Available *online* at : http://ejurnal.upnb.ac.id/

Jurnal Kesehatan

| ISSN (Print) 2085-7098 | ISSN (Online) 2657-1366 |

Work-Related Musculoskeletal Disorders in Brick Workers

Fea Firdani[1], Azyyati Ridha Alfian[2], Aria Gusti[3], Hendra Saputra[4], Intan Sahara Kusuma[5]*
[1-3]Department of Occupational Safety and Environmental Health, Faculty of Public Health, Universitas Andalas, Indonesia
[4]Department of Agro-industrial Technology, Faculty of Agricultural Technology, Universitas Andalas, Indonesia
[5]Bachelor Degree of Department of Occupational Safety and Environmental Health, Faculty of Public Health, Universitas Andalas, Indonesia

ARTICLE INFORMATION

Received: 01 Juni 2025
Revised: 26 Juni 2025
Accepted: 7 Juli 2025
Available online: 31 Juli 2025

KEYWORDS

Musculoskeletal Disorders
Brick Workers

CORRESPONDING AUTHOR

***Corresponding author, email:**

feafirdani@ph.unand.ac.id

ABSTRACT

The brick-making industry is an industry with rough work that relies on the physical strength of its workers. The posture of workers when carrying out the work process is often not ergonomic, so workers are at risk of experiencing musculoskeletal disorders and discomfort due to posture when doing work that is not ergonomic and heavy physical workload because it is done manually relying on strength. This study was conducted to determine the description of MSDs complaints experienced by brickmakers and the factors influencing them. This study is a quantitative study with a cross-sectional design. Conducted from March to September 2024, with the research location in Sarilamak Village, Lima Puluh Kota Regency, West Sumatra. The study population was all workers, totaling 76 people in 35 brick production sites; the number of samples was 66 workers. Data collection was carried out using questionnaires and weight and height measuring instruments. Data were analyzed using univariate and bivariate analysis. The study shows that 80.3% of brick workers experience high-risk MSDs complaints. The body parts most complained about by workers during and after work are the waist, back, and calves. There is no relationship between age (p-value = 0.512), work period (p-value = 0.799), BMI (p-value = 0.191), work posture (p-value = 0.713), and workload (p-value = 0.517) with MSDs complaints in brick workers. There is no relationship between age, length of service, BMI, work posture, and workload with MSD complaints in brick workers. Business owners should provide ergonomic equipment and be supported by regulations and technical guidance for traditional industries like brick factories to prevent occupational diseases, and incorporate ergonomics training into national OSH programs for informal workers.

INTRODUCTION

Every type of work has potential risks that can affect health, whether caused by the work process, the work environment, or the behavior of the worker himself [1]. This risk can cause the emergence of work-related diseases, namely diseases experienced by workers due to exposure to factors originating from work activities [2]. The high incidence of occupational diseases can increase the level of illness among workers, so it requires special attention. Based on 2021 International Labor Organization (ILO) data, it is estimated that every year there are 2.91 million deaths due to work accidents and occupational diseases, of which occupational diseases cause 2.58 million cases or 88.7% [3].

One of the most common occupational diseases is Musculoskeletal Disorders (MSDs). This disorder affects the body's structures, including muscles, joints, ligaments, tendons, nerves, cartilage, bones, and the local blood circulation system. MSDs can be triggered or exacerbated by the work environment conditions or the type of work being done. This disorder can cause symptoms ranging from mild pain to serious health problems that require medical treatment and recovery time. In some instances,

DOI: http://dx.doi.org/10.35730/jk.v16i2.1285

MSDs can even cause disability to joints or other body tissues [4]. Musculoskeletal Disorders (MSDs) are the second largest cause of disability worldwide, with low back pain being the leading cause of disability globally [5]. MSDs are a significant health problem affecting male
and female workers worldwide, with a global prevalence ranging from 50% to 80% in the working population [6]. Based on Global Burden of Disease (GBD) data in 2019, around 1.71 billion people worldwide experience MSDs. The highest number is found in developed countries, with a prevalence of 441 million cases, followed by countries in the Western Pacific region with 427 million cases and Southeast Asian countries with 369 million cases. Musculoskeletal disorders are also one of the leading causes of years lived with disability globally, with around 149 million people affected. This figure covers 17% of the total cases of disability worldwide [7].

