Identification of the Direction and Strength of Relationship between Complaints of Musculoskeletal Disorders (MSDs) to Smoking Habits and Repetitive Movements of Informal Workers in Surabaya, Indonesia Using Spearman Correlation Test Methods

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Abstract

The right statistical test to find out the relationship between variables that have ordinal data scale is a spearman correlation test. Spearman correlation shows how strong the relationship and the direction of the relationship between variables. The increasing muscle complaints have a close relationship with smoking habits. The longer and the higher the frequency of people smoke, the smaller the lung capacity. It then results in a decrease in the lung ability to consume oxygen. It also causes one more easily tired when carrying out tasks that require exertion. In addition, complaints due to repetitive movements occur because the muscles continuously receive workload pressure without a chance for relaxation. This condition triggers the occurrence of nerve swelling which will cause pain in the musculoskeletal area. This is an observational study with a cross sectional design. The study used a total sampling population of 12 workers. Spearman correlation is used to examine the strength and direction of the relationship between the dependent variable, MSDs complaints, an ordinal data scale, with independent variables, smoking habits and repetitive movements. This study found that smoking habits and the level of complaints of MSDs in the shelf frame bending workers have fairly strong, positive and unidirectional relationship with correlation coefficient value of 0.357. It also found that repetitive movements and complaint levels MSDs have a positive and perfect relationship with the correlation coefficient value of 1,000.

Keywords*: smoking habits, repetitive movements, complaints of musculoskeletal disorders, spearman correlation*

Introduction

Spearman test is a statistical tool used to test the relationship between variables with ordinal scale data. Spearman correlation method is a method used for ordinal or ranking scale and free of distribution (non-parametric). The Spearman correlation value is between -1 and 1. The coefficient value of 0 indicates that there is no correlation or relationship between independent and dependent variables. The spearman value of 1 indicates that there is a positive relationship between independent and dependent variables and if the value is -1, it indicates that there is a negative relationship between the variables[1].

After the industrial revolution, the development of the industrial sector in Indonesia grew rapidly. This was marked by the development of informal industries. This development occurs because this sector has strong resistance to economic crisis and high absorption capacity of labor. The informal sector is an unorganized and irregular sector, yet many of them were unregistered.

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Complaints often felt by workers are usually in parts of tendons, ligaments and joints. According to the European Agency for Safety and Health at Work, MSDs are one of the occupational related diseases. The Institution of Occupational Safety and Health estimates 553,000 workers in 2014-2015 suffered from musculoskeletal disorders caused by their current or past work. About 223,000 of these workers suffer from back pain. 233,000 of them had problems related to the upper limb and neck and around 97,000 had lower limb problems. As a result of the incident, it was estimated that 9.5 million workdays were lost due to illness in the musculoskeletal area caused by or worsened by work[2].

In his book, Tarwaka suggested that there are several factors that cause complaints of musculoskeletal disorders, such as excessive muscle stretching, repetitive movements, unnatural working attitudes, secondary causes, and combination causative factors[3]. Some experts also argued that individual factors, such as smoking habits, and occupational factors, such as repetitive movements, can also cause musculoskeletal complaints.

The increasing muscle complaints have close relationship with the length and level of smoking habits. The longer and higher the frequency of smoking a worker has, the higher the level of muscle complaints they make. Smoking habits can reduce lung capacity which then makes lungs ability to absorb oxygen decreases. As a result, the body's freshness also decreases. This then makes workers to be easily tired, especially when they carry out tasks that require exertion. The tiredness is because oxygen in the blood is low, burning carbohydrates is inhibited, and lactic acid accumulates, which then leads to the rise of muscle soreness[4].

Repetitive movements are the second main factor causing MSDs complaints. Repetitive motion is a movement that repeats itself at certain intervals. The time interval of the movement may be the same or not the same[5]. Complaints due to repetitive movements occur as the result of continuous workload pressure received by the muscles without the opportunity for relaxation[3]. Repeated movements that are carried out without sufficient relaxation time have the potential to cause nerve damage or swelling, which will cause pain in the musculoskeletal area[6].

