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ERGONOMIC RISK LEVEL ANALYSIS USING NORDIC BODY MAP (NBM), RULA, AND REBA METHODS ON MURYA 2 COLLECTION TAILORS

Novia Ramadhani Widya Prasetyo[1], Anik Dwiastuti[2]*, Rudi Nurdiansyah[3], Abdul Muid[4], Muhammad Nursyamsu Alhafidh[5], Rafida Salwa Nida[6], Zahra Aulia Fitri[7]
Teknik Industri, Universitas Negeri Malang, Malang
E-mail: novia.ramadhani.2205166@students.um.ac.id[1], anik.dwiastuti.ft@um.ac.id[2]*, rudi.nurdiansyah.ft@um.ac.id[3], abdul.muid.ft@um.ac.id[4], muhammad.nursyamsu.2205166@students.um.ac.id[5], rafida.salwa.2205166@students.um.ac.id[6], zahra.aulia.2205166@students.um.ac.id[7]

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Abstract

This study aims to analyze ergonomic risk levels among sewing workers at Murya 2 Collection using the Nordic Body Map (NBM), Rapid Upper Limb Assessment (RULA), and Rapid Entire Body Assessment (REBA). This study used a descriptive design with an observational ergonomics approach. The subjects were six active sewing workers, and data were collected through NBM questionnaires, direct observation, photographic documentation, and interviews. NBM was used to identify subjective musculoskeletal complaints, while RULA and REBA were applied to assess objective postural risks during sewing activities. The results showed that the highest complaints occurred in the upper back, neck, lower neck, right shoulder, middle back, lower back, right wrist, right hand, and right foot sole. Based on total NBM scores, two workers were categorized as high risk, while four workers were categorized as moderate risk. RULA results showed that most workers were in the medium-high risk category, whereas REBA results indicated that all workers were in the medium risk category. The use of the three methods showed that dominant complaints were generally consistent with postural risk findings. Recommended improvements include scheduled microbreaks, targeted stretching, posture awareness, foot relaxation, and simple workstation adjustments suitable for SME conditions.

Keywords: ergonomics, Nordic Body Map, REBA, RULA, sewing workers

INTRODUCTION

The garment industry is a labor-intensive manufacturing sector that relies on semi-manual activities such as fabric cutting, sewing, overlocking, finishing, and packaging. In small and medium-sized enterprises (SMEs), these processes are generally performed using simple work facilities and require high physical involvement from workers. Repetitive movements, static postures, and non-neutral body positions can increase the risk of musculoskeletal disorders (MSDs) (Das et al., 2023; Tarwaka, 2015). Sewing activities have specific ergonomic characteristics, including prolonged sitting, neck bending to maintain visual focus, forward trunk leaning, repetitive hand movements to guide fabric, and foot use to operate machine pedals. When performed continuously without sufficient movement variation and recovery, these activities may cause static and repetitive loads on the neck, back, shoulders, arms, wrists, and feet (Ramayanti & Koesyanto, 2021; Yusuf et al., 2023).

Murya 2 Collection is a garment SME in Malang City producing uniforms. The business employs eight workers, consisting of six sewing workers, one packaging worker, and one shop attendant. Sewing workers work from 08.00 to 16.00 with a break from 12.00 to 13.00 and are targeted to produce around ten clothing items per day. Preliminary observations showed that several sewing workers experienced stiffness and pain in the neck, shoulders, and back after work. Since sewing accounts for 20 minutes of the total 48-minute production process per product, it was selected as the focus of the ergonomic analysis.

The Nordic Body Map (NBM) was used to identify subjective musculoskeletal complaints across 28 body parts and is suitable for early detection of work-related discomfort (Ginanjar et al., 2018; Tarwaka, 2015). Rapid Upper Limb Assessment (RULA) was applied because sewing activities mainly involve repetitive and static upper-body movements, particularly in the neck, shoulders, arms, and wrists (Susanti et al., 2015; Wulandari, 2017). Rapid Entire Body Assessment (REBA) complemented the analysis by evaluating whole-body posture, including the trunk, legs, load, coupling, and work activity (Hignett & McAtamney, 2000).