Occupational diseases in Indonesia are currently described as the tip of the iceberg phenomenon, where the cases identified and reported are still very few and partial based on research results. This causes a picture that does not reflect Indonesia's overall magnitude of occupational safety and health problems [8]. The number of cases of work accidents and occupational diseases in Indonesia continues to increase every year. Based on BPJS Ketenagakerjaan data in the 2022 Indonesian National Occupational Health and Safety Profile, 234,370 cases of work accidents and occupational diseases were recorded in 2021, with 6,552 resulting in death [9]. Although specific data on Musculoskeletal Disorders (MSDs) in Indonesia are not yet available, the 2018 Basic Health Research Report (Riskesdas) shows that the prevalence of joint disease in the population aged ≥15 years reached 7.30%. Among 34 provinces, West Sumatra has a prevalence of joint disease of 7.21%. Given that joints are part of the musculoskeletal system, this prevalence rate of joint disease can illustrate that MSDs are likely included in one of the forms of joint disease [10].

MSDs can affect worker productivity in both formal and informal sectors. The informal sector, in particular, still pays less attention to ergonomic issues, such as work positions, work equipment, and the suitability of the tools used for the worker's physical condition. Although occupational health and safety has been widely implemented in the industrial sector, the informal sector and small and medium enterprises often lack or do not implement K3 properly. This is due to several obstacles, such as the lack of promotive and preventive programs regarding K3, which makes many business owners unaware of the importance of occupational health and safety [11]. In Indonesia, informal sector workers dominate the total workforce. Based on BPS data in February 2023, informal sector workers reached 60.12% of the total workforce (BPS RI, 2023).

One of the industries in the informal sector where almost all of its work processes are still manual, using human power without using machines, is brick making. So brick workers risk experiencing musculoskeletal disorders and discomfort due to posture when doing work that is not ergonomic and heavy physical workload because it is done manually relying on human power. There are several stages of the work process in brick production, from mixing raw materials to making bricks using human power with the help of a home. If it has become a brick dough, it is continued to the molding process; then, the molded brick dough is dried under direct sunlight for 7-10 days. Then, continue to the drying stage in an open space for 10-14 days until the bricks become whitish. Continue to the last stage, namely the brick-burning process in a special furnace for 4-7 days non-stop.

The brick-making industry is an industry with rough work that relies on the physical strength of its workers. Workers' posture when carrying out their work processes is often not ergonomic, namely doing monotonous movements such as bending, looking down, standing, twisting postures, raising hands, squatting, and repetitive activities for a long time, so brickmakers are susceptible to musculoskeletal disorders.

Ergonomic hazards in the manual brick-making process are very real when seen from the work process. Each stage can trigger various risks, such as tissue degeneration, muscle cramps and pain, acute muscle injuries, muscle damage, and bone and joint dislocations. Disorders in the neck, shoulders, elbows, hands, wrists, knees, ankles, and feet are also common in workers in the brick-making industry [13]. Activities such as repetitive dragging, throwing bricks with impact, squatting during molding, bending, standing in unergonomic positions, or lifting heavy loads on the shoulders or head can trigger or worsen musculoskeletal injuries. In addition, intense physical activity and heavy loads further burden the

DOI: http://dx.doi.org/10.35730/jk.v16i2.1285

workers' bodies. Most workers are unaware of these risks, while business owners tend to ignore their health and instead encourage workers to work double shifts with the promise of additional wages. Improper posture and continuous work increase the risk of musculoskeletal disorders (MSDs) in workers. In addition to working conditions, socio-economic factors and limited employment options make workers in this informal sector, especially in rural areas, face stress that negatively impacts their quality of life. Only a few studies have evaluated the risk of MSDs in brick kiln workers and offered practical solutions [14].

Work-related musculoskeletal disorders among brick workers are an escalating concern in many parts of the world, particularly in developing regions. The nature of brick manufacturing is physically demanding, involving repetitive tasks such as lifting heavy loads, which significantly contribute to the incidence of musculoskeletal injuries among workers. Research indicates that work-related musculoskeletal disorders account for a substantial proportion of all newly reported occupational illnesses, particularly in the construction sector, where they constitute over 33% of these cases (Fernando et al., 2016). Specifically, a study on Sri Lankan brick workers revealed that these disorders are often aggravated by the combination of physically intensive labor and inadequate ergonomic practices [15]. These findings are consistent with evidence from broader construction contexts, where high physical demands have been linked to a greater likelihood of early disability among workers [16]. Such statistics underscore the urgent need for targeted interventions and preventive measures to mitigate the risks faced by this demographic.

