Journal of
Health Science and Alternative Medicine

Original Article Open Access

Ergonomic Risk Level Assessment in Building Process at An Automobile Tire Manufacturing

Asanee Supooto[1], Prapamon Seeprasert[1], Anchalee Katramee[1*]

[1] *Occupational Health and Safety Program, School of Health Science, Mae Fah Luang University, THAILAND*

Received November 4, 2020
Accepted December 12, 2020
Published December 23, 2020

*Corresponding author: Anchalee Katramee, Department of Occupational Health and Safety, School of Health Science, Mae Fah Luang University, Thailand 57100

e-mail: anchalee.kat@mfu.ac.th

ABSTRACT

Background: Ergonomic problem among employees who are working in a workplace could induce the performance of employee in either positive or negative direction. Therefore, fixing ergonomic problems in a particular place could be improvement the productivity of a company. **Methods:** Ergonomic risk in the building process, automobile tire manufacturing at a plant in Rayong Province, Thailand were evaluated by using a cross-sectional study. The rapid entire body assessment (REBA) was used as a tool to detect the ergonomic risk and its levels among employees. **Results:** Five tasks or processes of work were found at risk index level 4 which were required immediate improvement or correction; i) pulling the raw cover out of the tire-forming machine, ii) peeling the tread, iii) changing the bead ring in the machine, iv) removing the raw rubber clog in the processing machine, called an extruder, and v) lifting the tread onto the tire building machine. Filling the steel grid with metal powder was found at risk level-3 which was required for further investigation and improvement. Lastly, at the department of the rubber sheet on softer steel called shin-gane was found at risk level 2 which was required to be investigated and continuously monitored. **Conclusion:** The findings of risk assessment from this study could be used for establishing the tire manufacturing safety measures or development a guideline to reduce the risk of ergonomic problems such as musculoskeletal disorders and enhance employees' performance.

Keywords: *Ergonomic; Tires; Building process; REBA method*

Introduction

Ergonomics is an inevitable problem in industries especially in the section of produce parts or large and heavy products like automobile tires. Manual labor is required to lift and move large objects during the production process. This may result in adverse effects or illness. Severe impacts on the health of the workforce can lead to musculoskeletal disorders [1]. The body structure is composed of muscles, joints, ligaments, nerves, bones, and local circulatory systems [2]. Musculoskeletal disorders are a work-related disease caused by assuming the long same position such as standing or sitting for long periods, reduced or no body movement, inadequate rest periods, lifting or moving heavy objects and twisting, bending, or tilting any part of the body when assuming an awkward posture [3]. The symptoms and severity of musculoskeletal disorders depend on the duration and frequency of workload exposure [4] and are expressed from mild to extreme pain. The Labor Force Survey (LFS) reported that disruption to the economy towards the end of 2020 due to the emergence of COVID-19 as a national health issue had the potential to have impacted on workplace injury and work-related ill health. Between 2019 and 2020, a total of 480,000 cases of work-related musculoskeletal disorders were reported throughout the whole Thailand, and it accounted for 1,420 per 100,000 workers [5]. In 2018, musculoskeletal disorders among informal employees related to work behavior were experienced at 43.4% or 1.4 million people [6,7] which was greatly reported among employees working in heavy manufacture.

An automotive tire manufacturing involves several manual operations including material processing, tire building, curing, inspection and storage. Hazard and risk assessment focus on the ergonomic issues in all these operational processes. Employees use different parts of their bodies to lift and move heavy tires. In particular, the tire-building process requires various components, and each has to be moved into the tire-building machine. The tire building machine employees have experience musculoskeletal disorders symptoms (MSDs) which are involving on having ache, pain or body discomfort during and after work. Most frequent report of MSDs are found in several points of body; the shoulder (76.4%), lower back (72.6%), and wrist or hand pain (62.8%) [1].

