The Indonesian Journal of Occupational Safety and Health
2024, 13 (1): 29-36
p ISSN: 2301 8046, e ISSN: 2540 7872
http://doi.org10.20473/ijosh.v13i1.2024.29-36

ORIGINAL ARTICLE

Manual Handling as Contributor of Low Back Pain for Workers: A Case Study at PT Sumber Mandiri Jaya, Kabupaten Merauke

Boyke Elyas Michael Sambeko, Nugroho Susanto, Azir Alfanan
Department of Public Health, Faculty of Public Health Science, Respati University of Yogyakarta, Indonesia
Jalan Raya Tajem KM 1,5 Maguwoharjo, Depok Sleman, Yogyakarta, Indonesia

ABSTRACT

Introduction: Manual handling activities are a main causative factor of low back pain injuries. Around 1.71 billion people worldwide live with musculoskeletal conditions, including low back pain. In the Southeast Asia region, it is estimated that around 369 million people experience low back pain. In Indonesia more than 11.9% of health workers are diagnosed with musculoskeletal disease and diagnostic specific for worker obtained 24.7%. The purpose of this study was to determine the dominant indicators of manual handling for low back pain. **Method:** Study design used is cross-sectional study. Sample was 62 subjects. The variables of low back pain were collected using a modified questionnaire adopted from the Oswestry Low Back Pain Disability Questionnaire. Data were analyzed with linear regression test for the main indicators contributing to low back pain. **Result:** Average age of workers is 26.06±7.28, education level senior high school 45%, under 4 years length of work 83.9%. Average manual handling variable is 613.45 ± 383.39, low back pain 6.48 ± 3.607. Manual handling is not significantly related to low back pain r = -0.182. Duration, frequency and load are significant in predicting low back pain. The factors of duration, frequency and lift were estimated to contribute 5.4% for low back pain. **Conclusion:** The main factors related to low back pain are lifting load for workers, while the factors of lifting duration and frequency are not significantly related to low back pain. The lifting load is the main factor contributing to low back pain.

Keywords: manual handling, low back pain, workers

Corresponding Author:
Nugroho Susanto
Email: Nugroho_susanto@respati.ac.id
Telephone: +6289687773467

INTRODUCTION

The World Health Organization (WHO) estimates that around 1.71 billion people worldwide live with disturbed musculoskeletal conditions, including low back pain (LBP). In the Southeast Asia region it is estimated that around 369 million people are experiencing low back pain. LBP is the main contributor to overall musculoskeletal conditions; around 570 million cases are found worldwide, or 7.4% of disability events each year (WHO, 2022). The Health Basic Research (2018) estimated that health workers in Indonesia was diagnostic musculoskeletal disease more 11.9% and musculoskeletal diagnostic specific for worker obtained 24.7%. In Indonesia LBP for workers is estimated at between 7.6% and 37% (Kemenkes, 2019).

Work activities related to manual handling are a major risk factor for work accidents, such as Low Back Pain injury, in which the worker suffers pain in the muscles, nerves or structures in the back area. This is caused by the work of process lifting weights manually (Mayasari *et al*., 2019). Manual handling activities are a main factor causing low back pain injuries. Manual handling can be defined as an activity that requires the use of a person's body strength in lifting, lowering, pushing, pulling, carrying, or holding any object. Manual handling is described as the process of moving anything using human energy (Department of Occupational Safety and Health, Ministry of Human Resources, 2018).

Low Back Pain, often known as back pain, is a skeletal muscle injury and is caused by the work

Cite this as: Sambeko, B. E. M., Susanto, N. and Alfanan, A. (2024) 'Manual Handling as Contributor of Low Back Pain for Workers: A Case Study at PT Sumber Mandiri Jaya, Kabupaten Merauke', *The Indonesian Journal of Occupational Safety and Health*, 13(1), pp. 29-36.

 doi:10.20473/ijosh.v13i1.2024.29-36. Received February 05, 2023; 1st revision June 26, 2023; 2nd revision October 31, 2023; Accepted February 20, 2024; Published: April 2024. Published by Universitas Airlangga.

done by manually lifting materials (Permenaker RI, 2018). Several risk factors, such as severity of work, work posture, manual lifting/handling method, heavy workload, and long working hours can cause Low Back Pain. Other factors that can influence the occurrence of low back pain include psychological factors and low physical exercise (Sowah *et al*., 2018).

