

Research Article

Risk Analysis of Upper Limb Musculoskeletal Disorders in Industrial Skin Measurement Workers Using the Assessment of Repetitive Task Method

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Abstract

In the leather industry production process in the Piyungan area of Yogyakarta, Indonesia, the operators do a lot of repetitive activities with intensity and frequency of movement for a long time, for 8 hours in a sitting position. Operators measure on average 4700 pieces of leather per day. This leads to fatigue and complaints of musculoskeletal disorders (MSDs). For this reason, research was conducted to measure the level of risk of MSDs and improve them to reduce muscle complaints. This research was conducted experimentally on all skin-cutting operators at companies in the Piyungan area of Yogyakarta. Measurement of the risk level of upper limb musculoskeletal disorders using the Assessment of Repetitive Tasks (ART) method. The data was analyzed based on ART scores obtained, ranging from low, medium, and high risk level scores. The conclusion of the results showed that the risk level of upper limb musculoskeletal disorders in this skin measurement operator included medium and high risk levels on the left and right upper limb operators. Improvements that can be made to reduce the level of risk are improvements to work facilities in the form of chairs, additional short rest periods, and stretching muscles before and after doing work on all skin measurement production operators.

Keywords

Risk Analysis, Upper Limb, Musculoskeletal Disorders (MSDs), Assessment of Repetitive Task (ART)

1. Introduction

Labor is the main capital and asset to support the development of industry and business. The interaction between workers, labor and means of production can increase the risk of occupational diseases. One of the occupational diseases is musculoskeletal complaints. Musculoskeletal complaints are complaints in the skeletal muscles experienced by a person starting with mild complaints to pain. If the muscle receives static load for a long time, it will cause complaints in the form

of destruction of joints, ligaments and tendons. These complaints are often called musculoskeletal disorders [1-3].

A study on newly employed manufacturing workers found that most musculoskeletal disorders including upper extremity disorders develop within the first twelve months. Another study, in the early 90s, compared part-time jobs with full-time (8 hours), and after comparing the data they reported that a 5-hour workday can delay the development of some muscu-

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musculoskeletal disorders [4-6].

The United States Bureau of Labor Statistics has reported that MSDs have affected 32 percent of occupational diseases in America, where higher cases are reported among male workers compared to females [7, 8]. In the manufacturing industry, muscle disorders in workers are one of the factors that can reduce productivity in the production process. Muscle disorders can also cause fatigue that takes away efficiency and lowers the body's endurance capacity. Musculoskeletal disorders associated with upper extremities (UL-MSDs) are a disease that occurs in carriers with complaints of the skeletal muscles. This can happen because of activities that are done repeatedly with static loads for a long time, which can result in damage to joints, ligaments, and tendons [9-11].

In Yogyakarta there are several companies engaged in the leather industry. Some of these companies are located in the Piyungan leather industrial area. The company produces leather sheets that will be made into gloves. In each production process, the operator does a lot of repetitive activities with intensity and frequency of movement for 8 hours in a sitting position, one of which occurs in the skin measurement operator, during one day of work, the operator measures the skin on average 4700 pieces of skin/day. Based on the results of interviews with several skin measurement workers, many workers have complaints of pain or pain that occurs in the upper limb, namely the wrists, head, fingers, and elbows. This is due to workers doing work activities with static loads and doing repetitive movements an average of 30 times in one minute. As for the finishing workstation in the leather measurement section, there are 3 operators who carry out their duties.

The first worker is in charge of lifting the skin, pulling the skin and inserting the skin into the measuring machine, the second worker is in charge of pulling the skin, and lifting the skin, the third worker is in charge of typing the label with the size of the skin listed on the machine, then attaching the label to the end side of the skin.

Risk assessment used in this study through an approach with scoring methods in accordance with the object to be studied. In this study, the quantitative method used was the Assessment of Repetitive Task (ART) tools. The objectives of this study are: (a) determine the level of risk of upper limb musculoskeletal disorders in skin measurement operators using the Assessment of Repetitive Task (ART) Tools method, (b) make improvement proposals to reduce the risk of upper limb musculoskeletal disorders. The benefits of this study include: (a) can obtain the level of risk of upper limb musculoskeletal disorders in skin measurement workers, (b) can

minimize the level of risk hazard by providing improvement proposals using the Assessment of Repetitive Task (ART) Tools Method.

