

Ergonomic risks in manual material handling activities and musculoskeletal disorders complaints in the animal feed industry production area in East Java, Indonesia

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Abstract

Introduction: Manual lifting and load transfer processes that are not carried out properly will result in over exertion-lifting and carrying, i.e. body tissue damage caused by excessive lifting. One of the work-related diseases caused by this activity is Musculoskeletal Disorders (MSDs), a disorder that occurs in the muscles, nerves, tendons, ligaments, joints, cartilages, or the intervertebral discs. The study aims to find out the picture of ergonomic risk in manual material handling activity and musculoskeletal complaints.

Methods: Data was obtained from two respondents through accidental sampling. The measurement of the lifting index is done with meters and calculated using the formula of the calculation of the lifting index. The instrument for measuring musculoskeletal disorders was the GOTRAK SNI 9011:2021 Questionnaire.

Results: Lifting activities performed by the Hand Add section (LI: 3.054-3.228) and Bagging Off (LI: 3.073-3.470) have a Lifting Index value that is in category > 3 so the interpreted activity has a high risk of causing musculoskeletal complaints. Workers who perform manual material handling activities have high complaints of skeletal and muscle disorders in the upper limbs.

Conclusion: Manual handling activities performed in the industry have a high risk of causing injury. Workers who perform manual material handling activities are known to have high complaints of muscle and muscle disorders in the upper limbs.

Keywords: Ergonomic risks; Manual material handling; Lifting index; Musculoskeletal disorders

1. Introduction

The evolution of the times and modernization has had an impact on all aspects of life, including in the economic and industrial spheres. These technological advances have made many industries use machines in their production processes. Although all forms of work can now be replaced by human to machines, manual material handling still exists. The material handling manual covers all loading activities with the activity of rotating, bending, grabbing, dropping, pushing, pulling, carrying, and reversing performed by the worker in order to move the load from a location of origin to a specific destination [1]. Manual material handling has several advantages and disadvantages. As for the advantages of the application of manual material handling activities, it is more flexible to move materials in irregular workplaces, easy to do for light loads, as well as cheaper compared to the use of machines [2]. On the other hand, one of the disadvantages is that there is an ergonomic risk that can lead to work-related illness.

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Manual lifting and load transfer processes that are not performed properly will result in over exertion-lifting and carrying, i.e. body tissue damage caused by excessive lifting [2]. One of the work-related diseases caused by this activity is Musculoskeletal Disorders (MSDs), a disorder that occurs in the muscles, nerves, tendons, ligaments, joints, cartilages, or the intervertebral discs [3]. Musculoskeletal complaints are most often caused by excessive activity that can affect the ability of the worker to perform his or her job, such as lifting, pulling, pushing, and withholding torque reactions [4].

A recent analysis of Global Burden of Disease (GBD) data in 2019 shows that there are about 1.71 billion people in the world living with musculoskeletal problems, including cases of lower back pain, neck pain, bone fractures, osteoarthritis, rheumatoid arthritis, and other injuries. This condition is also the largest contributor, accounting for 17% of all years of life with disability worldwide [5]. In Indonesia itself, based on the results of Basic Health Research, it is known that the prevalence of musculoskeletal problems is 7.3% [6]. In line with the conditions, data from the ILO (2013) stated that production processes involving high manual handling, pushing or pulling activity, and repetitive movements accounted for 47% of claims related to musculoskeletal problems in Indonesia. In one study of 40 transport workers, it was found that as many as 70% of respondents were at risk of developing complaints based on the calculations of the Lifting Index and 47.5% had severe musculoskeletal grievances. Then an analysis of the lambda association test was carried out and the results of the connection between manual material handling and musculoskeletal complaints were obtained [7].

The potential dangers of ergonomics in the workplace almost always exist because the ergonomic aspects have wide coverage, covering workers and everything in their working environment. Musculoskeletal complaints as one of the risks caused by ergonomic factors are vulnerable to workers in all industries, without exception in workers in one of the cattle feed industries in East Java, Indonesia. Based on the company's 2021 work environment measurement, workers in the Hand Add and Premix areas show that the risk of ergonomic factors is in the highest category, whereas in the Bagging Off section, the risk was in the middle category. Meanwhile, the results of the 2022 ergonomic factors measurements in the Working Off, Premix, and Loading Dock areas have moderate risk. Measurement results with the current risk category mean that further research and corrective action need to be carried out promptly, while the high-risk category means that change action has to be implemented. Therefore, initial observations were carried out in the production area and there was still any manual material handling activity performed by workers in the industry, in the Hand Add and Bagging Off areas.