Moreover, the socio-economic context of brick workers exacerbates the risks associated with work-related musculoskeletal disorders. Many workers in this sector are subjected to unsafe working conditions, including exposure to dust and heat, which can further impair their health [17]. Brick kilns in Bangladesh, for instance, are notorious for poor working environments that jeopardize workers' physical well-being and hinder access to proper occupational health services [18]; [19]. The combination of high physical demands, inadequate health infrastructure, and socio-economic vulnerabilities positions brick workers at a heightened risk for developing debilitating musculoskeletal disorders, which can lead to long-term impacts on their quality of life and economic productivity [20]. Addressing these issues requires comprehensive strategies focusing on ergonomic improvements, health resources, and regulatory enforcement to safeguard the health and welfare of brick workers.

The brick industry in Indonesia plays a significant role in the country's economy, providing employment to numerous workers in rural and suburban settings. It is characterized by labor-intensive processes that include clay preparation, molding, drying, and firing, often conducted under suboptimal working conditions. A considerable portion of brick workers in Indonesia are unskilled laborers who encounter various challenges, including exposure to harsh environmental conditions, which contribute to the prevalence of work-related musculoskeletal disorders among them. A study on eco-brick workers in Indonesia found that improper ergonomics during the manufacturing process led to adverse health outcomes, particularly musculoskeletal injuries stemming from prolonged awkward postures and heavy lifting [21]. Additionally, the informal nature of the sector typically results in inadequate regulatory oversight, further compromising health and safety measures that could mitigate these risks [22]. Moreover, workers face high rates of respiratory ailments due to exposure to airborne pollutants from brick manufacturing, highlighting the urgent need for targeted interventions to improve occupational health standards in this critical industry [23].

Furthermore, research and policy development in the brick industry in Indonesia are often limited, despite its significant workforce. The seasonal and informal nature of brick production restricts workers' access to social protections and health services, leaving them vulnerable to occupational hazards [24]. Studies indicate that many brick workers report chronic pain, particularly in the lower back and upper extremities, which is exacerbated by unsafe working practices and inadequate training on ergonomics [25]. Existing strategies to address work-related musculoskeletal disorders within the industry remain insufficient due to the heavy reliance on manual labor and improper handling of materials [26]. Addressing these challenges is vital to enhancing the well-being of brick workers and improving productivity while fostering healthier working environments within this sector.

DOI: http://dx.doi.org/10.35730/jk.v16i2.1285

In West Sumatra Province, many small-scale brick-making industries are owned by individuals, which can be found in various regions, including Sarilamak Village, Limapuluh Kota Regency. Based on an initial survey that was conducted through interviews and observations with workers, when and after work, workers felt complaints of pain in the back and waist, in the legs, thighs, calves, and knees; workers also felt complaints in the arms and hands and the shoulder part. Therefore, further research was carried out to understand the description of complaints of musculoskeletal disorders experienced by brick-making workers and the factors that influence them. This study is different from formal sector research because it examines MSD in brick factory workers, one of the informal sectors, where no mandatory regulations directly regulate ergonomics for informal workers in Indonesia.

