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The Relationship Between Load Lifting Positions and Low Back Pain (LBP) Complaints Based on The Ovako Work Posture Analysis System (OWAS) Among Porters at Kalimas Port Manado

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Abstract
Introduction: *Porters often face the risk of musculoskeletal injuries, including Low Back Pain (LBP), due to non-ergonomic working postures while lifting loads. LBP is a condition with an increasing prevalence, reaching 619 million cases in 2020 and projected to rise to 834 million by 2025. In Indonesia, the prevalence of joint disorders is recorded at 7.3%, while in North Sulawesi, the prevalence of musculoskeletal disorders reached 24.7% in 2018, with a significant increase in LBP cases in 2019.* ***Objective****: This study aims to analyze the relationship between load-lifting positions and LBP complaints using the Ovako Work Posture Analysis System (OWAS).* ***Methods****: This research is an analytical study with a cross-sectional design involving 40 porters at Kalimas Port, Manado. Data were collected through observation, the Nordic Body Map questionnaire, and work posture assessments using OWAS. Data analysis was conducted using the Spearman correlation test.* ***Results and Discussion****: Most workers exhibited non-ergonomic work postures, such as bending their backs (100%) and lifting loads heavier than 20 kg (10%). A total of 72.5% of workers reported varying intensities of LBP complaints. Statistical analysis revealed a significant relationship between load-lifting positions and LBP complaints ($p<0.001$) with a strong correlation ($r=0.550$).* ***Conclusion****: Non-ergonomic load-lifting positions are significantly associated with LBP complaints among porters at Kalimas Port, Manado. Ergonomic improvements are necessary to reduce the risk of injurie*

Keywords: Weight Lifting Position; Low Back Pain; OWAS;

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Introduction

In the era of modern industry, porters play a crucial role in ensuring the smooth operation of logistics, especially in major ports such as Kalimas Port, Manado. However, this work often involves strenuous physical activities, including repetitive and continuous heavy lifting, which increases the risk of musculoskeletal injuries by putting excessive strain on the spine and surrounding tissues. One of the most common disorders among workers with physically demanding jobs is Low Back Pain (LBP), which can significantly impact quality of life and work productivity (Yahya & Sulolipu, 2021), (Mahdavi, Riahi, Vahdatpour, & Kelishadi, 2021)

Low Back Pain is a significant global health issue, and non-ergonomic body postures, particularly in jobs involving load lifting, are one of its primary causes. The Ovako Work Posture Analysis System (OWAS) is an effective method for assessing work postures and identifying ergonomic risks that could lead to injuries (Prasetio & Nurtjahyo, 2020). By using OWAS, an in-depth evaluation of load-lifting positions can be conducted to understand the relationship between work posture and LBP complaints.

This aligns with research conducted by Wahyu et al., which analyzed the impact of load lifting on complaints of Musculoskeletal Disorders (MSDs) among market porters (Prayogi, Sultan, Hardianti, Ramdan, & Lestari, 2024). Their study found that the increased risk of MSD complaints occurred among workers engaged in lifting loads, exceeding safe weight limits and adopting non-ergonomic postures.

There is considerable data on Low Back Pain (LBP), recognized as a prevalent condition in society. In 1990, there were 377.5 million cases of LBP, which rose to 577 (Vos et al., 2020). million cases in 2017. According to data from the Global Burden of Disease 2017, the highest prevalence of LBP was in Latin America at 13.47%, followed by the Asia Pacific at 13.15%, and East Asia at 3.92%. Ergonomic disabilities due to LBP were estimated to affect approximately 26% of the population in 2010.

