Jurnal Teknologi dan Manajemen Industri Terapan (JTMIT) Vol. 5, No. 3, September 2026 pp. 1833 - 1839
P-ISSN: 2829-0232 E-ISSN: 2829-0038

Ergonomic Work Posture Assessment Using REBA to Identify Musculoskeletal Disorder Risks among Modern Retail Employees

Syahreen Nurmutia[1*], Wahyu[2], Esa Pratiwi[3], Safira Amanda Tama[4]
[1,2,3,4] Department of Industrial Engineering, Faculty of Engineering, Pamulang University
Surya Kencana Street No.1, Pamulang, Banten, Indonesia
Email: dosen02440@unpam.ac.id, dosen02342@unpam.ac.id, dosen02976@unpam.ac.id, amandasafira1201@gmail.com

ABSTRACT

The modern retail sector exposes employees to the risk of musculoskeletal disorders due to non-ergonomic working postures, particularly during repetitive activities such as item scanning, goods lifting, and cashier service. This study aims to analyse employees' working posture conditions at a modern retail store in Bekasi, identify potential contributing factors associated with ergonomic risks, and formulate ergonomic improvement recommendations. A descriptive ergonomic assessment study was conducted using purposive sampling involving cashiers, warehouse staff, and shelf attendants. The study used the Rapid Entire Body Assessment (REBA) method to assess body segments including the neck, trunk, legs, upper arms, lower arms, and wrists. The assessment results showed a final REBA score of 9, indicating that the observed work activities were categorized as high risk with an action level of 3. The high-risk posture was associated with excessive neck flexion exceeding 20°, trunk bending at 37°, and unacceptable coupling conditions. Repetitive work patterns without adequate job rotation further influenced these conditions. Based on the identified ergonomic risks, recommended improvements include optimizing workplace layout, adjusting work equipment dimensions according to employee anthropometric characteristics, and implementing structured job rotation and rest programs to reduce musculoskeletal disorder risks and improve employee comfort.

Keywords: *Ergonomics; Work Posture; Rapid Entire Body Assessment (REBA); Musculoskeletal Disorders (MSDs); Modern Retail.*

Introduction

The continuously evolving dynamics of global industry, particularly in the era of the Fourth Industrial Revolution, have encouraged companies to continuously improve both their technological capabilities and human resource management practices. Increasingly intense competitive pressures require every business actor to improve the quality of products and services to meet consumer expectations. Therefore, optimal empowerment and use of all organizational resources have become essential [1]. The retail industry is a strategic sector that contributes significantly to national economic growth by providing a wide range of consumer products, from basic necessities to lifestyle goods. In Indonesia, retail formats are generally divided into traditional retail, such as small shops, kiosks, and public markets, which are typically small-scale and characterized by personal interactions, and modern retail, such as minimarkets, supermarkets, hypermarkets, and department stores, which operate through more structured management systems and professional technological support. Along with rising productivity demands, employees' physical health issues caused by non-ergonomic working postures have become a concern that cannot be overlooked, particularly in retail environments such as a modern retail store in Bekasi.

Employees working as cashiers, warehouse staff, and shelf attendants are often exposed to working conditions that require non-ideal body postures, such as prolonged standing, repetitive bending, or static sitting without adequate support. These conditions may increase the risk of Musculoskeletal Disorders (MSDs) and reduce employee comfort during work activities [2]. Human labor remains dominant in Manual Material Handling (MMH) activities in Indonesian industries. Although MMH provides flexibility of movement when handling light loads, it is also associated with serious risks of spinal disorders, particularly Low Back Pain. Historical data from New South Wales, Australia, reported that an average of 18% of occupational accidents during the 1982–1985 period were caused by MMH activities, of which 93% resulted from strain injuries and 61% occurred in the back region [3]. Globally, more than 50% of workers in the industrial sector experience musculoskeletal injuries caused by non-ergonomic postures, while posture- and repetitive-movement-related injuries account for 38% of all industrial injuries worldwide. Empirical evidence from studies in the footwear industry further supports these findings, showing that more than 70% of workers reported lower back pain due to non-ergonomic postures during the production process.

