The Indonesian Journal of Occupational Safety and Health
2024, 13 (3): 343-350
p ISSN: 2301 8046, e ISSN: 2540 7872
http://doi.org10.20473/ijosh.v13i3.2024.343-350

ORIGINAL ARTICLE

Fatigue Assessment: Study Based on Physical Activity and Muscular Strength at Sedentary Workers

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ABSTRACT

Introduction: Work fatigue is often a neglected problem because the symptoms are not specific and not visible directly to the naked eye. Occupational fatigue itself contributes more than 60% of all occupational accidents that occur in the workplace. The high rate of occupational fatigue that can contribute to work accidents is very interesting to be studied further related to the causal factors, including physical activity and muscular strength. The purpose of this study was to analyze the effect of physical activity and muscular strength with the incidence of fatigue in sedentary workers at Kalla Group located in Makassar, South Sulawesi. **Method:** The research is cross sectional study with samples in this study were sedentary workers who had relatively similar workloads and lifestyles which were then selected through simple random sampling calculations. This research uses ordinal regression statistical tests. **Result:** The test results obtained are p-value (p = 0.046) which means there is a significant relationship between fatigue and muscle strength, but there is no relationship between fatigue and exercise habits, no relationship between fatigue and smoking habits, no relationship between fatigue and staying up late and no relationship between fatigue and sitting time in a day on sedentary workers at Kalla Group, Makassar, South Sulawesi. **Conclusion:** Workers need to do light muscle stretching so that workers do not get tired easily when working in a static position for a long time and workers also need to adopt a healthy lifestyle.

Keywords: fatigue, muscular strength, physical activity

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INTRODUCTION

Work fatigue has several types, namely physical and psychological fatigue. Occupational fatigue is often a neglected problem in the workplace because the symptoms are not specific and not visible directly to the naked eye but if not controlled properly it can cause a problem and considerable losses. Several studies have shown that workers who are not well-controlled so that they experience physical and mental fatigue, tend to experience a decrease in productivity which then results in losses experienced by the company. In addition, people who experience work fatigue are at great risk of committing an unsafe act due to poor focus levels, which can have an impact on their safety. Occupational fatigue itself increased the risk of occupational accidents that occur in the workplace (Cunningham *et al*., 2022).

In addition, scientifically, fatigue can also have an impact on several health problems, for example if it is related to physical fatigue where workers do their work using excessive energy. Workers can experience problems in the muscles and joints, then lifestyle and diet are also one of the factors that can affect how well a person's body can recover quickly when experiencing fatigue.

Sedentary lifestyle or commonly known as lazy movement or minimal movement has a very serious impact on health (Park, *et al*., 2020). Sedentary workers are a type of work that uses minimal muscle

Cite this as: *Arini, S. Y. et al. (2024) 'Fatigue Assessment: Study Based on Physical Activity and Muscular Strength at Sedentary Workers', The Indonesian Journal of Occupational Safety and Health, 13(3), pp. 343-350*

 doi:10.20473/ijosh.v13i3.2024.343-350. Received June 19, 2024; 1st revision July 7, 2024; 2nd revision October 20, 2024; Accepted December 17, 2024; Published: December 2024. Published by Universitas Airlangga.

to carry out activities, but the mental workload is quite large. This tendency often makes sedentary workers unable to maintain their lifestyle. Poor work attitudes and the risk of weakening muscles from the lack of physical activity, one of which is because they sit a lot while doing their work, put these sedentary workers at risk of experiencing psychological job fatigue. In previous research, it was said that one of the causes of work fatigue is physical activity. This is in line with the statement that there is a relationship between physical activity and work fatigue in workers in Malalayang Village, Manado (Mokosuli, Jesephus and Joseph, 2016). Fatigue caused by static work is different from dynamic work. In static muscle workers, with 50% exertion of maximum muscle strength can only work for 1 minute while at <20% exertion physical work can last long enough.