By 2019, the global prevalence of Low Back Pain reached 568.4 million, ranking first in global Years Lived with Disability (YLD) with 63.7 cases (Shim et al., 2024). In 2020, epidemiological data showed that 619 million people suffered from LBP, equivalent to 10% of the global population, and this figure is projected to rise to nearly 834 million cases by 2025 (Ferreira et al., 2023)

In Indonesia, data from the 2018 Riskesdas (Basic Health Research) showed that the prevalence of joint diseases diagnosed by doctors reached 7.3% (Aisah, Fachrin, & Suyuti, 2024). While specific data on Low Back Pain in Indonesia is unavailable, studies indicate that 3–17% of hospital patients present with LBP complaints, as noted in a journal by Putri S. North Sulawesi is among the ten provinces with a prevalence of joint diseases exceeding the national average. According to Riskesdas 2018, the prevalence of musculoskeletal symptoms in North Sulawesi was 24.7%. Additionally, reports from the Minanga Health Center in Manado City in 2019 recorded 290 musculoskeletal cases, a significant increase from 92 cases in 2018.

Based on the above findings, this study aims to explore the relationship between load-lifting positions and LBP among porters at Kalimas Port, Manado. The goal is to identify risk factors and provide ergonomic improvement recommendations to enhance worker well-being.

Literature Review

1. Spinal Biomechanics

Spinal biomechanics explains how the structure and function of the spine interact to provide stability, mobility, and protection (Purnawinadi & Sitanggang, 2022). Stability is achieved through the interplay of the spine's structural components, intervertebral discs, and ligaments. Mobility allows for upper body movement and the transfer of load from the head and trunk to the pelvis, while the spine also protects the spinal cord (Kumbea, Sumampouw, & Asrifuddin, 2021)

Chaffin and Andersson (1991) elaborated on the static biomechanics of the body during work activities, particularly regarding the estimation of compressive forces on the L5/S1 segment during specific lifting tasks. To achieve balance during lifting activities, the moment at the L5/S1 segment is counteracted by significant muscular forces from the spinal erector muscles (FM) and abdominal forces (FA). These forces are influenced by intra-abdominal pressure (PA), which contributes to body stability against the effects of moments and forces, as illustrated in their model.

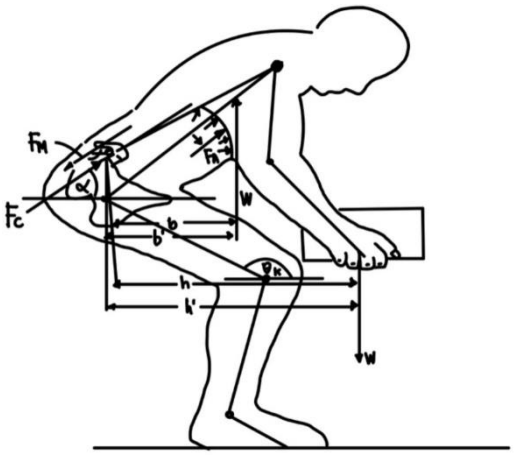

Figure 1. Spinal Biomechanics

2. Ergonomics

The load-lifting method is based on two principles within the concept of ergonomics: utilizing the arm muscles more than the back muscles and using body weight momentum to initiate horizontal movement. This method incorporates five fundamental factors: proper foot positioning, a strong and stable back, keeping the arms close to the body, lifting correctly, and leveraging body weight (Zadry & Yuliandra, 2015)

The Ovako Work Posture Analysis System (OWAS) is a posture analysis method that helps determine the load on workers' musculoskeletal systems, identify improper postures, and optimize work methods. The foundation of the OWAS method lies in assessing work posture, which categorizes four positions for the back, three for the arms, seven for the lower limbs, and evaluates the weight of the load or the amount of force applied. Value Positions in OWAS:

a. Back Posture
1. Straight
2. Bent forward
3. Twisted or tilted sideways
4. Bent and twisted, or bent forward and sideways

b. Arm Posture
1. Both arms below shoulder level
2. One arm at or above shoulder level
3. Both arms at or above shoulder level

Load Weight:
1. Load weight is less than 10 kg ($W \leq 10$ kg)
2. Load weight is 10–20 kg ($10 \text{ kg} < W \leq 20$ kg)
3. Load weight is greater than 20 kg ($W > 20$ kg)

c. Leg Posture:
1. Sitting
2. Standing with weight evenly distributed on both straight legs
3. Standing with weight on one straight leg
4. Standing with weight on both legs, knees bent
5. Standing with weight on one leg, knee bent
6. Kneeling on one or both knees
7. Walking

