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Ergonomic Risk, Muscle Tension, Lactic Acid, and Work Performance on Transport Workers at Fish Auction

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ABSTRACT

One of the main occupations in fish auction facilities was transport worker. Manual handling activities are a leading cause of workplace injuries such as strains and back injuries. This study aims to analyze the association between ergonomic posture with muscle tension, lactic acid buildup, and work performance. This study was carried out in November 2020. The instruments in this study were portable electromyography, lactate analyzer, REBA Assessment sheet, and questionnaire. The analysis was performed with statistical test using Fisher Exact Test. This study is analytical survey research with cross-sectional study design with 51 respondents selected using convenience sampling method. Based on the data obtained, it was found that 36 respondents (70.59%) did not work ergonomically. The result of the analysis is that there is an association between ergonomic posture and muscle tension (p=0.000) and lactic acid buildup (p=0.002), but there is no association between ergonomic posture and work performance (p=0.761). It is necessary to improve the quality of fish auction facilities services by providing ergonomic transportation aids such as lifting trolleys and training related to the dangers of ergonomic risk factors at fish auction facilities.

INTRODUCTION

Indonesia is the biggest archipelago country in the world. The total area of Indonesia is around 7.81 million km^2. The total area of the ocean is 3.25 million km^2. Meanwhile, 2.55 million km^2 is the Exclusive Economic Zone, and about 2.01 million km^2 is islands. With the vast marine area, Indonesia has enormous marine and fishery potentials. Fisheries are one of the sectors that are relied upon for national development.[1]

In operational activities, the process of transporting fish from the pier to the fish auction facilities is assisted by transport workers operating around the port. After going to sea, fishermen land their cargo of fish at the dock, and transport workers help bring it to the fish auction facilities, fish market, or fish processing place.[2] Problems in transport workers are closely related to ergonomic problems. Ergonomics, according to the Occupational Safety and Health Administration (OSHA), is an association between humans and work environment that does not cause a disturbance. In conclusion, ergonomics means the occurrence of a healthy, safe, and convenient working environment for humans.[3] A combination of men, machine, and the environment should take into account the real capabilities of the person who work in the system.[4] Maintaining a physical workplace environment as ergonomic as possible can help employees to achieve higher performance.[5]

Transport workers do their work manually. Manual material handling is an activity or work in the handling or movement of materials carried out in a job manually. Activities in manual material handling include carrying, lifting, lowering, pushing, and pulling loads.[6] The recommended load for manual lifting from NIOSH Lifting Equation is 51 pounds (23 kg), which represents the maximum recommended load weight to be lifted under ideal conditions.[7] Loads that are too heavy can cause injury to the spine, muscle tissues, and joints due to excessive movement.[8] It is recommended to lift weights to 10 kg from knuckle to shoulder height at one lift per minute within acceptable limits.

Lifting weights with excessive bending can result in a higher spinal load and result in Low Back Pain (LBP).[9] Additionally, the study result by Antwi-Afari et al. shows that the increase in lifting load significantly increases electromyography activity.[10] Another abnormality is Muscle and Bone Disorders (MSD) such as back pain, tendonitis, herniated disc, and carpal tunnel syndrome. Gradual-onset injuries that usually occur after repeated micro-trauma to a specific body part can lead to cumulative trauma disorders.[11] Workers who are still growing and carry heavy loads are at high risk for bone damage and impaired growth.[12] However, the severity of the injury depends on several factors, such as the dependance on the duration, frequency, and/or magnitude of exposure to each.[13]

Fish Auction Facilities where the research is conducted is one of the biggest and most famous facilities on Java Island. The process of loading and unloading of fishing boats requires a lot of transport workers to be involved. Based on the pilot study, workers complained of dehydration, muscle aches in their limbs, and excessive fatigue. Muscle aches or pain are caused by metabolic waste such as lactic acid in muscles and extracellular fluids, irritating the ends of the sensory fibers.[14] In addition, workers also complained of muscle stiffness as a result of wrong working positions. Workers do not understand the correct working position for lifting and transporting and how to reduce/control work fatigue. A study showed a high-risk work posture associated with MSDs complaints.[15]

The previous explanation shows that the importance of the study is the possibility to identify ergonomic factors among transport workers at TPI. At the end of the article, there are efforts or recommendations to reduce ergonomic hazards. This study aimed to investigate the correlation between ergonomic posture with muscle tension, lactic acid buildup, and work performance.

