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Article

Rapid Entire Body Assessment (REBA): Evaluating and Optimizing Tofu Makers' Work Posture

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Abstract: Informal businesses such as tofu production contribute immensely to employment in Indonesia. However, workers in this sector commonly develop musculoskeletal disorders (MSDs) due to improper working postures and manual labor. This study aims to analyze the working postures of tofu factory workers in Semarang using the Rapid Entire Body Assessment (REBA). A descriptive observational approach was employed, involving direct posture assessments of 18 workers at the TL Tofu Factory in Semarang through field observations, interviews, and photo-based posture documentation. The REBA method was employed to evaluate postural risks by assessing various body parts, including the neck, trunk, legs, arms, forearms, and wrists. The data showed that 27.8% of the workers were dealing with heavy loads, while 38.9% often took up awkward postures like prolonged bending and standing. The REBA scores showed that 44.4% were at high risk (score 3), followed by 33.3% at medium risk (action at score 2), 16.7% at very high risk (score 4), for which immediate corrective actions were needed), and 5.6% found to be at low risk (score 1). The most affected body parts were the lower back, shoulders, and legs, mostly due to prolonged forward flexion and repetitive movements. These results underscore the urgent need for ergonomic interventions, including posture training and body stretching, to relieve musculoskeletal strain among tofu factory workers.

Keywords: ergonomics; Rapid Entire Body Assessment (REBA); working posture; tofu industry

1. Introduction

The informal business sector has been identified as important in Indonesia's development and its impact on income and employment. Recently, the informal sector has incorporated a large share of its workforce. According to Indonesia's Central Bureau of Statistics, 83.83 million (57.96%) people employed in Indonesia, are in the informal sector [1]. However, the rising number of workers in this sector is not without their share of Occupational Safety and Health (OSH) issues [2]. These problems may result in workplace accidents and work-related diseases that affect both small and large firms [3].

The most typical health complaint among workers is muscle pain resulting from inappropriate working postures. For example, repeating the same activity, particularly Manual Material Handling (MMH) with incorrect posture for a long time, may lead to muscle disorders and the development of Musculoskeletal Disorders (MSDs) [4]. MSDs affect the musculoskeletal system, including the spine, tendons, nerves, muscles, ligaments, and joints, and are often characterized by pain during or after work [5]. Hence, ergonomics in the industrial sector is important for avoiding injuries and enhancing work performance [6].

Ergonomics is the process of ensuring that the work environment, tools, and techniques employed by workers fit them physically [7]. Poor working posture is a major cause of physical and mental discomforts. Hence,

ergonomic working conditions can help minimize discomfort and prevent injuries [8]. Rapid Entire Body Assessment (REBA) is sound in classifying ergonomic risks in terms of body posture, workload, and other environmental factors in the workplace [9]. According to the Semarang City Report, nine tofu factories are located in Jomblang Sub District [10]. The Tofu Factory selected for this research was the TL Tofu Factory in the Jomblang Sub District, Semarang.

Based on Manpower Law Number 13 of 2003, the legal working hours in Indonesia are seven hours per day with a maximum of 40 hours per week, with one day off, or eight hours per day with a maximum of 40 hours per week, with two days off. The TL Tofu Factory operates in a single work shift, running from 07:30 AM to 03:30 PM WIB (UTC+7). However, working hours may be extended depending on the daily tofu customer demand. This factory is open from Monday to Sunday, without a holiday. Factory workers were between 25 and 50 years of age. On average, the TL Tofu Factory produces up to one ton or 1000 kg daily. The production process, which relies heavily on manual labor, poses ergonomic risks, particularly in terms of unnatural working postures and repetitive movements.

The preliminary study interviewed six workers at the TL Tofu Factory. The informants expressed their subjective complaint of frequently experiencing muscle strain after working. Therefore, this study aims to assess workers' postures at the TL Tofu Factory in Semarang City using REBA.