The results of the OWAS work posture analysis are categorized into four levels of hazardous work postures for workers:

a. Category 1: In this posture, there are no issues with the musculoskeletal system, and no improvements are necessary.
b. Category 2: In this posture, there is a risk to the musculoskeletal system (the work posture causes significant strain), and improvements are needed in the future.
c. Category 3: In this posture, the risk to the musculoskeletal system is greater (the work posture causes very significant strain), and improvements are needed as soon as possible.
d. Category 4: In this posture, the risk to the musculoskeletal system is severe (the work posture poses a clear danger), and immediate corrective actions are required

3. Low Back Pain

Low Back Pain (LBP) is defined as pain or discomfort located in the area between the costal region (lower ribs) and the inferior gluteal folds (buttocks) and may radiate to the lower extremities (Tamtomo & Murti, 2024), (Yuwono & Wahyuni, 2021), (Wami, Abere, Dessie, & Getachew, 2019)

The Nordic Body Map (NBM) is a tool used to identify musculoskeletal disorder (MSD) complaints, including Low Back Pain. This method involves the use of a body map questionnaire that allows respondents to indicate the areas of their body experiencing

pain and to rate the severity of the pain, ranging from no pain, mild pain, moderate pain, to severe pain (Beatrix & Wijayanto, 2023), (Pascoe et al., 2021),

Method

This study employs a quantitative method with an analytical approach using a cross-sectional design to analyze the relationship between load-lifting positions and complaints of low back pain (LBP) using the Ovako Work Posture Analysis System (OWAS). The research was conducted at Kalimas Port, Manado, involving 40 porters selected through the Simple Random Sampling technique. Participants met the criteria of regularly lifting loads without tools, being aged 30–50 years, and having no history of musculoskeletal disorders. Data were collected through the Nordic Body Map (NBM), completed by each respondent to assess LBP complaints, and observation to evaluate load-lifting positions by assigning codes to each posture assessed using the OWAS evaluation sheet. The data were then analyzed using IBM SPSS software with the Spearman correlation test.

Results and Discussion

Result

Univariate Analysis

The results of this univariate analysis include the characteristics of the research sample, the position of lifting the load based on OWAS, and complaints *of Low Back Pain*.

1. Characteristics of the research sample

Table 1

Characteristics of the study sample by age

Age	Frequency (n)	Percentage (%)
30-34	12	30
35-39	8	20
40-44	11	27.5
45-49	8	20
50	1	2.5
Total	**40**	**100**

Based on the data on the distribution of results by age (Table 1), information was obtained that there were 12 respondents (30%) between 30-34 years old, 8 respondents (20%) between 35-39 years old, 11 respondents (27.5%) between 40-44 years old, 8 respondents (20%) between 45-49 years old, and 1 respondent (2.5%) aged 50 years.

Table 2
Characteristics of the research sample based on length of work

Length of Work	Frequency (n)	Percentage (%)
1-5	23	57,5
6-10	9	22,5
11-15	3	7,5
16-20	4	10
20-25	1	2,5
Total	**40**	**100**

Based on the data on the distribution of results by length of work (Table 2), information was obtained that there were 23 respondents (57.5%) who had worked for 1-5 years, 9 respondents (22.5%) who had worked for 6-10 years, 3 respondents (7.5%) who had worked for 11-15 years, 4 respondents (10%) who had worked for 16-20 years, and 1 respondent (2.5%) who had worked for 20-25 years.

2. Load Lifting Position based on OWAS

Table 3
Back Attitude

Back Posture	Frequency (n)	Percentage (%)
Bending and twisting or bending forward and sideways	40	100
Total	**40**	**100**

Based on the data on the distribution of results according to the back attitude (Table 3), information was obtained that all transport workers (100%) had a hunched back attitude and turned or bent forward and sideways.

Table 4
Arm Posture

Arm Posture	Frequency (n)	Percentage (%)
Both arms below shoulder level	40	40
Total	**40**	**100**

Based on the data on the distribution of results according to the attitude of the arms (Table 4), information was obtained that all transport workers (100%) had an attitude of both arms under the shoulders.