MATERIAL AND METHOD

This cross-sectional, quantitative study was developed with transport workers in November 2020 at Fish Auction Facilities in Pati, Central Java. This study sample is the total population (n = 51). Samples of the population that are selected non-randomly in this way are termed convenience samples as they are easy to recruit. Transport workers who were present on site for job opportunities were included in the study. The independent variable is ergonomic posture. The dependent variable includes muscle tension, lactic acid buildup, and work performance.

The instrument to measure ergonomic posture in this study was Rapid Entire Body Assessment (REBA). REBA was used to assess and analyze posture. REBA is also extensively used to analyze lifting assignments. The value of REBA indicating low risk is 2-3, medium risk 4-7, and high 8-10. Observations were made by recording all worker activities to get their posture. Then, the video was cut within the framework of each job. The first step was the assessment of the body part belonging to group A (trunk, neck, legs) and group B (upper arm, lower arm, right wrist, and left wrist) added by a force/load score. Furthermore, the total score of group B was summed with the coupling/grip score. The total final value of groups A and B is score C. The scores of static postures and/or repetitive actions (more than four times per minute) or the change in posture faster in Table C were summed with activity scores to obtain the final value of REBA. Additionally, a lactate analyzer was used to measure lactic acid levels. Lactate levels were grouped into normal (≤ 2 mmol/L) and not normal (> 2 mmol/L). Lactate testing was performed directly after the respondents finished their work to get blood lactate concentrations during higher work rates.

Another instrument used was portable Electromyography (EMG) to measure muscle tension. EMG was used to display real-time muscle activity. EMG signal could be used to determine the muscle-fatigue conditions.[16] Surface EMG was recognized as an effective and useful tool to evaluate the appropriateness of therapy by providing reliable and unique information on biomechanical and musculoskeletal dysfunction. Surface EMG w commonly used to study the loading of the forearm. Muscle tension is classified as relaxed (≤ 3 microvolts) and not relaxed (>3 microvolts).

Work performance was measured using questionnaire. Work performance data were obtained from the results of self-assessment based on how many workers can afford to transport in a day. One aspect of work performance that can be calculated is quantity. The estimation used to judge quantity varies among industries. Quantity is the achievement of workers who have far exceeded the target or expectation.[17] In this study, workers who were able to transport more than 500 kg of fish were included in the high work performance category. Meanwhile, workers who transport fish less than 500 kg are categorized as having low work performance.

SPSS software was used to perform the statistical analyses. The data obtained were then analyzed using Fisher's Exact Test with a significance level of $p < 0.05$. The protocol of this study was approved by the Research Ethics Committee of the Faculty of Public Health, Diponegoro University, Number 16/EA/KEPK-FKM/2020. Written informed consent was obtained from all respondents.

RESULTS

The characteristics of all respondents in this study are shown in Table 1. A total of 51 transport workers were included in this study, and all of them were males. Based on the data obtained, it was found that 15 respondents worked with medium-risk of posture while 36 respondents (70.59%) worked in high-risk posture. Based on the level of lactic acid, 52.94% of the respondents had normal lactic acid levels.

Based on Table 2, it is known that 7 workers have ergonomic postures or 46.67% have relaxed muscle tension. Meanwhile, 8 workers have a medium risk of ergonomic postures or 53.33% have non-relaxed muscle tension. Online one worker has a high-risk ergonomic posture or 2.78% have relaxed muscle tension while 35 workers have high-risk postures or 97.22% have non-relaxed muscle tension. The results of the statistical test using the Fisher's Exact Test showed a significance value of 0.000 (< 0.05) which indicates that there is an association between ergonomic posture and muscle tension.

Table 1. Frequency Distribution of Ergonomics Posture, Muscle Tension, Lactic Acid Buildup, and Work Performance

Characteristics	n = 51	%
Ergonomic Posture		
Low Risk	0	0.00
Medium Risk	15	29.41
High Risk	36	70.59
Muscle Tension		
Relax	8	15.69
Not Relax	43	84.31
Lactic Acid Buildup		
Normal	27	52.94
Not Normal	24	47.06
Work Performance		
Low	19	37.25
High	32	62.75

Source: Primary Data, 2020

The result of statistical tests using Fisher's Exact showing a significance value of 0.002 (< 0.05) which indicates that there is an association between ergonomic posture and lactic acid buildup. Table 2 shows that more workers have ergonomic postures, namely 13 people, or 86.67% have normal lactic acid buildup, compared to 2 workers (13.33%) with ergonomic postures who have normal lactic acid buildup. Less than half of the workers have non-ergonomic postures, namely 14 (38.89%) with normal lactic acid buildup while 22 (61.11%) workers with non-ergonomic postures do not have normal lactic acid buildup.