Previous studies consistently reported that sewing activities are associated with musculoskeletal complaints and ergonomic risks due to prolonged sitting, repetitive movements, and non-neutral postures. Wulandari (2017) used REBA and NBM and found moderate postural risk and musculoskeletal complaints but did not specifically assess upper-body posture using RULA. Sari (2022) applied RULA and NBM and identified high musculoskeletal complaints with moderate-to-high upper-body postural risk, although the analysis focused only on the upper body. Hunusalela et al. (2022) used NBM, RULA, and REBA and found moderate-to-high ergonomic risk levels, but improvement priorities were not specifically determined. Dewantari et al. (2025) reported dominant complaints in the neck, shoulders, and back using RULA, QEC, and NBM, while Ningtias et al. (2024) found RULA scores of 5–6 with complaints in the shoulders, back, waist, arms, and feet among sewing workers.

The reviewed studies demonstrate that sewing activities are closely related to musculoskeletal complaints and ergonomic risks caused by prolonged sitting, forward bending posture, repetitive hand movements, and non-ergonomic work facilities. Their strength lies in the use of established ergonomic assessment methods such as NBM, RULA, REBA, and QEC to identify risk levels and affected body parts. However, most studies focused mainly on risk identification and general recommendations, while limited attention was given to combining subjective complaints from NBM with objective postural assessments using both RULA and REBA to determine improvement priorities. Therefore, this study uses NBM, RULA, and REBA to formulate ergonomic improvement priorities based not only on postural risk scores but also on dominant worker complaints and the practical limitations of SME garment production. This study aims to identify the location and severity of musculoskeletal complaints among sewing workers and assess work posture risk using RULA and REBA. In addition, it analyzes the correspondence between subjective complaints and objective postural risk assessments and formulates realistic and applicable work system improvement priorities for Murya 2 Collection.

METHOD

This study used a descriptive research design with an observational ergonomics approach to analyze ergonomic risks in the main sewing activity at Murya 2 Collection. The research subjects consisted of all active sewing workers, totalling six workers; therefore, the data represented the actual conditions of the sewing section. The study was conducted while the production process was running normally without any changes to the existing work system. The research stages included preliminary observation, identification of musculoskeletal complaints using Nordic Body Map (NBM), work posture assessment using Rapid Upper Limb Assessment (RULA) and Rapid Entire Body Assessment (REBA), comparison of subjective and objective findings, and formulation of ergonomic improvement priorities.

Primary data were collected through the Nordic Body Map (NBM) questionnaire, direct observation, and photographic documentation of work postures. Secondary data were obtained through interviews with the business owner, business profile information, number of workers, working hours, production targets, and production process flow. Preliminary observations were conducted to identify the characteristics of sewing activities, including repetitive movements, static posture, working duration, and pedal use. Based on the production flow, sewing was identified as the dominant activity and selected as the focus of ergonomic analysis.

The identification of musculoskeletal complaints was carried out using the Nordic Body Map (NBM) questionnaire. NBM is a subjective instrument used to identify the location and severity of musculoskeletal complaints perceived by workers (Tarwaka, 2015; Ginanjar et al., 2018). The questionnaire evaluated 28 body parts using a scale of 1–4 consisting of no pain, mild pain, pain, and severe pain. The NBM stages included distributing questionnaires, identifying body parts experiencing discomfort, assigning complaint scores, and calculating total scores for each respondent and body part. The classification of musculoskeletal complaint risk levels based on the Nordic Body Map (NBM) scoring system is presented in Table 1.

Table 1. NBM Risk Classification

Score Range	Risk Level	Action
28–49	Low	No action needed
50–70	Moderate	Future improvement
71–91	High	Immediate action
92–112	Very High	Urgent action

Work posture assessment was conducted using RULA. RULA is an observational ergonomic method used to evaluate postural risks in the upper body, particularly the neck, shoulders, arms, wrists, and trunk (Susanti et al., 2015; Wulandari, 2017). Observation and photographic documentation were used to assess the posture angles of

workers while operating the sewing machine, especially during pedal operation and fabric guiding. Photographs were taken from the side to capture the angles of the neck, trunk, upper arms, lower arms, wrists, and legs. The RULA assessment included Group A evaluation consisting of the upper arm, lower arm, wrist, and wrist twist, and Group B consisting of the neck, trunk, and legs, followed by adjustments for muscle use and force/load to obtain the final score. The evaluation of worker posture was carried out using the standard RULA worksheet presented in Figure 1.