2. Method

2.1. Research Design

This study was conducted with an observational design to analyze the risk of upper limb musculoskeletal disorders in skin measurement workers using the assessment of repetitive task (ART) tools. This research was conducted at a company engaged in the leather industry in Bantul, Yogyakarta, Indonesia. The object of study on the operator of the skin measurement part.

2.2. Data and Data Collection Techniques

The data needed in conducting this research are primary data and secondary data. Primary data is data obtained by observation and observation as well as direct interviews with skin measurement operators. The primary data taken were the age of workers, as well as operator questionnaire data and time studies. Secondary data is data obtained indirectly related to documents owned by the company and the results of research of other similar people.

The data collection stages in this study are:

1. Interview. The interview was conducted to obtain some information directly with a question and answer process to the operator about the perceived complaint.
2. Observation. Observation is carried out by observing and doing work directly at the finishing warehouse work station with the object of the skin measurement operator and recording the results of observations that have been made.
3. Documentation. Documentation is carried out by taking pictures or photos and videos on the object of research to be studied. This is used as proof of research which will be attached at the end of the study. The documentation taken is in the form of photos while the operator is doing skin measurement work.

2.3. Research Flow

The brief explanation of the research flow is as shown below.

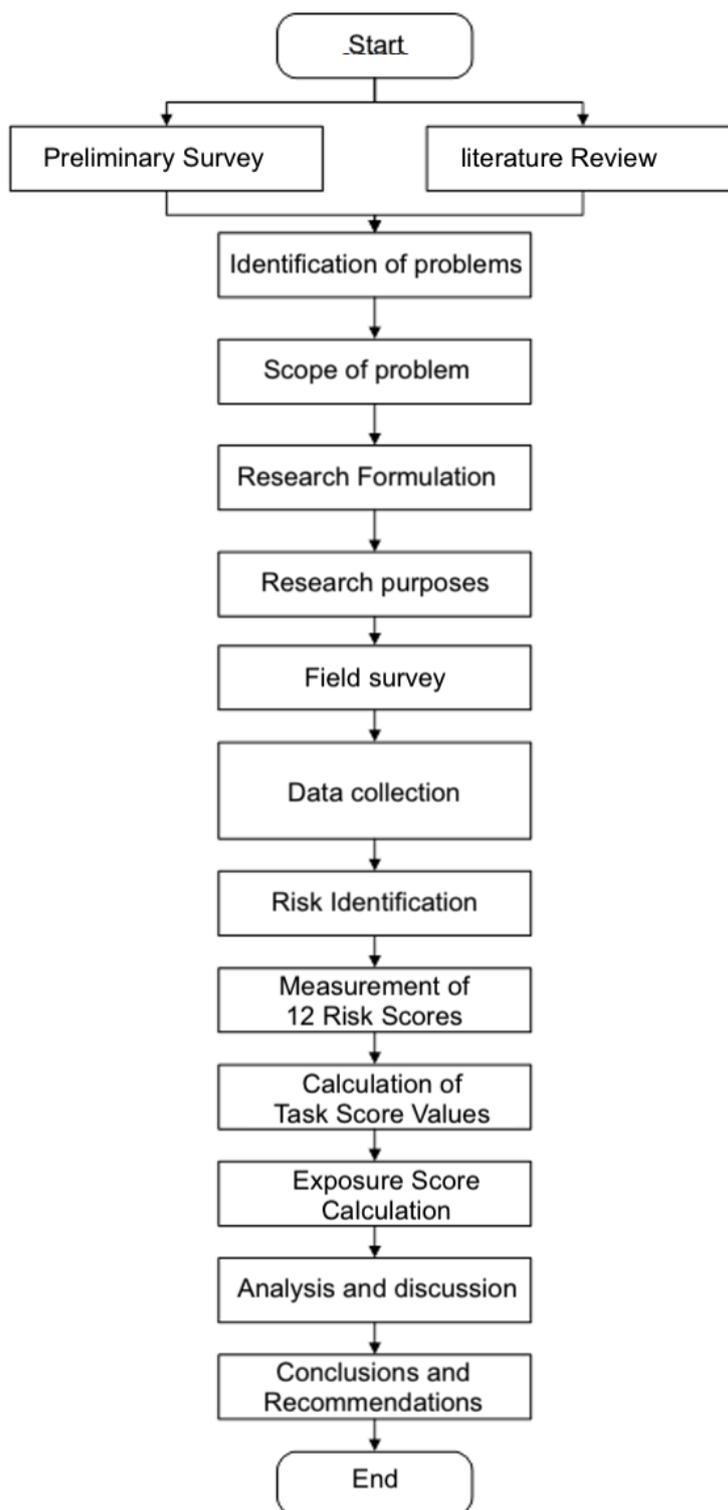


Figure 1. Research Flow.

