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Halaman 1 - 10

Evaluating Musculoskeletal Disorder Risk Factors through Quick Exposure Check: A Case Study in a Crumb Rubber Factory

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Abstract

Manual Material Handling (MMH) encompasses activities such as lifting, moving, carrying, pulling, and lowering materials or finished goods, relying on manual human power. The pressing workstation in the crumb rubber factory is a setting where MMH tasks are performed. Workers at this station are involved in lifting and moving bandelas weighing approximately 35 kg daily, without the aid of assistive devices, thereby exposing them to potential risks of musculoskeletal disorders. This study is designed to assess the work posture of employees at the pressing workstation concerning the risk of musculoskeletal disorders in the crumb rubber factory. The Quick Exposure Check (QEC) method was employed for evaluation, utilizing data collected through the QEC questionnaire from a total of 10 workers. The results showed that 80% of workers were at high risk of developing musculoskeletal disorders, characterized by an exposure level score of more than 70% and requiring improvement and change as quickly as possible. In contrast, 20% of workers showed exposure levels below 70% and required immediate remediation. This research contributes to increasing employee awareness of the risks of GMS and the importance of ergonomic work practices. This increased awareness can contribute to reducing the incidence of injuries and improving the welfare of workers in rubber factories.

Keywords: ***MMH, musculoskeletal disorders, quick exposure check, exposure level, crumb rubber***

Abstrak

Penanganan material secara manual (MMH) mencakup kegiatan seperti mengangkat, memindahkan, membawa, menarik, dan menurunkan material atau barang jadi, bergantung pada kekuatan manusia secara manual. Stasiun pemepresan di pabrik karet crumb adalah tempat di mana tugas MMH dilakukan. Pekerja di stasiun ini terlibat dalam mengangkat dan memindahkan bandela berat sekitar 35 kg setiap hari, tanpa bantuan perangkat bantu, sehingga menempatkan mereka pada risiko potensial gangguan muskuloskeletal. Studi ini bertujuan untuk menilai postur kerja karyawan di stasiun pemepresan sehubungan dengan risiko gangguan muskuloskeletal di pabrik karet crumb. Metode yang digunakan adalah Quick Exposure Check (QEC). Data dikumpulkan menggunakan kuesioner QEC dari total 10 pekerja. Hasil penelitian menunjukkan bahwa 80% pekerja berisiko tinggi mengembangkan gangguan muskuloskeletal, ditandai dengan skor tingkat paparan lebih dari 70% dan memerlukan perbaikan dan perubahan secepat mungkin. Sebaliknya, 20% pekerja menunjukkan tingkat paparan di bawah 70% dan memerlukan perbaikan segera. Penelitian ini berkontribusi untuk meningkatkan kesadaran karyawan terhadap risiko GMS dan pentingnya praktik kerja yang ergonomis. Peningkatan kesadaran ini dapat berkontribusi pada pengurangan insiden cedera dan peningkatan kesejahteraan pekerja di pabrik karet.

Kata kunci: MMH, gangguan muskuloskeletal, Quick Exposure Check, tingkat paparan, karet remah

1. Introduction

Manual Material Handling (MMH) encompasses activities such as lifting, moving, carrying, pulling, and lowering materials or finished goods, relying on manual human power. Manual Material Handling (MMH) activities that are not carried out correctly can cause work-related injuries, one of which is the risk of musculoskeletal disorders (MSD) [1]. Musculoskeletal disorders (MSD) are related injuries to the body including muscles

and tendons, bones, nerves, and areas of the spine. Factors that affect disorders of the musculoskeletal system are age, gender, load carried, lifestyle, working conditions, body posture, and so on [2]. MMH activities can also occur in crumb rubber-producing companies.

The company is a producer and exporter of crumb rubber to countries such as America, Canada, Japan, and India. Characteristics activities include selecting raw materials received from suppliers and processing them into wet processes and dry processes. After completing the dry process, crumb rubber in the form of bandela. The Bandela has been dried in the dryer and will be lifted manually to the weighing areas. After being weighed, the bandela will be transferred to the press machine and packaged at the pressing workstation. This activity is carried out repeatedly and takes place every day without any tools. The weight of the bandela is around 35 kg. The body postures when lifting, moving, and lowering are excessive bending. The weight of the bandela being moved does not match the recommended weight or a maximum of 25 kg [1].