A previous study showed that frequency of manual handling increases low back pain (Sauter *et al*., 2021). The study by Lee, Heo and Lee (2021) found that loads lifted are relatively heavy. Another previous study found that 55.3% experienced low back pain. Manual handling is significantly correlated with low back pain p = 0.007 (Nurfajri, Subakir and Hapis, 2022). Low back pain is a common symptom of manual handling (Artadana, Sali and Sujaya, 2019). A study in Saudi Arabia found that the prevalence of low back pain was 40.8% (Al Amer, 2020). A study in Malaysia showed that agricultural workers risk damage of back pain when working (Mat Zain and Lee, 2022).

The previous studies stated that manual handling is a factor related to low back pain in workers, so a study is needed regarding the manual handling indicators related to low back pain. The type of work performed by workers at the company PT Sumber Mandiri Jaya includes the duration of lifting weights, the frequency of lifting weights, and weight of lift load. The types of lift load at the company include materials such as cement, ceramics, and iron which are lifted manually. A preliminary study conducted on 10 workers found that seven workers stated they experienced low back pain and other symptoms. Based in study of the low back pain in the seven workers, it was found that for five workers the duration was above 50 minutes, the frequency of lifting more than 500 times, and the weight lifted was more than 30 kilograms. This type of work poses a risk of bone injuries and work accidents. The purpose of this study was to determine the dominant indicators of manual handling for low back pain.

METHODS

The study design used was a cross-sectional study. The study population is subjects who work at PT Sumber Mandiri Jaya. The sample is 62 subjects, including inclusion and exclusion criteria. The sampling technique used is total sampling. The study variables are the indicators of manual handling design, and the dependent variable is low back pain (LBP). The manual handling variable was collected using interviews with questionnaire guidelines referring to Permenaker No. 5/2018 consisting of three indicators of manual handling. The low back pain variable was collected using a modified questionnaire adopted from the Oswestry Low Back Pain Disability Questionnaire. The instrument consists of three points of manual handling and the low back pain variable consists of 10 points of disability indicators from manual handling. The data were analyzed using IBM SPSS Statistics 22 software, with univariate analysis to explain each variable by making a distribution frequency table. The data were analyzed using a statistical test with linear regression for the main indicators contributing to low back pain. This study has been approved by the Committee of Human Research Publication and Ethics No. 145.3/FIKES/PL/IX/2022 of the Faculty of Public Health, Universitas Respati Yogyakarta.

RESULT

The study was conducted on 62 subjects. The study examined company workers' daily activities of workers in manual handling, including duration, frequency and lifting load. Manual handling activities of workers related to duration, frequency, and load are shown in Figure 1. The data were analyzed based on the study characteristics of the subjects as shown in Table 1.

Table 1 shows that the average age of the workers is 26.0±7.2, the dominant education level is senior high school level, with 28 workers (45%), and the lowest is college graduate college, with only one worker (1.6%). In terms of length of work, the majority of workers had been with the company

Table 1. Characteristics of Study Respondents by Age, Education, and Length of Work

Variable	N	Mean ± SD Frequency (%)
Age	62	26.0±7.2
Education		
Elementary School	13	21.0%
Junior High School	20	32.3%
Senior High School	28	45.2%
College graduate	1	1.6%
Length of Work		
≥ 4 Years	10	16.1%
< 4 Years	52	83.9%

for under four years (52 workers, 83.9%) and ten workers had been working longer than four years (16.1%).

The characteristics of variables of manual handling and indicators of low back pain are shown in Table 2. Table 2 shows that the average manual handling variable is 613.4 ± 383.3; by indicators it shows that the average duration is 65.3±32.1 (minutes /day), frequency is 524.4±334.6 (times/day) and lift load is 23.7±19.6 (kg). The variable of low back pain average is 6.4 ± 3.6, where the highest indicator of pain intensity is average 1.7±1.0, while the lowest indicator is sexual life, 0.0±0.0.