3. Results and Discussion

3.1. Risk Level Assessment of Upper Limb MDSs

After assessing the level of risk using the art tools method, the following results were obtained.

Table 1. Results of operator risk level assessment 1 shift 1.

| Factor Risk | Operator 1 shift 1 | |
|------------------------------------|--|-------------|
| | Left | Right |
| A1. Pattern of arm movement | 3 | 3 |
| A2. Frequency of technical actions | 6 | 6 |
| B. Power level | 2 | 2 |
| C1. Head/neck posture | 1 | 1 |
| C2. Back posture | 2 | 2 |
| C3. Mail Extension | 2 | 2 |
| C4. Wrist posture | 2 | 1 |
| C5. Hand/finger grip | 2 | 2 |
| D1. Break time | 6 | 6 |
| D2. Work tempo | 0 | 0 |
| D3. Other Factors | 1 | 1 |
| Total Score | 27 | 26 |
| D4. Duration multiplier factor | X 0.75 | |
| Exposure score | 20.25 | 19.50 |
| Exposure Level | Medium risk | Medium risk |
| D5. Psychosocial factors: | Work that requires high concentration, monotonous work | |

After analyzing and processing the data, the results of the risk level scoring assessment were obtained with reference according to the Health and Safety Executive (HSE) [12, 13]. With a score of three for both the left and right hands, A1 is classified as being at medium risk. A2 is classified as high risk since it received a score of 6. B, with the left and right hands, which are in the medium risk category, receiving a score of 2. With a head posture score of 1, C1 falls into the medium risk category. C2 falls into the high risk category with a score of 2 for back posture, while C3 falls into the medium risk category with a score of 2 for both the right and left hands. C4 has a score of 1 for the right hand, placing it in the medium risk category,

and a score of 2 for the left hand, placing it in the high risk category. C5 having a high risk group score of 2 for both the left and right hands, D1 having a high risk group score of 6 for both the left and right hands, D2, which is in the low risk category, has a score of 0 for both the left and right hands. D3, with a total score of 27 for the left hand and 26 for the right hand, and scores of 1 for both the right and left hands, which are in the medium risk group. Exposure scores of 20.25 for the left hand and 19.50 for the right hand indicate a D4 multiplier of 0.75; the exposure level falls into the medium risk category for both the left and right hands, as do D5 psychosocial elements when operators do repetitive tasks requiring high attention.

Table 2. Results of the risk level assessment of operators 2 shift 1.

| Factor Risk | Operator 2 shift 1 | |
|------------------------------------|--------------------|-------|
| | Left | Right |
| A1. Pattern of arm movement | 6 | 3 |
| A2. Frequency of technical actions | 6 | 6 |
| B. Power level | 4 | 4 |
| C1. Head/neck posture | 0 | 0 |

| Factor Risk | Operator 2 shift 1 | |
|--------------------------------|--|-------------|
| | Left | Right |
| C2. Back posture | 0 | 0 |
| C3. Mail Extension | 4 | 2 |
| C4. Wrist posture | 2 | 1 |
| C5. Hand/finger grip | 2 | 2 |
| D1. Break time | 6 | 6 |
| D2. Work tempo | 2 | 2 |
| D3. Other factors | 1 | 1 |
| Total Score | 33 | 27 |
| D4. Duration multiplier factor | X 0.75 | |
| Exposure score | 24.75 | 20.25 |
| Exposure Level | High risk | Medium risk |
| D5. Psychosocial factors: | Work that requires high concentration, monotonous work | |

In Table 2, data analysis and processing obtained the results of the risk level scoring assessment with reference according to the Health and Safety Executive (HSE) [12, 13]. Regarding A1, the left hand with a score of 6 falls into the high risk category, and the right hand with a score of 3 falls into the medium risk category. A2 is classified as high risk since it received a score of 6. B, with the left and right hands scoring four points each, falling into the medium risk category. C1 falls into the low risk category with a head posture score of 0 and C2 falls into the low risk group with a back posture score of 0. The left hand, C3, has a score of 4, placing it in the high risk category; the right hand, C3, has a score of 2, placing it in the medium risk category. C4, where the left hand has a score

of 2 and is classified as high risk, while the right hand has a score of 1 and is classified as medium risk. C5 with a score of 2 for the left and right hands in the high-risk category, D1 scored six points for both the right and left hands in the high-risk group, while D2 scored two points for both the right and left hands in the high-risk group. D4 multiplier of 0.75, exposure score of 24.75 for left hand and 20.25 for right hand; left hand exposure level is included in the high risk group while right hand is included in the medium risk group; D5 psychosocial factor where operators perform tasks requiring high concentration and monotony; and D3 with a score of 1 for both hands, which are included in the medium risk group; overall score of 33 for left hand and 27 for right hand.