The Rapid Entire Body Assessment (REBA) method, introduced by McAtamney and Hignett (2000), has become one of the most widely used postural risk assessment instruments because it is capable of evaluating the worker's entire body, exceeding the scope of the Rapid Upper Limb Assessment (RULA) method, which focuses only on the upper extremities. Studies in the manufacturing industry have demonstrated that interventions based on REBA assessment results can reduce injury rates by up to 30%, while studies in the food processing industry have reported a 25% reduction in muscle pain complaints. Nevertheless, many companies have not fully adopted this method, and the improvements implemented remain partial, failing to address potential contributing factors associated with ergonomic risks [4], [5].

Based on the operational conditions at a modern retail store in Bekasi, several problems can be identified. First, there is a potential risk of Musculoskeletal Disorders (MSDs) due to repeated non-ergonomic postures during work activities. Second, employees may experience reduced physical comfort because they must maintain awkward postures in their daily work routines. Third, the company may face potential financial losses due to increased healthcare costs and higher employee absenteeism. Fourth, operational performance may decline due to early fatigue, which can ultimately affect the quality of customer service. Fifth, work design standards oriented toward ergonomic principles are lacking in the retail environment. Sixth, evidence-based guidelines for improving working postures that similar retail industries can adopt are still lacking.

Based on the problem identification described above, this study's research questions are formulated as follows: What are the working posture conditions of employees at a modern retail store in Bekasi while performing their tasks? What factors contribute to non-ergonomic working postures in the workplace? How can ergonomics-based postural improvements reduce ergonomic risks and improve employee comfort?

This study aims to analyse the working posture conditions of employees at a modern retail store in Bekasi while performing their tasks, identify the factors causing non-ergonomic working postures, and formulate and evaluate improvement recommendations based on ergonomic principles to sustainably enhance employee health, comfort, and ergonomic conditions.

The results of this study are expected to help the management of a modern retail store in Bekasi understand employees' working posture conditions in a real and measurable way. In addition, the findings can serve as a basis for designing effective ergonomic interventions, such as adjustments to work tables, chairs, and workplace layout. Practically, this study is expected to reduce the risk of musculoskeletal complaints, such as back, neck, and shoulder pain, commonly experienced by retail workers, while also improving work comfort so employees can work with greater focus and productivity.

Research Methods

Research Site and Period

This research was conducted at a modern retail store, a company operating in the retail sector, located at District, Bekasi City, West Java Province. The research location was selected because the object is relevant to the ergonomic issues that are the focus of this study. The research was carried out over a twelve-month period, from September 2025 to August 2026.

Research Design and Approach

This study is a descriptive ergonomic assessment study using direct observation and ergonomic evaluation methods to identify musculoskeletal disorder risks among modern retail employees. This study uses a descriptive approach, combining quantitative and qualitative methods. According to Creswell [6], A mixed-methods approach enables researchers to obtain a more comprehensive understanding of the phenomenon under investigation. The qualitative approach was used to obtain supporting information regarding workplace conditions and ergonomic issues identified during observation. Meanwhile, the qualitative approach was used to explore employees' subjective experiences, their perceptions of the working postures applied, and the barriers to implementing ergonomic principles in the department store environment.

Data Types and Sources

The data used in this study are divided into two categories. First, qualitative data, which include the company profile and organizational structure, along with the duties and responsibilities of each position. Second, quantitative data, which were obtained through direct field measurements. Based on their sources, the data are classified as primary or secondary. Primary data were obtained directly from the company without undergoing further processing, such as the company profile and organizational structure. In contrast, secondary data refer to data obtained from the company that require further processing before they can be used in the analysis.

Data Collection Methods

Data collection was carried out through two main approaches, namely literature study and field study. The literature study involved reviewing scientific literature, reference books, and academic sources relevant to ergonomics and occupational health. Meanwhile, the field study included several techniques: direct observation of work activities in the field, interviews with relevant parties to obtain more in-depth information, and documentation through data collection from company records or archives.