Several methods or approaches can be used to address MSD-related problems in several types of industries. The Quick Exposure Check (QEC) method has been used in several industries to evaluate body posture [1]-[6] and combined with the Nordic Body Map (NBM) [7], the RULA method, REBA, WERA [8]-[10], as well as the PLIBEL method at PT. Karsa Wijaya Pratama [11]. The results obtained are that the posture of the worker's MMH activities is considered to need immediate corrective action with a high level of risk and the proposed improvements in the form of design and use of assistive devices are considered acceptable as a preventive step to reduce MSD problems at work. The use of work aids accompanied by a reduction in standard time can have a significant impact on reducing the risk of MSD [12]. Proposed improvements in the form of an ergonomic desk design can also be an alternative solution for improvement [13]. In other studies, evaluation of work posture in workers using the Cornell Musculoskeletal Discomfort Questionnaires [14], JSI [15]-[17], RULA, REBA, and BRIEF [18]-[22] found that workers experience complaints in the body and needs further corrective action. The proportion of body parts that were injured was back by 6.5%, the upper limbs by 32.7%, and the lower limbs by 67.9% [23]. Among these methods, QEC has advantages compared to other methods. QEC considers assessments from two points of view, those of observers and workers.

Based on previous studies, workers' complaints on the upper limbs can be evaluated for posture at work using the QEC method. This is because the QEC method considers two points of view, namely from the observer and the operator/worker [2]-[4]. For this reason, this study aimed to analyze the risk of musculoskeletal disorders (MSD) on the back, arms or shoulders, wrists, and necks in the pressing workstation workers in the crumb rubber factory using the Quick Exposure Check (QEC) method. Based on the results of the QEC method, suggestions for improvements will be given that are considered appropriate to be applied to workers at the crumb rubber factory.

2. Material and Methods

This study was conducted at the pressing workstation in the crumb rubber factory. The data used is primary data in the form of a Quick Exposure Check (QEC) questionnaire involving 10 workers in the pressing workstation. Total workers The sampling technique used is saturation sampling, where all workers in the pressing section will be sampled [24]. The method used in this research is Quick Exposure Check (QEC). Data was collected using a questionnaire filled out by observers (researchers) and all workers.

The steps involved in processing the data are first, conducting an MSD risk assessment using the QEC questionnaire consisting of sheets for observers and workers. Second, combining the results of the observer's assessment with the workers to obtain an exposure score from each body part assessed (table 1) [2].

Table 1. Exposure Score

Category	Exposure Score			
	Low	Moderate	High	Very High
Back (Static)	8-15	16-22	23-29	29-40
Back (Moving)	10-20	21-30	31-40	41-56
Shoulder/ Arm	10-20	21-30	31-40	41-56
Wrist/Hand	10-20	21-30	31-40	41-56
Neck	4-6	8-10	12-14	16-18

Third, grouping the level of exposure score for each part of the body that is assessed. Fourth, calculate the exposure level based on the division between the total exposure score and the X_{max} value. X_{max} is a fixed constant of the type of work used, where an X_{max} value of 162 is used for static work, and an X_{max} value of 176 is used for dynamic manual material handling work. Fifth, classify the types of action levels (table 2) which are used as the basis for improvement. Last, provide appropriate improvement suggestions based on the results of the action level that has been obtained.

Table 2. Action level

QEC Score (E)	Action
≤40%	Acceptable risk
41-50%	Investigate further
51-70%	Investigate further and change soon
>70%	Investigate and change immediately

3. Results and Discussion

Workers Characteristics

The number of workers at the pressing station is 10 people. Based on Table 3, all workers are male with an age range of 29-45 years and the majority of workers are in the age range of 36-40 years. All of these workers are smokers and tend to exercise rarely. Individual factors, such as smoking, are one of the factors that need to be considered [20]. As for working time, workers work for 8 hours, including 1 hour rest time, starting at 07.00 to 15.00 from Monday to Saturday.

Table 3. Worker characteristics

Characteristics	Range	Total
Gender	Male	10
	Female	0
	<35	2
	36-40	5
	> 40	3

The working posture of workers in the pressing section tends to be done by bending repeatedly to lift a bandela weighing 35 kg without tools and done by themselves. The lifting activity is carried out to move it to the weighing section and to the press machine section.