Through a question-and-answer process with the company's HSE (Health and Safety Environment) Supervisor, information was obtained that almost all employees were known to have musculoskeletal complaints. Therefore, to minimize the possibility of such potential hazards in posing MSDs risks, the implementation of Health and Safety at Work (OHS) becomes an urgent necessity in industrial activities. Indonesian Ministry of Employment Regulations No. 5 of 2018 on Occupational Safety and Health Environment Article 23 paragraphs 1 to 3 states that measurement and control of ergonomic factors in the workplace should be carried out that have potential ergonomic hazards. The potential ergonomic hazard, one of which is the lifting of loads that exceed the working capacity. If the measurement is not following the standard, then control efforts should be made. The ergonomic factor standard is described in more detail on the attached page, including about threshold value for manual handling activities [8]. Through this, the occupational health and safety (OHS) aspect became an important idea for protecting the workforce from a variety of hazards and risks in the workplace in particular are ergonomic hazards.

2. Material and methods

In support of the success of this study, there are several methods of data collection to obtain both primary and secondary data. Data is obtained from two respondents through accidental sampling, which is a method of sample-taking in which individuals or elements included in the sample are selected based on availability and matching to certain criteria that facilitate the data collection process. The selection of these techniques was dismissed on the grounds that the researchers only aimed to understand a particular phenomenon without the need to generalize to the population because the manual material handling activity was not performed by everyone in the population.

- Primary Data
 - Field Observations
 - The observations are carried out by observing activities in the Department of Production, especially on the part that performs manual material handling activity i.e. on the Hand Add and Bagging Off sections.
 - Measurement of lifting index
 - The process measures the lifting indexes on the manual material handling activity carried out by employees in the Hand Add and Bagging Off section using a meter [9].

- Measuring complaints MSDs
 - The process of measuring the complaint of MSD in employees performing manual materials handling activities using the GOTRAK complaining questionnaire instrument on SNI 9011:2021.
- Ask Answer Questions
 - Process to obtain more in-depth information related to complaints MSDs perceived by employees and the manual activity of material handling carried on.
- Secondary Data
 - Secondary data is obtained through the relevant authority. Secondary information includes company profiles, production flows carried out, employee data, and other supporting information. Processing and Data Analysis Techniques After data is collected, the recommended weight limit calculation process will be carried out using the calculation formula described in the library survey. Then, the results of the calculation will be used to calculate the lifting index. After learning the lifting index, the results are analyzed to determine whether the classification of manual activity of the measured handling material is safe or not.

3. Results and discussion

3.1. Measurement Results of Lifting Index on Manual Material Handling Activities

The lifting index is measured on workers in the Hand Add and Bagging Off areas to determine whether the lifting work is safe or risky. The components needed to calculate the lifting index were identified by conducting direct field measurements using meters. As for the identified components, they include horizontal, vertical values, lift weight, lifting angle, lift frequency, and work duration. All the components are identified both at the starting position and at the end position. These components will be used to calculate the RWL value. The identification results of components required in the calculation will be described in more detail in the pictures and tables below.

Table 1 Identification Results of Variable in The Hand Add Area

Respondent						1					
Age						24					
Department						Production / Hand Add					
Job Description						Lifting and Pouring Sack					
Object Weight		Hand Location				D	Asymmetric Angle		Freq Rate	Duration	Coupling Object
		Ori		Dest			Ori	Dest			
L (avg)	L (max)	H	V	H	V	A	A	Lifts/min	Hrs	C	
17.5	17.5	53	41	54	64	23	90 ⁰	90 ⁰	0.33	8	Fair

Table 1 shows the identification and measurement results of the components of the calculation of the lifting index on the workers in the Hand Add section. The work done in this area is to lift and pour out bags containing additives for feed products. Measurement is done with the help of meters. Next, this is the identification result on the Bagging Off Area.