Figure 1. Daily Activities of Workers Related to Frequency, Duration and Lifting Load at PT Sumber Mandiri Jaya

Table 2. Distribution Frequency of Indicators of Manual Handling and Indicators of Low Back Pain

Variable	N	Mean ± SD Frequency (%)
Manual Handling		613.4±383.3
Duration (minutes /day)		65.3±32.1
≤ Threshold value	36	58.1%
> Threshold value	26	41.9%
Frequency (times/day)		524.4±334.6
≤ Threshold value	36	58.1%
> Threshold value	26	41.9%
-Lift load (kg)		23.7±19.6
≤ Threshold value	25	40.3%
> Threshold value	37	59.7%
Low Back Pain		6.4±3.6
Pain Intensity (0-5)	62	1.7.±1.0
Self-care (0-5)	62	0.6±0.6
Lift (0-5)	62	1.1±0.9
Walk (0-5)	62	0.1±0.3
Sit (0-5)	62	1.1±0.9
Stand (0-5)	62	0.1±0.3
Sleep (0-5)	62	0.5±0.5
Sexual life (0-5)	62	0.0±0.0
Social life (0-5)	62	0.6±0.6
Traveling (0-5)	62	0.2±0.4

Table 3. Correlation between Manual Handling and Pain Intensity, Self-care, Lifting Weight, Walking, Sitting, Standing, Sleeping, Sexual Life, Social Life, Traveling, and Low Back Pain

Variable	(N)	Manual Handling			
		Duration	Frequency	Lift	Manual Handling
		r	r	r	r
Pain Intensity	62	-.264*	-0.289*	-0.224	-0.308*
Self-care	62	-0.171	-0.165	-0.257*	-0.190
Lift	62	-0.244	-0.245	-0.039	-0.248
Walk	62	-0.179	-0.207	-0.257*	-0.229
Sit	62	0.072	0.084	-0.204	0.063
Stand	62	0.121	0.214	-0.027	0.204
Sleep	62	-0.002	-0.044	-0.064	-0.047
Sexual life	62	-	-	-	-
Social life	62	0.144	0.118	-0.083	0.122
Traveling	62	0.065	0.122	0.038	0.121
Low back pain	62	-0.155	-0.156	-0.273*	-0.182

The relationship between manual handling and low back pain is shown in Table 3. Table 3 shows that manual handling is not significantly related to low back pain (r = -0.182), but when viewed from each indicator of manual handling, it is shown that the indicator of lifting load is significantly related to low back pain (r = -0.273). Based on each indicator of manual handling and low back pain, it is shown that the indicator of lifting duration is significantly related to pain intensity (r = -0.264). The lifting frequency is significantly related to pain intensity (r = -0.289); the lifting load is significantly related to self-care (r = -0.257) and the ability to walk (r = -0.257), while overall manual handling is significantly related to pain intensity (r = 0.308).

Table 4 shows that Model 1, the factor of duration, is predictive for low back pain but not significant: R2 = 0.008, p = 0.230. The factor of duration contributed an estimated 0.8% for low back pain. Model 2 shows that duration and frequency are predictive of low back pain but not significant: R2 = 0.008, p = 0.813. Duration and frequency contributed an estimated 0.8% for low back pain. Model 3 shows that duration, frequency and lift are significant predictors for low back pain: R2 = 0.054, p = 0.032. the factors of duration, frequency and lift contribute an estimated 5.4% for low back pain.

DISCUSSION

Characteristics of Subjects

The study was conducted to determine the correlation between manual handling design and low back pain. The study aims to examine the relationship between each indicator of manual handling variable and low back pain variable for workers at PT Sumber Mandiri Jaya, Merauke Regency. The study examined 62 subjects with mean age of 26.0 years, education level of senior high school 45.2%, length of service less than four years 83.9%.

Table 4. Model Analyzing Factors Contributing to (R2) Low Back Pain such as Duration, Frequency and Lift for Workers

Variable	Low Back Pain		
Manual Handling	Model 1 R^2 (P)	Model 2 R^2 (P)	Model 3 R^2 (P)
Duration	0.008 0.230		
Duration, frequency		0.008 0.813	
Duration, frequency, lift			0.054 0.032*

The previous study by Couto *et al*. (2019) showed that subjects aged > 26 years old were correlated with injury. The study by Omura *et al*. (2022) showed that the average age of workers is 41.2 years. The study by Tjahayuningtyas (2019) showed that the majority of subjects > 35 years old was 57.9%. In the study by Aleku *et al*. (2021), workers aged between 40 and 59 years old were 51.4%. Increasing age has an impact on muscle weakness and thus a negative impact on workers.