Table 3. Results of operator risk level assessment 3 shift 1.

| Factor Risk | Operator 3 shift 1 | |
|------------------------------------|--------------------|-------|
| | Left | Right |
| A1. Pattern of arm movement | 6 | 3 |
| A2. Frequency of technical actions | 6 | 6 |
| B. Power level | 4 | 4 |
| C1. Head/neck posture | 2 | 2 |
| C2. Back posture | 2 | 2 |
| C3. Mail Extension | 0 | 0 |
| C4. Wrist posture | 2 | 0 |
| C5. Hand/finger grip | 2 | 1 |

| Factor Risk | Operator 3 shift 1 | |
|--------------------------------|--|-------------|
| | Left | Right |
| D1. Break time | 6 | 6 |
| D2. Work tempo | 2 | 2 |
| D3. Other Factors | 1 | 1 |
| Total Score | 33 | 27 |
| D4. Duration multiplier factor | X 0.75 | |
| Exposure score | 24.75 | 20.25 |
| Exposure Level | High risk | Medium risk |
| D5. Psychosocial factors: | Work that requires high concentration, monotonous work | |

Table 3 demonstrates that the left hand, which is included in the high risk group, received a score of 6 in A1, while the right hand, which is included in the medium risk group, received a score of 3. A2 is classified as high risk because of its score of 6, B as medium risk because of its score of 4 for the right and left hands, and C1 as high risk because of its score of 2 for head posture. C2, which is in the high risk category and has a back posture score of 2, C3, which falls into the low risk category, has a score of 0 for both the left and right hands. C4 has a score of 2 for the left hand, placing it in the high risk category, and a score of 0 for the right hand, placing it in the low risk category. C5 has a score of 2 for the left hand, which

is in the high risk category, and a score of 1 for the right hand, which is in the medium risk group. D1 having a high risk group score of 6 for both the left and right hands, D4 multiplier factor of 0.75, exposure score of 24.75 for left hand and 20.25 for right hand, exposure level included in the high risk group for left hand and medium risk group for right hand, D5 psychosocial factor where operators perform activities requiring high concentration and monotony, and D2 with a score of 2 for right and left hands which are included in the high risk group, D3 with a score of 1 for right and left hands which are included in the medium risk group, and total score of 33 for left hands and 27 for right hands.

Table 4. Results of operator risk level assessment 1 shift 2.

| Factor Risk | Operator 1 shift 2 | |
|------------------------------------|--------------------|-------|
| | Left | Right |
| A1. Pattern of arm movement | 3 | 3 |
| A2. Frequency of technical actions | 6 | 6 |
| B. Power level | 2 | 2 |
| C1. Head/neck posture | 1 | 1 |
| C2. Back posture | 2 | 2 |
| C3. Mail Extension | 2 | 2 |
| C4. Wrist posture | 2 | 1 |
| C5. Hand/finger grip | 2 | 2 |
| D1. Break time | 6 | 6 |
| D2. Work tempo | 0 | 0 |
| D3. Other Factors | 1 | 1 |
| Total Score | 27 | 26 |
| D4. Duration multiplier factor | X 0.75 | |

| Factor Risk | Operator 1 shift 2 | |
|---------------------------|--|-------------|
| | Left | Right |
| Exposure score | 20.25 | 19.50 |
| Exposure Level | Medium risk | Medium risk |
| D5. Psychosocial factors: | Work that requires high concentration, monotonous work | |

Table 4 displays A1's score of 6 for the left hand, placing it in the high risk category, and its score of 3 for the right hand, placing it in the medium risk group. A2 is classified as high risk since it received a score of 6. B, with the left and right hands scoring four points each, falling into the medium risk category. C1 falls into the low risk category with a head posture score of 0 and C2 falls into the low risk group with a back posture score of 0. C3 has a score of 4 for the left hand, placing it in the high risk category, and a score of 2 for the right hand, placing it in the medium risk category. C4 has a score of 2 for the left hand, placing it in the high risk category, and a score of 1 for the right hand, placing it in the medium

risk category. The right and left hands in the high-risk group receive a score of 2 for C5, 6 for D1, and 7 for D1, respectively. The right and left hands in the D2 group have a score of 2, while the right and left hands in the D3 group have a score of 1. The total score for the left and right hands is 33, and the D4 multiplier is 0.75. The exposure scores for the left and right hands are 24.75 and 20.25, respectively. The left hand's exposure level is included in the high risk group, while the right hand is included in the medium risk group. The D5 psychosocial factor is where operators perform repetitive, high-concentration tasks.

