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The Effect of Work Duration and Spinal Trauma on Low Back Pain in the Warship Production Support Departement

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ABSTRACT Low back pain (LBP) is recognized as one of the prevalent occupational ailments that can significantly influence work productivity. Within the Warship Division Production Support Department, employees have reported instances of low back pain following prolonged periods of working in a seated position, slightly bent over computer screens, for approximately 8 hours daily, in a routine manner. This study aims to analyze the correlation between the duration of work and the occurrence of spinal trauma in relation to the prevalence of low back pain. Conducted in an analytic observational framework with a cross-sectional approach, this research encompasses all personnel within the Production Support Department, comprising a sample size of 39 workers. Statistical analysis of the data was conducted employing the Fisher's Exact Test. The study outcomes indicate that 71.8% of the workers experienced LBP characterized by minimal disability, whereas the remaining 28.2% reported LBP associated with moderate disability. The study also found that the majority of workers had a moderate work duration (4-5 hours/day) (35.9%), had no spinal trauma (76.9%), and complained of LBP with minimal disability (71.8%). The statistical analysis demonstrated a significant correlation between work duration (p -value = 0.028) and spinal trauma (p -value = 0.000) with the occurrence of LBP. In order to mitigate the LBP, workers are advised to attentively address the relevant risk factors present in their workplace. This proactive approach aims to minimize the incidence of LBP arising from their routine tasks.

INDEX TERMS Low Back Pain; Work Duration; Spinal Trauma

I. INTRODUCTION

Persistent Low Back Pain (LBP) lasting for more than a day can lead to numbness or leg pain. Complaints of LBP can restrict their ability to work and maintain their health [1]. The Global Burden of Disease (GBD) in 2010 stated that LBP is one of the largest burdens of infection and injury with a higher number of Disability-Adjusted Life Years (DALYs) than HIV, road injuries, TB, lung cancer, chronic obstructive pulmonary disease, and complications of premature birth [2].

According to the World Health Organization (WHO), LBP occurs annually in 2-5% of workers in industrialized countries. Poor work posture accounts for up to 90% of back pain cases [3]. Based on the Basic Health Research results in 2018, the prevalence of LBP in Indonesia varies from 7.6% to 37% [4]. The high prevalence of LBP in Indonesia places this condition second only to influenza [5]. Findings from a national study conducted in May 2002 at 14 teaching

hospitals by PERDOSSI (Indonesian Association of Neurological Specialists) indicated that 45% of 1,598 individuals experienced lower back pain [6].

LBP holds significant implications for morbidity and incapacity across numerous nations. It possesses the potential to influence personal, physical, social, and psychological dimensions, thus leading to escalated expenditures for enterprises, governmental bodies, and the community [7]. Factors that can influence work-related LBP complaints are individual factors (age, gender, body mass index, physical activity, and stress) and occupational factors (work duration, length of service, and workplace design) [8]. According to Andini (2015), the factors influencing LBP can be divided into three categories: individual factors (age, gender, body mass index, length of service, smoking habits, educational history, income level, physical activity, and history of spinal trauma), occupational factors (workload,

work position, repetition, and work duration), and physical environmental factors (vibration and noise) [9].

The Production Support Department is one of the departments within the Warship Division, working within office spaces to carry out tasks related to employee salary disbursement, tracking employee hours (work hours, overtime hours, and absentee hours), employee permits, and material requisitions in the shipbuilding process. Workers in the Warship Division Production Support Department also have other job responsibilities besides working in a seated posture in front of computers; they also visit production areas to ensure that every task within those spaces is proceeding smoothly and without shortages of production materials or personal protective equipment (PPE) for the workers.

The initial observation results in the Warship Production Support Department indicate that the daily workers sit, bend, and face the computer with a duration ranging from 1.5 to 8 hours each day, and not all chairs are adjustable in height and backrest. This condition is evident from interview findings, which revealed that 66.67% of workers complained of LBP after working.

This research is undertaken to address the insufficient studies on the specific occupational factors contributing to LBP among workers in the Warship Production Support Department. The purpose of this research is to address the following questions: (1) Is there a correlation between the duration of employment and LBP among workers in the the Warship Production Support Department? (2) Is there a correlation between spinal trauma and LBP among workers in the Warship Production Support Department?.

This paper is structured as follows: Section I consists of an introduction, including the background and context of the research problem, the rationale and significance of the study, research questions or hypotheses, and a brief outline of the paper's structure. Section II describes the methodology of the study, including the research design, sample, data collection, and data analysis. Section III presents the results of the data analysis and the statistical tests. Section IV discusses the findings and their implications, as well as the limitations and suggestions for future research. Section V concludes the paper and provides some recommendations.