Sedentary workers are very susceptible to occupational fatigue, this is due to minimal muscle movement or do not require significant energy to carry out their activities in a sitting or lying position. The energy required for sedentary activities is <1.5 Metabolic Energy Turnovers / METs (Newton Jr, *et al*., 2013). Sedentary workers are usually experienced by office workers, where this lifestyle has begun to increase along with advances in science and technology. Technology provides many conveniences, various activities can be done just by sitting, which makes individuals lazy to move. This research is in line with research conducted by Haetami and Triansyah (2021) that fatigue and muscle pain occur due to lack of oxygen and cause lactic acid to increase in the blood. Muscle fatigue is influenced by mental health disorders such as stress and depression which usually occur in sedentary workers (Tarwaka, 2015).

The working hours of sedentary workers at Kalla Group located in Makassar, South Sulawesi starts at 09.00 until 17.00 WITA which means workers work for 8 hours. All sedentary workers at Kalla Group spend almost all of their working time sitting in front of a laptop and are supported by their lifestyle and smoking habits. In addition, preliminary studies on sedentary workers at Kalla Group located in Makassar, South Sulawesi also show that most workers have a habit of staying up late and do not have a habit of exercising.

Therefore, the study wanted to analyze the effect of physical activity and muscular strength on the incidence of fatigue in sedentary workers where many people do not realize that their daily activities do not require much muscle or energy but they are still at risk of fatigue due to muscle weakening.

METHODS

This study examines the relationship between fatigue and the variables of physical activity, muscle strength, and micronutrient deficiencies using both quantitative and qualitative methodologies. According to one perspective, data collecting comes under the category of observational research, which is defined as investigations carried out without giving study participants any special treatment or intervention. Furthermore, considering statistical tests will be conducted to validate the hypothesis, this study also includes analytical research. According to the time period, this study's design fits within the category of cross-sectional research.

The population in this study is sedentary workers in Kalla Group located in Makassar, South Sulawesi. The sample in this study were workers in the sedentary workers category who had relatively similar workloads and lifestyles and the total samples were 133 workers. The results of the study could be generalized which were then selected through the calculation of simple random sampling. The sample size in this study was calculated using the Slovin formula. Research Location: Kalla Group, Makassar City, South Sulawesi.

In this study, there are two research variables, namely the dependent variable and the independent variable. The dependent variable in this study is fatigue as measured using reaction timer. The independent variables in this study are physical activity (exercise habits, staying up late, and sitting time) measured using a questionnaire survey and muscular strength used handgrip dynamometer. Statistical analysis was used to determine the relationship between the independent and dependent variables in the study. For categorical data, statistical analysis used bivariate analysis statistical tests to determine which variables had the most influence on the incidence of fatigue experienced by sedentary workers. All data analysis was conducted in IBM SPSS Statistics 22. The study has obtained ethical clearance with Number: 96/EA/KEPK/2023 from the Faculty of Public Health, Airlangga University.

RESULT

Based on table 1, it is known that out of 9 respondents (0.1%) with fatigue in the severe

category, there are 4 people (3.9%) who have normal muscle strength; and 5 people (4.8%) who have weak muscle strength. Based on a total of 46 respondents with fatigue in the normal category, there were 14 people (20.1%) who had normal muscle strength; 1 person (0.7%) who had muscle strength in the strong category; and 31 people (24.6%) who had weak muscle strength. Based on a total of 59 respondents with fatigue in the mild category, there were 29 people (25.7%) who had normal muscle strength; 1 person (0.9%) who had muscle strength in the strong category; and 29 people (31.5%) who had weak muscle strength. It can also be seen from a total of 19 respondents with fatigue in the moderate category, 13 people (8.3%) who included having muscle strength in the normal category; and 6 people (10.1%) who included having weak muscle strength. The Pearson Chi-Square Test results showed an association between fatigue and muscle strength (p-value <0.05) (attached in table 1).

