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The Relationship of Lifting Position with Low Back Pain Complaints Based on the National Institute for Occupational Safety and Health (NIOSH) Lifting Equation in Transport Workers at Kalimas Port Manado

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Abstract
Introduction: *Low back pain is one of the health problems that is often experienced by workers, especially in transport workers who often do heavy lifting. According to WHO, low back pain occurs in 2% to 5% of employees in developed countries every year and causes 15% of work absenteeism, especially in the steel industry and trade sectors.* ***Objective:*** *The purpose of this study was to determine the relationship between weight lifting position and low back pain complaints based on the NIOSH Lifting Equation in transport workers at Kalimas Port Manado.* ***Methods:*** *The study was conducted with observational analytic research using cross sectional design. Then analysed using IBM SPSS software with spearman statistical test.* ***Results:*** *The results showed that most workers experienced low back pain with varying intensity. A significance value of 0.044 ($p<0.05$) was obtained.* ***Conclusion:*** *There is a relationship between the position of lifting the load with complaints of low back pain based on the NIOSH Lifting Equation in transport workers at Kalimas Port Manado*

Keywords: Low Back Pain; NIOSH; Lifting Equation; Weight Lifting Position; Nordic Body Map;

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Introduction

A health problem often experienced by workers, especially those related to musculoskeletal system disorders, is low back pain (LBP) (Sahara & Pristya, 2020). This condition is characterized by pain in the lumbar and lumbosacral areas that is local, radicular, or a combination of both, thus interfering with daily activities (Muheri, 2010), (Pristianto, Septiawan, Putri, & Meitriyana, 2023). Work is one of the main factors causing LBP, with prevalence reaching 50-80% in industrialized countries. According to the World Health Organization (WHO), about 2% to 5% of employees in developed countries experience LBP every year, leading to 15% absenteeism, especially in the industrial and trade sectors (Maizura, 2015)

In Indonesia, LBP is also a serious problem in the informal sector. Based on data from the Ministry of Health, the prevalence of LBP is found in various physical occupations, such as oil palm farmers (31.6%), leather puppet craftsmen (21%), and mining workers (16%) (Heriyanto, 2004) at (Purba, Sipayung, & Syapitri, 2019). Most major cases of LBP are caused by incorrect body positioning while working, especially when lifting heavy loads (Harwanti, Ulfah, & Nurcahyo, 2018). Manual handling that involves carrying and transporting loads is often the main cause of injury, with more than 25% of work accidents related to this activity (Werner, Ponnala, Doutcheva, & Holden, 2021).

From an ergonomics perspective, unergonomic work positions increase the risk of injury to the muscles and spine (Simanjuntak & Susetyo, 2022). Application of the National Institute for Occupational Safety and Health (NIOSH) Lifting Equation principles can help identify and reduce the risk of LBP (Azwar, 2020), (Mayangsari, 2020), (A Rahmawati, 2021). Transport workers, as one of the vulnerable groups of workers, are often exposed to strenuous physical activities, such as shouldering, carrying, and carrying goods. These activities increase pressure on the spine, so the risk of LBP in transport workers is quite high (Harini, 2022), (Chegini, Ghousi, Naeini, & Karuppiah, 2020), (Dawad, Yasin, Darus, Jamil, & Naing, 2024), (Anis Rahmawati, Sudarmanto, & Hasan, 2019).

Based on this background, this study aims to analyse the relationship between load carrying and LBP complaints in transport workers at Kalimas Port Manado, using the NIOSH Lifting Equation approach. The results of the study are expected to be the basis for the application of ergonomics to reduce the risk of LBP and improve worker welfare.

Methods

This study is an analytical observational study with a cross-sectional approach, which aims to analyse the relationship between load positioning and low back pain complaints in transport workers at Kalimas Port Manado. The study population consisted of all transport workers at Kalimas Port Manado. The research sample was taken from the population by fulfilling the predetermined inclusion and exclusion criteria.

Sample size was calculated using the Slovin formula:

$$n = \frac{N}{1 + Ne^2}$$

Where n is the sample size, N is the population size, and e is the margin of error (10% or 0.1). Based on the calculation:

$$n = \frac{66}{1 + \ 66\ x\ 0.1^2}$$

n = 39,7

From the calculation of the Slovin formula, the result was 39.7 and then rounded up to 40 workers as a sample.

Inclusion and Exclusion Criteria:

Inclusion Criteria:

a. Transport workers at Kalimas Port Manado who perform routine lifting activities.
b. Workers who agree to participate in the study and provide written consent.
c. Workers who have an age of 30-50 years.

Exclusion Criteria:

a. Workers who have a history of diseases such as fractures, osteoporosis, and others.
b. Workers who use lifting aids.

Research Variables consist of:

a. The independent variable in this study is the load lifting position.
b. The dependent variable in this study is Low Back Pain.