Table 5. Results of 2 shift 2 operator risk level assessment.

| Factor Risk | Operator 2 shift 2 | |
|------------------------------------|--|-------------|
| | Left | Right |
| A1. Pattern of arm movement | 6 | 3 |
| A2. Frequency of technical actions | 6 | 6 |
| B. Power level | 4 | 4 |
| C1. Head/neck posture | 0 | 0 |
| C2. Back posture | 0 | 0 |
| C3. Mail Extension | 4 | 2 |
| C4. Wrist posture | 2 | 1 |
| C5. Hand/finger grip | 2 | 2 |
| D1. Break time | 6 | 6 |
| D2. Work tempo | 2 | 2 |
| D3. Other factors | 1 | 1 |
| Total Score | 33 | 27 |
| D4. Duration multiplier factor | X 0.75 | |
| Exposure score | 24.75 | 20.25 |
| Exposure Level | High risk | Medium risk |
| D5. Psychosocial factors: | Work that requires high concentration, monotonous work | |

The results of the analysis as Table 5 show that A1 with a score of 6 for the left hand which is included in the high risk group, and the right hand with a score of 3 which is included in the medium risk group, A2 with a score of 6 is included in the high risk group, B with a score of 4 for the right and left hands which are included in the medium risk group, C1 with a score of 0 for head posture which is included in the low risk group, C2 with a score of 0 for back posture which is included in the low risk group, C3 with a score of 4 for the left hand which is included in the high risk group and the right hand with a score of 2 which is included in the medium risk group, C4 with a score of 2 for the left hand which is included in the high risk group and the right hand with a score of 1 which is

included in the medium group risk, C5 with a score of 2 for right and left hands with a high risk group, D1 with a score of 6 for right and left hands with a high risk group, D2 with a score of 2 for right and left hands which are included in the high risk group, D3 with a score of 1 for right and left hands which are included in the medium risk group, total score of 33 for left hand and 27 for right hand, D4 multiplier of 0.75, exposure score of 24.75 for left hand and 20.25 for right hand, left hand exposure level is included in the high risk group while right hand is included in the medium risk group, and D5 psychosocial factor where operators carry out activities that require high concentration, and monotonous.

Table 6. Results of 3 shift operator risk level assessment 2.

| Factor Risk | Operator 3 shift 2 | |
|------------------------------------|--|-------------|
| | Left | Right |
| A1. Pattern of arm movement | 6 | 3 |
| A2. Frequency of technical actions | 6 | 6 |
| B. Power level | 4 | 4 |
| C1. Head/neck posture | 2 | 2 |
| C2. Back posture | 2 | 2 |
| C3. Mail Extension | 0 | 0 |
| C4. Wrist posture | 2 | 0 |
| C5. Hand/finger grip | 2 | 1 |
| D1. Break time | 6 | 6 |
| D2. Work tempo | 2 | 2 |
| D3. Other Factors | 1 | 1 |
| Total Score | 33 | 27 |
| D4. Duration multiplier factor | X 0.75 | |
| Exposure score | 24.75 | 20.25 |
| Exposure Level | High risk | Medium risk |
| D5. Psychosocial factors: | Work that requires high concentration, monotonous work | |

In Table 6, for A1 with a score of 6 for the left hand which is included in the high risk group, and the right hand with a score of 3 which is included in the medium risk group, A2 with a score of 6 is included in the high risk group, B with a score of 4 for the right and left hands which are included in the medium risk group, C1 with a score of 2 for head posture which is included in the high risk group, C2 with a score of 2 for back posture which is included in the high risk group, C3 with a score of 0 for the left and right hands which are included in

the low risk group, C4 with a score of 2 for the left hand which is included in the high risk group and the right hand with a score of 0 which is included in the low risk group, C5 with a score of 2 for the left hand which is included in the high risk group and the right hand with a medium risk group with a score 1, D1 with a score of 6 for right and left hands with high risk group, D2 with a score of 2 for right and left hands which are included in the high risk group, D3 with a score of 1 for right and left hands which are included in the medium risk

group, total score of 33 for left hands and 27 for right hands, D4 multiplier factor of 0.75, exposure score of 24.75 for left hand and 20.25 for right hand, exposure level is included in the high risk category for left hand and medium risk for right hand, and D5 psychosocial factor where operators perform activities that require high concentration, and monotony.