Based on table 2, it is known that out of 9 respondents with severe fatigue category, there are 7 people (4.9%) who have the habit of exercising often and 2 people (4.8%) who have the habit of always exercising. Based on a total of 46 respondents in the normal fatigue category, there was 1 person (1.4%) who never exercised; 16 people (14.5%) who rarely exercised; 23 people (25.2%) who often exercised; and 6 people (24.6%) who always exercised. Based on a total of 59 respondents in the mild fatigue category, there were 3 people (1.8%) who never exercised; 19 people (18.6%) who rarely exercised; 32 people (32.4%) who often exercised; and 5 people (31.5%) who always exercised. It can also be seen from a total of 19 respondents with moderate fatigue category, there are 7 people (6.0%) who have the habit of rarely exercising; 11 people (10.4%) who have the habit of exercising often; and 1 person (10.1%) who has the habit of always exercising. Pearson Chi-Square Test results showed no association between fatigue and exercise habits (p-value >0.05) (attached in table 2).

Based on table 3, it is known that all respondents, namely 9 people (8.3%) with fatigue

Table 1. Relationship between Muscle Strength and Fatigue

Muscle Strength	Fatigue								Total	p-value
	Weight		Normal		Light		Medium			
	f	%	f	%	f	%	f	%		
Normal	4	3.9	14	20.1	29	25.7	13	8.3	60	0.046
Strong	0	0.1	1	0.7	1	0.9	0	0.3	2	
Weak	5	4.8	31	24.6	29	31.5	6	10.1	71	
Total	9		46		59		19		133	

Table 2. Relationship between Exercise Habits and Fatigue

Exercise Habits	Fatigue								Total	p-value
	Weight		Normal		Light		Medium			
	f	%	f	%	f	%	f	%		
Never	0	0.3	1	1.4	3	1.8	0	0.6	4	0.510
Rarely	0	2.8	16	14.5	19	18.6	7	6.0	42	
Often	7	4.9	23	25.2	32	32.4	11	10.4	73	
Always	2	0.9	6	4.8	5	6.2	1	2.0	14	
Total	9		46		59		19		133	

Table 3. Relationship between Smoking Habit and Fatigue

Smoking Habit	Fatigue								Total	p-value
	Weight		Normal		Light		Medium			
	f	%	f	%	f	%	f	%		
Smoking	0	0.7	3	3.8	6	4.9	2	1.6	11	0.704
Not Smoking	9	8.3	43	42.2	53	54.1	17	17.4	122	
Total	9		46		59		19		133	

in the severe category are included in the category of respondents who do not smoke. Based on a total of 46 respondents with fatigue in the normal category, there were 3 people (3.8%) included in the category of respondents who did not smoke and 43 people (42.2%) included in the category of respondents who smoked. Based on a total of 59 respondents with fatigue in the mild category, there were 6 people (4.9%) included in the category of respondents who did not smoke and 53 people (54.1%) included in the category of respondents who smoked. It can also be seen from a total of 19 respondents with fatigue in the moderate category, there are 2 people (1.6%) included in the category of respondents who do not smoke and 17 people (17.4%) included in the category of respondents who smoke. The results of the Pearson Chi-Square Test showed no relationship between fatigue and smoking habits (p-value>0.05) (attached in table 3).

Based on table 4, it is known that out of 9 respondents with severe fatigue category, there were 2 people (0.5%) who included never staying up late; 3 people (3.2%) including rarely staying up late; 1 person (2.0%) including often staying up late and 3 people (2.3%) including always staying up late. Based on a total of 46 respondents with normal fatigue category, there were 3 people (2.8%) who included never staying up late; 22 people (18.6%) including rarely staying up late; 9 people (11.2%) including often staying up late and 12 people (13.3%) including always staying up late. Based on a total of 59 respondents with mild fatigue category, there were 4 people (3.5%) who included never staying up late; 23 people (23.5%) including rarely staying up late; 14 people (14.2%) including often staying up late and 18 people (16.8%) including always staying up late. It can also be seen from a total of 19 respondents with moderate fatigue category, there is 1 person (1.2%) who includes never staying up late; 5 people (7.7%) including rarely staying up late; 8 people (4.6%) including often staying up late and 5 people (5.5%) including always staying up late. The results of the Pearson Chi-Square Test showed there was no relationship between fatigue and exercise habits (p-value>0.05) (attached in table 4).