Table 2 Identification Results of Variable in The Bagging Off Area

Respondent						2					
Age						30					
Department						Produksi / Bagging Off					
Job Description						Lifting Product Box					
Object Weight		Hand Location				D	Asymmetric Angle		Freq Rate	Duration	Coupling Object
		Ori		Dest			Ori	Dest			

L (avg)	L (max)	H	V	H	V		A	A	Lifts/min	Hrs	C
20.5	20.5	57	24	49	148	124	0°	0°	<0.2	8	Fair

Table 2 shows the results of the identification and measurement of the components of the calculation of the lifting index in the workers in the Bagging Off section especially in the superior feed area. The work done in this area is to lift and assemble the carton containing the superior food products. Measurement is done with the help of meters. The collected variable data is used to calculate the Recommended Weight Limit (RWL) on manual handling activities performed in the Hand Add and Bagging Off sections.

Table 3 The Process of Calculating the Initial and Final RWL for Activities in The Hand Add Area

Component	Measurement of RWL (Pre)	Measurement of RWL (Post)
LC	23 Kg	23 Kg
HM	25/H $25/53 = 0.472$	25/H $25/54 = 0.463$
VM	$1 - (0.003 V-75)$ $1 - (0.003 41-75) = 0.898$	$1 - (0.003 V-75)$ $1 - (0.003 64-75) = 0.967$
DM	$0.82 + (4.5/D)$ $0.82 + (4.5/13) = 1.016$	$0.82 + (4.5/D)$ $0.82 + (4.5/13) = 1.016$
AM	$1 - (0.0032A)$ $1 - (0.0032 (90)) = 0.712$	$1 - (0.0032A)$ $1 - (0.0032 (90)) = 0.712$
FM	0.81	0.81
CM	0.95	0.95

Table 4 The Process of Calculating The Initial and Final RWL for Activities in The Bagging Off Area

Component	Measurement of RWL (Pre)	Measurement of RWL (Post)
LC	23 Kg	23 Kg
HM	25/H $25/57 = 0.439$	25/H $25/49 = 0.510$
VM	$1 - (0.003 V-75)$ $1 - (0.003 24-75) = 0.847$	$1 - (0.003 V-75)$ $1 - (0.003 148-75) = 0.781$
DM	$0.82 + (4.5/D)$ $0.82 + (4.5/124) = 0.856$	$0.82 + (4.5/D)$ $0.82 + (4.5/124) = 0.856$
AM	$1 - (0.0032A)$ $1 - (0.0032 (0)) = 1$	$1 - (0.0032A)$ $1 - (0.0032 (0)) = 1$
FM	0.85	0.85
CM	0.95	1

After the RWL variable data is calculated in the process as described in Table 4.2 and 4.3, the components will be entered into the calculation formula of the RWL ($LC \times HM \times VM \times DM \times AM \times FM \times CM$) to find out the RWL value. Here is the RWL calculation of each respondent.

Table 5 Measurement Results of The RWL

Respondent	Position	Recommended Weight Limit Variable							RWL
		LC	HM	VM	DM	AM	FM	CM	
1: Hand Add	Awal	23	0.472	0.898	1.016	0.712	0.81	0.95	5.421
	Akhir	23	0.463	0.967	1.016	0.712	0.81	0.95	5.730
2: Bagging Off	Awal	23	0.439	0.847	0.856	1	0.85	0.95	5.908
	Akhir	23	0.510	0.781	0.856	1	0.85	1	6.671

Table 5 shows the results of the calculation of the Recommended Weight Limit on the Hand Add and Bagging Off activities. Subsequently, the value will be used to calculate the Lifting Index of each activity with the Weight formula divided by RWL.

Table 6 Measurement Results of The Lifting Index

Respondent	Position	Load Weight	RWL	LI	Risk Classification
1: Hand Add	Initial	17.5	5.421	3.228	High
	Final	17.5	5.730	3.054	High
2: Bagging Off	Initial	20.5	5.908	3.470	High
	Final	20.5	6.671	3.073	High

Table 6 shows that all manual handling activities especially on lifting activities have a high risk of causing musculoskeletal complaints in workers. Lifting activities performed by Hand Add and Bagging Off have a Lifting Index value that is in category > 3 so the interpreted activity has a higher risk of causing musculoskeletal complaint.

3.2. Measurement Results of Musculoskeletal Disorders Complaints

The measurement of musculoskeletal complaints is carried out on workers to identify subjective complaints related to muscle disorders felt by workers as a result of the work they did. Measurement of musculoskeletal complaints using the GOTRAK Complaints Survey instrument at SNI 9011:2021. This complaint measurement takes into consideration the aspects of frequency and severity perceived to determine the risk category of each of the complaints. Here's the measurement of musculoskeletal complaints from each worker.