3.2. Improvements to Reduce the Risk of Upper Limb Msds

After processing data and assessing the level of risk using the ART Tools method, it can be seen that improvements are needed to reduce the risk of UL-MSDs to 6 operators in the skin measurement section at the leather industry in Bantul, Yogyakarta. The improvement recommendations are in the form of improving work posture in the form of redesigning the chair used, pausing rest periods and stretching muscles before and after while working.

a) Improved work posture in the form of redesigning work facilities

Improving work posture in the form of redesigning work facilities, namely chairs based on anthropometric data. The operator performs work with a non-ergonomic chair with a static and repetitive work posture with monotonous tasks. Here is a picture of the chair used by the operator when doing work:



Figure 2. Work facilities used by operators.

For skin measurement activities, the operator does a lot of work with the machine. The machine cannot be moved or patented so that the work posture can be improved by replacing the worker's chair. Here are improvements to the chairs used by workers:



Figure 3. Work Facilities Repair.

The operator does a lot of work in a static state of the back and hands without any backrest and hands in the seat. The backrest on the seat serves to rest the back and stretch the muscles when the operator feels tired. While the armrests on the chair function to hold the elbows when not doing any activity.

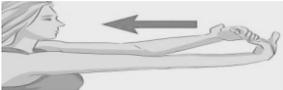
b) Fixed pauses and rest periods.

Improvement of pauses and rest periods is needed as the result of the risk level assessment above that for rest periods are included in the high risk category where operators work for 4 hours. The operator only has a break when the operator clears the toilet after which the operator resumes the work. Therefore, it is necessary to improve the break time every 2x for 30 minutes of work. This improvement is very useful for operators so that they do not feel tired easily and can reduce injuries to muscles by doing muscle stretching movements. Short breaks in between work will restore body freshness so that workers can work more productively [14-16]. When taken properly, taking a break is incredibly advantageous for everybody involved. Worker concentration can be increased with well-timed work breaks. When working, it's important to give your mental health a break in addition to your physical health. Taking a break enables you to recover mentally when handling issues at work [8, 17]. Therefore, work can be more concentrated, thereby reducing work errors and increasing work productivity [18-20].

c) Stretching muscles before and after work.

This stretch is one of the exercises that is useful for maintaining muscle flexibility and flexibility. Muscle stretching exercises also have a function to reduce the risk of pain felt by the operator when the operator performs work with a static work posture for a long time. Based on physiology, decreased muscle performance is often caused by fatigue in working due to decreased metabolism of substances in the body, causing fatigue. With the stretching of the muscles helps the muscles more flexible so that oxygen in the body increases [21, 22]. The following is a table of figures of muscle stretching.

Table 7. Muscle Stretching Movements.

| No | Movement | Movement Patterns |
|----|---|---|
| 1 | Touch your toes with your hands while standing up straight to stretch your back, hamstrings, and muscles. Calf. |  |
| 2 | Perform stretching of shoulder muscles and triceps |  |
| 3 | Sit on the floor while pointing your arms back to stretch biceps muscle |  |
| 4 | Do Stretching the wrist by bending the palm up and down |  |
| 5 | Stretch your chest and back muscles while standing in the corner of the room |  |

4. Conclusion

Based on the results and discussion above, the following conclusions were obtained.

1. The risk level of upper limb musculoskeletal disorders in skin measurement operators using the Assessment of Repetitive Task (ART) Tools method in skin measurement operators in leather industry companies in Bantul, Yogyakarta, including high and medium risk levels.
2. Improvements that can be made to reduce the risk level of upper limb musculoskeletal disorders are improvements to work facilities in the form of chairs used by operators, both operators, additional pause periods for short breaks, and stretching muscles before and after doing work on all operators of the skin measurement production section.
3. Recommendations for further research are redesigning the seat facilities used by operators so that they can be used more safely and comfortably, providing additional comfort such as providing additional calorie intake snacks when resting and listening to music that operators like when working.

Abbreviations

ART: Assessment of Repetitive Task

HSE: Health and Safety Executive

MSDs: Musculoskeletal Disorders

UL-MSDs: Upper Limb Musculoskeletal Disorders

Conflicts of Interest

The authors declare no conflict of interest.

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