Table 5
Foot Posture

Leg Posture	Frequency (n)	Percentage (%)
Standing with weight on both legs, knees bent	12	30
Walking	28	70
Total	**40**	**100**

Based on the data on the distribution of results according to foot posture (Table 5), information was obtained that as many as 12 research samples (30%) had a foot posture, namely standing on both legs with the knees bent and as many as 28 research samples (70%) had a foot posture, namely walking.

Table 6
Load Weight

Load Weight	Frequency (n)	Percentage (%)
Load weight is less than 10 kg	24	60
Load weight is between 10–20 kg	12	30
Load weight is more than 20 kg	4	10
Total	**40**	**100**

Based on the data on the distribution of results by load weight (Table 6), information was obtained that as many as 24 research samples (60%) lifted weights with a load weight of less than 10 Kg, 12 research samples (30%) lifted weights with a load weight of less than 10-20 Kg, and 4 research samples (10%) lifted weights with a load weight of more than 20 Kg.

Table 7
Load Lifting Position

Load-Lifting Position	Frequency (n)	Percentage (%)
Hazardous posture for the musculoskeletal system	14	35
More hazardous posture for the musculoskeletal system	10	25
Very hazardous posture for the musculoskeletal system	16	40
Total	**40**	**100**

Based on the data on the distribution of results according to the position of lifting the load (Table 7), information was obtained that as many as 14 research samples (35%) had a dangerous attitude to the musculoskeletal system, 10 research samples (25%) had a more dangerous attitude to the musculoskeletal system, and 16 research samples (16%) had a very dangerous attitude to the musculoskeletal system.

3. Low Back Pain *Complaints*

Table 8
Pain in the Lower Back

Pain in the Lower Back	Frequency (n)	Percentage (%)
No Pain	11	27,5
Moderate Pain	8	20
Pain	15	37,5
Very Painful	6	15
Total	**40**	**100**

Based on the data on the distribution of results according to pain in the waist (Table 8), information was obtained that as many as 11 research samples (27.5%) did not feel pain in the waist, 8 research samples (20%) felt the intensity of pain in the waist, 15 research samples (37.5%) felt the intensity of pain in the waist, and 6 research samples (15%) felt the intensity of pain in the waist.

Bivariate Analysis

The result of the bivariate analysis is to test the research hypothesis proposed by the researcher by identifying whether there is a relationship between the independent variable, namely the position of the load lifting according to OWAS, and the dependent variable, namely the LBP complaint.

Table 9
Relationship between Weight Lifting Position and *Low Back Pain* Complaints Based on *Ovako Work Posture Analysis System*

Variable	Category	*Low Back Pain*				Total (%)	*P Value*
		No Pain (%)	Moderate Pain (%)	Pain (%)	Very Painful (%)		
Load-Lifting Position Assessment	Hazardous posture for the musculoskeletal system	9 (64,3%)	2 (14,3%)	3 (21,4%)	0 (0,0%)	14 (35,0%)	<0.001
	More hazardous posture for the musculoskeletal system	1 (10,0%)	3 (30,0%)	4 (40,0%)	2 (20,0%)	10 (25,0%)	
	Very hazardous posture for the musculoskeletal system	1 (6,30%)	3 (18,8%)	8 (50,0%)	4 (25,0%)	16 (40,0%)	

Based on the distribution data of the relationship between the load lifting position and *Low Back Pain complaints* based on the OWAS method (Table 9), information was obtained that there was a correlation or relationship between the load lifting position and LBP complaints based on the OWAS method. This was obtained through the statistical test process, namely *the Spearmen* correlation test which produced *a P Value* of <0.001 which is in accordance with the basis for making decisions of *the Spearman* correlation

test, namely *the P Value* is less than 0.005. The results of this bivariate analysis also have a strong correlation level as evidenced by the value of the correlation coefficient of 0.550 (0.51-0.75).