MDS affects physical health, mental health and work performance. The main impacts resulting from work-related musculoskeletal disorders are increased days off work, increased medical expenses and decreased productivity. The study of ergonomic risk level provides the necessary information for working process improvement through enhanced workstation design. Both proactive and passive control measures can be used to determine healthcare policies or work safety health promotions, with the ultimate goal of reducing fatigue, injury and musculoskeletal disorder by eliminating risk from improper work postures. Safety and well-being are basic human rights. Focusing on productivity or organizational profit is no longer the trend in modern industry that now recognizes the importance of the human resource. The promotion of health and safety at work will bring great benefits to any establishment, while also creating a good company image. This study assessed the ergonomic risk levels among employees working in the automobile tire-building process. The findings could be used for reducing the risk and improvement the performance of employees. Some specific guideline also could be developed to use in the similar settings.

Methods

A cross-sectional study was used to collect information from participants who were working in a tire manufacturing plant located in Rayong Province, Thailand between March and May 2020. Employees who were working in five departments were observed and assessed the risk; material preparation, tire-building, curing, product inspection and warehouse storage. At the tire-building process, it was focused ergonomic problems caused by exertion lifting characteristics and heavy tire movement during the tire-building process. Six of 18 workers were observed and recorded a video to assess the problem in later. Body posture was analyzed using a rapid entire body assessment (REBA) [8], which is one of the sensitive and specific of observational posture analysis ergonomic tools. The tool is used to assess an articular angle, observing the force load and movements' repetitiveness and the postural changes' frequency [8]. REBA divides the body position into segments and is coded independently according to movement planes. A scoring system is assigned for muscle activity throughout the entire body, stagnantly, dynamically, fast-changing, or in an unsteady way, where manual handling may occur [8]. Neck, trunk, legs, arms and wrist postures are assembled into ranges. Each positional range, corresponding to the anatomical areas assessed, is related to a score corresponding to the values that get increasingly higher as the distance from the segment's neutral position increase.

Measurement interpretation

Score "A" represents the summation of the posture scores for the neck, trunk and legs. The force or load score which is determine the load or force required to perform the task is added. Score "B" is the sum of the posture scores for arms, and wrists and the coupling score for each hand. The coupling score between 0-3 is added. The score at "0" when there is a well-fitting handle with mid-range power grip, "1" when acceptable but not ideal hand hold or coupling acceptable with another body part, "2" when and hold not acceptable but possible, and "3" if no handles, awkward, and unsafe with any part of body.

The "A" and "B" scores are combined and finally, an activity score that describes any static postures held for longer than one minute and repetition at more than four times per minute, large rapid changes in postures, or an unstable base which will be either "0" or "1" is added to give the final REBA score.

Then the REBA score has been converted into action levels between "0" and "4", which is defining whether action is required and its urgency [9] (Table 1).

Results

Employees worked in the tire-building process had different postures which could have diverse risks of injury from ergonomic problems while working in seven different tasks or processes as follows: i) pulling the raw cover out of the tire-forming machine, ii) peeling the tread, iii) changing the bead ring in the machine, iv) removing the raw rubber clog in the processing machine, called an extruder, v) lifting the

Table 1 Rapid entire body assessment action levels.

Action level	**REBA score**	**Risk level**	**Action** (Including further assessment)
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

Table 2. Rapid entire body assessment score for each of the seven tasks.

Task	Task characteristic	Posture	REBA score	REBA action level
No.1 Pulling the raw cover out of the tire-forming machine	Bending out the body to remove the raw cover from the tire-forming machine.		11	4
No.2 Peeling the tread	Bending over and reaching out with the arms to peel the tread, which is then placed on the top of a pallet on the floor.		11	4
No.3 Changing the bead ring in the machine	Bending the trunk and raising the legs as support during lifting the bead ring from the machine.		10	4
No.4 Removing the raw rubber clog in the extruder	Bending the trunk to remove the raw rubber clog in the machine, which is a batch process for mixing and heating.		8	4
No.5 Lifting the tread onto the tire building machine	Exerting wrist and arm to support the sheet tread onto the building machine.		8	4
No. 6 Filling the steel grid with metal powder	Standing and bowing head to fill the steel grid with metal powder.		4	3
No.7 Placing the rubber sheet on shin-gane	Bending and reaching out to place the rubber sheet on shin-gane.		3	2

steel grid with metal powder, and vii) placing the rubber sheet on softer steel called shin-gane. The REBA score of each task or process is shown in Table 2.