2. Materials and Methods

The REBA system is widely used as an observational tool for evaluating postural risk associated with MSDs. REBA is specifically useful for identifying work postures commonly found in informal industries. REBA has been shown to have high sensitivity and is effective in detecting postures and tasks that pose significant ergonomic risks in the working posture [11]. This study employed a multi-stage sampling method to select the TL tofu factory as the study site, based on having the largest working population size among the tofu factories in Jomblang Sub District, Semarang. At the selected factory, a total sampling technique was applied to include all 18 workers as research respondents. An observational study design was used to assess the working postures of the workers in the TL Tofu Factory. This observational study was conducted over six working days, approximately 3–5 min, for each worker to minimize bias. Observations were also conducted for sufficient but non-intrusive distance. The workers were not informed about the exact timing of the observations; only the owner was notified, and permission had already been obtained beforehand to maintain the natural working conditions in their daily routine. The REBA was used to assess workers' postures during their working hours. The TL Tofu Factory is a small-scale, informal factory with a semi-manual labor system that employs 18 workers in tofu production. It consists of six stations: soybean, tofu, tofu, tofu, tofu, tofu, and boilers. It is considered the most reliable among similar factories because of its consistent daily tofu production, which ensures an uninterrupted supply. Interviews were conducted to acquire details regarding past and current workers' complaints. Interviews were conducted with workers who had high-risk and very high-risk REBA result scores to validate whether the REBA corresponded to the worker's personal experiences.

This study captured the factory working conditions and ergonomic risks experienced by workers, and their working postures were photographed. The coverage of the study included movements of the workers and a few key body segments on their neck, trunk, arms, forearm, wrist, and legs, as referred to by REBA [9].

The angles formed by each body part were measured using an angular meter and classified according to Sue Hignett and McAttamney's REBA scoring guides in 2000. The assessment sheet was completed using the REBA method, scoring according to Table A (neck, trunk, and leg) and Table B (arm, forearm, and wrist), with additional consideration of load force, coupling, and activity levels [9].

The assessment results were categorized into five risk levels: negligible (1), low (2–3), medium (4–7), high (8–10), and very high (11–15); (Table 1). The score increased as ergonomic intervention was needed the most. Ethical clearance for this research was obtained from the Research Ethics Committee of the Faculty of Public Health at Diponegoro University (No.456/EA/KEPK-FKM/2024). All participants provided informed consent before being examined. REBA scores were used to identify high-risk postures and suggest ways to enhance workplace ergonomics.

Table 1. REBA Action Levels.

Action Level	REBA Score	Risk Level	Action
0	1	Negligible	None Necessary
1	2–3	Low	Maybe Necessary
2	4–7	Medium	Necessary
3	8–10	High	Necessary Soon
4	11–15	Very High	Necessary Now

3. Results

Most of the study participants were male workers (13/18, 72.2%). Regarding age, most participants fell into the category of 43–46 years (9/18, 50%). In terms of work experience, the most common group was workers with 16–20 years of experience (7/18, 38.9%), which put them in constant contact with monotonous and physically demanding work.

The tofu production process begins with the boiler operator preparing the steam boiler to heat the furnace and preparing the raw soybean by measuring soybean sacks containing 50 kg of raw soybeans. The soybeans were then divided into approximately three to four sacks, with each sack containing 14 kg of raw soybeans. The soybeans were then thoroughly washed and soaked for 3 h before grinding using a grinding machine and boiling in a furnace at the soybean grinding station. Once the soybeans were cooked at the cooking station, they were filtered to separate the soybean pulp from the soybean extract. The soybean extract is then mixed with vinegar water, after which the curd is collected and molded into firm tofu; the tofu is then transferred to a flipping/pressing station to flip the tofu molds after the tofu has set after pressing with heavy blocks. Once the tofu has been set, it is ready to be cut in the cutting station and then packed in the packaging station for distribution. Each workstation presents distinct tasks and challenges related to body posture, exposing workers to varying levels of ergonomic risk that may contribute to musculoskeletal strain and occupational health concerns.

Based on the workflow (Figure 1), the researcher calculated the work position using the REBA method, resulting in categorization of the risk level based on the score. The results of the REBA measurements showed score variations that reflect workers' postural positions during work activities. The score was assessed individually for each participant in specific activities and workstations, resulting in different scores in Table A, load score, Table B, coupling, and activity score [9]. The coupling score indicates a good hand grip, and the overall activity score ranges from 0 to 2, indicating the frequency of repetitive movements. The overall load variation score shows heavy lifting loads, particularly at the soybean grinding and tofu flipping/pressing stations. The sum of these scores determined the final REBA score. Based on the measurement results of the neck using the REBA method on production workers at Tofu Industry TL in Semarang, most workers (50%) received a score of 2. This result was followed by 38.9% of the workers who received a score of 1, while a small percentage (11.1%) received a score of 3. The REBA assessment revealed that most workers tended to lean forward, which increased their risk of neck strain. A forward or backward tilt > 20° is a significant risk factor for neck pain [12].