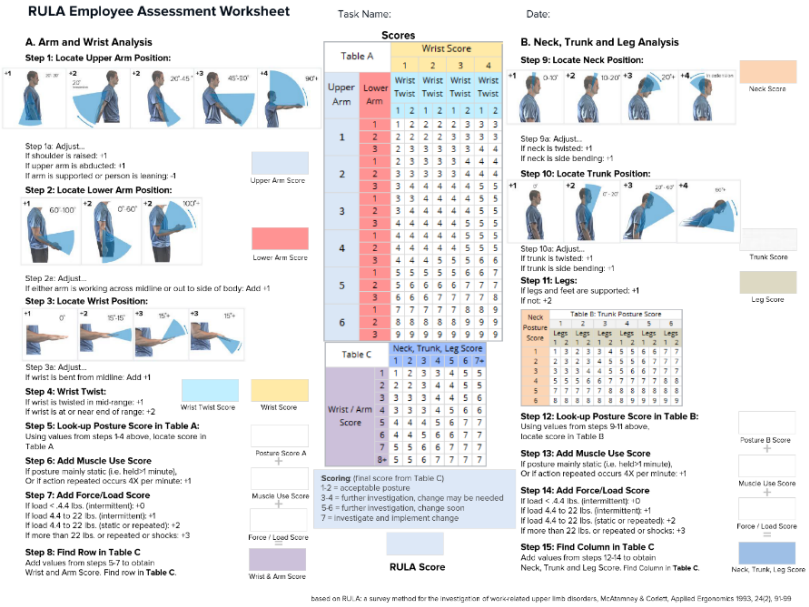

Figure 1. RULA Worksheet

To complement the upper-body-focused assessment, work posture was also analyzed using REBA. REBA is an observational method used to evaluate whole-body ergonomic risks, including the neck, trunk, legs, arms, wrists, load handling, coupling, and work activity (Hignett & McAtamney, 2000). The REBA assessment stages included posture observation, body angle measurement, Group A evaluation consisting of the neck, trunk, and legs, and Group B consisting of the upper arm, lower arm, and wrist, followed by adjustments for force/load, coupling, and activity score to determine the final REBA score. The evaluation of worker posture was carried out using the standard REBA worksheet presented in Figure 2.

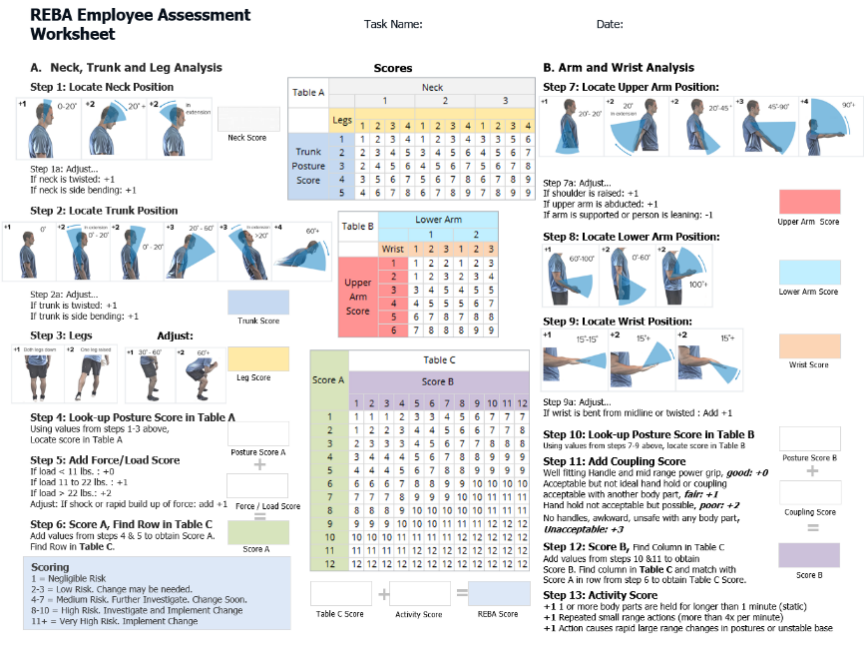

Figure 2. REBA Worksheet

Data analysis was conducted using a descriptive-comparative approach. The NBM results were compared with the RULA and REBA results to examine the correspondence between subjective complaints and objective postural risks. Improvement priorities were determined based on dominant complaint locations, body segments with high-risk scores, and the characteristics of sewing activities. The proposed improvements focused on realistic and applicable ergonomic interventions for SMEs, such as scheduled microbreaks, stretching, posture awareness, foot relaxation, and simple workstation adjustments. The scope of this study was limited to the main sewing activity under normal working conditions. Environmental factors such as lighting, noise, temperature, and humidity were not analyzed in depth. The proposed improvements were also limited to simple work system improvements and supporting tools that are realistic for SME conditions.