Five postures of work in seven tasks or processes in tire building were dentified in the ergonomic risk at level 4; i) pulling the raw cover out of the tire-forming machine, ii) peeling the tread, iii) changing the bead ring in the machine, iv) removing the raw rubber clog in the processing machine, called an extruder which is a batch process for mixing and heating, and v) lifting the tread towards the tire building machine. These indicated that many tasks or processes of work were required to be improved immediately.

A posture of work in the task or process of filling the steel grid with metal powder was found in having an ergonomic risk level 3 which was required future investigation and improvement. While the posture in task or process on bending and reaching out to place the rubber sheet on shin-gane was needed the action level 2 which was needed more attention.

Discussion and conclusion

The postures of work in seven tasks or processes in the tire building process are facing an ergonomic risk due to having improper postures which are violated the nature of the body such as bowing the head and trunk, reaching out with the arms and knee bending. Many important ergonomic risk factors were reported in the previous study, and indicated to remove and lift the threats from the stack; a) awkward postures by the leaning forward and lateral bending; overreaching and forceful exertion creates tension as well as discomfort at lower back and lower legs; b) body discomfort area including hand, wrist, arms, neck, shoulder, back and legs; c) tacky surface and weight of thread contribute to force loading to the body parts especially the wrist [1].

These postures can cause an injury, illness or physical pain to the employees. Previous findings were also reported that the ergonomic problems occurred by improper and repetitive work posture over long periods, together with heavy lifting exertion. Moreover, body stress could induce back pain with resultant musculoskeletal disorder [10].

We recommend the prevention measures to reduce the ergonomic risk in the tire building process as follows: i) use lifting equipment to raise heavy objects which will reduce exertion to within the body capabilities and eliminate work postures that violate natural muscle use, especially when pulling the raw cover out of the tire-forming machine and changing the bead ring during the task; ii) redesign the workstation to be high and appropriate for staff physique to prevent the need for bending over while working, especially during peeling the tread and filling the steel grid with metal powder; iii) apply a rubber mat to reduce fatigue from standing for long periods; iv) Adequate rest time should be provided to reduce fatigue during work; v) health promotion activities should be implemented such as exercises with proper posture before starting work, focusing on body parts that may become fatigued; vi) organize a campaign or train and educate employees to have more aware of the dangers of ergonomic risks and the importance of their health.

References

[1] Kamal BM, Syed SA. Assessment of ergonomic risk level at tire manufacturing plant in Petaling Jaya, Selangor. Journal of Advanced Research in Occupational Safety and Health. 2018; 2: 20-7.

[2] Agbor KHA. Work-related musculoskeketal deisorders amongst oral health workers in Cameroon. OHDM. 2016; 15(6):1-6.

[3] Damaj O, Fakhreddine M, Lahoud M, Hamzeh F. Implementing ergonomics in construction to improve work performance. In: Proc. 24th Ann. Conf. of the Int'l. Group for Lean Construction, Boston, MA, USA. 2016; sect.11: 53-62.

[4] Kumar S. Theories of musculoskeletal injury causation. ergonomics. 2001; 44(1): 17-47. DOI: 10.1080/00140130120716.

[5] Health and Safety Executive, Annual Statistics: Work related musculoskeletal disorder statistics (WRMSDs) in Great Britain. Available from: https://www.hse.gov.uk/statistics/

[6] Heng-Leng C, Krishna GR, Abherhame C. Ergonomic risk factors of work processes in the semiconductor industry in Peninsular Malaysia. Industrial health. 2004; 42:373-81.

[7] Kentawai W, Kongtawelert A, Sujirarat D, Bhuanantanondh P. Prevalence of musculoskeletal disorders among female pottery workers in Khiri Mat, Sukhothai Province, Thailand. Journal of Science and Technology Mahasarakham University. 2019; 38:282-91.

[8] Hignett S, McAtamney L. Rapid entire body assessment (REBA). Applied ergonomics. 2000; 31(2): 201-5. DOI: 10.1016/S0003-6870(99)00039-3.

[9] Madani DA, Dababneh A. Rapid entire body assessment: a literature review. American Journal of Engineering and Applied Sciences. 2016; 9(1):107-18. DOI: 10.3844/ajeassp.2016.107.118.

[10] Lasota AM. Reba-based analysis of packer's workload: a case study. Scientific Journal of Logistics. 2014; 10:87-95.