Based on table 5, it is known that out of 9 respondents with severe fatigue category, there is

Table 4. Relationship between Staying Up Late and Fatigue

Staying Up Late	Fatigue								Total	p-value
	Weight		Normal		Light		Medium			
	f	%	f	%	f	%	f	%		
Never	2	0.5	3	2.8	4	3.5	1	1.2	10	0.735
Rarely	3	3.2	22	18.6	23	23.5	5	7.7	53	
Often	1	2.0	9	11.2	14	14.2	8	4.6	32	
Always	3	2.3	12	13.3	18	16.8	5	5.5	38	
Total	9		46		59		19		133	

Table 5. Relationship between Sitting Time in a Day and Fatigue

Sitting Time in a Day	Fatigue								Total	p-value
	Weight		Normal		Light		Medium			
	f	%	f	%	f	%	f	%		
4 Hours	0	0.2	2	1.0	0	1.3	1	0.4	3	0.415
5 Hours	1	0.5	3	2.8	3	3.5	1	1.1	8	
6 Hours	0	1.1	4	5.5	12	7.1	2	2.3	16	
7 Hours	1	1.1	5	5.5	8	7.1	2	2.3	16	
8 Hours	5	2.4	11	12.5	20	16.0	5	5.1	36	
9 Hours	0	0.7	6	3.8	5	4.9	1	1.6	11	
10 Hours	2	1.6	11	8.3	8	10.6	5	3.4	24	
11 Hours	0	0.2	2	1.0	1	1.3	0	0.4	3	
12 Hours	0	0.4	2	2.1	2	2.7	2	0.9	6	
Total	9		46		59		19		133	

1 person (0.5%) with sitting time of 5 hours in a day; 1 person (1.1%) with sitting time of 7 hours in a day; 5 people (2.4%) with sitting time of 8 hours in a day and 2 people (1.6%) with sitting time of 10 hours in a day. Based on a total of 46 respondents with normal fatigue category, there were 2 people (1.0%) with sitting time of 4 hours in a day; there were 3 people (2.8%) with sitting time of 5 hours in a day; there were 4 people (5.5%) with sitting time of 6 hours in a day; there were 5 people (5.5%) with sitting time of 7 hours in a day; 11 people (12.5%) with a sitting time of 8 hours a day; 6 people (3.8%) with a sitting time of 9 hours a day; 11 people (8.3%) with a sitting time of 10 hours a day; 2 people (1.0%) with a sitting time of 11 hours a day; and 2 people (2.1%) with a sitting time of 12 hours a day. Based on a total of 59 respondents in the mild fatigue category, there were 3 people (3.5%) with a sitting time of 5 hours a day; 12 people (7.1%) with a sitting time of 6 hours a day; 8 people (7.1%) with a sitting time of 7 hours a day; 20 people (16.0%) with sitting time of 8 hours in a day; 5 people (4.9%) with sitting time of 9 hours in a day; 8 people (10.6%) with sitting time of 10 hours in a day; 1 person (1.3%) with sitting time of 11 hours in a day; and 2 people (2.7%) with sitting time of 12 hours in a day. It can also be seen from a total of 19 respondents with moderate fatigue category, 1 person (0.4%) with sitting time of 4 hours in a day; 1 person (1.1%) with sitting time of 5 hours in a day; 2 people (2.3%) with sitting time of 6 hours in a day; 2 people (2.3%) with sitting time of 7 hours in a day; 5 people (5.1%) with sitting time of 8 hours in a day; 1 person (1.6%) with sitting time of 9 hours in a day; 5 people (3.4%) with sitting time of 10 hours in a day; and 2 people (0.9%) with sitting time of 12 hours in a day. Pearson Chi-Square Test results showed no association between fatigue and exercise habits (p-value >0.05) (attached in table 5).