RESULTS AND DISCUSSION

This study involved six active sewing workers at Murya 2 Collection as research respondents. The number of respondents represented the entire population of sewing workers in the production section; therefore, all workers were included to reflect the actual working conditions in the SME. The study focused on the main sewing activity performed during normal production operations without any modification to the existing work system. Data collection was conducted using the Nordic Body Map (NBM) questionnaire, direct observation, photographic documentation, and interviews. The NBM questionnaire was used to identify subjective musculoskeletal complaints, while posture observations and photographic documentation were used to assess work posture risks using the RULA and REBA methods. The observations focused on sewing activities when workers operated the sewing machine, guided fabric movements, and pressed the machine pedal during the production process. The observed working postures of the six sewing workers during sewing activities are presented in Figure 3.

Figure 3. Working postures of sewing workers (P1–P6) during sewing activities at Murya 2 Collection.

Nordic Body Map (NBM)

Respondent characteristics are presented in Table 2. The respondents consisted of six active sewing workers with varying ages and work experience, which may influence musculoskeletal complaints due to differences in cumulative work exposure (Morato et al., 2023).

Table 2. Characteristics of Respondents

Respondents	Age	Employment Period	Exposure
P1	48	12	Relatively long work experience
P2	54	2	Shortest work experience
P3	52	5	Moderate exposure
P4	48	12	Relatively long work experience
P5	51	8	Moderate-to-long exposure
P6	60	20	Highest age and longest work experience, cumulative exposure requires particular attention

The Nordic Body Map (NBM) results were obtained from questionnaire responses completed by all sewing workers. Each respondent assessed 28 body parts using a scale of 1–4, consisting of no pain (1), mild pain (2), pain (3), and severe pain (4). The score for each body part was calculated by summing the responses from all respondents. The score for Nordic Body Map is presented in Table 3.

Table 3. Nordic Body Map Result

No	Body Part Complaint	P1	P2	P3	P4	P5	P6	Total	%
0	Neck pain	3	4	3	3	4	4	**21**	**87.5%**
1	Lower neck pain	4	3	3	4	3	4	**21**	**87.5%**
2	Left shoulder pain	3	2	2	3	2	3	**15**	**62.5%**
3	Right shoulder pain	4	3	3	3	3	4	**20**	**83.3%**
4	Left upper arm pain	2	2	2	2	2	3	**13**	**54.2%**
5	Upper back pain	4	4	3	4	3	4	**22**	**91.7%**
6	Right upper arm pain	3	2	2	3	2	3	**15**	**62.5%**
7	Middle back pain	3	3	4	3	3	4	**20**	**83.3%**
8	Lower back pain	4	3	3	4	3	2	**19**	**79.2%**
9	Buttock pain	3	2	3	2	3	3	**16**	**66.7%**
10	Left elbow pain	1	1	1	2	1	2	**8**	**33.3%**
11	Right elbow pain	2	1	2	2	2	2	**11**	**45.8%**
12	Left forearm pain	2	2	1	2	2	3	**12**	**50.0%**
13	Right forearm pain	3	2	2	3	2	3	**15**	**62.5%**
14	Left wrist pain	2	1	2	3	2	2	**12**	**50.0%**
15	Right wrist pain	3	2	3	4	3	3	**18**	**75.0%**
16	Left hand pain	2	1	2	2	2	2	**11**	**45.8%**
17	Right hand pain	3	2	3	3	3	3	**17**	**70.8%**
18	Left thigh pain	2	2	2	1	2	3	**12**	**50.0%**
19	Right thigh pain	2	2	2	2	2	3	**13**	**54.2%**
20	Left knee pain	2	3	2	2	2	2	**13**	**54.2%**
21	Right knee pain	3	3	3	2	3	3	**17**	**70.8%**
22	Left calf pain	2	2	2	1	2	3	**12**	**50.0%**
23	Right calf pain	2	3	3	2	2	4	**16**	**66.7%**
24	Left ankle pain	1	1	2	1	2	2	**9**	**37.5%**
25	Right ankle pain	2	2	2	2	3	3	**14**	**58.3%**
26	Left foot sole pain	1	2	2	1	2	2	**10**	**41.7%**
27	Right foot sole pain	3	3	3	3	3	4	**19**	**79.2%**
Total		**71**	**63**	**67**	**69**	**68**	**83**		