Research Participants and Instruments

The research participants were four employees from a modern retail store in Bekasi, selected using purposive sampling. The selection criteria were based on work activities involving repetitive movements, prolonged standing, manual material handling, and non-neutral working postures that may increase the risk of Musculoskeletal Disorders (MSDs). Sugiyono stated that purposive sampling is used when researchers require subjects with specific characteristics relevant to the study objectives [7], [8].

Four employees participated in this study, representing three main work categories: one female cashier, two male warehouse staff members, and one male shelf attendant. Participants ranged in age from 22 to 30 years and worked about 8 hours per day. The cashier had 1 year of work experience, the warehouse staff had 2 years of work experience, and the shelf attendant had 6 months of work experience. Table 1 presents the characteristics of the research participants.

Table 1 Characteristics of Research Participants

Job Category	Number of Workers	Gender	Age Range	Work Experience	Working Hours	Main Activity Observed
Cashier	1	Female	22–30 years	1 year	8 hours/day	Cashier service and item scanning activities
Warehouse staff	2	Male	22–30 years	2 years	8 hours/day	Manual material handling, lifting, and moving goods
Shelf attendant	1	Male	22–30 years	6 months	8 hours/day	Product arrangement and shelf replenishment
Total	**4**					

We conducted the work posture assessment through direct observation using the Rapid Entire Body Assessment (REBA) method [4], [9]. Observed activities included cashier service, warehouse material handling, and shelf arrangement in a modern retail store.

Research Procedure

The research procedure consisted of three stages. The first stage involved preliminary observation and problem identification through direct observation and informal interviews to understand workplace conditions and employees' working postures. The second stage involved ergonomic risk assessment using the Rapid Entire Body Assessment (REBA) method to identify potential musculoskeletal disorder risks. The final stage involved developing ergonomic improvement recommendations based on the identified ergonomic risks.

Rapid Entire Body Assessment (REBA) Method

This study used the Rapid Entire Body Assessment (REBA) method for working posture analysis. This method systematically evaluates all segments of the human body in an occupational context. Hignett and McAtamney explained that REBA produces an assessment score that reflects musculoskeletal injury risk based on observed body posture [9]. A higher REBA score indicates a greater level of risk; therefore, it serves as a basis for prioritizing corrective actions [10], [11]. Therefore, this study applies the REBA method to identify work areas that require the most urgent ergonomic interventions to minimize the risk of health disorders during the work process.

Results and Discussion

Work Posture Assessment Results Using the REBA Method

We conducted a work posture assessment using the Rapid Entire Body Assessment (REBA) method on manual material handling and product arrangement activities performed by employees of a modern retail store in Bekasi. Measurements were taken on several body segments, including the neck, trunk, legs, upper arms, lower arms, and wrists. In the neck segment, the measured posture angle was 33°, resulting in a score of +2 based on the REBA table, as it exceeded the 20° angle threshold.

Table 2 Neck Segment Score

Movement	Score	Additional Score

Between 0°–20°	+1	+1 if the neck is twisted or side-bent
More than 20°	+2	
In extension	+2	

The trunk position was measured at an angle of 37°, resulting in a score of +3 because it fell within the 20°–60° range. Meanwhile, the leg position received a score of +1 because the posture was supported with an evenly distributed load. Based on the REBA Table A matrix, the combination of neck score (+2), trunk score (+3), and leg score (+1) resulted in a Table A value of 3. Since the load handled by the employee did not exceed 5 kg, the load/force score was 0. Therefore, the final Score A was calculated as follows.