DISCUSSION

Relationship between Muscle Strength and Fatigue

According to Farisa, Amir and Jafar (2017) muscle strength can be interpreted as the voltage exerted by the muscles against the load with a maximum effort at a certain time. In working, a worker needs good muscle strength. This is because muscle strength will support workers in doing their work. Workers with good muscle strength will not get tired easily while working (Wahyono and Sudibjo, 2019)

Fatigue can arise when muscle work is inhibited due to the accumulation of lactic acid from glycogen used when muscles contract (Kawatu and Lery 2012). Lactic acid then builds up in the muscle and causes the muscle to become swollen making it difficult to contract which then causes fatigue (Hendrayati, Rowa and Mappeboki, 2009). In general, fatigue can arise due to lack of energy reserves and increased metabolism as a cause of loss of muscle efficiency that can inhibit brain centers in controlling movement so that the potential frequency of activity in nerve cells is reduced. Thus the slower one's movement will show the weaker one's muscle condition (Medianto, 2017).

Based on table 1 shows that in the Pearson Chi-Square Test, the p-value (p = 0.046) is smaller than 0.05 (p-value <0.05), then H_0 is rejected and Ha is accepted. It can be concluded that there is a significant relationship between fatigue and muscle strength in sedentary workers at Kalla Group, Makassar, South Sulawesi.

The result were in line with Rinaldi's research (2020) which shows a p value of 0.000 (P <0.05), which means that there is a relationship between age and work fatigue in the tank car crew (AMT) at PT Elnusa Petrofin Banjarmasin because age is one of the factors that affect endurance and work capacity such as a person's muscle strength which results in fatigue the older a person is, the more his muscle strength decreases. The results of this study are also in line with research by Ismiarni *et al*. (2017) which obtained a p value of 0.029 (p>0.05) which means that there is a relationship between work posture and back muscle strength which has an impact on fatigue in sanding section furniture workers at PT. X Jepara.

Relationship between Exercise Habits and Fatigue

The more often a person exercises, the higher the level of body fitness will be. According to the National Institute of Occupational Safety and Health (NIOSH) report, when a person has a low level of fitness, it can increase the risk of complaints by 7.1% (Tarwaka, Bakri . and Sudiajeng, 2004).

Based on the Pearson Chi-Square Test, the p-value (p = 0.510) is greater than 0.05 (p-value > 0.05), then H_0 is accepted and Ha is rejected, so it can be concluded that there is no significant relationship between fatigue and exercise habits in

sedentary workers at Kalla Group, Makassar, South Sulawesi. The results of this study are in line with the research of Aprianti and Agustin (2018) showing the results of the Spearman Rank correlation test that the p value = 0.373> α.

Therefore, there is no significant relationship between exercise habits and work fatigue of Nutrition Installation workers at Dr. H. Moch. Ansari Saleh Banjarmasin Hospital. According to research by Samara and Nasir (2024) also mentioned that the results of bivariate analysis showed a p value of 0.681, where there was no relationship between exercise habits and work fatigue in lecturers of Fikes UIN Syarif Hidayatullah. This can be caused because workers consider that when working is the same as doing sports so it is possible if workers are lazy to do activities such as exercise after work (Tjahayuningtyas, 2019). However, in some studies mention that exercise habits can prevent various kinds of unfavorable conditions such as obesity, where people with obesity will more easily experience fatigue (Li, He and Liu, 2024).

Relationship between Smoking Habit and Fatigue

According to Tarwaka (2014), when workers carry out their work activities which certainly require exertion, they will get tired easily because the oxygen content in the blood is low, carbohydrate burning is inhibited, lactic acid accumulation occurs and fatigue eventually occurs. As well as smoking habits in workers because when someone smokes, the amount of oxygen in the lungs and in the bloodstream becomes less. The oxygen will be replaced by cigarette smoke. Whereas oxygen is very important for health and body activity (Febriyanto, Gunawan and Amalia, 2019).

