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The Effect Of Age, Working Period, Work Position And Whole-Body Vibration On Fatigue On The Impact Of Lower Back Pain On Heavy Equipment Operators In Makassar New Port Development

[1]Andi Yepita Deviyanti, [2]Atjo Wahyu, [3]Yahya Thamrin, [4]Lalu Muhammad Saleh, [5]Stang, [6]Wahiduddin

[1]Master Program in the Department of Occupational Safety and Health, Faculty of Public Health, Hasanuddin University, Indonesia
[234]Department of Occupational Safety and Health, Faculty of Public Health, Hasanuddin University, Indonesia
[5]Department of Biostatistics, Faculty of Public Health, Hasanuddin University, Indonesia
[6]Department of Epidemiology, Faculty of Public Health, Hasanuddin University, Indonesia \

Abstract

Diseases that arise due to work relationships are diseases related to work factors that have a role together with other factors in the development of the disease, one of which is complaints of low back pain. This study aims to determine the effect of age, working period, working position and whole body vibration on fatigue impact on low back pain on heavy equipment operators Makassar New Port construction in 2022. This research is a quantitative research with analytical observational design and cross sectional approach. The population is heavy equipment operators with a total of 32 people and the sampling technique used is exhaustive sampling. The data collection instruments were whole body vibration, reaction timer, rapid entire body assessment (REBA), oswestry disability index (ODI) questionnaire, interviews and observations. Data analysis in this study is using path analysis. The results of the path analysis showed that there was a direct effect of age (p=0,000) and work position (p=0,009) on low back pain and there was an indirect effect of whole body vibration on low back pain (p=0,029). Meanwhile, working period showed no direct and indirect effect on low back pain. Therefore, the company should adjust the work based on the age and physical ability of heavy equipment operators and improve the quality of ergonomics training.

Keywords: Low Back Pain, Fatigue, Whole Body Vibration, Heavy Equipment Operator.

Introduction

The acceleration of infrastructure development by the government is a development of the era of industrialization that is global in nature and has rapid development, such as the construction industry which provides construction services and has a significant role in current development [1]. Work in the construction sector is increasing and growing so that the risk of occupational diseases and accidents also increases, so it is necessary to increase occupational safety and health in an effort to suppress occupational diseases or work accidents, as well as increase productivity.

Construction projects in progress are supported by the use of heavy equipment operated by operators. Heavy equipment is a tool to help humans carry out the work of building large-scale building structures that are run by machines and mechanical work equipment, causing mechanical vibrations that can move throughout the body [2].

Vibration has the potential to cause lower back pain when spending longer time driving or in a work environment that has a vibration hazard [3]. Based on the Regulation of the Minister of Manpower Number 5 of 2018 concerning the threshold value (NAV) of whole body vibration for 8 hours of work is 0.8661 m/s2 [4]. If workers are exposed to vibrations that exceed the NAV, it will cause health problems, namely fatigue. Fatigue that arises in a situation is generally indicated by a loss of will to work. So that muscle fatigue arises which is characterized by tremors or muscle pain [5]. Meanwhile, according to Feuerstein et al that fatigue conditions can cause low back pain [6].

Low back pain (LBP) is a global health problem, which results in activity restrictions and absenteeism from work. Should low back pain not cause death, but cause individuals who experience it to become unproductive [7]. LBP is pain felt in the lower back area that occurs due to musculoskeletal disorders.

At World Health Statistics in 2017, explained that health workers are one of the indicators of achieving SDG's (Suistanable Development Goals) in 2030, WHS in 2017 explained that workers must be protected from dangerous, unsafe and unhealthy conditions in the work environment. Based on data from the U.K. Labor Force Survey (LFS), workers who experienced LBP disorders in 2016/2017 were 590 cases per 100,000 workers. This equates to 194,000 total cases in 2016/2017 (Health and Safety Executive, 2017).

Based on the results of the Basic Health Research (2018), the prevalence of musculoskeletal in Indonesia diagnosed by health workers is 11,9% and based on diagnosis or symptoms is 24,7%. The number of sufferers of low back pain in Indonesia is not known for certain, but it is estimated to be between 7,6% to 37%. Data from the Occupational Health and Sports Program Recording and Reporting System in 2020, South Sulawesi Provincial Health Office that low back pain is the third highest occupational disease after work-related pulmonary TB and dermatitis with 581 cases in South Sulawesi (Sul-Sel Provincial Health Office, 2020).

The effect of age on LBP is related to aging with age including bone regeneration which has an impact on increasing the risk of low back pain. A long working period can affect LBP because it is an accumulation of load on the spine due to monotonous daily activities [7]. The most common causes of LBP are sitting too long, wrong sitting posture, excessive activity and trauma. Jobs that are at risk of LBP are jobs with long working hours and require sitting in a certain sitting position [9].