In terms of length of work, a previous study by Tjahayuningtyas (2019) found that the length of workers > 5 years was 52.6%. Another study (Aleku *et al*., 2021) stated that the majority of subjects who had worked 6 to 10 years was 53.5%. the study by Omura *et al*. (2022) showed that the average length of work experience was 9.1 years. Workers who have worked for a long time have a greater likelihood of lower back pain.

Relationship of Duration and Low Back Pain

The study showed that the duration indicator of Manual handling was significantly related to the variable of pain intensity of low back pain. A previous study on finishing workers found that 56% of workers experienced low back pain. There was a significant relationship between manual handling and the incidence of low back pain: p = 0.021 (Nabilah *et al*., 2020). In a previous study Nurfajri, Subakir and Hapis (2022), where 55.3% of subjects experienced low back pain, the study showed that there is a significant correlation between manual handling and low back pain: p = 0.007. Another previous study Artadana, Sali and Sujaya (2019) found that low back pain is a common symptom of manual handling. The position of load lifting for a long time causes the body to be more tired. The process of lifting loads carried out for a long period without rest breaks causes injuries to body tissues, a condition contributing to worker accidents.

A study Al Amer (2020) conducted in Saudi Arabia found that the prevalence of low back pain was 40.8%. The problem often found in low back pain was for lumbar 1-5. Another study Firouzabadi *et al*. (2021) concluded that manual handling is related to problems in the spine such as lumbar 1-5. Workers with this condition are very prone to experiencing pain. A study Mat Zain and Lee (2022) conducted in Malaysia on agricultural workers found potential damage of back pain during working. Another study Bernardes *et al*. (2022) found that manual handling is significantly related to a decrease in low back pain (PR 1.375, 95% CI 1.038–1.821).

This study shows that the indicators of duration of manual handling such as self-care, lift, walk, sit, stand, sleep, social life, and traveling have no significant correlation. This condition is because most of the subject are young and still strong with a higher ability to lift (Couto *et al*., 2019). Strength and power in a younger age are factors of the duration not related with self-care, lift, walk, sit, stand, sleep, social life, and traveling.

A study of German workers Sauter *et al*. (2021) found that standing had no significant impact on low back pain: OR = 0.98 (95% CI: 0.91-1.06). The more dominant cause of pain is temperature changes because it is in a cold area. A study (Couto *et al*., 2019) conducted in Brazil found that manual handling was not significant for aspects of standing and walking for low back pain: OR = 1.08 (95%CI: 0.08-1.31).

Relationship of Frequency and Low Back Pain

This study showed that frequency of manual handling is significantly related to the indicator intensity. A study in Brazil Couto *et al*. (2019) showed that low back pain is caused by physical factors such as overload, physical pressure and lifting procedure errors OR = 1.18 (95% CI: 1.01-1.39), factor length of work > 26 years OR = 1.22 (95% CI; 1.04-1.44). The length of work factor is a more dominant factor causing low back pain.

The factors of frequency of manual handling such as self-care, lift, walk, sit, stand, sleep, social life, traveling have no significant correlation with low back pain. This situation shows that most of the subject with four years length of work or less have minimal work experience. This condition is a factor related to no significant of duration with self-care, lift, walk, sit, stand, sleep, social life, traveling.

A study conducted in Japan Iwakiri *et al*. (2023) showed that working time was not significantly related to low back pain: p = 0.724. Workers are more likely to seek large salaries when compared to the potential pain they experience. Another study Brents *et al*. (2021) concluded that low back pain is caused by incorrect manual handling procedures. The study by Couto *et al*. (2019) showed that manual handling was not significant in the hand movement aspect of low back pain OR = 0.90 (95% CI; 0.74-1.10). Joseph *et al*. (2023) conducted a journal review which stated that there was no significant correlation between manual handling and low back pain. The incidence of low back pain can be influenced by work stress factors and job perceptions.