Table 3 Trunk Segment Score

Movement	Score	Additional Score
Upright position / 0°	+1	+1 if the trunk is twisted or side-bent
In extension	+2	
Between 0°–20°	+2	
Between 20°–60°	+3	
More than 60°	+4	

Table 4 Leg Segment Score

Movement	Score
Legs supported, weight evenly distributed, walking, or sitting	+1
Legs unsupported, weight unevenly distributed, or unstable posture	+2

Based on the combination of the scores for the three body segments, the value obtained from Table A was 3. Since the load handled did not exceed 5 kg, the load/force score was 0. Therefore, the final Score A was calculated as follows: 3 + 0 = 3

Table 5 Load/Force Score

Movement	Score	Additional Score
Less than 5 kg	0	+1 if the load is applied suddenly or unexpectedly
Between 5–10 kg	+1	
More than 10 kg	+2	

For the upper extremity segments, the upper arm was measured at an angle of 53°, resulting in a score of +3; the lower arm was measured at an angle of 101°, resulting in a score of +2; and the wrist was measured at an angle of 30°, resulting in a score of +2. Based on these values, the Table B score was 5. The coupling condition was categorized as unacceptable, receiving an additional score of +3. Therefore, the final Score B was calculated as follows.

Table 6 Score for Upper Arm Posture

Upper Arm	LA1–W1	LA1–W2	LA1–W3	LA2–W1	LA2–W2	LA2–W3
1	1	2	2	1	2	3
2	1	2	3	2	3	4
3	3	4	5	4	5	5
4	4	5	5	5	6	7
5	6	7	8	7	8	8
6	7	8	8	8	9	9

The coupling condition in this activity was categorized as unacceptable; therefore, it received a score of +3. As a result, the final Score B was calculated as follows: 5 + 3 = 8.

Table 7 Coupling Condition Score

Condition	Score
Good condition, with an easy-to-grip handle	0
Fair condition, with an adequate but not ideal handle	+1
Poor condition, with a suboptimal handle although still usable	+2
Unacceptable condition or no handle available	+3

The combination of Score A (3) and Score B (8) was then entered into REBA Table C, resulting in a value of 8. With the addition of a repetitive activity score of +1, the final REBA score was calculated as follows:
Final REBA Score = 8 + 1 = 9

The final REBA score of 9 indicates a high ergonomic risk level with an action level of 3, meaning that further investigation and ergonomic improvements are required to reduce potential musculoskeletal disorder risks among employees. Based on the classification established in this method, a score of 8–10 indicates that further investigation and the implementation of working posture improvements should be carried out immediately to prevent potential injuries among the employees concerned [10].

This finding directly addresses the research question regarding employees' working posture conditions at A Modern Retail Store. Based on the measurement results, the neck position, which formed an angle of 33° during the activity, consistently exceeded the recommended safe threshold of no more than 20°. Nurfajriah and Sari emphasized that REBA is a highly sensitive method for detecting risky postures, particularly in jobs involving sudden position changes or prolonged static postures. In this context, excessive neck flexion that occurred repeatedly during the work process became one of the dominant factors contributing to the high risk score obtained[11].

The trunk position, which repeatedly formed an angle of 37°, reflects excessive static loading on the lumbar region of the spine. This condition is one of the main predictors of Musculoskeletal Disorders (MSDs) among workers. Putri et al. stated that MSDs are among the most common health impacts arising directly from non-ergonomic working postures, which may ultimately disrupt the overall work process significantly. Furthermore, working posture is closely related to physical workload, whereby the failure to apply ergonomic principles may lead to discomfort and the cumulative development of pain in certain parts of the body.

Another determining factor that significantly contributed to the REBA score reaching a critical level was the coupling condition, which was categorized as unacceptable with a score of +3. Sajid et al. explained that, in developing the REBA method, the coupling factor, or grip quality, is one of the important variables that contributes to determining the final assessment of overall body posture [12]. Non-ergonomic grip conditions not only increase the risk of wrist and finger injury but also force the body to adopt compensatory postures that place greater strain on other body segments.

The repetitiveness of work activities, indicated by the addition of a +1-activity score, further exacerbated this condition. Fan et al. stated that the REBA method is designed to evaluate posture, force, activity, and coupling factors that may lead to injuries from repetitive workplace activities [9]. Repetitive work performed without postural variation and adequate recovery breaks prolongs exposure to risky postures, significantly increasing the likelihood of musculoskeletal complaints among employees.