Table 7 Measurement Results of The MSDs

Body Part		Respondent 1 (Hand Add)			Respondent 2 (Bagging Off)		
		F	S	I	F	S	I
Neck		1	1	1	1	1	1
Shoulder	Right	1	2	2	3	3	9
	Left	1	2	2	3	3	9
Elbow	Right	3	3	9	2	3	6
	Left	3	3	9	2	3	6
Back	Top	1	1	1	1	1	1
	Bottom	3	2	6	3	2	6
Arms	Right	3	3	9	3	3	9

	Left	3	3	9	3	3	9
Hands	Right	3	3	9	3	3	9
	Left	3	3	9	3	3	9
Hips	Right	3	2	6	3	2	6
	Left	3	2	6	3	2	6
Thighs	Right	1	1	1	2	2	4
	Left	1	1	1	2	2	4
Knees	Right	1	1	1	2	2	4
	Left	1	1	1	2	2	4
Calvis	Right	1	1	1	1	1	1
	Left	1	1	1	1	1	1
Legs	Right	1	1	1	1	1	1
	Left	1	1	1	1	1	1

According to Table 7, both respondents (100%) had high blood pressure complaints in the right arm, left arm, right hand, and left hand. Then respondents 1 also had low blood pressure on the right and left elbow. Thus, it can be concluded that both respondents had high complaints on the upper extremity limbs.

3.3. Ergonomic Risks on Manual Material Handling Activities at Animal Feed Industry in East Java, Indonesia

The activity carried out in the Hand Add Area is to pour bags containing feed additives into the hole that has been provided. In the Bagging Off section, the activity is to remove cardboard containing food products to be placed on the pallet. The measurement of the Lifting Index of both activities showed a Lifting index value greater than 3. The research was carried out at the manufacturing company of PT. Bogasari in the Consumer Packing section also showed similar results, where the calculations and analyses done on 3 workers at different workstations, all resulted in a Lift Index value larger than 3 [10]. Research conducted on a similar activity to this study, namely the rising bag activity at the XYZ Store showed that the result of the calculation of the Lifting Index was also in the category of more than 1 [11]. The result of the calculation of the Lifting Index greater than 1 indicates that there is a potential ergonomic hazard especially associated with the risk of musculoskeletal complaints. A study conducted by Santiasih (2013) on 60 workers in the packing section showed that 85% of respondents who suffered from low back pain had a Lifting Index value greater than 1 [2].

3.4. Musculoskeletal Disorders Complaints of Workers Performing Manual Material Handling Activities

The musculoskeletal complaint is often experienced by employees. In this study, a measurement of musculoskeletal complaints was performed in workers who performed manual material handling activities, i.e. workers in the Hand Add and Bagging Off sections. The measurements were performed with the GOTRAK Complaints Survey instrument in SNI 9011:2021, wherein the instrument, the complaint was measured based on the frequency and severity aspects perceived by the worker. Based on the measurements, it is known that the worker has high complaints on the upper limbs. Research on musculoskeletal disorders in various types of industries has been done with the acquisition of studies showing that the part of the muscle that is often complained is the skeletal muscle, among them the muscles of the neck, shoulders, arms, hands, fingers, back, waist, as well as lower muscles [12]. The appearance of musculoskeletal complaints can be triggered by activity or work performed, where both respondents measured are known to be performing manual material handling activities alike. One study on the relationship between the manual work of material handling and the musculoskeletal complaint carried out in 127 gallons of inputs has found that there is a relationship between manual work risk of materials handling and musculoskeletal disorders [13]. Purchases on porters carried out by Chinichian et al. (2021) showed the prevalence of musculoskeletal disorders throughout the body was 53.8% in the last 1 year [14].

4. Conclusion

Based on the results of the analysis of the study on the picture of ergonomic risks in manual material handling activity and musculoskeletal complaints in employees of animal feed industry in East Java, Indonesia, the following conclusion was obtained:

- Ergonomic risk in manual materials handling activity is in the Hand Add and Bagging Off sections. Based on the risk identification results, it is known that the activities carried out in both parts are classified as having a high risk of causing injury.
- Workers who perform manual material handling activities have been to have high complaints of skeletal and muscular disorders in the upper limbs, especially in the right arm, left arm, right hand, left hand, right elbow, left elbows, right shoulders, and left shoulders.

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