The assessment scores for trunk posture were as follows: 4 (38.9%), 2 (33.3%), 3 (16.7%), and 5 (11.1%). These results indicate the potential risks that can occur in most workers. Improper sitting, standing for long periods, excessive bending, and heavy lifting were identified as the primary contributors to lower back strain and musculoskeletal discomfort [13]. These findings indicate the need for immediate ergonomic interventions such as posture correction, workplace modifications, and the application of appropriate lifting techniques to minimize the risk of musculoskeletal disorders. Based on the results of the interviews, the workers reported that they experienced frequent back pain due to prolonged work in a rounded-back posture.

Regarding leg posture, most workers received a REBA score of 2 (55.6%), while 38.8% scored 1, and 5.6% scored 3. These scores indicate the risk of leg pain and stiffness, particularly for tasks that require prolonged standing. Extended standing periods can lead to muscle fatigue and strain, especially when workers transition to a squatting position to relieve discomfort, as noted by some respondents [14]. Table 2 shows the results for the risk levels of the 18 workers.

The results of the REBA show that there is a varying level of ergonomic risk in workstations. The REBA scores showed that 44.4% were in the high-risk category (score 3), 33.3% medium risk (score 2), 16.7% very high risk (score 4), which needs immediate correction, and 5.6% low risk (score 1). The highest REBA was given to the soybean grinding and tofu cooking stations, where workers performed heavy loading, repeated bending, and manual material handling almost daily.

Prolonged standing, repetitive upper-limb movements, incorrect load handling at the boiler operator, cutting, packaging, and flipping/pressing stations produce high-risk postures. The lower back, shoulder, and legs are the affected parts of the body, and workers frequently report musculoskeletal discomfort and fatigue. Poor workstation design, such as a cooking station height that does not match the worker's body height, forces the worker to bend and hunch over, and repetitive tasks contribute to these ergonomic risks, as confirmed in the interviews.

In this study, the upper arm postures of production workers at the Tofu Industry TL in Semarang City were assessed using the REBA method. The results showed that the majority of the workers received a score of 3 (33.3%), the second most frequent score was 2 (22.2%), scores of 4 and 5 were also observed at 16.7% each, and a score of 1 was assigned to 11.1% of the workers. The possible risk related to this posture is pain in the muscles of the arms because the arm is raised too high [15]. In interviews with research participants, several workers

reported that they experienced pain in the upper arms due to incorrect hand positioning when pouring tofu into the molding equipment.

Lower arm posture measurements resulted in the majority of workers having a score of 1 (72.2%), 27.8% having a score of 2, and 11.1% having a score of 1. The wrist posture measurements indicated that most workers had a score of 2 (61.1%), 27.8% had a score of 3, and 11.1% had a score of 1, which means that the wrist angle was between 0 and 15 degrees.

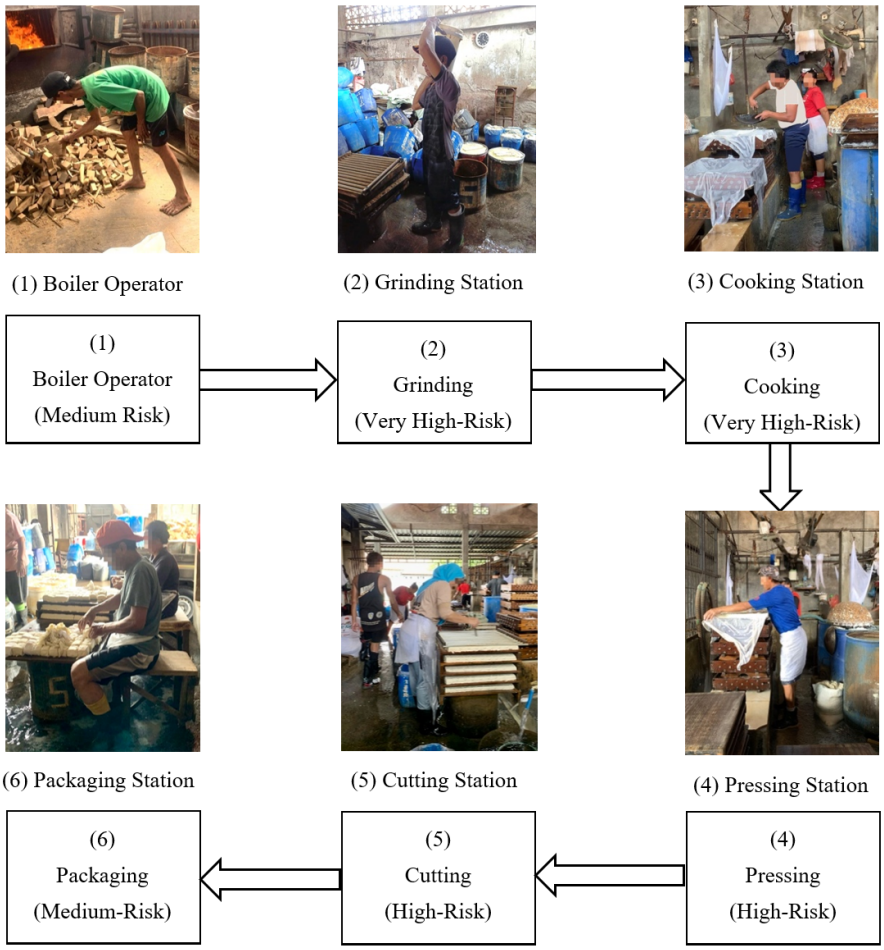

Figure 1. Work Station Work Flow.