Based on the analysis results, several potential contributing factors may increase ergonomic risk among employees in modern retail stores. First, the workstation and workplace facility design may not fully match employees' anthropometric characteristics, potentially causing awkward postures during cashier service, material handling, and product arrangement activities [13]. Second, the absence of standardized ergonomic work procedures may lead to inconsistent posture application during daily tasks. Third, repetitive activities performed without adequate job rotation and structured rest periods may increase employees' exposure to non-neutral working postures [14]. Karki et al. emphasized that the REBA assessment sheet is designed to identify combined risks across multiple body segments simultaneously, allowing all these loading factors to be detected comprehensively in a single integrated assessment.

Regarding improvement recommendations, Krishnanmoorthy et al. showed that participatory ergonomic interventions, which involve employees directly in problem identification and solution development, have proven effective in preventing musculoskeletal disorders while reducing sickness absenteeism and work-related stress. This approach is relevant for implementation at a modern retail store, considering that repetitive activities such as cashier service, material handling, and product arrangement are performed continuously during employees' work shifts. Recommended ergonomic improvements include adjusting cashier workstation height, optimizing storage and shelf arrangement to minimize awkward postures during material handling and product arrangement, and implementing a structured job rotation program with adequate rest periods.

Previous studies have shown that ergonomic interventions can reduce musculoskeletal disorder risks by improving work posture and workplace conditions. Therefore, ergonomic improvements in modern retail environments should prioritize reducing awkward postures and minimizing physical exposure during repetitive activities. In line with this, Sajid et al. revealed that comprehensive ergonomic interventions can significantly reduce the prevalence of musculoskeletal disorders among workers engaged in repetitive tasks. Thus, investing in ergonomic improvements at A Modern Retail Store is not merely a matter of meeting occupational safety requirements but also a long-term strategy that directly contributes to sustainable improvements in ergonomic conditions and employee comfort.

A more in-depth examination of the REBA assessment results should also consider the cumulative impact of prolonged exposure to risky postures on employees' physiological conditions. Each body segment repeatedly loaded beyond its tolerance threshold may accumulate fatigue in muscle and ligament tissues, which, if left unaddressed, can lead to chronic injury. Rahmania et al. stated that continuous exposure to awkward postures for more than four hours per day significantly increases the risk of low back pain, even among young workers.

This condition is relevant to employees at A Modern Retail Store, who perform similar activities throughout their shifts without planned postural variation [16].

Beyond biomechanical factors, the physical work environment also contributes to non-ergonomic postures. Inadequate lighting, for example, may unconsciously encourage employees to lean their heads further toward the work object to gain sufficient visibility, worsening neck flexion that has already exceeded the safe threshold. Stanton et al. emphasized that physical environmental conditions, such as lighting, temperature, and workplace layout, indirectly shape employees' postural habits over the long term. Therefore, a comprehensive ergonomic evaluation should include not only direct assessment of body posture but also a thorough audit of the overall work environment.

Employees' psychological state is also a variable that cannot be separated from posture-based ergonomic studies. High work pressure from productivity demands or strained interpersonal relationships can physiologically increase muscle tension, even when the physical workload remains unchanged. Etterlid-Hägg explained that psychological stress leads to excessive motor activation in postural muscles, causing workers to maintain stiffer and more tense postures. This condition accelerates muscle fatigue and increases pain sensitivity in the neck, shoulders, and back, which are already biomechanically overloaded.

Implementing ergonomic interventions in the retail environment requires a planned, gradual approach so the changes are permanent rather than temporary. The first stage is to disseminate ergonomic awareness across all employee levels, from operational staff to management, to establish a shared understanding of the importance of proper working posture. Pheasant and Haslegrave stated that the long-term success of an ergonomics program depends heavily on the level of understanding and active participation of all stakeholders within the organization. Without a strong foundation of understanding, employees in the field may not consistently follow even modifications to work equipment and procedures [17].