METHOD

This study uses a quantitative method with a cross-sectional design to determine the description of Musculoskeletal Disorders (MSDs) complaints in brick workers and the factors that influence them, namely work factors, namely work posture and workload, and individual factors such as age, length of service, and body mass index. The study was conducted from March to September 2024, with the research location in Sarilamak Village, Lima Puluh Kota Regency, West Sumatra. The population in this study were all brick production workers in Sarilamak Village, totaling 76 people in 35 brick production sites, with the sampling technique in this study being a total sampling of 66 workers, because 10 workers interviewed during the initial observation were excluded and no longer used as samples during the research. Respondents signed informed consent forms for approval to participate in this study. Data collection was carried out using questionnaires and weight and height measuring instruments. The Nordic Body Map is used to measure Musculoskeletal Disorders (MSDs) Complaints. The measurement result categories of the research variables are Musculoskeletal Disorders Complaints with low-risk measurement results if the score is 0 to 20, moderate risk if the score is 21 to 41 and high risk if the score is 42 to 62, and very high risk if the score is 63 to 84, work posture with low-risk measurement results if the score is 1 to 3, moderate risk if the score is 4 to 7 and high risk if the score is 8 to 15, physical workload with light measurement results if the score is <mean/median, heavy, if the score is ≥mean/median, age category with measurement results with the category of not at risk if age <35 years and at risk if age ≥35 years, work period variables with the category of new work period with a work period of ≤ 5 years and long with a work period of >5 years, body mass index with the category of not at risk, if BMI is 17 - 25 and at risk, if BMI <17 and > 25. Then, the data was analyzed using univariate analysis to describe the distribution and frequency of each variable studied, and bivariate analysis (chi-square test) with SPSS to identify the relationship between independent variables and dependent variables with a confidence level of 95% and $\alpha = 0.05$. This study passed the ethical clearence and received ethical approval from the Research Ethics Commission, Faculty of Public Health, Universitas Andalas with Certificate Number : B/46/UN16.12.D/PT.01.00/2024.

RESULTS AND DISCUSSION

The brick industry in Sarilamak Village, Lima Puluh Kota Regency, West Sumatra Province, is one of the informal industries owned by individuals. The number of brick-making places is 35, with a total of 76 workers, and the number of workers at each brick-production place is between 2 and 5 people. A total of 66 workers were respondents in the study, consisting of 27 (40.9%) who were male and 39 people (59.1%) female. There are more female workers than male workers. Female workers play a role in molding, drying, and firing bricks. The majority of workers live directly around the brick production location. Making bricks starts from 08.00 to 16.00 WIB with a break time of about 1 hour. Workers can complete as many as ±500 to 1000 bricks in one day. The brick-making process is still done manually, and the place of work is carried out in a wooden building without walls with a roof of thatch or zinc.

The brick-making process consists of several stages. The first stage involves taking raw materials in the form of clay. Clay is taken from the hills around the brick-making location. The equipment used is a hoe, shovel, and wooden basket to hold the soil. After being collected, the clay is delivered to the brick production site using a car. After that, the raw materials, which consist of clay and water, are mixed.

DOI: http://dx.doi.org/10.35730/jk.v16i2.1285

Mixing, or what is commonly called scaffolding, is done using buffalo power directed by workers. This mixing or scaffolding process is carried out in a unique clay and water pool. When taking clay and scaffolding, the condition workers do not use personal protective equipment; even workers are found not wearing footwear while working, so it can be a risk to workers' health from contamination of the processed soil.

Then, it continued with the brick printing stage. Brick printing is done using a unique rectangular molding tool made of wood. In this printing process, fine sand that has been dried beforehand is used so that the mixture does not stick to the mold. In one day, workers can print ± 500 to 1000 bricks. Workers carry out the printing process with a standing body position for a long time, which is ± 6 hours/day. Then, after printing, workers lift and move bricks with a bent and non-ergonomic body position, which is risky for the worker's body if done for a long time. In this printing section, it is mainly done by female workers.

The molded bricks are then arranged and dried in the production area. This drying process lasts 7 days if the weather is hot, but if it is rainy, it can take up to 20 days. The condition of the workers when carrying out this process is that the workers must periodically check the bricks that have been dried; if one side of the brick is dry, then the other side is turned over to get sunlight so that it dries evenly. The worker's body position is often bent when carrying out this process.

The dried bricks are then neatly arranged to form a furnace to be fired. The number of bricks that can be fired in one firing is 10,000-15,000. The firing process lasts for 10-15 days non-stop. The risk experienced by workers at this stage is exposure to particulates in the form of dust and smoke produced from the firing process. The condition of workers in this firing process is that they do not use personal protective equipment in the form of masks while working. After the bricks have been fired and cooled, they are unloaded and loaded into a car to be delivered to customers if there is an order. Lifting stones onto a vehicle can cause the risk of cramps and muscle pain due to the heavy load.

Musculoskeletal Disorders Complaints

Musculoskeletal Disorders (MSDs) complaints in brick production workers were measured using the Nordic Body Map (NBM) questionnaire by identifying complaints in each body part and the complaints from no pain to very pain. The results of the study showed that 80.3% of brick workers experienced high-risk MSDs complaints with an NBM score ≥ 42, which can be seen in Table 1.