Table 2. REBA Method Results.

Participants	Work Stations	Action Level
1	Grinding	*Very High*
2	Grinding	*Very High*
3	Cooking	*Medium*
4	Cooking	*Very High*
5	Cooking	*High*
6	Cooking	*High*
7	Cooking	*Medium*
8	Cooking	*Very High*
9	Flipping/Pressing	*High*
10	Flipping/Pressing	*High*
11	Flipping/Pressing	*High*
12	Cutting	*High*
13	Cutting	*Medium*
14	Cutting	*High*
15	Packaging	*Medium*
16	Packaging	*Medium*
17	Packaging	*Low*
18	Boiler Operator	*Medium*

4. Discussion

This study is in line with a previous assessment conducted on extract workers in a tofu factory by Wijaya Y, who identified a REBA score of 10 as a high-risk classification requiring urgent posture correction [16]. These work postures are at high risk and must be improved immediately. The cause of this high risk is excessive forward bending and improper upper-arm positioning. Simultaneously, lifting and poor neck and leg alignment contribute to increased ergonomic strain.

The REBA conducted at the Tofu Industry TL in Semarang City further supports these findings. The results showed that 27.8% of the workers regularly lifted heavy weights, receiving a score of 2, with the weight lifted exceeding 10 kg. The most physically demanding tasks were observed at the tofu flipping/pressing and soybean grinding stations, where workers frequently transported finished tofu containers and buckets of ground soybean to the cooking station. The load weighs 14.73 kg at the grinding stations. At the tofu flipping/pressing stations, it lifts a load of 24.68 kg. Repetitive lifting activities pose a significant ergonomic risk, highlighting the need for intervention strategies to reduce musculoskeletal strain and improve workplace safety.

At the flipping/pressing station, the workers lift heavy loads with two hands while standing, whereas at the soybean grinding station, the weight is carried on the shoulders. In the interviews, the workers at the tofu flipping station stated that they experienced back pain in the lower back region during work. At the grinding station, the same workers stated that they experienced shoulder pain due to the heavy load after working for 10 days. These findings concur with another study by Viatina, which stated that lifting activities among workers are generally high according to the REBA ratings and fall within the cautionary to hazardous categories [17].

The coupling score results showed that 83.3% of workers were classified as ‘good. ’ This finding indicates that the grip position of the hands or tools used in the tofu production process at Tofu Industry TL was optimal. Grips are achieved most effectively when using well-designed containers with handles or handholds, or when handling objects without containers that allow for a comfortable and secure grasp, ensuring that hands can easily wrap around the object. The remaining 16.7% of workers had a coupling score of ‘fair,’ which means that the grip position occurs on containers with improperly sized handles or handholds or when the object must be held by bending the fingers at a 90° angle [18].

A total of 61.1% of workers had a score of 2 for their work activities. 38.9 Of the workers, 38.9% scored 1, implying that they made more than four repetitive movements per minute. Furthermore, some tasks implied abrupt changes in body position. One participant reported experiencing lower back pain due to the prolonged bending required by their work. These findings are consistent with those of previous studies, indicating that complaints of muscle pain often stem from ergonomic-related issues in the workplace. Such discomfort is commonly associated with poor working postures that are maintained for extended periods [8].

Using the REBA methodology, we identified significant ergonomic risks among tofu workers. A very high action level (score 4) was detected in 16.7% of the workers, indicating an urgent need for immediate posture correction. Another 44.4% of workers had a high action level (score 3), which also required corrective postural interventions. Furthermore, 33.3% of workers fell into the medium-risk category (score 2), for whom postural adjustments were recommended but not immediately critical. Regarding the REBA score results, the most frequent result was 8, corresponding to action level 3, indicating a high risk of musculoskeletal disorders and the need for swift ergonomic interventions. The highest REBA score was recorded for participant 2 (score 13), followed by participants 1 and 4, with a score of 11, necessitating immediate posture corrections. The interviewed workers also reported discomfort in the shoulder and arm regions, further highlighting the impact of poor ergonomic conditions during daily work activities.