The next stage involves redesigning the interface between employees and their work equipment, which, in a modern retail store, includes cashier desks, product shelves, and lifting aids. Human-centered design principles require adjusting every piece of work equipment to the range of users' anthropometric dimensions, rather than forcing users to adapt to the equipment. Ainiyah et al. stated that the mismatch between equipment dimensions and users' body dimensions is a main cause of forced postures, which may ultimately trigger Musculoskeletal Disorders (MSDs). For example, cashier desk height can be adjusted gradually by installing adjustable supports based on individual employee needs [18].

A structured job rotation program is a managerial intervention that has proven effective in distributing biomechanical loads more evenly across different muscle groups. Well-designed rotation does not merely involve moving employees from one workstation to another; it must consider each position's loading profile to prevent load from accumulating in the same muscle groups. Buckle and Devereux showed that job rotation that balances muscle load can reduce the incidence of musculoskeletal complaints by up to 40% compared with static work systems without rotation. The implementation of this rotation system at A Modern Retail Store should be arranged in a written schedule and communicated transparently to all employees [19].

Continuous ergonomic evaluation is an important component for ensuring that recommended improvements remain appropriate as work processes or equipment change. Periodic monitoring with the REBA instrument after the intervention enables management to objectively and measurably assess the effectiveness of the changes made. Punnett and Wegman emphasized that a consistent evaluation cycle in an ergonomics program can identify potential new risks as work processes or equipment change [20]. By establishing a culture of continuous ergonomic evaluation, A Modern Retail Store can reduce musculoskeletal complaints in the short term and develop a work system that adapts to future changes in operational needs. Ultimately, this approach positions ergonomic investment as an integral part of a sustainability-oriented human resource management strategy.

Conclusion

The examination of work activities performed by employees of a modern retail store in Bekasi showed that the observed working posture was classified as high risk, as indicated by a Rapid Entire Body Assessment (REBA) score of 9. This condition was mainly influenced by excessive neck flexion, trunk bending beyond the recommended range, and unacceptable coupling conditions during work activities. The absence of standardized ergonomic work procedures, potential mismatch between workplace design and anthropometric characteristics, and repetitive work patterns without adequate job rotation were identified as potential contributing factors that may increase the risk of Musculoskeletal Disorders (MSDs) among employees.

Management of modern retail stores in Bekasi is recommended to consider ergonomic improvement strategies to reduce musculoskeletal risk exposure among employees. Priority actions include improving workstation and workplace layout, adjusting work equipment dimensions according to employee anthropometric characteristics, implementing structured job rotation and rest programs, and providing ergonomic posture

training. These efforts are expected to improve employee comfort and reduce the risk of work-related musculoskeletal disorders.

References

[1] M. Hita-Gutiérrez, M. Gómez-Galán, M. Díaz-Pérez, and Á.-J. Callejón-Ferre, "An Overview of REBA Method Applications in the World [Una descripción general de las aplicaciones del método REBA en el mundo]," *Int. J. Environ. Res. Public Health*, vol. 17, no. 8, pp. 1–22, 2020.

[2] J. Lietz, A. Kozak, and A. Nienhaus, "Prevalence and occupational risk factors of musculoskeletal diseases and pain among workers," *Int. J. Environ. Res. Public Health*, vol. 18, no. 14, p. 7460, 2021, doi: 10.3390/ijerph18147460.

[3] M. Joshi and V. Deshpande, "Investigative study and sensitivity analysis of Rapid Entire Body Assessment (REBA)," *Int. J. Ind. Ergon.*, vol. 79, p. 103004, 2020.

[4] M. K. Faudy and S. Sukanta, "Analisis Ergonomi Menggunakan Metode REBA Terhadap Postur Pekerja pada Bagian Penyortiran di Perusahaan Bata Ringan," *Go-Integratif J. Tek. Sist. Dan Ind.*, vol. 3, no. 01, pp. 47–58, 2022.