Table 1. Distribution of MSDs Complaints in Brick Workers

MSDs Complaints	f	%
Medium Risk	13	19,7
High Risk	53	80,3
Total	66	100

It can be seen in Figure 1, the description of the frequency distribution of MSDs complaints in brick workers; it is known that the body parts that are most complained about by brick workers during and after work are the waist, back, and calves. In the waist were complaints of very pain at 34.8% and pain at 45.5%; in the back were complaints of very pain at 27.3% and pain at 36.4%; and in the left and right calves were complaints of very pain at 13.6% and pain at 31.8%.

DOI: http://dx.doi.org/10.35730/jk.v16i2.1285

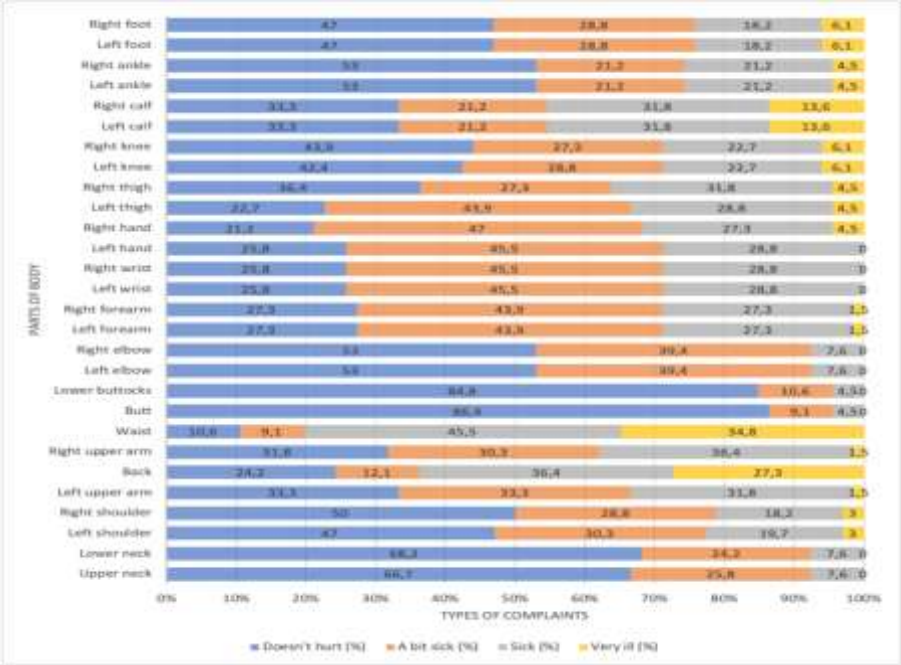

Figure 1. Frequency Distribution of MSDs Complaints

Individual and Job Characteristic Factors

The individual characteristic variables observed in this study were age, length of service, and body mass index. At the same time, the work factors observed were the work posture and workload of brick workers. Table 2 shows that 69.7% of brick workers are included in the risky age category if they are ≥ 35 years old. The average age of workers is 41 years, with the youngest worker being 19 years old and the oldest being 64 years old; 54.5% of brick workers are included in the long service category, namely if they have worked for > 5 years. The average length of service of workers is 8 years, with the most recent length of service being 1 year and the longest being 30 years; 66.7% of workers have a non-risk BMI, namely if the BMI is 17-25. The average BMI of workers is 23, with the lowest BMI being 15.23 and the highest BMI being 29.96. Meanwhile, for work posture, it is known that brick workers with moderate risk work posture are 54.5%, namely if the REBA measurement result is <8, and 65.2% of brick workers have a heavy workload, namely if the score is ≥ 40 (median). The median value is taken because the data is not normally distributed.