II. METHODOLOGY

This research employs an analytic observational method with a cross-sectional approach. The selection of a cross-sectional design is motivated by the need to capture a snapshot of the variables under investigation at a specific point in time. This design allows for the examination of relationships and patterns within a homogeneous sample, providing a comprehensive understanding of the research objectives. The study was conducted at the Warship Division Production Support Department from January to June 2023.

The target population comprises all workers in the Warship Division Production Support Department. The sample size for this study was 39 respondents, selected through the application of the Slovin formula. The respondents were chosen using a simple random sampling

technique, employing the lottery method. The study incorporates both primary and secondary data. Primary data were gathered through observations and interviews utilizing a questionnaire. The questionnaire aimed to ascertain the respondents' work duration, spinal trauma, and the level of LBP, which was measured using the Oswestry Disability Index (ODI) questionnaire. The questionnaire was distributed in person, and respondents were provided with clear instructions on how to fill out the questionnaire. The questionnaire distributed in this study amounted to 39, and all of them were successfully completed by the respondents, resulting in a response rate of 100%. The response rate is calculated by dividing the number of filled questionnaires by the total number distributed. This calculation provides insights into the sample representation and the extent to which the collected data reflects the population.

Secondary data encompassing the company's general description, workforce composition, and types of work were obtained directly from the company records. The collected data underwent processing and analysis using the Fisher Exact Test statistic, with a significance level of 5% set as the threshold for testing. The Fisher Exact Test is employed as a statistical tool due to its appropriateness for analyzing categorical data, especially in situations where sample sizes are small. This method is well-suited for detecting associations or differences between groups when dealing with nominal data, providing a robust and reliable means of drawing conclusions from the collected data. The application of the Fisher Exact Test ensures the validity and accuracy of the statistical analyses performed in this study. Fisher Exact Test used because there is an expected frequency of less than 5 more than 20% in the cells after being compressed into a 2x2 table.

This research has undergone an ethical review process by the Research Ethics Committee of Health (RECH) at the Surabaya Health Polytechnic, with Approval No.EA/1588/KEPK-poltekkes_Sby/V/2023.

III. RESULT

Based on **TABLE 1** and **FIGURE 1**, it can be observed that 33.30% of workers have a short work duration, while 35.90% of workers have a moderate work duration, and the remaining 30.80% have a long work duration. The research results in the Warship production support department are presented in the tables and figures.

TABLE 1
Frequency Distribution of Workers Based on Work Duration

Work Duration Category	n	%
Short: < 4 hours/day	13	33,30
Moderate: 4-5 hours/day	14	35,90
Long: > 5 hours/day	12	30,80
Total	39	100,0