Based on Table 2, it is known that most workers with good ergonomic postures have high work performance as many as 10 people (66.67%). Likewise, most workers with non-ergonomic work postures still have high work performance as many as 22 people (61.11%). The results of the statistical test obtained a significance value of 0.761 (> 0.05) which indicates that there is no association between ergonomic posture and work performance.

DISCUSSION

The current study findings showed an association between ergonomic posture and muscle tension (Table 2). In general, ergonomics can be defined as fitting a job to a person by adjusting work elements to the human body which is expected to make them work more efficiently and productively. In addition to the lack of tools in lifting and carrying activities for transport workers at fish auction facilities, inappropriate and repeated work positions contribute to muscle fatigue which in turn can result in musculoskeletal disorders including muscle injury and low back pain.[18] Heavy physical work, climatic factors, awkward postures, whole-body vibrations, slips, and falls, and working in a cold environment contribute to multifactorial back pain.[19] Transport workers at fish auction facilities work at night when cold temperatures can cause complaints of stiffness & lack of muscle coordination.[20] Work-related MSDs can be prevented using the ergonomic principle because it helps reduce muscle fatigue by reducing the workload on the muscles or improving the working postures to minimize awkward positions.[21]

One of the strategies to prevent complaints is to work using an assistive device. Improvements can be made by designing a tool such as trolleys to move materials easily and safely, thereby minimizing the number of material damage. In addition, trolleys can transport materials more effectively and efficiently. This strategy can also reduce musculoskeletal complaints, slow down the rate of fatigue, decrease cycle times, and ultimately increase overall productivity.[22,23]

Regarding the association between ergonomic posture and lactic acid buildup (Table 2), the finding of this study suggested an association. This is in line with the research by Yudisianto that there was a weak positive correlation between the work position and physical fatigue in the circular loom and jumbo bag sub units at PT X with a coefficient value of 0.354.[24] Complaints in the musculoskeletal system are influenced by the abnormal work of muscles as a result of an unnatural work attitude, the impact of which can cause muscle fatigue and pain or discomfort. Pressure on the soft tissue can block blood flow and result in reduced oxygen and carbon dioxide build-up and produce lactic acid waste. This situation leads to discomfort or pain sensation.[25]

Table 2. The Association Between Ergonomic Factors and Muscle Tension, Lactic Acid Buildup, Work Performance

Variable	Ergonomic Posture				Total		*p-value*
	Medium Risk		High Risk				
	n = 15	%	n = 36	%	n = 51	%	
Muscle Tension							
Relaxed	7	46.67	1	2.78	8	15.69	0.000
Not Relaxed	8	53.33	35	97.22	43	84.31	
Lactic Acid Buildup							
Normal	13	86.67	14	38.89	27	52.94	0.002
Not Normal	2	13.33	22	61.11	24	47.06	
Work Performance							
Low	5	33.33	14	38.89	19	37.25	0.761
High	10	66.67	22	61.11	32	62.75	

Source: Primary Data, 2020

The longer a job is, the less energy is produced, so there will be residual combustion in the form of lactic acid. Accumulation of lactic acid itself can be a biomarker of muscle fatigue. Glycolysis makes pyruvate production where, when pyruvate production exceeds the oxidation process, the pyruvate will turn into lactic acid which in turn reduces muscle power.[26] One of the ways to recover lactic acid levels is by stretching muscles or sitting for a while between working and recovering. Resting plays a key role to overcome fatigue. With resting, the body can get a supply of oxygen to oxidize lactic acid to pyruvic acid again.[27]

The results of this study revealed an association between ergonomic posture and work performance (Table 2). Findings from another study show that an increase in REBA scores will cause a decrease in the productivity of traditional coconut fiber peeler workers because of increased work fatigue due to a bad (non-ergonomic) working position.[28] Work performance can be a factor to determine work productivity. Ergonomically designed work positions, work equipment, and work areas aim to create a safe, comfortable work environment and are expected to improve work performance which leads to increased productivity.[29] An experimental study with an ergonomic factor intervention has shown a significant increase in productivity in the intervention group.[30] In this study, other factors that were not investigated could contribute to the work performance of the transport workers.