Previous research on chronic musculoskeletal pain and smoking habits in Canada stated that, even though the relationship between the two variables is not very strong, chronic back pain is more common in smoking individuals, who smoke every day[7]. Another study conducted on electricians stated that ergonomic factors such as awkward postures, static and repetitive movements were closely associated with the occurrence of musculoskeletal disorders[8].

This study aimed to examine the direction and strength of the relationship between complaints of musculoskeletal disorders with smoking habits and repetitive movements of informal workers using the Spearman correlation test.

Material and Method

This study was an observational study as the data was obtained by interviews and observations without any treatment to the object of research. This study used a cross sectional design as the variables were observed at the same time. Data was analyzed using descriptive statistics, which describes the process by analyzing the direction and strength of relationships between variables.

The population of this study was all workers in the welding section of the informal industry in Surabaya Indonesia, totaling 12 people. The sample in this study used the total sampling method, so the sample was 12 workers. The variables in this study were smoking habits, repetitive movements and musculoskeletal disorders. Only primary data was collected in this study. The data was obtained through interviews, for the variables of smoking habits and complaints of perceived MSDs (Nordic Body Map method), and observations, for the variable of repetitive motion.

The dependent variable in this study was MSDs complaints, which is an ordinal data, while the independent variables were smoking habits and repetitive movements, which were nominal and ordinal data. For the data type of those variables, the right statistical test to use to analyze data iss the Spearman correlation test.

Findings

To obtain data on workers regarding smoking habits, repetitive movements and complaints of MSDs, two methods were used. Interviews were used to collect data on smoking habits and complaints of worker MSDs, while observations were used to collect data about repetitive movements.

MSDs complaint assessment can be done using the Nordic Body Map (NBM) method. The NBM method is a method used to assess the severity of musculoskeletal system disorder (MSDs) occurrence[3]. Some argued that this method is a very subjective assessment method, which means that the successful application of this method depends on the situation and conditions experienced by workers. However, this method has often been used by ergonomists to assess the severity of disorders of the musculoskeletal system and has proven to have fairly good validity and reliability.

This method was proven to be able to assess the level of complaints felt by workers on 28 body parts. It asked the workers to range the degree of pain they felt, ranging from no pain to very pain. The result of body map analysis of workers' complaints was used to determine the level of MSDs complaints.

Tabel 1. Frequency of MSDs Complaints Based on the Body Parts of Informal Workers

No	Part of Body	Percentage of Respondents in Working Position Sitting							
		TS		AS		S		SS	
		N	%	N	%	N	%	N	%
0.	Upper neck	3	25	4	33	3	25	2	17
1.	Lower neck	0	0	4	33	4	33	4	34
2.	Left shoulder	0	0	0	0	5	42	7	58
3.	Right shoulder	0	0	0	0	3	25	9	75
4.	Upper left arm	1	8	1	8	7	59	3	25
5.	Back	0	0	1	8	0	0	11	92
6.	Upper right arm	0	0	2	17	4	33	6	50
7.	Waist	5	41	3	25	2	17	2	17
8.	Bottom	1	8	5	42	5	42	1	8
9.	Hip	1	8	4	34	6	50	1	8
10.	Left elbow	11	92	0	0	1	8	0	0
11.	Right elbow	12	100	0	0	0	0	0	0
12.	Lower left arm	4	33	3	25	4	33	1	9
13.	Lower right arm	4	33	3	25	4	33	1	9
14.	Left wrist	1	8	2	17	9	75	0	0
15.	Right wrist	1	8	2	17	8	67	1	8
16.	Left hand	4	33	5	42	2	17	1	8
17.	Right hand	4	33	5	42	2	17	1	8
18.	Left thigh	5	42	4	33	1	8	2	17
19.	Right thigh	0	0	0	0	0	0	12	100
20.	Left knee	6	50	3	25	3	25	0	0
21.	Right knee	1	8	1	8	2	17	8	67
22.	Left leg	6	50	3	25	3	25	0	0
23.	Right leg	0	0	2	17	2	17	8	66
24.	Left ankle	10	84	1	8	1	8	0	0
25.	Right ankle	0	0	1	8	5	42	6	50
26.	Left foot	11	92	0	0	1	8	0	0
27.	Right foot	4	33	2	17	3	25	3	25