Based on the Pearson Chi-Square Test, the p-value (p = 0.704) is greater than 0.05 (p-value > 0.05), then H_0 is accepted and Ha is rejected, so it can be concluded that there is no significant relationship between fatigue and smoking habits in sedentary workers at Kalla Group, Makassar, South Sulawesi. The test results are in line with the research of Prakoso, Setyaningsih and Kurniawan (2018) also stated that the results of the Rank Spearman statistical test obtained a probability value between smoking habits and work fatigue of 0.800, which means that there is no relationship between smoking habits and work fatigue in educational staff at X Educational Institution.

Hermawan, Haryono and Soebijanto (2017) show the magnitude of OR = 1, it means that smoking is not a risk factor for occupational fatigue in factory workers of the "SP" aluminum production unit in Yogyakarta City. Especially for workers, smoking can provide positive suggestions which cause when smoking, workers will feel better body condition and can easily concentrate. Smoking also can cause several respiratory problems that can make a smoker feel more easily breathless and tired (Sari and Prasasti, 2020).

Relationship between Staying Up Late and Fatigue

The habit of staying up late can affect the lack of sleep duration, which is the length of time a person sleeps in one day. Inappropriate sleep duration can have a negative impact on workers. Lack of sleep can affect concentration and fatigue. Based on the Pearson Chi-Square Test, the p-value (p = 0.735) is greater than 0.05 (p-value > 0.05), then H_0 is accepted and Ha is rejected, so it can be concluded that there is no significant relationship between fatigue and the habit of staying up late on sedentary workers at Kalla Group, Makassar, South Sulawesi.

The results of this study are in line with the research which states that based on the results of the Chi Square relationship test, the p value is 0.238, which means that there is no significant relationship between sleep duration and work fatigue in mechanics at PT X Plant Jakarta (Triana and Wahyuni, 2017). This can be caused by the ideal length of a person's sleep time depending on the age of each person. On the other hand, although there may be a fair number of workers who go to bed at a fairly late hour, if their total hours of sleep are deep sleep, it can reduce the risk of workers experiencing fatigue the next day (Tesfaye *et al*., 2023).

Relationship between Sitting Time of Day and Fatigue

Tarwaka (2014) explains that static work attitudes for a long time should be avoided to reduce fatigue levels and strive for a more dynamic work attitude so that blood and oxygen circulation can run normally to all limbs. Based on the Pearson Chi-Square Test, the p-value (p = 0.415) is greater than 0.05 (p-value > 0.05), then H0 is accepted and Ha is rejected, so it can be concluded that there is no significant relationship between fatigue and sitting

time in a day on sedentary workers at Kalla Group, Makassar, South Sulawesi.

The results of this study are in line with the results of research by Nugroho, Ulfah and Harwanti (2015) which shows the results of the chi square test obtained a value of $p = 0.156 > \alpha = 0.005$ which indicates that there is no relationship between work attitude and fatigue in laundry workers in the washing section. This can occur because workers have sufficient rest time so that they can allow the body the opportunity to recover by stretching for a moment. In addition, ergonomic work area design also affects fatigue because even though workers are in a sitting work posture if in an ergonomic work environment, it can minimize fatigue in workers (Wennberg *et al*., 2016).

CONCLUSIONS

Based on the results of the research conducted showed that there is a significant relationship between fatigue with muscle strength, there is no significant relationship between fatigue with exercise habits, smoking habits, staying up late habits and sitting time in a day in sedentary workers at Kalla Group, Makassar, South Sulawesi. Suggestions that can be given to sedentary workers in Kalla Group, Makassar, South Sulawesi is that workers need to do light muscle stretching so that workers are not easily tired when working in a static position for a long time. Workers also need to adopt a healthy lifestyle by reducing smoking and consumption of coconut milk and fried foods. Not only that, workers also need to pay attention to sleep time so that they do not develop the habit of staying up late.

ACKNOWLEDGMENTS

We would like to thank Kalla Group, located in Makassar, South Sulawesi, for facilitating the data collection. We would also like to thank the research team from the Faculty of Public Health, Universitas Airlangga, who supported the implementation of this study.