Relationship of Lift and Low Back Pain

Looking at load indicator, the manual handling variable shows that it is significantly related to self-care and walking. The heavy loads workers carry every day pose a significant related risk to self-care and working condition. A previous study (Tjahayuningtyas, 2019) found that workload is significantly related with musculoskeletal disorders: p = 0.00. Lower loads lifted by workers reduced musculoskeletal disorders.

Low back pain is also caused by the characteristics of the workers themselves. One study Bernardes *et al*. (2022) found that low education level is significantly related to low back pain (PR 2.166, 95% CI 1.218–3.855). another study (Sauter *et al*., 2021) found that there significant difference by sex in low back pain: OR = 1.21 (1.17; 1.26), in which female workers are at greater risk of low back pain than male workers. A study (Aleku *et al*., 2021) conducted in Uganda found that gender was significantly related to low back pain: p = 0.028. A study Iwakiri and Liu (2023) found that gender is related low back pain: p = 0.003. The study by Iwakiri and Liu (2023) found that age is significantly related to low back pain: p = 0.001.

Studies have shown that intensity, lift, sit, stand, sleep, social life, traveling have no significant correlation with manual handling. A study Couto *et al*. (2019) in Brazil found that manual handling was not significant for the movement aspect of low back pain OR = 1.15 (95% CI; 0.99-1.35). Another study Brents *et al*. (2021) in the United States found that lifting weights to the side was not significantly related to low back pain (p = 0.19); lifting to the left side was not significant to low back pain (p = 0.31); and lifting to the right side was not significantly related to low back pain (p = 0.19).

The factor that caused pain was the average lifting of the curve either to the right or left side p = 0.02. Another study Sauter *et al*. (2021) found that lifting weights above the head does not significantly cause low back pain: OR = 0.98 (95% CI; 0.91-1.05).

Relationship of Manual Handling and Low Back Pain

Based on the dominant factors for low back pain, lifting load is the main factor that contributes to low back pain, compared to duration and frequency. Lifting loads that are too heavy causes low back pain. Another study (Sauter *et al*., 2021) shows that frequency of manual handling increases low back pain OR = 1.41 (1.32; 1.50) compared to never doing manual handling. The study by Lee, Heo and Lee (2021) found that the average lifting weight is 68.34 ± 7.16 kg. This study shows that the load lifted is relatively heavy.

The study by Ferguson *et al*. (2019) found that lift load did not significantly correlate with low back pain (p = 0.484). Aleku *et al*. (2021) found that lift load is not significantly related to low back pain (p = 0.855). This indicates that low back pain is caused by poor lifting procedures. This condition requires education for workers to lift weights correctly and according to set procedures. The study by Lee, Heo and Lee (2021) about low back pain showed that the approach to reducing risk factors in manufacturing workers is carried out through education efforts. Education or training for workers could reduce the risk of low back pain.

Other factors that contribute to low back pain include additional working hours, work shifts, and characteristic factors such as age, education level, and gender. Sauter *et al*. (2021) found that working overtime is a risk factor for low back pain compared to workers who do not work overtime: OR = 0.98 (0.91; 1.05). Iwakiri and Liu, 2023 found that the work shift system is related to low back pain: p = 0,019. This same study found that full-time and part-time work are not significantly related to low back pain: p = 0.724. Bernardes *et al*. (2022) found that low quality sleep significantly contributed to low back pain (PR 1.425, 95% CI 1.13–1.796). Varrecchia *et al*. (2022) found that fatigue caused increasing low back pain.

Characteristic factors such as age play an important role in works, especially for jobs that require more physical activity. Tjahayuningtyas (2019) found that age was not significantly related to musculoskeletal disorder: p =0.102. The condition caused diverse age variations in study. Ferguson *et al*. (2019) found that age was not significantly related to low back pain: p = 0.403. The age of workers is an important factor to considered in recruitment, especially for jobs that involve manual lifting. Problems that can occur are related to age factors such as health problems and physical ability problems. Previous studies show that in productive age there are many other health problems such as infectious diseases. One study (Susanto *et al*., 2022) found that age is a predictive factor for systolic blood pressure: p= < 0.05. Another study Aleku *et al*. (2021) found that age was significantly related low back pain: p = 0.002.