On the table above, TS means not hurt, AS means a little hurt, S means hurt, and SS means very hurt. The table illustrates complaints of the informal workers based on the level of pain from the 28 body parts. The table shows that the pain complaints by informal workers were mostly on the body parts of the left and right shoulder, back, right upper arm, right knee right thigh, right leg, and right ankle. This can be seen from the largest percentage in the complaints category of very pain from 28 body parts.

Table 2. Frequency of MSDs Complaints Levels of Informal Workers Using the NBM Method

Level of MSDs Complaints	Frequency (n)	Percentage (%)
Medium	5	42
High	7	58
Total	12	100

The MSDs complaint level category was divided into several categories, namely low, medium, high and very high. However, the results show that there were no workers whose complaints of MSDs in the level of either low or very high. Therefore, based on Table 1, it is known that the majority of 58% of workers have high levels of MSDs complaints and 42% of workers have moderate levels.

The results on the direction and strength of the relationship between smoking habits and repetitive movements with MSDs complaints can be found in the tables below:

Table 3. Relationship between Smoking Habits and MSDs Complaints Levels of Informal Workers

Smoking habit	Level of MSDs Complaints				Total		Spearmen Coefficient
	Medium		High				
	n	(%)	n	(%)	N	(%)	
Yes	4	36	7	64	11	100	0.357
No	1	100	0	0	1	100	
Total	5	42	7	58	12	100	

The table above shows that the majority of workers who have a smoking habit (64%) are at a high level of complaints of MSDs. Meanwhile, all workers who did not have the smoking habit were at the complaints level of medium category. Data analysis found that smoking habits and MSDs complaint rates in shelf frame bending workers had a strong, positive and unidirectional relationship. This can be seen from the Spearman coefficient of 0.357.

This finding is in line with the research conducted on rock breaker industrial lift-up workers in Karangnongko Sub-district, Klaten which found a positive relationship between smoking habits and musculoskeletal complaints[4]. This is due to the fact that smoking can cause loss of bone mineral content. The pathogenesis is complex, due to direct toxic effects on the activity of osteoblast or nicotine osteoclasts, and indirect effects on sex and adrenocortical hormones, vitamin D, and calcium absorption in the intestines, vessels and oxygen

supply. Smoking can trigger or even worsen the development of rheumatoid arthritis and back pain[9].

Table 4. Relationship between Repetitive Movement and MSDs Complaints Level of Informal Workers

Repetitive Movement	Level of MSDs Complaints				Total		Spearman Coefficient
	Medium		Medium				
	n	(%)	n	(%)	N	(%)	
High	5	42	7	58	12	100	1.000
Total	5	42	7	58	12	100	

Repetitive movements were divided into two categories, namely low (cycle time> 30 seconds) and high (cycle time <30 seconds). However, the results show that there were no respondent with low level of repetitive movements. Table 4 shows that most respondents (58%) with high repetitive movements have high rates of complaints of MSDs. Data analysis found that repetitive movements and complaint levels of MSDs in informal workers in Surabaya had a perfect relationship and positive direction. It is shown by the correlation coefficient of 1.000. This result is in line with research conducted on Ulos weaving workers in South Siantar Sub-district, Pematang Siantar City which found that there was a relationship between repetitive movements and musculoskeletal disorders[10].

Conclusion

There is a fairly strong correlation between smoking habits and MSDs complaints in informal workers in Surabaya, Indonesia. In addition, there is a perfect relationship with a positive direction between repetitive movements with the level of MSDs complaints of informal workers in Surabaya, Indonesia. Workers are recommended to stretch between jobs to reduce pain complaints in some of their body parts and reduce smoking, both in terms of quantity (number of cigarettes) and intensity.

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