Ergonomic work position and work design as well as adequate rest time are also a form of prevention of Cumulative Trauma Disorders (CTDs) which is a common occupational disease in various fields of work. CTDs are MSDs that are formed due to repetitive physical movements, exceeding capacity with awkward postures from work activities, causing fatigue and getting worse due to lack of recovery time for the body, causing permanent injuries such as disorders of tendons and nerves.[31] Intervention with an improvement of working conditions and the combination of giving static stretching and McKenzie exercise can reduce physiological responses and increase work productivity in workers in the incense printing section.[32]

CONCLUSION AND RECOMMENDATION

This study contributes to the importance of controlling ergonomic risk factors in informal sectors. There is an association between ergonomic posture with muscle tension and lactic acid buildup in transport workers. It is recommended that management of TPI together with higher education propose potential strategies, education and training options, workplace design models, and specific manual handling equipment.

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AUTHOR CONTRIBUTIONS

Bina Kurniawan and Zen Rahfiluddin conceived and designed the experiments; Bina Kurniawan performed the experiments; Bina Kurniawan and Yuliani Setyaningsih analyzed the data; Nurjazuli contributed reagents and materials; Bina Kurniawan wrote the paper.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

REFERENCES

1. Pratama O. Konservasi Perairan Sebagai Upaya menjaga Potensi Kelautan dan Perikanan Indonesia. Jakarta: Direktorat Jenderal Pengelolaan Ruang Laut; 2020. [Report]. Available from: https://kkp.go.id/djprl/artikel/21045-konservasi-perairan-sebagai-upaya-menjaga-potensi-kelautan-dan-perikanan-indonesia.
2. Nadia RAN. Buruh Angkut dan Keluarga Nelayan di Pelabuhan Muara Angke. *Lembaran Sejarah.* 2017;12(1):44-58.
3. OSHA. Ergonomics: An Overview. Timber Products Manufacturers Association; 2018. Available from: https://www.osha.gov/sites/default/files/2018-12/fy14_sh-26336-sh4_Ergonomic-Overview-Handout.pdf.
4. Kurbonov R, Normurodov A. Role and Importance of Ergonomics in Providing Safety of Work. *Internation Journal on Orange*

Technologies. 2021;3(7):18–22.