Efforts to reduce pain can be done in various ways such as exercise, mobility, and regular physical activity. One study Joern *et al*. (2022) examined a program to reduce low back pain through mobility training. Exercise to promote mobility reduced back workload and reduced low back pain. Omura *et al*., 2022 fund that motion and mobility reduce workers' risk of conditions related to back workload and damage due to low back pain. Preventive efforts can reduce the risk of workers' conditions becoming worse (Susanto, 2020). Preventing back pain from becoming worse is a preventive effort for workers and requires serious attention from companies.

CONCLUSION

The factors related to low back pain are lifting load factors for workers, while lifting duration and frequency factors are not significantly related to low back pain. Lifting load is the main factor contributing to low back pain. This study shows that some low back pain indicators have no significant correlation with manual handling, such as self-care, lift, walk, sit, stand, sleep, social life, and traveling. The researchers recommend that future studies investigate the indicators of manual handling such as lifting to right and to left side, and indicators of low back pain such as self-care, lift, walk, sit, stand, sleep, social life, and traveling.

ACKNOWLEDGMENTS

I am very grateful to the subjects who agreed to participate in the study, and the company PT Sumber Mandiri Jaya, for all their support in preparing this paper.

REFERENCES

Aleku, M., *et al*. (2021) 'Lower Back Pain as an Occupational Hazard Among Ugandan Health Workers', *Frontiers in Public Health*, 9, pp. 1-8. doi: 10.3389/fpubh.2021.761765.

Al Amer, H.S. (2020) 'Low Back Pain Prevalence and Risk Factors among Health Workers in Saudi Arabia: A Systematic Review and Meta-analysis', *Journal of Occupational Health*, 62, pp. 1–23.

Artadana, M. A. W., Sali, I. W. and Sujaya, I. N. (2019) 'Hubungan Sikap Pekerja Dan Lama Kerja Terhadap Keluhan Low Back Pain Pada Pekerja Di Industri Batu Bata Press', *Jurnal Kesehatan Lingkungan*, 9(2), pp. 126–135.

Couto, M. C.B. M, *et al.*(2019) 'Prevalence and Work-related Factors Associated with Lower Back Musculoskeletal Disorders in Female Shellfish Gatherers in Saubara, Bahia-Brazil', *International Journal of Environmental Research and Public Health*, 16(5), pp. 1–15. doi: 10.3390/ijerph16050857

Bernardes, J. M., *et al* (2022) 'The Impact of Manual Patient Handling on Work Ability : A Cross- Sectional Study in a Brazilian Hospital', N*ursing Open*, 9, pp. 2304–2313. doi: 10.1002/nop2.1228

Brents, C., *et al*. (2021) 'Trunk Posture during Manual Materials Handling of Beer Kegs', *International Journal of Environmental Research and Public Health*, 18(14). doi: 10.3390/ijerph18147380

Department of Occupational Safety and Health Ministry of Human Resources (2018) Guidelines for Manual Handling at Workplace. Malaysia: Department of Occupational Safety and Health Ministry of Human Resources.

Ferguson, S. A., *et al* (2019) 'Prevalence of Low Back Pain, Seeking Medical Care, and Lost Time due to Low Back Pain among Manual Material Handling Workers in the United States', *BMC Musculoskeletal Disorders*, 20(1), pp. 1–8.

Firouzabadi, A., *et al*. (2021) 'Sex-Dependent Estimation of Spinal Loads During Static Manual Material Handling Activities—Combined in Vivo and in Silico Analyses', *Frontiers in Bioengineering and Biotechnology*, 9(November), pp. 1–14.

Iwakiri, K., *et al* (2023) 'Effect of Relative Weight Limit Set as a Body Weight Percentage on Work-related Low Back Pain among Workers', *PLoS ONE*, 18(4 April), pp. 1–15. doi: 10.1371/journal.pone.0284465

Iwakiri, K. and Liu, X. (2023) 'Organization Factors Influencing Quality of Work Life among Seniors' Care Workers with Severe Low Back Pain', *Journal of Occupational Health*, 65, pp. 1–8.