One of the current efforts of the Makassar City government is to develop the Soekarno-Hatta Port by building the Makassar New Port, which is motivated by the very strategic role of Makassar City as an international port and the largest in Eastern Indonesia [10].

The construction of Makassar New Port was signed by PT. Housing Development (PP) on June 3, 2015. The construction work on the Makasaar New Port during the research was in stages 1B and 1C, which included dockwork and container yards. The types of work for this project include steel frame workers, blacksmiths, masons and heavy equipment operators. Operators of heavy equipment are certainly exposed to vibrations throughout the body due to work activities and as a result, complaints of low back pain arise.

Methods

The type of research used is quantitative research design with analytical observational methods and using a cross sectional study approach. The population used in this study were operators of heavy equipment construction of Makassar New Port Phase 1B 1C and the sampling in this study was exhaustive sampling (total sample). Based on a relatively small population of 32 respondents, the entire population was sampled in this study. Data were obtained using a questionnaire, measuring work position using a rapid entire body assessment (REBA) sheet, measuring whole body vibration using a whole body vibration measuring instrument by the Makassar OSH team, measuring work fatigue using a reaction timer measuring instrument by the Makassar OHS team, and data low back pain using the Oswestry Disability Index (ODI) questionnaire. The collected data were then analyzed univariately and bivariately using the SPSS application and for multivariate analysis

using path analysis with the SmartPLS program.

Results and Discussion

Univariate Analysis

Table 1. Characteristics of Heavy Equipment Operators Based on Low Back Pain Makassar New Port Development in 2022

Research Variables	Low Back Pain				Total	
	Experience		Not Experiencing			
	n	%	n	%	n	%
Age						
Old (≥ 35 Years Old)	18	94,7	1	5,3	19	100
Young (<35 Years Old)	5	38,5	8	61,5	13	100
Working Period						
Duration (≥ 3 Years)	21	80,8	5	19,2	26	100
New (< 3 Years)	2	33,3	4	66,7	6	100
Work Positions						
No Ergonomic (REBA >4)	14	60,9	9	39,1	23	100
Ergonomics (REBA 1-4)	9	100,0	0	0,0	9	100
Whole Body Vibration						
Eligible (≥NAV)	3	100,0	0	0,0	3	100
Ineligible (<NAV)	20	69,0	9	31,0	29	100
Fatigue						
Tired (≥ 240 m/s)	20	87,0	3	13,0	23	100
Not Tired (< 240 m/s)	3	33,3	6	66,7	9	100

Source: Primary Data, 2022

Table 1 shows that the age category of respondents is more in the old heavy equipment operator, namely 19 (59,4%) compared to the young category as many as 13 (40,6%), for the most heavy equipment operator service period with a long working period of 26 respondents (81,2%) compared to the new tenure of 6 respondents (18,8%), for the most heavy equipment operator work positions with non-ergonomic work positions as many as 23 respondents (71,9%) compared to ergonomic work positions as many as 9 respondents (28,1%), also obtained 3 respondents (9,4%) who experienced whole body vibration intensity exposure that met the requirements (≥ NAV that is 0,8661 m/s2) and as many as 29 respondents (90,6%) who experienced total body vibration intensity exposure that did not meet the requirements (< NAV < 0,8661 m/sec2) and most of the heavy equipment operators experienced low back pain as many as 23 respondents (71,9%) and who did not experience low back pain as many as 23 respondents. 9 respondents (28,1%).

Bivariate Analysis

The results of the cross tabulation in Table 1 show that heavy equipment operators with a sample of 32 old heavy equipment operators experienced more low back pain, namely 18 respondents (94,7%) than young heavy equipment operators who experienced low back pain as many as 5 respondents (38,5%). For the long tenure, 21 respondents (80,8%) experienced lower back pain compared to 2 respondents (33,3%). Then, heavy equipment operators with non-ergonomic work positions experienced more low back pain, namely 14 respondents (60,9%) compared to 9 respondents (100,0%). Whole body vibration intensity does not meet the requirements (< NAV that is < 0,8661 m/sec2) more than 20 respondents (69,0%) experience lower back pain than those who meet the requirements (≥ NAV that is 0,8661 m/sec2) as many as 3 respondents (100,0%). Also, those classified as tired experienced more low back pain as many as 20 respondents (87,0%) than those who were not tired as many as 3 respondents (33,3%).