Research Instruments: The instruments used in this research are NIOSH Lifting Equation Calculator, Nordic Body Map Worksheet, angulus, meter, goods scale, calculator, stopwatch, and camera.

Location and Time This research was conducted at Kalimas Port Manado in November 2024.

Data Analysis: Data analysis will use IBM SPSS software with the spearman statistical test.

Result and Discussion

Results

This study is an observational analytic study with a cross-sectional design to examine the relationship between loading position and low back pain complaints based on the NIOSH Lifting Equation in transport workers at Kalimas Port Manado. The study was conducted in November 2024 using the Nordic Body Map questionnaire and documentation of load carrying positions.

The study population consisted of 66 transport workers aged 30-50 years. The sample was determined using the Slovin formula with a margin of error of 10%, resulting in 40 samples. Sampling was done by simple random sampling, and all respondents

agreed to informed consent.

Table 1
Distribution of respondents based on Age

Age (Years)	Frequency (n)	Persentage (%)
30 - 35	13	32.5
36 - 40	12	30.0
41 - 45	12	30.0
46 - 50	3	7.5
Total	**40**	**100.0**

Table 1 based on age shows that of the 40 research samples, the highest number was at the age of 30-35 years with 13 samples (32.5%) compared to the ages of 36-40 years and 41-45 years with 12 samples (30.0%), and the lowest number at the age of 46-50 years with a sample (7.5%).

Table 2
Distribution of respondents based on length of service

Length of Service (Years)	Frequency (n)	Persentage (%)
0 – 5	23	57.5
> 5 – 10	9	22.5
> 10	8	20.0
Total	**40**	**100.0**

Table 2 based on tenure shows that respondents who have worked for up to 5 years are 23 people (57.7%), respondents with a tenure of more than 5 to 10 years are 9 people (22.5%) and respondents with a tenure of more than 10 years are 8 people (20.0%).

Table 3
Distribution of respondents based on *low back pain* complaints

Low Back Pain	Frequency (n)	Persentage (%)
No Pain	11	27.5
Moderate Pain	8	20.0
Pain	15	37.5
Very Painful	6	15.0
Total	**40**	**100.0**

Table 3 based on low back pain complaints shows that the most respondents felt the intensity of pain, namely 15 people (37.5%), respondents who did not experience low back pain were 11 people (27.5%), respondents who felt the intensity of pain was somewhat painful as many as 8 people (20.0%) and respondents who felt the intensity of pain was very painful as many as 6 people (15.0%).

Table 4
Distribution of respondents based on the risk of lifting position

Load Lifting Position	Frequency (n)	Persentage (%)
Low Risk	6	15.0
Medium Risk	21	52.5
High Risk	13	32.5
Total	**40**	**100.0**

Table 4 based on the risk of lifting position shows that most respondents have moderate risk, namely 21 people (52.5%), respondents with low risk as many as 6 people (15.0%) and respondents with high risk as many as 13 people (32.5%).

Relationship between Load Lifting Position and Low Back Pain

Table 5
Relationship between weight lifting position and *low back pain* complaints

Variable	Category	Low Back Pain								Total		*p*-value
		No Pain		Moderate Pain		Pain		Very Painful				
		n	%	n	%	n	%	n	%	n	%	
Load Lifting Position (NIOSH Lifting Index)	**Low Risk**	4	10	0	0	2	5	0	0	6	15	0,044
	Medium Risk	4	10	6	15	10	25	1	2.5	21	52.5	
	High Risk	3	7.5	2	5	3	7.5	5	12.5	13	32.5	

In the data analysis of the relationship between weight lifting position and low back pain complaints (table 5), using the Spearman correlation statistical test, the Sig. 2-tailed (P value) = 0.044. The results of this study are significant because the P value is smaller than 0.05 (0.044> 0.05), it can be concluded that H1 is accepted because there is a correlation or relationship between the position of lifting the load and complaints of low back pain based on the NIOSH Lifting Equation in transport workers at Kalimas Port Manado.

Discussion

The Nordic Body Map method can be used to assess the intensity of low back pain and consists of 4 categories which include the categories of no pain, mild pain, pain and severe pain. Based on the results of the study, respondents who did not experience low back pain were 11 people (27.5%), respondents who felt the intensity of pain was somewhat painful as many as 8 people (20.0%), respondents who felt the intensity of pain was 15 people (37.5%) and respondents who felt the intensity of pain was very painful as many as 6 people (15.0%).

The results showed that low back pain is a significant problem among workers, with the majority of respondents experiencing quite severe pain intensity. Factors such as poor posture, lifting weights, and long work duration contribute to the high prevalence of low back pain. Therefore, more attention should be paid to improving aspects of ergonomics

and educating workers on how to lift safely, to reduce the risk of more severe low back injuries.