Table 2. Distribution of Individual and Job Characteristics of Brick Workers

Characteristics	Category	f	%
Age	<35 years	20	30,3
	≥35 years	46	69,7
Working Period	≤ 5 years	30	45,5
	>5 years	36	54,5
Body Mass Index	17 – 25	44	66,7
	< 17 and > 25	22	33,3
Work Posture	Medium risk	36	54,5
	High risk	30	45,5
Workload	Light	23	34,8
	Heavy	43	65,2
Total		66	100

Analysis of the Relationship between Individual and Job Characteristic Factors with MSDs Complaints

Bivariate analysis used the chi-square test to see the relationship between individual factors, namely age, length of service, and body mass index, and work factors, namely work posture and workload, with complaints of Musculoskeletal Disorders (MSDs). It can be seen in table 3 that high-risk MSDs complaints are more often experienced by workers with a risky age (82.6%) compared to workers

DOI: http://dx.doi.org/10.35730/jk.v16i2.1285

with a non-risk age (75%) with the results of statistical tests obtained p-value = 0.512, high-risk MSDs complaints are more often experienced by workers with a new work period (83.3%) compared to workers with a long work period (77.8%) with the results of statistical tests obtained p-value = 0.799, high-risk MSDs complaints are more often experienced by workers with a risky BMI (90.9%) compared to workers with a non-risk BMI (75%) with the results of statistical tests obtained p-value = 0.191, high-risk MSDs complaints are more often experienced by workers with a moderate risk work posture (83.3%) compared to workers with a high risk work posture (76.7%) with the results of statistical tests obtained p-value = 0.713, high-risk MSDs complaints are more often experienced by workers with a light physical workload (87%) compared to workers with a heavy physical workload (76.7%) with the results of statistical tests obtained p-value = 0.517. This means there is no significant relationship between age, length of service, body mass index, work posture, and workload with complaints of MSDs in brick industry workers. The relatively uniform high prevalence of musculoskeletal disorders across all respondents' subgroups may indicate a general and even exposure to ergonomic hazards, masking individual variables' influence and resulting in the absence of statistically significant relationships.

Table 3. Analysis of the Relationship between Individual and Job Characteristic Factors with MSDs Complaints in Brick Workers

Variable	Category	Keluhan *Musculoskeletal Disorders*				Total		p value
		Medium risk		High risk				
		n	%	n	%	n	%	
Age	<35 years	5	25	15	75	20	100	0,512
	≥35 years	8	17,4	38	82,6	46	100	
Working Period	≤ 5 years	5	16,7	25	83,3	30	100	0,799
	>5 years	8	22,2	28	77,8	36	100	
Body Mass Index	17 – 25	11	25	33	75	44	100	0,191
	< 17 and > 25	2	9,1	20	90,9	22	100	
Work Posture	Medium risk	6	16,7	30	83,3	36	100	0,713
	High risk	7	23,3	23	76,7	30	100	
Workload	Light	3	13	20	87	23	100	0,517
	Heavy	10	23,3	33	76,7	43	100	

DISCUSSION

Musculoskeletal Disorders Complaints

Musculoskeletal Injuries may have long-term impacts on workers and productivity. Musculoskeletal Injuries involve pain in the hands, arms, shoulders, neck, back of the legs, or feet, while Musculoskeletal Disorders include muscles, bones, tendons, nerves, or other soft tissues [27]. MSDs complaints in this study were measured using the Nordic Body Map (NBM) questionnaire. Based on the results of the survey conducted on 66 brick production workers, it was found that 53 people (80.3%) and 13 people (19.7%) of brick workers experienced high-risk MSDs complaints. Workers in the waist, back, and calf areas mostly felt complaints in the very painful category. This can be caused by several factors, such as non-ergonomic body posture and work stages with lifting positions, standing for long periods, and bending a lot.

MSDs complaints are felt while working and after work. Workers feel pain in the back and waist because of the position when lifting raw clay materials, the bending position when drying bricks, and repeated muscle use when unloading and loading bricks. At the same time, workers complain about the calf because of the body's position, which is standing for a long time during the brick molding process. These positions are at risk of causing MSDs complaints in brick production workers.

Individual and Job Characteristic Factors

Age is one of the factors that can affect the level of MSDs complaints in workers. As workers age, muscle strength and endurance decrease, and the risk of muscle complaints increases [5]. Workers aged ≥35 years are categorized as workers with a risky age, while workers aged <35 years are categorized as workers with a non-risk age. Based on the study's results, 46 workers (69.7%) were in the risky age category, while 20 workers (30.3%) were in the non-risk age category. Brick production workers are aged

DOI: http://dx.doi.org/10.35730/jk.v16i2.1285

≥35 years (risky age) compared to workers with a non-risk age. The average age is 41, the youngest is 19, and the oldest is 64.