These findings emphasize the critical need for ergonomic interventions to prevent MSDs, improve worker safety, and enhance the overall productivity in tofu production facilities. Specific ergonomic corrections should be implemented as soon as possible. The hands and wrists were aligned with the fingers to avoid tilting, flexion, or extension. The neck should remain neutral with a maximum forward or backward tilt of 20° to prevent excessive pressure on the cervical discs. The shoulders should not be elevated and the elbows should remain close to the body to maintain a stable shoulder posture. Additionally, the trunk should remain upright to avoid lateral tilting and excessive forward bending beyond 20° [19].

These findings align with those of a previous study by Meri Andriani conducted among tofu workers, which emphasized the need for immediate posture correction to prevent the development of MSDs [20]. Similarly, research by Widodo was conducted in the tofu workers industry; the REBA evaluation in that study reported an average posture score of 11.5, which also falls within the very high-risk category, necessitating immediate ergonomic interventions to reduce the risk of work-related musculoskeletal disorders [21]. These findings further

underscore the necessity of workplace ergonomic improvements, particularly in occupations involving manual labor and repetitive movements, to mitigate MSD risks and enhance worker safety.

The evaluation (REBA) identified significant ergonomic risks among tofu industry workers, primarily owing to bending, repetitive arm and wrist movements, and improper load handling. These factors increase the likelihood of developing MSDs and other long-term health issues. The evaluation revealed that most workers were at high to very high risk, requiring immediate corrective measures to prevent injuries. These findings align with a book about musculoskeletal disorders by Susan, which revealed that MSDs are common and costly injuries caused by repetitive motion, force, vibration, or awkward posture [22].

Interviews with workers about their awareness of the need to stretch when feeling sore after work revealed that most admitted that they rarely do so. Instead, they tend to endure discomfort and wait for pain to go away on their own. When they first started working at TL Tofu Factory, no occupational safety or health (OSH) training was provided, although personal protective equipment (PPE), such as boots, was available.

Posture training and education are essential to mitigate these risks. They equip workers with the knowledge of proper postures, lifting techniques, and stretching exercises to reduce strain. Factory owners should implement scheduled rest breaks and conduct regular ergonomic assessments to ensure safe working conditions. Adjustments in workstation design are also necessary to improve the load distribution and posture alignment, reducing unnecessary physical strain. Balancing the load is crucial for the workers at soybean grinding stations. Using two evenly distributed ergonomic buckets, each holding no more than 7 kg, can help minimize upper arm strain. At the tofu cooking station, maintaining a straight trunk posture, adjusting wrist and arm positioning, and maintaining the wrists in a neutral position while scooping will help prevent discomfort and injury. Implementing these ergonomic improvements will enhance worker safety and increase productivity by reducing fatigue and risk of MSDs in the tofu industry.

5. Conclusions

The ergonomic assessment using the REBA method of TL Tofu Factory in Semarang City revealed significant risks of MSDs among workers owing to poor posture, repetitive movements, and heavy loads. The REBA method highlights high-to-very high ergonomic risk levels, emphasizing the urgent need for interventions to prevent long-term health issues.

The study recommends targeted ergonomic training, improved workstation design, and regular evaluations to enhance worker safety and productivity and mitigate these risks. Specific posture corrections, such as a balanced load distribution for soybean grinding workers and proper wrist positioning for cooking station workers, are essential for reducing strain. Implementing these measures will contribute to a safer and more efficient working environment for the tofu industry.

Author Contributions

H.A.: conceptualization, methodology, investigation, writing—original draft preparation; H.M.D.: supervision, validation, writing—reviewing and editing; D.L.: data curation, software, visualization. All authors have read and agreed to the published version of the manuscript.

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Institutional Review Board Statement

The study was conducted according to the guidelines of the Declaration of Helsinki and approved by the Institutional Review Board (Health Research Ethics Committee, Faculty of Public Health, Diponegoro University) with protocol code 456/EA/KEPK-FKM/2024, dated 27 December 2024.

Informed Consent Statement

Informed consent was obtained from all subjects involved in the study. Written informed consent was also obtained from the patient(s) to publish this paper, including any potentially identifiable information or images.

Data Availability Statement

The raw data supporting the findings of this study are available from the corresponding author upon reasonable request. The data will be accessible to qualified researchers for at least 10 years following publication, provided that participant confidentiality is maintained and no legal or ethical restrictions apply.

Conflicts of Interest

The authors declare no conflicts of interest, since this research received no external funding and was conducted independently with no financial support from any funding agency.

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