Discussion

Based on the results of age analysis on the research sample, it was found that the most transport workers were in the age range of 30-34 years as many as 12 people and the least was at the age of 50 years as many as 1 person. This illustrates that the majority of respondents are in the productive age range, which is 30 to 44 years old, which is the age at which individuals usually have optimal physical strength to perform heavy work. This is in line with what Hasanah and Widowati have stated, that younger workers tend to have higher productivity due to better physical strength.

The majority of transport workers at Kalimas Port Manado have been working for 1-5 years as presented in table 2. This data shows that most respondents are new workers or those who are still in the early stages of their careers, while the number of workers with longer experience is decreasing. This can indicate the dynamics of the workforce that are constantly changing. This is relevant to what Smith and Jones (2020) have proposed, where they found that certain industries tend to have a high turnover rate that affects the distribution of work experience.

In the position of lifting the load, the researcher assessed 3 attitudes and the weight of the load carried out by the transport workers at Kalimas Port Manado. All transport workers show an unhealthy back attitude, namely 100% of them have the habit of bending over, whether it is bending forward or sideways. This hunched back position can lead to increased pressure on the spine, especially in the lumbar region. According to research conducted by Cholewicki et al., the position of the body bending over when lifting weights increases the pressure on the intervertebral discs and ligaments around the spine, which increases the likelihood of injury. The load focused on one part of the spine, especially in the lumbar region, increases the tension on the muscles and tissues that support the spine, which ultimately leads to pain and inflammation.

Based on the data presented in Table 4, all transport workers have an attitude where both arms are under the shoulders. This attitude reflects a working position that is closer to a neutral posture, that is, a position of the body in which the muscles work with minimal load. Another study noted that the working stance with both arms under the shoulders is more commonly used by haulers because it provides stability when handling heavy loads. However, repetition and duration of fixed work can lead to muscle fatigue and pain. Shoulder movements during lifting involve the rotation of the scapula to maintain the stability of the shoulder joint. The position of the arm under the shoulder helps maintain optimal rotation of the scapula thereby reducing pressure on the shoulder joint structure.

In table 5, the leg posture of transport workers consists of 30% resting on both legs with knees bent where this is done by workers who oversee lifting goods from the inside of the car to the outside edge of the car, while the other 70% stand because they must lift goods from the car to the ship. Smith et. Al (2022) found that the correct standing position can improve stability and reduce the risk of injury to muscles and joints. This is in accordance with the theory of biomechanics which states that a good body position when standing or walking can affect the distribution of weight and reduce stress on the joints. While sitting can reduce the risk of injury, sitting is the best starting position for everyone when lifting weights. This is due to the difference in the activation of the back thigh muscles (*hamstrings*) and the front thigh muscles (*quadriceps*). With a sitting position, it will provide the best load stability for muscle activation.

As transport workers, of course, they lift weights with various types of load weights every day. The sample in this study, 60% lifted less than 10 Kg. This is relevant to the results of a study that suggested that in the working population, most individuals lifted weights below 15 Kg, with only 15% lifting more than 20 Kg. Study by Chaffin et. al corroborates the above statement with its findings that lifting loads of more than 25 kg significantly increases the risk of injury to workers.

Based on the results of the analysis of the load lifting position based on the OWAS method on transportation workers at Kalimas Port Manado, it was found that 40% of transportation workers have a very dangerous attitude to the musculoskeletal system (Table 7). This research is in line with research conducted by MSMEs of Manunggal Sumber Rejeki Rice Mill where the results were obtained that workers who carry out activities to lift and place rice sacks are included in the category of high risk, dangerous, and require repair as soon as possible. *The action code* obtained in this study is 2-1-4-2, namely the position of the back is bent, both arms are under the shoulders, standing on both legs with the knees bent, and the weight of the load is more than 20 Kg. Research and mutually supportive results are also obtained in the employees of the rice storage warehouse section researched by Randany and Masrofah which shows that the rice lifting activity is at the level of category 3, which is high risk and needs to be improved immediately.