Quick Exposure Check (QEC)

The exposure score is based on the total score for each part of the body being assessed. The categories assessed include the back, shoulders/arms, wrists, and neck. The following is a recapitulation of exposure score calculations for 10 workers at the pressing workstation.

Table 4. Exposure Score for worker 1

Category	Back	Shoulder / Arm	Wrist/ Hand	Neck
Score 1	12	12	6	8
Score 2	10	10	6	6
Score 3	12	12	10	-
Score 4	-	12	6	-
Score 5	10	10	8	-
Score 6	10	-	-	-
Total	54	56	36	14
Exposure		160		

Based on table 4, the exposure score for worker 1 obtained a total score for all parts of the body assessed at 160 with the highest score being on the shoulder/arm and the lowest on the neck with scores of 54 and 14.

Table 5. Exposure Score for worker 2

Category	Back	Shoulder / Arm	Wrist/ Hand	Neck
Score 1	12	10	8	8
Score 2	10	8	8	6
Score 3	12	12	10	-
Score 4	-	10	8	-
Score 5	12	8	8	-
Score 6	10	-	-	-
Total	56	48	42	14
Exposure		160		

Based on Table 5, the highest score for worker 2 is in the area of the back and the lowest is in the neck area of 14. The total score for all parts of the body is 160.

Table 6. Exposure Score for worker 3

Category	Back	Shoulder / Arm	Wrist/ Hand	Neck
Score 1	12	12	8	8
Score 2	10	10	8	6
Score 3	12	12	10	-
Score 4	-	12	8	-
Score 5	10	10	8	-
Score 6	10	-	-	-
Total	54	56	42	14
Exposure		166		

Based on Table 6, the total score for all parts of the body assessed was 166 with the highest score on the body part of the shoulder/arm which was 56, and the lowest on the neck by 14.

Table 7. Exposure Score for worker 4

Category	Back	Shoulder / Arm	Wrist/ Hand	Neck
Score 1	10	12	8	8
Score 2	8	10	8	6
Score 3	12	12	10	-
Score 4	-	10	8	-
Score 5	8	8	8	-
Score 6	6	-	-	-
Total	44	52	42	14
Exposure		152		

Based on table 7, the highest score is on the shoulder/arm with a total score of 52 and the lowest on the neck by 14. The total for all parts of the body is 152.

Table 8. Exposure Score for Worker 5

Category	Back	Shoulder / Arm	Wrist/ Hand	Neck
Score 1	12	8	6	8
Score 2	10	6	6	6
Score 3	12	12	10	-
Score 4	-	8	8	-
Score 5	10	8	8	-
Score 6	8	-	-	-
Total	52	42	38	14
Exposure		146		

Based on Table 8, the total score obtained by worker 5 is 146 with the highest body part score being 52 on the back and the lowest on the neck of 14.

Table 9. Exposure Score for Worker 6

Category	Back	Shoulder/ Arm	Wrist/ Hand	Neck
Score 1	6	6	4	6
Score 2	6	6	6	6
Score 3	10	10	8	-
Score 4	-	6	6	-
Score 5	6	6	8	-
Score 6	6	-	-	-
Total	34	34	32	12
Exposure		112		

Based on Table 9, the total score obtained by worker 6 is 112 with the highest body part score being 34 on the back and shoulders/arms, and the lowest being 12 on the neck.

Table 10. Exposure Score for Worker 7

Category	Back	Shoulder / Arm	Wrist/ Hand	Neck
Score 1	12	10	8	8
Score 2	10	8	8	6
Score 3	10	12	10	-
Score 4	-	8	8	-
Score 5	10	8	8	-
Score 6	8	-	-	-
Total	50	46	42	14
Exposure		152		

Based on Table 10, the total score obtained by worker 7 is 152 with the highest body part score being 50 on the back and the lowest on the neck of 14.

Table 11. Exposure Score for Worker 8

Category	Back	Shoulder / Arm	Wrist/ Hand	Neck
Score 1	12	10	8	8
Score 2	10	8	8	6
Score 3	10	12	10	-
Score 4	-	8	8	-
Score 5	10	8	8	-
Score 6	8	-	-	-
Total	50	46	42	14
Exposure		152		

Based on Table 11, the total score for all parts of the body assessed was 152 with the highest score on the back body at 50 and the lowest on the neck at 14.