Working period refers to how long a person has worked, calculated from when they started working. Length of service is one of the factors that can cause MSDs complaints in workers because MSDs are not diseases that appear in a short time but appear in a relatively long time and have long stages to develop until they cause pain. Workers who have worked for a long time are at high risk of experiencing muscle pain because the muscles continue to receive workloads for a long time, coupled with non-ergonomic working positions. Based on the research that has been conducted, 36 workers (54.5%) have a long work period (> 5 years), and 30 workers (45.5%) have a new work period. The most recent work period is 1 year, and the longest is 30 years of producing bricks.

Body mass index is a measure used to determine a person's nutritional status by comparing weight and height. The aim is to determine the nutritional status of workers, which can affect their work productivity. Based on the research that has been conducted, there are 22 workers (33.3%) with a BMI at risk and 44 workers (66.7%) with a BMI that is not at risk. So, most workers have a normal BMI.

Furthermore, the assessment of work posture in brick production workers was carried out using the REBA (Rapid Entire Body Assessment) assessment sheet, which evaluated ergonomic work positions at the stages of work carried out during brick-making according to each worker's tasks. It is known that there are 30 workers (45.5%) who have unergonomic work postures in the high-risk category and 36 workers (54.5%) who have unergonomic work postures in the medium-risk category. Based on the results of the observation, it is known that unnatural work positions occur when lifting raw clay materials, standing body positions for long periods during the brick molding process, bending positions when drying bricks, and repeated use of muscles when unloading and loading bricks. This can cause tension in the back, waist, arms, and knees, increasing the risk of injury to the skeletal muscles such as the back, waist, shoulders, and legs due to unnatural work postures carried out repeatedly for a long time.

In line with the research Ijaz et al. (2020), workers in the brick industry in Pakistan, such as workers in the brick-making industry, often have to work for long periods in non-ergonomic body positions. This position, which is maintained continuously, contributes to the development of various musculoskeletal disorders that primarily affect the ankles, upper and lower back, wrists, knees, shoulders, neck, and other parts of the body. In addition, the brick kilns surveyed in this study usually operate non-stop for 24 hours a week, so workers have to adjust their work schedules to keep up with the intense operational rhythm [13].

This is in line with other studies, research by Sanjel et al. (2016), conducted in the brick kiln industry, which is spread across various regions in Nepal, which is known for its large informal industrial sector. This industry plays a significant role in the local economy, but often operates with poor occupational safety standards. The results showed that workers in the brick kiln industry are exposed to various environmental and occupational pollutants, including dust, smoke, and hazardous chemicals, which have severe health impacts. The main complaints reported included respiratory problems, eye irritation, chronic fatigue, and musculoskeletal disorders, which were significantly associated with unergonomic working environments and lack of personal protective equipment. The high exposure to risks across worker groups also suggests that workplace hazards are prevalent, masking the effects of individual factors. Thus, this study emphasizes the importance of strengthening occupational safety and health (OHS) regulations, especially in the informal sector, and the need to integrate pollutant control and ergonomic interventions to improve worker health protection sustainably [18].

Another work factor is workload, namely the weight of the load that workers must bear during the work process 43 workers (65.2%) in the heavy category and 23 workers (34.8%) in the light category. Based on the study's results, most workers have a heavy workload. Based on observations of high workloads when having to work harder and longer to meet increasing demand, for work stage activities with heavy loads, many are when lifting clay raw materials by taking clay in a bent position and continuing to lift it to the car to the production location and also the stage of lifting bricks to the car when they will be delivered to consumers.

This finding is in line with the results of a study by Adiyanto et al. (2023) on eco-brick workers in Indonesia, which also reported a high prevalence of musculoskeletal complaints in similar body areas,

DOI: http://dx.doi.org/10.35730/jk.v16i2.1285

namely the lower back and lower legs and showed that poor working environment factors and repetitive physical loads had a greater influence than individual characteristics. This similarity indicates a regional pattern in the type of informal work in the brick production sector, which tends to involve heavy physical loads and minimal ergonomic interventions [21].