The results of the study on transport workers found that as many as 15 research samples complained of pain in the waist, 8 people complained of pain in the waist, 6 people complained of severe pain in the waist, and only 11 people did not have complaints of pain in the waist (Table 8). Of course, this is related to the position of the body and the improper way of lifting weights so that it causes injuries to muscles and bones. From the results of the bivariate analysis (Table 9) conducted in this study, it was found that as many as 40% of the research sample was included in the category of very dangerous attitudes in the musculoskeletal system with 4 people complaining of very pain, 8 complaining of pain, 3 complaining of somewhat pain, and only 1 person did not complain of pain in the waist.

Through the *Spearman* test conducted on the data obtained in this study, a P *Value of* <0.001 was obtained. Therefore, in accordance with the basis of the Spearmen Test decision-making, it was obtained that there was a relationship between the position of lifting the load and the complaint of LBP based on OWAS on the transport worker at Kalimas Port Manado. The value of the correlation coefficient obtained in this study is 0.550 which means that the level of correlation strength in this study is a strong relationship (the value of the correlation coefficient is 0.51-0.75).

The results of this study are in line with the results of the analysis carried out on pickers at PT. The Tambi Wonosobo plantation also obtained *a P Value* of 0.014 which means that there is a significant relationship between work posture and LBP complaints. As many as 58.3% of workers have a medium posture category and 41.7% of workers have a high posture category. 50% of the pickers at PT. The Tambi Wonosobo plantation also complained of *low back pain.* Respondents from this study in the high-risk category complained about LBP the most in the severe severity category. Research on the relationship between weight lifting and back pain complaints in fruit transport workers at Johar Market in Semarang conducted by Rista Indriyani also supports this research. From his research, a *P Value* of 0.027 was obtained, which means that there is a significant relationship between the weight of the load and back pain complaints.

Excessive weight lifting without proper technique can cause disproportionate pressure on the soft tissues around the spine, such as muscles and ligaments. This causes overstretching, strain, or even tearing of the tissue, which eventually triggers inflammation and pain. This condition, known as lumbosacral *strain*, is one of the main causes of *Low Back Pain* (LBP), which is often experienced by workers who engage in strenuous physical activity.

Lifting heavy loads in an improper way can lead to injury to the intervertebral discs, which serve as cushions between the vertebrae. Excessive load causes this disc to be compressed, and can even develop a herniation that damages the structure of the spine and causes intense pain. Damage to ligaments and joints can also occur due to excessive and unevenly distributed loads. Based on a study conducted by Nachemson, lifting weights in the wrong way can affect joint stability and lead to postural abnormalities. Joint injuries that occur as a result of incorrect weight lifting can worsen LBP symptoms and prolong recovery time.

In a study conducted on industrial workers in CV. The Jember multibuilding obtained an LBP incidence value of 10%, including a high value with a workload of 20%. The results of this research also stated that there was a relationship between workload and LBP events as evidenced by the P *Value* of 0.01. This is in accordance with this study, all transport workers at Kalimas Port Manado who lift more than 20 kg complained of pain in the waist with a slightly sore, sore, and very painful range. This happens because manually lifting heavy weights can cause mechanical injury to the soft tissues, ligaments,

and joints around the spine, as well as the risk of lumbosacral strains and other body tissue damage.

The results of this study are different from the research by Wahyudianto and Suci Khasanah, where they did not find significant results between the position of lifting weights and LBP complaints. They found that psychological factors and improper mobilization were more at risk for the incidence of LBP compared to weight-lifting positions, The results showed that relaxation interventions could reduce pain. The research conducted by Dano, et al. also stated that there was no significant relationship between the weight lifting position and LBP complaints in trained athletes because based on the results of their study, the weight lifting position was only useful to prevent injury and only physical exercise was related to the incidence of *low back pain* with *P Value* by 0.034. Meanwhile, the other 13 factors studied were not related to the incidence of LBP.

Conclusion

There is a relationship between the position of lifting the load and complaints *of low back pain* based on OWAS in transport workers at Kalimas Port Manado. This is inferred from the results of the *Spearman* test score of <0.001 ($p<0.05$). The results of this study show that the load-lifting position with a dangerous attitude for the musculoskeletal system significantly affects the complaints of *low back pain* in transportation workers at Kalimas Port Manado.

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