Based on the NBM results, musculoskeletal complaints were found in almost all assessed body parts. The highest complaints were reported in the upper back (91.7%), followed by the neck and lower neck (87.5%), right shoulder and middle back (83.3%), and lower back and right foot sole (79.2%). These findings indicate that sewing activities mainly affect the neck, back, shoulders, wrists, and feet. The dominant complaints were associated with prolonged sitting posture, forward trunk inclination, repetitive upper limb movements, and continuous pedal operation during sewing activities. The total NBM scores showed that Sewing Workers 1 and 6 were in the high-risk

category, while the remaining workers were classified as moderate risk. Overall, the NBM results indicate the need for ergonomic improvements focused on reducing static posture and repetitive movement during sewing activities.

RULA and REBA

The RULA and REBA scores were obtained from direct observation and photographic documentation of sewing workers during sewing activities. Posture angles of the neck, trunk, upper arms, lower arms, wrists, and legs were evaluated based on the RULA and REBA assessment procedures. In the RULA assessment, Group A scores were determined from the upper arm, lower arm, wrist, and wrist twist positions, while Group B scores were obtained from the neck, trunk, and leg positions, followed by adjustments for muscle use and force/load. Similarly, the REBA scores were calculated from Group A assessment (neck, trunk, and legs) and Group B assessment (upper arm, lower arm, and wrist), followed by adjustments for load, coupling, and activity score. The final scores were then categorized according to the corresponding action levels and risk categories. RULA and REBA scores are presented in Table 4.

Table 4. RULA and REBA Assessment Results

Tailors	RULA Score	RULA Category	REBA Score	REBA Category
P1	6	Medium-high	7	Medium
P2	4	Low-medium	5	Medium
P3	5	Medium-high	6	Medium
P4	5	Medium-high	6	Medium
P5	5	Medium-high	5	Medium
P6	4	Low-medium	5	Medium

The RULA assessment results show that four sewing workers, namely P1, P3, P4, and P5, were in the medium-high risk category, with scores ranging from 5 to 6. This indicates that their upper-body postures require corrective action in the near future. The higher RULA scores are associated with the dominant involvement of the neck, trunk, shoulders, arms, and wrists during sewing. These body segments are continuously used to maintain visual focus, guide the fabric, and control the sewing process. Meanwhile, P2 and P6 obtained RULA scores of 4, categorized as low-medium risk, indicating that their postures still require attention, although the urgency of correction is lower.

The REBA results show that all sewing workers were in the medium risk category, with scores ranging from 5 to 7. This means that further investigation and work posture improvements are needed for all respondents. The highest REBA score was found in P1, with a score of 7, indicating the greatest whole-body postural risk among the workers. These results reflect that sewing activities do not only affect the upper body, but also involve the trunk and lower limbs, especially due to prolonged sitting and repeated pedal operation. Overall, the RULA and REBA results indicate that sewing activities at Murya 2 Collection present ergonomic risks that require improvement. RULA identified greater risk in upper-body postures (Susanti et al., 2015), while REBA confirmed that the overall body posture also falls within the medium risk level (Hignett & McAtamney, 2000). Therefore, ergonomic interventions should focus on reducing static sitting posture, minimizing forward neck and trunk flexion, improving upper-limb working posture, and reducing repetitive load during sewing.

Correspondence of NBM, RULA, and REBA Results

The results show a correspondence between musculoskeletal complaints identified through NBM and postural risks assessed using RULA and REBA. Dominant complaints were found in the neck, back, right shoulder, right wrist, and right foot, which are consistent with the RULA and REBA findings indicating upper-body and whole-body ergonomic risks during sewing activities. These complaints are associated with prolonged neck and trunk flexion, static sitting posture, repetitive upper-limb movements, and repeated pedal operation, indicating that sewing activities involve continuous static and non-neutral working patterns.