Joern, L., *et al*. (2022) 'Pain Cognitions and Impact of Low Back Pain after Participation in a Self-Management Program: A Qualitative Study', *Chiropractic and Manual Therapies*, 30(1), pp. 1–8. https://doi.org/10.1186/s12998-022-00416-6

Joseph, L., *et al*. (2023) 'Causal Relationship Between the Risk Factors and Work-Related Musculoskeletal Disorders Among Professional Drivers: A Systematic Review', *Human Factors*, 65(1), pp. 62–85. doi: 10.1177/00187208211006500

Kemenkes (2019) IndoDatin K3. Pusat Data dan Informasi, Kementerian Kesehatan RI.

Lee, S., Heo, S. and Lee, J. Y. (2021) 'A Pilot Study to Assess a Risk of a High-Risk Group of Low Back Pain Membership in Workers who Perform the Manual Material Handling Tasks', *Annals of Occupational and Environmental Medicine*, 33, pp. 1–11.

Mat Zain, N. S. and Lee, L. K. (2022) 'Health Complaints, Mental Status and Quality of Life among the Aquaculture Workers: A Cross-Sectional Study in Northern Region of Peninsular Malaysia', *International Journal of Environmental Research and Public Health*, 19(23), pp. 1-14.

Mayasari, D., *et al*. (2019) 'Analysis of Manual Material Handling Technique and Its Association with Low Back Pain (LBP) Among Fisherman In Kangkung Village, Bandar Lampung', *KnE Life Sciences*, 4(10), pp. 228–234. doi: 10.18502/kls.v4i10.3724

Nabilah, T., *et al*. (2020) 'Hubungan Aktivitas Manual Material Handling Dengan Keluhan Low Back Pain Pada Pekerja Bagian Finishing Di Proyek Rusun X Tahun 2019', *Jurnal Ergonomi dan K3*, 5(2), pp. 46–57.

Nurfajri, T., Subakir, S. and Hapis, A. A. (2022) 'Faktor-Faktor Yang Berhubungan Dengan Keluhan Nyeri Punggung Bawah Pada Pekerja Batu Bata Di Desa Talang Belido Tahun 2021', *Jurnal Inovasi Penelitian*, 2(12), pp. 3933–3938.

Omura, Y., *et al*. (2022) 'Development and Evaluation of a New Assistive Device for Low Back Load Reduction in Caregivers: An Experimental Study', *Scientific Reports*, 12(1), pp. 1–13. https://doi.org/10.1038/s41598-022-21800-5

Permenaker RI (2018) Peraturan Menteri Ketenagakerjaan Republik Indonesia Nomor 5 Tahun 2018 Tentang Keselamatan Dan Kesehatan Kerja Lingkungan Kerja, Undang–Undang Dasar Negara Republik Indonesia Tahun 1945 dalam Satu Naskah. Indonesia.

Sauter, M., *et al*. (2021) 'Manual Handling of Heavy Loads and Low Back Pain among Different Occupational Groups: Results of the 2018 BIBB/BAuA Employment Survey', *BMC Musculoskeletal Disorders*, 22(1), pp. 1–14. https://doi.org/10.1186/s12891-021-04819-z

Sowah, D., *et al*. (2018) 'Occupational Interventions for the Prevention of Back Pain: Overview of Systematic Reviews', *Journal of Safety Research*, 66, pp. 39–59. doi: 10.1016/j.jsr.2018.05.007

Susanto (2020) *Epidemiologi Pencegahan Penyakit*. Yogyakarta: CV Gosyen Publishing.

Susanto, N, *et al*. (2022) 'Usia sebagai Prediksi Peningkatan Tekanan Darah Sistole dan Diastole pada Penderita Infeksi Saluran Pernafasan Akut (ISPA)', J*urnal Formil (Forum Ilmiah) KesMas Respati,* 7(3), pp. 274–281.

Tjahayuningtyas, A. (2019) 'Faktor Yang Mempengaruhi Keluhan Musculoskeletal Disorders (MSDs) Pada Pekerja Informal', T*he Indonesian Journal of Occupational Safety and Health*, 8(1), pp 1-10.

Varrecchia, T., *et al*. (2022) 'Trunk Muscle Coactivation in People with and without Low Back Pain during Fatiguing Frequency-Dependent Lifting Activities', *Sensors,* 22(1417), pp. 1–16.

WHO (2022) Musculoskeletal health. World Health Organization.