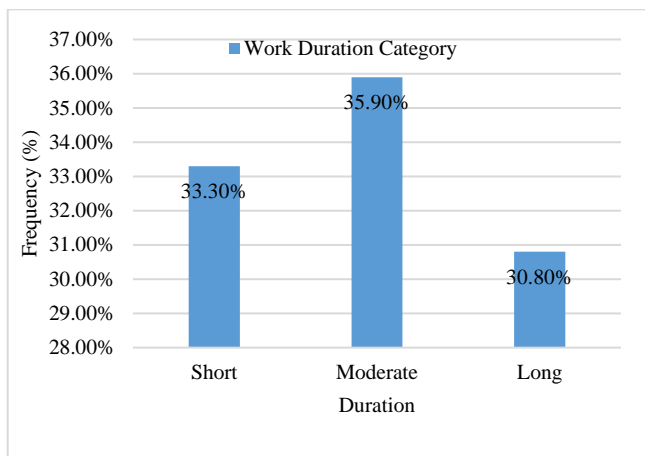


FIGURE 1. Frequency Distribution Diagram of Workers Based on Work Duration

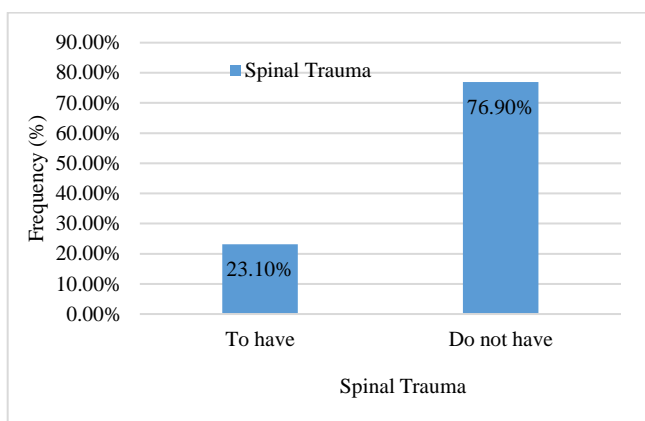


FIGURE 2. Frequency Distribution Diagram of Workers Based on Spinal Trauma

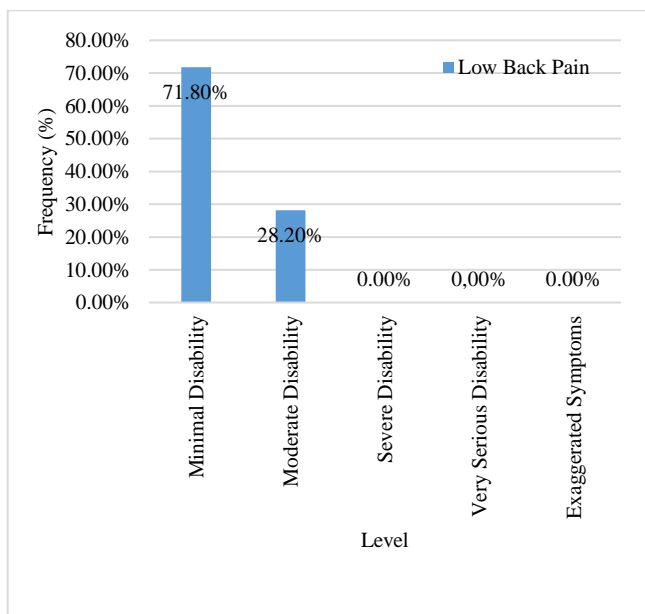


FIGURE 3. Frequency Distribution Diagram of Workers based on Low Back Pain

TABLE 2
 Frequency Distribution of Workers Based on Spinal Trauma

Spinal Trauma	n	%
To have	9	23,1
Do not have	30	76,9
Total	39	100,0

Based on TABLE 2 and FIGURE 2, it can be observed that 23.1% of workers have a spinal trauma, while 76.9% do not have a spinal trauma.

TABLE 3
 Frequency Distribution of Workers based on Low Back Pain

Low Back Pain	n	%
Minimal Disability	28	71,8
Moderate Disability	11	28,2
Severe Disability	0	0
Very Serious Disability	0	0
Exaggerated Symptoms	0	0
Total	39	100,0

Based on TABLE 3 and FIGURE 3, it can be seen that 71.8% of workers reported experiencing Low Back Pain (LBP) with minimal disability, while 28.2% reported LBP with moderate disability. Based on TABLE 4, it can be observed that workers with short work durations (< 4 hours/day) who complain of minimal disability LBP amount to 46.2%, while 53.8% experience moderate disability LBP. Among workers with moderate work durations (4-5 hours/day), 92.9% report minimal disability LBP, while 7.1% experience moderate disability LBP. Workers with long work durations (> 5 hours/day) who experience minimal disability LBP account for 75%, while 25% experience moderate disability LBP. Based on these results, it can be concluded that moderate disability LBP is mostly experienced by workers with short work durations. Based on the results of the statistical test using Fisher's Exact Test, a p-value of 0.028 (≤ 0.05) was obtained, which can be interpreted as indicating that work duration influences LBP among workers in the Production Support Department of the Warship Division.

Based on TABLE 5, it can be observed that among the group of workers with a spinal trauma who reported minimal disability due to LBP, the percentage is 11.1% of workers, while 88.9% of workers reported moderate disability due to LBP. On the other hand, among the group of workers without a spinal trauma, 90% of workers reported minimal disability due to LBP and 10% of workers reported moderate disability due to LBP. Descriptively, it can be concluded that Workers with a spinal trauma are 8 times more likely to report moderate disability due to LBP compared to workers without

TABLE 4
 The Influence of Work Duration on Low Back Pain

Work Duration	Low Back Pain										Total		α	P Value
	Minimal Disability		Moderate Disability		Severe Disability		Very Serious Disability		Exaggerated symptoms		Σ	%		
	Σ	%	Σ	%	Σ	%	Σ	%	Σ	%				
Short	6	46.2	7	53.8	0	0	0	0	0	0	13	100	0.05	0.028
Moderate	13	92.9	1	7.1	0	0	0	0	0	0	14	100		
Long	9	75	3	25	0	0	0	0	0	0	12	100		
Total	28	71.8	11	28.2	0	0	0	0	0	0	39	100		

