results, where count (n), standard deviation (SD)

Profession	n = 21	RULA score Mean ± SD	Risk level	Action
Assembly of ironing boards workers	7	3 = 7p 2 = 6p 2 = 8p 7.0 ± 0.8	3 high	implement change now
Packaging of ironing boards workers	7	2 = 9p 3 = 8p 2 = 7p 8.0 ± 0.8	3 high	implement change now
Inspection staff for ironing boards	7	4 = 6p 3 = 5p 5.6 ± 0.5	2 medium	further investigation, change soon

Assessing work postures with RULA method, it should be concluded that assemblers and packers are subdued to high risk level, but inspectors – to medium risk level, which corresponds to evaluation with REBA method as well.

During the study it was observed that board assemblers use 5–10 seconds for one work operation. In this time the body takes posture bent at 10–25 degrees. The load goes to hands, legs and shoulder girdle. Within a shift the body is situated in this posture averagely for 40–45 minutes. As to board packers, during the work more load is received by the lower back and arms. During a work operation the lower back is bent at 10–25-degree angle from the vertical position. This lasts averagely for 10 seconds and within a shift it makes up 38–45 minutes. Assessing body postures in board inspectors it was found out that basically during the work the lower back, arms and shoulder girdle are loaded. The employees work in bent position (the inclination angle from the vertical is 10–25 degrees and the process lasts averagely 55–60 minutes per shift).

The results of our study correspond with those of the study on workers' postures in a car production enterprise, in which applying RULA and REBA method it was proved that the workers are under moderate to high risk of Work-related Musculoskeletal disorders (Qutubuddin et al., 2013). In other studies, for example, in the study of craftsmen's WRMSDs it is also pointed out that during the work employees' back, shoulder girdle, upper extremities and legs are loaded. It is promoted by work in forced postures, repeated and frequent body movements, age, length of service in the profession and psychosocial risks (Das et al., 2018). Our study proved that forced work postures are an essential risk factor at work and employees are subjected to WRMSDs due to the load on certain body parts during the work: shoulder and neck area, lower back, legs and arms. Main recommendations to reduce workload can be suggested by changing work tasks, meaning that the employee should work half a day at the assembling workplace and the other half, for example, at packaging workplace. It is currently being used partly already as workers are changing operations with ironing board packing and inspecting workplace, but in many these cases hard work is being replaced by hard work again. Hence additional measures are necessary. For example, workstations are recommended

to be adjustable, especially the work surface to worker`s height. Also different types of work chairs for changing work positions are recommended as well as the height of the shelf placement for all employees should be adjusted in order to assure comfortable reaching positions. During the rest breaks employees are recommended to perform muscle (lumbar, shoulder, neck) and stretching exercises to help avoid occupational diseases.

CONCLUSIONS

The chosen research methods proved that employees of an enterprise, related with the load and posture at work, are subjected to high and moderate risk according to RULA and REBA research methods. The study will be continued paying attention to psychosocial risks at work, including a bigger group in the study and use of objective research methods.

REFERENCES

Al Madani, D. & Dababneh, A. 2016. Rapid Entire Body Assessment: A Literature Review. *American Journal of Engineering and Applied Sciences* **9**(1), 107.118.

Costa-Black, K.M., Loisel, P., Anema, J.R. & Pransky, G. 2010. Back pain and work. *Best Pract Res Clin Rheumatol.* **24**(2), 227–40.

Da Costa, B.R. & Vieira, E.R. 2010. Risk factors for work-related musculoskeletal disorders: A systematic review of recent longitudinal studies. *Am J Ind Med*. **53**(3), 285–323.

Das, D., Kumar, A. & Sharma, M. 2018. A systematic review of work-related musculoskeletal disorders among handicraft workers. *International Journal of Occupational Safety and Ergonomics*. Published online: https://doi.org/10.1080/10803548.2018.1458487 Accessed 12.12.2018.

Eatough, E.M., Way, J.D. & Chang, C.H. 2012. Understanding the link between psychosocial work stressors and work-related musculoskeletal complaints. *Applied Ergonomics* **43**(3), 554–63.

Guidelines for Manual Handling at Workplace. 2018. Department of Occupational Safety and Health Ministry of Human Resources. Malaysia, 90 pp. http://www.dosh.gov.my/index.php/en/competent-person-form/occupational-health/guidelines/ergonomic/2959-guidelines-for-manual-handling-at-workplace-2018/file Accessed 07.11.2018

Hignett, S. & McAtamney, L. 2000. Technical note Rapid Entire Body Assessment (REBA). *Applied Ergonomics* **31**. 201–205.

Hoy, D., Bain, C., Williams, G., March, L., Brooks, P., Blyth, F., Woolf, A., Vos, T. & Buchbinder, R.2012. A systematic review of the global prevalence of low back pain. *Arthritis Rheum*. **64**(6), 2028–37.

Huisstede, B.M., Bierma-Zeinstra, S.M., Koes, B.W. & Verhaar, J.A. 2006. Incidence and prevalence of upper-extremity musculoskeletal disorders. A systematic appraisal of the literature. *BMC Musculoskeletal Disorder* 7, 7.

Keogh, J.P., Gucer, P.W., Gordon, J.L. & Nuwayhid, I. 2000. Patterns and predictors of employer risk-reduction activities (ERRAs) in response to a work-related upper extremity cumulative trauma disorder (UECTD): reports from workers' compensation claimants. *Am J Ind Med*. **38**(5), 489–497.

Leclerc, A., Landre, M.F., Chastang, J.F., Niedhammer, I. & Roquelaure, Y. 2001. The Study group on Repetitive Work. Upper-limb disorders in repetitive work. *Scand J Work Environ Health* **27**, 268–78.

McAtamney, L. & Corlett, N.E. 1993. RULA: a survey method for the irvestigation of world-related upper limb disorders. *Applied Ergonomics* **24**(2), 91–99.

Muggleton, J.M., Allen, R. & Chappell, P.H. 1999. Hand and arm injuries associated with repetitive manual work in industry: a review of disorders, risk factors and preventive measures. *Ergonomics* **42**, 714–39.

Okunribido, O. & Wynn, T. 2010. Ageing and Work-Related Musculoskeletal Disorders: A Review of the Recent Literature. UK, *Health and Safety Executive*, 50 pp.

Qutubuddin, S.M., Hebbal, S.S. & Kumar, A.C.S. 2013 Ergonomic Risk Assessment using Postural Analysis Tools in a Bus Body Building Unit. Industrial Engineering Letters. www.iiste.org (online) Accessed 15.12.2018.

Urquhart, D.M, Kelsall, H.L. & Sim, M.R. 2012. Ergonomic design and training for preventing work-related musculoskeletal disorders of the upper limb and neck in adults. Cochrane Database Syst Rev. Aug. **8**, CD008570. https://doi.org/10.1002/14651858.CD008570.pub2. Accessed 11.11.2018.

Vargas-Prada, S., Martínez, J.M., Coggon, D., Delclos, G., Benavides, F. G. & Serra, C. 2013. Health beliefs, low mood, and somatizing tendency: contribution to incidence and persistence of musculoskeletal pain with and without reported disability. *Scand J Work Environ Health*. **39**(6), 589–98.