In this study, the risk of load lifting position is assessed based on the lifting position of laborers when carrying out load carrying activities. The risk assessment of the load lifting position uses the NIOSH Lifting Equation method. The results obtained in respondents with low risk of load lifting position and experiencing low back pain were 2 people (33.3%) while those who did not experience low back pain were 4 people (66.7%). In respondents who have a risk of moderate weight lifting position and experience low back pain as many as 17 people (80.9%) while those who do not experience low back pain are 4 people (19.1%). In respondents who have a high risk of weight lifting position and experience low back pain as many as 10 people (76.9%) while those who do not experience low back pain are 3 people (23.1%).

The results of bivariate analysis using the Spearman correlation statistical test obtained Sig. 2-tailed (P value) = 0.044. The results of this study are significant because the P value is smaller than 0.05 ($\alpha > 0.05$), it can be concluded that H1 is accepted. The results of this study are in line with research conducted by Tika Benynda on 122 transport workers in Tanah Abang Market Blok A, Central Jakarta using the Pearson statistical test obtained a P value of $0.000 < \alpha$ (0.05) which means that there is a significant relationship between the way of working to lift transport with complaints of low back pain in Porters in Tanah Abang Market Blok A.

The results of this study are also in line with previous research. The results of this study are also in line with previous research conducted by Ariana Sumekar on 50 transport workers in the Yogyakarta Giwangan Market using the Pearson test obtained a P value of $0.000 < \alpha$ (0.05) which means that there is a significant relationship between manual handling attitudes and low back pain in transport workers in the Yogyakarta Giwangan Market. In this study, a correlation value of 0.572 was obtained with a positive patterned relationship direction, which means that the higher the risk of manual handling, the greater the low back pain complaints experienced by transport workers at Giwangan Market Yogyakarta.This study is also in line with the results of research conducted by Yusuf on 60 workers in the packaging section of the Spinning Department. This study used logistic regression analysis method to see the relationship between lifting index and low back pain complaints. Based on data analysis, the p-value obtained is 0.042, which indicates that the relationship between the lifting index and the incidence of low back pain is statistically significant ($p < 0.05$).

One study that is not in line with the results of the study is a study by Rahmawati, who examined the relationship between work position and low back pain complaints in 60 workers in the production department of a Textile Company.

The study concluded that there was no significant relationship between work position and low back pain complaints, with a p-value of 0.078 ($p > 0.05$). This study suggested that other factors, such as age, exercise habits, and medical history, played a greater role in low back pain complaints than work position.This difference could be due to variations in working conditions, duration of work, and level of ergonomic awareness among workers. Port port porters tend to work with heavy loads, long duration, and often without appropriate assistive devices, increasing the risk of low back pain. This underscores the importance of applying the NIOSH Lifting Equation standard to assess and minimize risks in lifting activities.

When a person lifts a load in an unergonomic position, there is an increase in the moment of force (torque) on the spine, especially on the lumbar segment. This moment is generated by a combination of the weight of the load, the distance of the load from the body, and the angle of the body to gravity. This increased moment of force causes pressure on the intervertebral discs, which if prolonged can trigger low back pain. Improper lifting position can cause acceleration or additional unbalanced forces on the body, especially on the lower spine (lumbar spine). The lifted load creates a gravitational force ($F = m \times g$), which acts along the body axis. If the load is lifted in a bent or unstable position, this force can create excess pressure on the intervertebral discs. The moment of force (torque) is the product of the force (F) and the distance (r) from the pivot point of rotation. When a laborer lifts a load with a bent body position, the distance (r) from the body's center of gravity to the load becomes greater. This increases the moment of force that the muscles and spine must withstand. The greater the torque, the higher the risk of injury to the lower back. Lifting in a seated position can reduce the risk of injury by lowering the torque on the spine, maintaining the body's center of gravity, and distributing the load to other large muscles. However, its use must be adapted to the type of load and work environment.

The NIOSH Lifting Equation considers variables such as load weight, horizontal and vertical location of the hands, vertical distance, asymmetry angle, frequency, duration, and object coupling when lifting. If these parameters are not optimized, the resulting forces and moments become excessive, in accordance with the above laws of physics, which can increase the risk of low back pain

Conclusion

The lifting position of Kalimas Manado Port transport workers analysed based on the NIOSH Lifting Equation is in the low category (LI<1), medium category (LI 1-<3), high category (LI ≥3), where the lifting position with moderate risk is the risk that causes the most complaints of low back pain. From the Nordic Body Map data, complaints at the waist are dominated by complaints of pain. There is a relationship between lifting position and low back pain complaints based on the NIOSH Lifting Equation for transport workers at Kalimas Port Manado.

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Ethical Clearance: This study has received approval from the Health Research Ethics Committee of the Bani Saleh Collage of Health Sciences No: EC.222/KEPK/STKBS/XII/2024 on December 4, 2024.
Informed Consent Statement: Informed Consent was obtained from all subjects involved in the study.
Data Availability Statement: The data used in this study are available upon request from the corresponding author in accordance with applicable data protection and privacy regulations.
Conflicts of Interest: The authors declare that there are no conflicts of interest regarding the publication of the manuscript.

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