CONFLICT OF INTEREST

The authors declared no potential conflicts of interest with respect to the research, authorship and/or publication of this article.

AUTHOR CONTRIBUTION

SYA conceived this study and did data collection. DRA help to collect the data and analyzed the data with statistical test, BSPI contributed to prepare the instrument of this research, AMA managed the administration when submitting the ethical clearance

REFERENCES

Aprianti, A. and Agustin, D.N. (2018) 'Status Gizi, Kebiasaan Olahraga Dan Masa Kerja Dengan Kelelahan Kerja pada Pekerja (Studi di Instalasi Gizi RSUD Dr. H. Moch. Ansari Saleh Banjarmasin)', *Jurusan Gizi Politeknik Kesehatan Banjarmasin*, 1(2), pp. 39–51.

Cunningham, T. R. *et al*. (2022) 'Work-related Fatigue: A Hazard for Workers Experiencing Disproportionate Occupational Risks', *American Journal of Industrial Medicine*, 65(11), pp. 1913–925. doi:10.1002/ajim.23325.

Farisa, D., Amir, N. and Jafar, M. (2017) 'Evaluasi Kekuatan Otot Lengan Petani Kelapa Sawit Kecamatan Simpang Kanan Kabupaten Aceh Singkil', *Jurnal Ilmiah Mahasiswa Pendidikan Jasmani, Kesehatan dan Rekreasi Fakultas Keguruan dan Ilmu Pendidikan Unsyiah*, 3(2), pp. 105–115.

Febriyanto, K., Gunawan, M.C. and Amalia, N. (2019) 'Hubungan Kebiasaan Merokok dengan Kelelahan Kerja pada Petugas Pemadam Kebakaran Kota Samarinda', *Jurnal Dunia Kesmas*, 8(1), pp. 19-24.

Haetami, M. and Triansyah, A. (2021) 'The Effect of Massage and Active Stretching on Speeding Up Blood Lactic Acid Recovery', *Halaman Olahraga Nusantara (Jurnal Ilmu Keolahragaan),* 4(2), pp. 326-338

Hendrayati, Rowa, S.S. and Mappeboki, S. (2009) 'Gambaran Umum Asupan Zat Gizi, Status Gizi dan Produktivitas Karyawan CV. Sinar Matahari Sejahtera di Kota Makassar', *Media Gizi Pangan*, 7(1), pp. 35-40.

Hermawan, B., Haryono, W. and Soebijanto, S. (2017) 'Sikap, beban kerja dan kelelahan kerja pada pekerja pabrik produksi aluminium di Yogyakarta', *BKM Journal of Community Medicine and Public Health*, 33(4), pp. 213–218.

Ismiarni, H. *et al*. (2017) 'Hubungan Postur Kerja dengan Kejadian Kelelahan Otot Punggung pada Pekerja Mebel Bagian Pengamplasan Di

PT. X Jepara', *Jurnal Kesehatan Masyarakat (e-Journal)*, 5(1), pp. 2356–3346. Available at: http://ejournal-s1.undip.ac.id/index.php/jkm

Kawatu, P. and Lery, F. (2012) *Bahan Ajar Kesehatan dan Keselamatan Kerja*. Manado: FKM-Unsrat.

Li, H., He, W. and Liu, G. (2024) 'Exercise habits and health behaviors on adolescent obesity', *Acta Psychologica*, 245, p. 104199. https://doi.org/10.1016/J.ACTPSY.2024.104199

Medianto, D. (2017) *Faktor-Faktor yang Berhubungan dengan Kelelahan Kerja pada Tenaga Kerja Bongkar Muat (TKBM) di Pelabuhan Tanjung Emas Semarang (Studi pada Pekerja TKBM Bagian Unit Pengantongan Pupuk)*. Undergraduate Thesis. Semarang: Faculty of Public Health Universitas Muhammadiyah Semarang.