TABLE 5
 The Influence of Spinal Trauma on Low Back Pain

Spinal Trauma	Low Back Pain										Total		α	P Value
	Minimal Disability		Moderate Disability		Severe Disability		Very Serious Disability		Exaggerated symptoms		Σ	%		
	Σ	%	Σ	%	Σ	%	Σ	%	Σ	%				
To have	1	11.1	8	88.9	0	0	0	0	0	0	9	100	0.05	0.000
Do not have	27	90	3	10	0	0	0	0	0	0	30	100		
Total	28	71.8	11	28.2	0	0	0	0	0	0	39	100		

a spinal trauma. Based on statistical analysis using Fisher's Exact Test, a p-value of 0.000 (≤ 0.05) was obtained, indicating that a spinal trauma significantly influences LBP among workers in the Production Support Department of the Warship Division.

IV. DISCUSSION
A. LOW BACK PAIN

Low back pain (LBP) represents a prevalent issue that results in discomfort, impairment, as well as difficulties with walking and maintaining balance [10]. Occupational low back pain commonly arises due to being exposed to elements like engaging in heavy lifting, performing work tasks involving forward bending, adopting incorrect postures that strain the waist and body, and encountering unfavorable working conditions. This often leads to injuries [11].

Minimal and moderate disability low back pain experienced by workers in the Production Support Department is a result of their daily sitting, bending, and facing the computer. The number of workers who complain of low back pain with minimal disabilities exceeds those who complain of low back pain with moderate disabilities. SungKyun (2020) also stated that an increasing number of workers who extensively utilize computers in their daily activities have reported experiencing low back pain accompanied by minor disability [12].

Complaints in the musculoskeletal system can be caused by excessive muscle stretching, unnatural working postures, and repetitive activities. Unnatural working postures or abnormal postures, such as bending, squatting, and lifting objects above shoulder level, can affect the musculoskeletal system. The further the position of body parts from the center of gravity, the higher the risk of complaints in the skeletal muscles [13]. According to the World Health Organization (WHO), low back pain is a term used to describe pain experienced in an anatomical area that is affected, with

varying degrees of pain intensity. This discomfort may be localized, radiating, or a combination of both. The lumbosacral region (between the lowest rib and the fold of the buttocks) is the location where this pain is felt. Discomfort may extend to the limbs and legs [14].

Physical therapy is the frequently employed form of non-invasive remedy for lumbar discomfort. Multiple systematic evaluations have affirmed that physical activity is beneficial for spinal well-being. Furthermore, these reviews underscored the efficacy of exercise therapy in addressing prolonged instances of lower back pain [15]. If left untreated, low back pain can lead to health issues and disrupt workers' job performance, thereby potentially reducing work productivity. Therefore, a problem-solving approach is needed, involving performing several stretching movements such as walking in place for 3-5 minutes or warming up by stretching muscles in the arms, neck, waist, and shoulders to prevent muscle tension during work intervals.

B. WORK DURATION

The research findings indicate that workers complaining of moderate disability due to LBP are more prevalent among those with short work durations (< 4 hours/day). However, statistical tests reveal that work duration significantly affects low back pain in workers with a p-value of 0.028 (≤ 0.05).

This can occur due to a workspace design that is not aligned with the workers' conditions, such as: chair height, backrest, armrest, and seat width that are not adjusted to the workers' body conditions when engaging in prolonged computer use tasks. Work duration refers to the time of exposure to risk factors experienced during work activities. Work duration significantly affects the risk of low back pain, as working in an awkward position and sustaining it for more than 10 seconds can elevate the risk of low back pain, subsequently impacting a decrease in work productivity [9]. Prolonged sitting in a static position while working exerts

pressure on specific spinal areas, leading to acute discomfort. Abnormal and prolonged muscle compression depletes muscle energy supply, resulting in muscle fatigue and potentially giving rise to pain [16].

The findings of this study are consistent with the research by Annamyra and Simanjorang (2023) who found a correlation between the sitting duration of KB Bukopin Bank employees and low back pain [17]. This study is also in line with the research by Devira et al. (2021), who discovered a connection between the work duration of seamstresses in Nagari Simpang Kapuak, Lima Puluh Kota Regency, and complaints of low back pain [18]. SoungKyun (2020) said that computer use time affects the back depression incentive, and many studies report that computer use time depression affects. The use of computers for more than 4 hours has a significant effect on the risk of experiencing low back pain. The risk of low back pain among workers who use computers for more than 4 hours is 0.005 times higher [19].