5. Sheila AO. Effect of Ergonomic Factors on Employees Performance in Nigeria's Banking Sector. *European Journal of Business and Management.* 2020;12(23):86–98.
6. Susanti L, Zadry HR, Yuliandra B. *Pengantar Ergonomi Industri*. Padang: Andalas University Press; 2015.
7. ErgoPlus. A Step-by-Step Guide to Using the NIOSH Lifting Equation for Single Tasks; 2021. Available from: https://ergoplus.com/niosh-lifting-equation-single-task/.
8. Hutabarat Y. *Dasar-Dasar Pengetahuan Ergonomi*. Malang: Media Nusa Creative; 2017.
9. Mondal K, Majumdar D, Pal MS, et al. Association of Manual Weight Lifting Tasks with Low Back Pain: A Pilot Study. *Journal of Clinical and Diagnostic Research*. 2019;13(2):10-15.
10. Antwi-Afari MF, Li H, Edwards DJ, et al. Biomechanical Analysis of Risk Factors for Work-Related Musculoskeletal Disorders During Repetitive Lifting Task in Construction Workers. *Automation in Construction.* 2017;83(11):41–47.
11. UNC Institutional Integrity and Risk Management: Environment, Health and Safety University of North Carolina. What is an MSD?. Chapel Hill, NC: UNC Institutional Integrity and Risk Management: Environment, Health and Safety; 2022. Available from: https://ehs.unc.edu/ workplace-safety/ergonomics/medical/.
12. ILO. *Meningkatkan Keselamatan dan Kesehatan Pekerja Muda*. Jakarta: International Labour Organization; 2018.
13. IOWA State University Environmental Health and Safety. Risk Factors. Available from: https://www.ehs.iastate.edu/ services/occupational/ergonomics/risk-factors.
14. Zulaini, Harahap NS, Siregar NS, et al. Effect Stretching and Recovery on Delayed Onset Muscle Soreness (DOMS) After Exercise. *Journal of Physics: Conference Series*.
15. Yosineba TP, Bahar E, Adnindya MR. Risiko Ergonomi dan Keluhan Musculoskeletal Disorders (MSDs) pada Pengrajin Tenun di Palembang. *Jurnal Kedokteran dan Kesehatan Publikasi Ilmiah Fakultas Kedokteran Universitas Sriwijaya.* 2020; 7(1):60–66.
16. Liu SH, Lin CB, Chen Y, et al. An EMG Patch for the Real-Time Monitoring of Muscle-Fatigue Conditions During Exercise. *Sensors*. 2019;19(14):3108.
17. Mulyani S. Hubungan antara Kepuasan Kerja dan Usaha Karyawan dengan Performansi Kerja pada Karyawan Universitas Ahmad Dahlan. *Prosiding Seminar Nasional Peran Budaya Organisasi Terhadap Efktivitas dan Efisiensi Organisasi.* 2012;117–130.
18. Soares CO, Pereira BF, Pereira Gomes MV, et al. Preventive Factors Against Work-Related Musculoskeletal Disorders: Narrative Review. *Revista Brasileira de Medicina do Trabalho.* 2019;17(3):415–430.
19. Hartvigsen J, Hancock MJ, Kongsted A, et al. What Low Back Pain is an and Why We Need To Pay Attention. *The Lancet*. 2018; 391(10137):2356–2367.
20. Setyaningsih Y. *Higiene Lingkungan Industri*. Semarang: FKM Undip Press Universitas Diponegoro; 2018.
21. Lu L, Megahed FM, Cavuoto LA. Interventions to Mitigate Fatigue Induced by Physical Work: A Systematic Review of Research Quality and Levels of Evidence for Intervention Efficacy. *Human Factors*. 2021; 63(1):151–191.
22. Denny HM. *Kesehatan dan Keselamatan Kerja di Sektor Industri Kecil dan Informal*. Semarang: FKM Undip Press Universitas Diponegoro; 2017.
23. Radin Umar RZ, Ahmad N, Halim I, et al. Design and Development of an Ergonomic Trolley-Lifter for Sheet Metal Handling Task: A Preliminary Study. *Safety and Health at Work* 2019;10(3):327–335.
24. Yudisianto I, Tualeka AR, Widajati N. Correlation between Individual Characteristics and Work Position with Work Fatigue on Workers. *The Indonesian Journal of Occupational Safety and Health*. 2021;10(3):350.

25. Ayu I, Sri M, Ariati NN, et al. Improving Ergonomic Work Attitudes Reducing of Musculoskeletal Disorders, Workload and Increasing Work Productivity of Pande Besi in Gubug Village Tabanan, Bali-Indonesia. *Eastern Journal of Agricultural and Biological Sciences (EJABS)*. 2021;2(1):10–14.
26. Wan JJ, Qin Z, Wang PY, et al. Muscle Fatigue: General Understanding and Treatment. *Experimental & Molecular Medicine.* 2017; 49(10):384.
27. Hidayah I. Peningkatan Kadar Asam Laktat Dalam Darah Sesudah Bekerja. *The Indonesian Journal of Occupational Safety and Health.* 2018;7(2):131.
28. Umboh MK, Malonda NSH, Mende J. Analisis Pengaruh Posisi Ergonomis Dengan Metode Rapid Entire Body Assessment (REBA) Terhadap Produktivitas Kerja pada Pekerja Pengupas Serabut Kelapa Tradisional di Minahasa Utara. *Jurnal Tekno Mesin.* 2018; 4(2):133–137.
29. Carson R. Reducing Cumulative Trauma Disorders. *AAOHN Journal.* 1994;42(6):270–276.
30. Filus R, Okimorto ML. The Effect of Job Rotation Intervals on Muscle Fatigue - Lactic Acid. *Work.* 2012;41:1572–1581.
31. CDC. Workplace Health Promotion: Work-Related Musculoskeletal Disorders & Ergonomics. USA: Centers for Disease Control and Prevention; 2020. Available from: https://www.cdc.gov/workplacehealthpromotion/health-strategies/musculoskeletal-disorders/index.html.
32. Sari NLMRW, Adiputra LMISH, Muliarta IM, et al. Perbaikan Kondisi Kerja Serta Pemberian McKenzie exercise dan Peregangan Statis Memperbaiki Respon Fisiologis dan Meningkatkan Produktivitas Pekerja pada Industri Pembuatan Dupa di UD. Manik Galih Tabanan. *Jurnal Ergonomi Indonesia (The Indonesian Journal of Ergonomic).* 2019;5(1): 1-9.