Some differences between methods were also identified, particularly in P6, who had the highest NBM score but did not obtain the highest RULA or REBA score. This suggests that NBM may reflect cumulative discomfort influenced by long-term work exposure, age, and work experience, while RULA and REBA mainly assess postural risk during observation. Therefore, NBM, RULA, and REBA provide complementary information for identifying ergonomic problems and determining improvement priorities.

Formulation and Discussion of Proposed Improvements

Ergonomic improvement priorities were formulated based on dominant musculoskeletal complaints, postural risk levels, and the characteristics of sewing activities. The proposed interventions focus on body segments with the highest ergonomic exposure, including the neck, trunk, upper limbs, and lower limbs, while also considering practical implementation under SME working conditions, as shown in Table 5.

Table 5. Work System Improvement Priorities Based on the Use of NBM, RULA, and REBA

Priority	Risk Basis (NBM, RULA, and REBA)	Main Improvement Focus	Intervention Direction
1	High NBM and medium-high RULA supported by medium REBA, especially in P1, indicate the strongest combined risk.	Neck and trunk	Microbreaks, neck-back stretching, temporary standing breaks, and sitting posture correction.
2	Medium-high RULA in most workers and dominant NBM complaints in the right shoulder, wrist, and hand indicate upper-limb risk.	Shoulder, arms, wrists, and hands	Upper-limb stretching, activity variation, and reduction of repetitive hand movement.
3	Medium REBA in all workers and NBM complaints in the lower back and right foot sole indicate whole-body and lower-limb involvement.	Lower back, right foot, and lower limbs	Foot relaxation, foot position variation, and simple foot support during pedal operation.
4	High NBM in P6 despite lower RULA and REBA scores indicates possible cumulative exposure.	Workers with accumulated complaints	Periodic monitoring, posture awareness, and adjustment of work-rest patterns.

The improvement priorities were formulated based on dominant musculoskeletal complaints identified through NBM and postural risks assessed using RULA and REBA. The highest priority focuses on the neck and trunk because these areas showed dominant complaints and medium-high postural risks caused by prolonged neck flexion, forward trunk inclination, and static sitting posture. Therefore, microbreaks, light stretching, temporary standing breaks, and sitting posture correction are recommended to reduce static load. The second priority targets the shoulders, arms, wrists, and hands due to repetitive upper-limb movements during fabric handling, which contributed to localized fatigue and discomfort. Stretching and short activity variation are recommended to reduce repetitive strain. The third priority addresses lower back and lower-limb discomfort associated with prolonged sitting and repeated pedal operation. Foot relaxation, foot position variation, and simple foot support are recommended to improve lower-limb comfort. In addition, periodic monitoring, posture awareness, and adjustment of work-rest patterns are necessary for workers with high accumulated complaints. Overall, the proposed interventions are designed to be simple, low-cost, and applicable to SME working conditions.

CONCLUSION

The results showed that sewing workers at Murya 2 Collection experienced musculoskeletal complaints in almost all assessed body parts, with dominant complaints found in the neck, back, right shoulder, right wrist, and right foot. Based on the NBM results, two workers were categorized as high risk, while the remaining workers were in the moderate-risk category. The RULA assessment indicated medium-high upper-body postural risk in most workers, while the REBA assessment showed medium whole-body ergonomic risk in all workers. These findings indicate that sewing activities expose workers to static posture, repetitive upper-limb movements, forward body inclination, and repeated pedal operation, which contribute to musculoskeletal discomfort and ergonomic risk. The use of NBM, RULA, and REBA showed a correspondence between subjective complaints and objective postural risks, although differences in several workers suggest the influence of cumulative exposure, age, and work experience. Based on these findings, ergonomic improvements should prioritize the neck and trunk, shoulder-arm-wrist area, lower back, and lower limbs through microbreaks, stretching, posture correction, foot relaxation, and simple workstation adjustments. The proposed interventions were designed to be realistic, low-cost, and applicable to SME conditions. Future research is recommended to involve a larger number of respondents and evaluate the effectiveness of ergonomic interventions after implementation.

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