Multivariate Analysis

Table 2. Multivariate Analysis Based on Line Analysis on Heavy Equipment Operators of the Makassar New Port Development in 2022

Influence Between Variables	*Estimate*	*P Value*	Conclusion
Age ✍ Fatigue	,800	,424	Not Significant
Age ✍ Low Back Pain	13,311	,000	Significant
Work Period ✍ Fatigue	,128	,898	Not Significant
Working Period ✍ Low Back Pain	,843	,400	Not Significant
Work Position ✍ Fatigue	,851	,395	Not Significant
Work Position ✍ Low Back Pain	2,625	,009	Significant
Whole Body Vibrations ✍ Fatigue	2,188	,029	Significant
Whole Body Vibration ✍ Low Back Pain	,661	,509	Not Significant
Fatigue ✍ Low Back Pain	2,359	,019	Significant

Source: Primary Data, 2022

Table 2 shows that there is no relationship between age and fatigue (p value = 0,424), there is a relationship between age and low back pain (p value = 0,000), there is no relationship between years of service and fatigue (p value = 0,898), years of service with low back pain (p value = 0,400), work position with fatigue (p value = 0,395), there is a relationship between work position and low back pain (p value = 0,09), whole body vibration with fatigue (p value = 0,029), whole body vibration with low back pain fatigue (p value = 0,509), and there is no relationship between whole body vibration and low back pain and there is no relationship between fatigue and low back pain (p value = 0,019).

The Effect of Age on Fatigue Its Impact on Low Back Pain Complaints

Field data shows that the oldest heavy equipment operator is 56 years old and the youngest is 26 years old. Based on the crosstab of age and low back pain variables using a questionnaire research instrument, many heavy equipment operators in the old age category experienced low back pain, as many as 18 respondents (94,7 %).

Based on the results of the path analysis showed that there was a direct effect of age on low back pain with p = 0,000 < 0,05. But there is no direct effect between the results of the analysis between age and fatigue with the results of statistical tests obtained p = 0,424 and fatigue on low back pain obtained p = 0,019 which indicates that there is a direct effect of fatigue on low back pain. It was concluded that there was a direct effect of age on low back pain but no indirect effect of age on low back pain through fatigue.

The direct influence of age on low back pain occurs because the size of the work area is not adjusted based on the age of the heavy equipment operator but the work experience of the heavy equipment operator. Thus, operators of heavy equipment in the old category are very likely to experience low back pain. This is because muscle strength weakens with age. In line with research conducted by Quarterly, (2019) also shows that there is a significant relationship between age and the incidence of low back pain (LBP). Likewise, Kurniati's research showed that there was a significant relationship between age and complaints of low back pain in heavy equipment operators [11].

This study shows that there is no indirect effect of age on low back pain through fatigue. This is because the age of heavy equipment operators is in a relatively homogeneous age range. In addition, the level of experience and emotion of the old category heavy equipment operator is more stable at work. However, the condition that is old will be directly proportional to the physical condition that also declines and gets tired quickly. According to Lewa's research that age can affect a person's health condition [12]. The older a person is, the higher the risk of experiencing a decrease in the elasticity of the bones and triggering symptoms of low back pain. So that muscle strength weakens as a person age.

The Effect of Working Period on Fatigue Its Impact on Low Back Pain Complaints

Working conditions at PT. PP (Persero) Makassar New Port development is dominated by heavy equipment operators with a long

working period who experience low back pain as much as 21 (80,8%). Based on path analysis, it shows that there is no direct effect of working period on complaints of low back pain where the results of statistical tests obtained p value = 0,400 also during work period on fatigue it is found that there is no direct effect with p value = 0,898. So it can be concluded that there is no direct and indirect effect of working period on complaints of low back pain through fatigue.

The results of the study found that there was no direct effect of tenure on low back pain in line with research conducted by [13] that there is no relationship between tenure and low back pain. In addition, the research by [14] identified that there was no significant relationship between tenure and the risk of low back pain complaints. The same thing is explained in a study conducted by [15] which shows that there is no significant relationship between tenure and the prevalence of low back pain (LBP).

However, this is in contrast to the research conducted by [16] regarding full-body vibrations and years of service related to low back pain in heavy equipment operators in mining. experienced. So that by modifying exposure tends to reduce the effect of working time on low back pain.

In this study, apart from a direct non-significant effect, the indirect effect of working time on low back pain through fatigue was also not found in this study. This is in line with Yogisusanti's research, that there is no significant relationship between working period and fatigue. The longer a person works, the more exposed to the dangers posed by the work environment. In addition, we basically know that the longer a person works, the more tired they will feel and the chances of body pain will arise [17]. However, in this study, there is a difference between the theory and the results of the study, which assumes that one sample with another has a working period that is not much different. Based on the researcher's observation that only a small part of the sample is a relatively new operator. So that operators who are included in the long service period experience a good adaptation process with their work so that respondents can have a positive effect that can reduce muscle tension and can increase activity or performance at work.

Effect of Work Position on Fatigue Impact on Complaints of Low Back Pain

Based on the results of research that has been done on heavy equipment operators, there are more heavy equipment operators with non-ergonomic categories and experiencing low back pain as many as 14 respondents (60,9%). This is because muscle strength is getting weaker if the position when working is not ergonomic and takes place continuously.