This study contradicts the research conducted by Harahap et al. (2019), which did not find a relationship between work duration and LBP complaints among traditional batik artisans in the Pelayangan Sub-district [20]. The research by Sumantra and Novendy (2022) also states that sitting duration is not related to the prevalence of lower back pain among employees of the Central Statistics Agency (BPS) of Bali Province [21]. It is also in contrast to the study by Cahyani et al. (2020), which stated that there is no relationship between sitting duration and complaints of back pain among employees of the University of Jember library [22].

The presence of the influence of work duration on LBP among workers in the Support Production Department of the Warship Division indicates the importance of engaging in active rest to avoid prolonged static positions, as well as to alleviate muscle tension resulting from work, in an effort to prevent work fatigue, regain mental clarity, enhance work productivity, and reduce musculoskeletal complaints, especially LBP [23]. Rest can be achieved by performing muscle stretches such as standing and walking around the workspace for 3-5 minutes, or by stretching the muscles of the arms, shoulders, neck, and waist to reduce the risk of increasing the level of LBP disability.

C. SPINAL TRAUMA

The research results indicate that workers with a spinal trauma are 8 times more likely to complain of moderate disability due to LBP. This is supported by the statistical test results which show that there is an influence of spinal trauma on workers' LBP with a p-value of $0.000 (\leq 0.05)$.

This can occur because workers who maintain awkward positions for prolonged periods of time can further exacerbate damage to the spinal structures due to prior trauma. Research findings indicate that the majority of spinal trauma histories among workers are caused by slipping while walking, falling from heights, and past motor vehicle accidents. A history of spinal trauma is one of the risk factors for Low Back Pain (LBP) arising from structural damage to

the spine that can lead to persistent pain [9]. Severe physical trauma history, such as pain from falling from heights or motor vehicle accidents, continuous and progressive pain without movement, abdominal or chest pain, or both, can also give rise to LBP [24]. Spinal disorders like lordosis, kyphosis, and scoliosis, along with a history of injuries and inflammation in the spine, are also among the risk factors that can heighten LBP complaints [25].

This study is in line with the research by Alnaami et al. (2019), which confirms that healthcare workers with a positive history of back trauma in the form of excessive trauma, falls, and frequent heavy lifting have a higher risk of experiencing LBP [26]. History of low back injury is one of the factors that are significantly associated with low back pain in male and female workers who work using computers [27].

The research results revealing the influence of spinal trauma on LBP among workers in the Production Support Department of the Warship Division highlight the need for caution on the part of both workers and the company to avoid and minimize all risk factors that could exacerbate or worsen the condition. The company should provide break times during work activities for stretching exercises to relax muscles and maintain worker fitness. Break times can be utilized for muscle stretching, such as standing and walking around the workspace for 3-5 minutes, in order to reduce the risk of increasing the disability level of workers with LBP.

Moderate disability LBP among workers with a of spinal trauma in the Warship Support Department can be managed by considering requirements related to spinal trauma in the recruitment of new employees as an effort to prevent a decline in work productivity.

The limitations of this study lie in the relatively small size of both the population and the sample, which may impact the generalizability of the findings. The quality of the data in this research is also a potential limitation due to various factors such as respondents' responses and answers when filling out the questionnaire, which may not accurately reflect their actual conditions. This discrepancy could potentially affect the accuracy of the research results. Additionally, the measurement of the level of low back pain disability, conducted solely through the distribution of questionnaires, is another limitation in this study. This approach may render the results regarding the disability levels of workers less relevant.

Researchers are encouraged to conduct further studies incorporating additional variables such as body mass index (BMI), length of employment, smoking habits, physical activity, workload, as well as workplace vibrations and noise. This is to identify the most influential risk factors for low back pain complaints among employees in the Warship Division Support Department of PT. PAL Indonesia. It is also hoped that future researchers will continue the study using nationally standardized ergonomic assessment tools, such as the Musculoskeletal and Ergonomic Disorders Questionnaire (GOTRAK), to ensure more accurate and reliable assessments of work postures.

V. CONCLUSION

The conclusion drawn from this research is that both work duration (p-value = 0.028) and spinal trauma (p-value = 0.000) exert a significant influence on the occurrence of low back pain (LBP) among workers in the Warship Division Production Support Department. These findings highlight the importance of investigating additional variables in future research, such as body mass index (BMI), years of work experience, smoking habits, physical activity level, workload, as well as vibration and noise exposure within the workplace. Such investigations are crucial to pinpoint the most influential risk factors contributing to LBP. It is strongly recommended that workers remain vigilant regarding these LBP risk factors within their workplace, as this vigilance can effectively mitigate the incidence of LBP arising from daily occupational tasks.

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