Mokosuli, R., Jesephus, J. and Joseph, W. B.S (2016) 'Hubungan Antara Aktivitas Fisik Dengan Kelelahan Kerja Pada Nelayan Di Kelurahan Malalayang 1 Timur Kecamatan Malalayang Kota Manado', *PHARMACON: Jurnal Ilmiah Farmasi*, 5(3), pp. 218-221.

Newton Jr, R. L. *et al* (2013) 'The Energy Expenditure of Sedentary Behavior: A whole Room Calorimeter Study', *PLoS One*, 8(5), pp. 1–6.

Nugroho, G.K.T., Ulfah, N. and Harwanti, S. (2015) 'Hubungan Sikap Kerja Dengan Kelelahan Kerja Pada Pekerja Laundry Di Kecamatan Purwokerto Utara Kabupaten Banyumas', *Jurnal Kesmasindo*, 7(3), pp. 209–217.

Park, J.H. *et al* (2020) 'Sedentary Lifestyle: Overview of Updated Evidence of Potential Health Risks', *Korean Journal of Family Medicine*, 41(6), pp. 365-373.

Prakoso, I.D., Setyaningsih, Y. and Kurniawan, B. (2018) 'Hubungan Karakteristik Individu, Beban Kerja, Dan Kualitas Tidur Dengan Kelelahan Kerja Pada Tenaga Kependidikan Di Institusi Kependidikan X', *Jurnal Kesehatan Masyarakat (e-Journal)*, 6(2), pp. 2356–3346. Available at: http://ejournal3.undip.ac.id/index.php/jkm.

Samara, S.S. and Nasir, N.M. (2024) 'Faktor-Faktor yang Berhubungan dengan Kelelahan Kerja pada Dosen saat Pandemi COVID-19', *Jurnal Ilmu Kesehatan Masyarakat*, 13(2), pp. 110–122.

Sari M.P, and Prasasti, C.I. (2020) 'Overview of Workers' Pulmonary Faal Conditions and Worker Actions at The End of The Final Scrub Industry X Surabaya'. *Indonesian Journal of Public Health*, 15(1), pp. 25-36.

Tarwaka. (2014) *Keselamatan dan Kesehatan Kerja: Manajemen dan. Implementasi K3 di Tempat Kerja*. Surakarta.: Harapan Press.

Tarwaka, Bakri, H.A. and Sudiajeng, L. (2004) *Ergonomi untuk Keselamatan, Kesehatan Kerja dan Produktivitas*. Surakarta: UNIBA Press.

Tesfaye, A. H. *et al.* (2023) 'Prevalence and Associated Factors of Poor Sleep Quality among Industrial Workers in Addis Ababa, Ethiopia: Findings from a Cross-sectional Study', *BMJ Open*, 13(10). Available at: https://doi.org/10.1136/BMJOPEN-2023-073340.

Tjahayuningtyas, A. (2019) 'Faktor Yang Mempengaruhi Keluhan Musculoskeletal Disorders (MSDSs) Pada Pekerja Informal', *Indonesian Journal of Occupational Safety and Health*, 8(1). https://doi.org/10.20473/ijosh.v8i1.2019.1-10

Triana, E. and Wahyuni, I. (2017) 'Hubungan Status Gizi, Lama Tidur, Masa Kerja dan Beban Kerja Dengan Kelelahan Kerja pada Mekanik Di PT X Plant Jakarta', *Jurnal Kesehatan Masyarakat (e-Journal)*, 5, pp. 2356–3346. Available at: http://ejournal3.undip.ac.id/index.php/jkm

Wahyono, H. and Sudibjo, P. (2019) 'Hubungan Status Kebugaran Jasmani dan Status Gizi dengan Produktivitas Kerja Pekerja Pembuat Buis Beton', *Pendidikan Kesehatan dan Rekreasi FIK - UNY* [Preprint]. https://doi.org/10.21831/medikora.v15i2.23203

Wennberg, P. *et al*. (2016) 'Acute Effects of Breaking up Prolonged Sitting on Fatigue and Cognition: A Pilot Study', *BMJ Open*, 6(2), p. e009630. https://doi.org/10.1136/BMJOPEN-2015-009630