Table 12. Exposure Score for Worker 9

Category	Back	Shoulder/ Arm	Wrist/ Hand	Neck
Score 1	10	10	4	6
Score 2	6	6	4	4
Score 3	10	10	6	-
Score 4	-	8	6	-
Score 5	10	4	6	-
Score 6	6	-	-	-
Total	42	38	26	10
Exposure		116		

Based on Table 12, the total score of all parts of the body assessed is 116 with the highest score on the back body of 42. The lowest score on the neck is 10.

Table 13. Exposure Score for Worker 10

Category	Back	Shoulder / Arm	Wrist/ Hand	Neck
Score 1	12	10	6	10
Score 2	10	8	8	6
Score 3	12	12	8	-
Score 4	-	12	6	-
Score 5	12	10	8	-
Score 6	10	-	-	-
Total	56	52	36	16
Exposure		160		

Based on Table 13, the total score obtained by worker 10 is 160 with the highest body part score being 56 on the back. Based on Table 14, it was found that the highest exposure score obtained was 166, and the lowest exposure score obtained was 112. The average exposure level (E) of labor jobs pressing work station is 84% and only 2 workers have an exposure level (E) value below 70%. While 8 other people are at an exposure level (E) above 70%. The highest exposure level is 94% and the lowest exposure level is 64%. If seen based on the characteristics of the workers, the workers are around 40 years old and active smokers. Based on the information provided by the respondents stated that age influences the risk of musculoskeletal disorders.

Based on the exposure level value, 80% of workers need action and change as soon as possible, while 20% of workers are at the action level and need improvement. The activities carried out by the workers at the pressing workstation are lifting, moving, and lowering the bandela whose working hours start from 7 am to 3 pm every day except Sunday. The workload raised by the pressing workstation workers is 35 kg without the help of work aids so it exceeds the recommended weight. Some workers said that pain in their back, arms/shoulders, wrists, and neck sometimes began to subside even when they were doing activities such as a morning walk before going to work which was accompanied by light stretching movements while walking.

Based on previous calculations, it can be seen that 80% of workers need corrective action as soon as possible, while the others need changes. For this reason, the change actions that need to be carried out are the need to improve the work system in completing the work of the workers at the pressing workstation. Posture while working at the pressing workstation is a lot of bending when placing the ball on the weighing station.

This makes some workers experience complaints in the form of aches and pains in the back and neck and activities and body postures like this are repeated every day. Another improvement solution is the need to add working tools in the form of a conveyor belt. This is intended to minimize the walking and lifting movements that workers usually do. This proposal is in line with the results of research conducted by Setiawan et al. [5] and Sukania et al. [14] that awkward posture and repetitive activities increase the risk of musculoskeletal disorders in heavy lifting and strong movements.

The implication of this research is the need for immediate improvements in the work system at the pressing station. Recommendations include reducing activities that cause bending as well as implementing ergonomic solutions, such as the addition of conveyor belts, to reduce walking and lifting movements. It is hoped that this research can provide guidance for rubber factory management in improving working conditions and worker welfare, as well as reducing the risk of disruption

Table 19. Exposure and action level

Worker	Total Score	Exposure Level	Action Level
1	160	91	Investigate and change immediately
2	160	91	Investigate and change immediately
3	166	94	Investigate and change immediately
4	152	86	Investigate and change immediately
5	146	83	Investigate and change immediately
6	112	64	Investigate further and change soon
7	152	86	Investigate and change immediately
8	152	86	Investigate and change immediately
9	116	66	Investigate further and change soon
10	160	91	Investigate and change immediately

4. Conclusion

Based on the results obtained using the Quick Exposure Check (QEC) method, it was found that 80% workers had an exposure level of more than 70%, so immediate corrective action and changes were needed. On the other hand, as many as 20% workers is at an exposure level below 70% and needs immediate improvement. However, there is a need for further research regarding work posture and the risk of musculoskeletal disorders so as to reduce the risk of injury and implement improvements. This research contributes to increasing employee awareness of the risks of GMS and the importance of ergonomic work practices. This increased awareness can contribute to reducing the incidence of injuries and improving the welfare of workers in rubber factories. For further research, it is suggested to be able to provide and implement

proposed improvements in the form of adding conveyor belt aids which are expected to be able to provide.

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