[5] M. Hita-Gutiérrez, M. Gómez-Galán, M. Díaz-Pérez, and Á.-J. Callejón-Ferre, "An Overview of REBA Method Applications in the World," *Int. J. Environ. Res. Public Health*, vol. 17, no. 8, p. 2635, 2020, doi: 10.3390/ijerph17082635.

[6] J. W. Creswell and J. D. Creswell, "Research design: Qualitative, quantitative, and mixed methods approaches (6th ed.)," *SAGE Publ.*, 2023.

[7] Sugiyono, *Metode Penelitian Kuantitatif, Kualitatif dan R &Metode Penelitian Kuantitatif, Kualitatif*. 2019.

[8] F. Ghasemi, I. Mohammadfam, and A. Soltanian, "Ergonomic assessment of manual material handling tasks and musculoskeletal disorders risk," *Work*, vol. 72, no. 4, pp. 1465–1475, 2022.

[9] L. J. Fan *et al.*, "Ergonomic risk factors and work-related musculoskeletal disorders in clinical physiotherapy," *Front. Public Heal.*, vol. 10, 2022, doi: 10.3389/fpubh.2022.1083609.

[10] S. Hignett and L. McAtamney, "Rapid Entire Body Assessment (REBA)," *Appl. Ergon.*, vol. 31, no. 2, pp. 201–205, 2000.

[11] Nurfajriah and S. Sari, "Identifikasi Postur Kerja Proses Pembuatan Tahu Pada Pabrik Tahu Pak Utar Dengan Metode Reba Dan Owas," *J. Ind. Eng. Manag.*, vol. 5, no. 1, pp. 218–224, 2020.

[12] U. Sajid, M. Ihsan, and A. Reba, "Work Environment Stress: Causes and Outcomes," vol. 15, pp. 754–761, May 2021.

[13] I. Dianat, J. Molenbroek, and H. I. Castellucci, "A review of the methodology and applications of anthropometry in ergonomics and workplace design," *Ergonomics*, vol. 65, no. 11, 2022.

[14] D. Van Eerd, E. Irvin, K. Cullen, and D. Rempel, "Effectiveness of workplace interventions to prevent musculoskeletal disorders," *Appl. Ergon.*, vol. 92, p. 103337, 2021, doi: 10.1016/j.apergo.2020.103337.

[15] P. C. Leider, J. S. Boschman, M. H. W. Frings-Dresen, and H. F. Van der Molen, "Effects of job rotation on musculoskeletal complaints and related work exposures: A systematic review," *Ergonomics*, vol. 58, no. 1, pp. 18–32, 2015, doi: 10.1080/00140139.2014.961562.

[16] A. D. Rahmania, I. D. Pratiwi, M. F. Rahmawan, A. Nafi'Addaroin, and A. R. Maulana, "Analisis Postur Kerja dan Risiko Musculoskeletal Disorders pada UMKM Penjahit Menggunakan Metode RULA dan REBA," *Nusant. Technol. Eng. Rev.*, vol. 3, no. 2, pp. 59–65, 2025.

[17] S. Pheasant and C. M. Haslegrave, "Bodyspace: Anthropometry, Ergonomics and the Design of Work, Third Edition," in *Taylor & Francis*, 2005.

[18] Y. N. Ainiyah, S. S. Dahda, and M. Jufriyanto, "Analisis Terjadinya Risiko Musculoskeletal Disorders Karyawan Bagian Finishing Menggunakan Metode Reba (Studi Kasus: UD Arryna Raya)," *SITEKIN J. Sains, Teknol. dan Ind.*, vol. 19, no. 2, pp. 373–382, 2022.

[19] J. Devereux and P. Buckle, "Interactions between physical and psychosocial risk factors at work increase the risk of back disorders: An epidemiological approach," *Occup. Environ. Med.*, vol. 56, pp. 343–353, Jun. 1999, doi: 10.1136/oem.56.5.343.

[20] L. Punnett and D. H. Wegman, "Work-related musculoskeletal disorders: the epidemiologic evidence and the debate," *J. Electromyogr. Kinesiol.*, vol. 14, no. 1, pp. 13–23, 2004.