Based on the results of the path analysis, the results showed that there was a direct effect of work position on complaints of low back pain with p = 0,009 <0,05. While there is no direct effect between work position on fatigue with statistical test results obtained p = 0,395 and fatigue on low back pain obtained p = 0,019 which indicates that there is a direct effect of fatigue on low back pain. Through the results above, it can be concluded that there is a direct effect of work position on low back pain but no indirect effect of work position on low back pain through fatigue.

In this study, there is a direct effect of working position with complaints of low back pain due to a working position with a static sitting posture and heavy equipment cabin or a limited work area making it difficult to stretch due to continuous work. Decreasing pain while resting, changing body posture by stretching. Because it can make the muscles of the body tend to relax [18]. In addition, some heavy equipment operator seats are no longer suitable, and cabin conditioning facilities are not functioning so that over time the operator will experience pain in the lower back area. This can have a negative impact on the lives of these workers and the company. In Thamrin's research regarding work ergonomics, it is better to apply ergonomic rules and principles by redesigning work tools that are not suitable for use [19].

From these results it can be seen that the less ergonomic a person's work position is, the greater the risk of low back pain. This is in line with Sifai's research which shows that a risky sitting position can come from the work environment itself and cause low back pain [20]. In addition, Jung's research that after a long time working in a sitting position and with a stooped state can increase the risk of experiencing discomfort in the back [21]. As

well as research by Thamrin that the work position is significant to the occurrence of complaints of musculoskeletal disorders [22].

Sitting position can cause fatigue in the abdominal and waist muscles, and increase pressure on the spine. This dysfunction arises due to an imbalance between the abdominal muscles and the pelvic muscles that support the spine [23]. Based on this theory, it is inversely proportional to this study that there was no indirect effect of work position on low back pain through fatigue. According to the researcher's observations, this happens because of other things outside the variable, namely physical activity. Physical activity is an activity that involves muscle activity over a certain period of time. Sufficient and routine physical activity can help prevent fatigue at work.

The Effect of Whole-Body Vibration on Fatigue Its Impact on Low Back Pain Complaints

Based on the measurement results of whole-body vibration on heavy equipment operators, the highest intensity value using a whole-body vibration meter is 0,2735 m/s2 and the lowest value for whole body vibration intensity on heavy equipment operators is 0,0697 m/s2. The test results in Table 1 show that operators of heavy equipment who are exposed to whole body vibrations exceed the threshold value and experience low back pain as many as 3 operators. Meanwhile, heavy equipment operators were exposed to whole body vibration less than the threshold value with complaints of low back pain as many as 20 operators.

Based on the results of path analysis in Table 2, it is found that there is no direct effect of whole-body vibration with complaints of low back pain with statistical test results obtained p = 0,509 > 0,05. But there is a direct effect of whole-body vibration with fatigue with a p value = 0,029 and fatigue has a direct effect on low back pain with a p value = 0,019. So, there is an indirect effect of whole-body vibration on low back pain through fatigue.

In this study, there was no direct effect of whole-body vibration on back pain. This does not agree with the research of [24] regarding factory machine operators that there is a significant relationship between low back pain and exposure to whole body vibration on operators with mechanical machine shocks. Research by [26] that the intensity of vibration exposed to heavy equipment operators is significant with the occurrence of low back pain that exceeds the NAV. In addition, there are laboratory studies that prolonged exposure to whole-body vibrations can increase physical fatigue and mental fatigue which are common problems [26].

Based on the differences in research results and the theory that vibration has the potential to cause low back pain, it is assumed that the sample is limited so that the sample selection process is not based on the same type. However, there is an indirect effect of whole body vibration on low back pain through fatigue. Based on the observations of the researchers, this is because there are other factors that influence the occurrence of low back pain in the form of a relatively long working time for quite heavy work, when working heavy equipment operators are exposed to vibrations continuously and are required to always be in top condition, this triggers the emergence of fatigue. So that the vibration of the whole body can affect low back pain if there is an intervening variable, namely fatigue.

Conclusion

Based on the results of the study, it was concluded that there was a direct effect of age and work position on low back pain and there was an indirect effect of whole body vibration on low back pain. Meanwhile, working period showed no direct and indirect effect on low back pain.

Limitations of the Research

This study has a limited number of 32 research subjects so that researchers process data using the SmartPLS program. In the use of SmartPLS the distribution of data cannot be known with certainty, but bootstrapping is a solution to assess the level of significance. In the process of selecting the research sample, the researcher did not choose the same type of heavy equipment so that there could be bias in the results of the whole body vibration measurement.

Statement of Ethics

Health Research Ethics Commission, Faculty of Public Health, Hasanuddin University on March 10, 2022 with the number: 2508/UN4.14.1/TP.01.02/2022.

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