The high prevalence of MSD complaints among brick factory workers, as found in this study, and the absence of significant relationships with individual variables indicate that the root of the problem lies in work factors and non-ergonomic work environments. This aligns with the spirit of the Minister of Health Regulation No. 56 of 2016 concerning the Implementation of the Occupational Health Management Program, which emphasizes the importance of early identification and control of risk factors for occupational diseases, including muscle and skeletal disorders. These results reinforce the urgency of implementing systematic ergonomic risk management in the informal sector and the need for regulatory support and technical training for traditional industry players such as brick factories to prevent occupational diseases comprehensively [8].

Analysis of the Relationship between Individual and Job Characteristic Factors with MSDs Complaints

Based on research, it is known that workers with an age at risk (≥35 years) experience more severe MSDs complaints compared to workers with an age not at risk (<35 years). This happens because increasing age affects the decline in a person's physical condition. As workers age, their muscle and physical strength will tend to decrease. The risk of muscle complaints will continue to increase along with reduced muscle strength. This can increase the risk of injury and musculoskeletal complaints [28].

Based on research, it is known that workers with an age at risk (≥35 years) experience more severe MSDs complaints compared to workers with an age not at risk (<35 years). This happens because increasing age affects the decline in a person's physical condition. As workers age, their muscle and physical strength will tend to decrease. The risk of muscle complaints will continue to increase along with reduced muscle strength. This can increase the risk of injury and musculoskeletal complaints [29].

Body mass index influences work productivity. Body weight, height, and body mass are factors that can cause MSDs complaints due to differences in the balance of the skeletal structure when given a load, either a heavy load originating from the body or an additional load originating from outside the body [28]. Based on research results, workers with a high body mass index are at greater risk of experiencing MSDs than workers with a normal BMI.

Based on the study's results, workers with moderate-risk non-ergonomic work postures experienced more high-risk MSDs complaints than workers with high-risk non-ergonomic work postures. So, from the study results of the stages of work carried out, there were no workers with ergonomic work postures; the measurement results showed all workers with moderate and severe risk non-ergonomic postures. Generally, muscle complaints arise from habits that a person does while working. These complaints can occur due to inappropriate work postures and are carried out for extended periods. Non-ergonomic work postures can cause MSDs complaints if done continuously.

Workers with light workloads experience more severe MSDs complaints compared to workers with heavy loads; this occurs because light workloads are more often done by female workers but more often experience MSDs complaints compared to male workers. Workloads can cause high muscle contractions due to the large load for a long time that is done repeatedly. Excessive muscle contractions will cause a decrease in blood flow to the muscles so that the oxygen supply to the muscles decreases and the metabolic system in the body is inhibited, which results in the accumulation of lactic acid, which can cause pain in skeletal muscles [29].

CONCLUSION

A large number of brick production workers experience high-risk MSDs complaints; the body parts most complained about by brick workers are the waist, back, and calves. Workers feel pain in the back and waist because of the position when lifting raw clay materials, the bending position when drying

DOI: http://dx.doi.org/10.35730/jk.v16i2.1285

bricks, and repeated muscle use when unloading and loading bricks. At the same time, workers feel complaints in the calf area because of the body's position, which is standing for a long time during the brick molding process. From the results of the statistical analysis, it is known that there is no relationship between age, length of service, BMI, work posture, and workload and complaints of musculoskeletal disorders in brick production workers.

Business owners are expected to facilitate workers with ergonomic work equipment and provide and use personal protective equipment such as boots, gloves, and masks to avoid risks from equipment and the work environment. Ergonomics training should be integrated into the national Occupational Safety and Health (OSH) program, targeting informal sector workers to improve awareness and preventive practices. Regulatory frameworks should be strengthened to ensure compliance, such as brick factories, which require structured technical training and support to comprehensively reduce the risk of occupational diseases.

REFERENCES

[1] L. Jauhari, K. Prabowo, A. Fridianti, P. Sarjana, and T. Kesehatan, "Analisis Distribusi Tingkat Keparahan Keluhan Subjektif Musculoskeletal Diseases (MSDs) dan Karakteristik Faktor Tingkat Risiko Ergonomi pada Pekerja Kantor Asuransi," *J. Info Kesehat.*, vol. 15, no. 1, pp. 20–28, 2017, [Online]. Available: http://jurnal.poltekeskupang.ac.id/index.php/infokes%0AAnalysis

[2] ILO, "Global Trends on Occupational Accidents and Diseases," Geneva, 2015.

[3] ILO, "Occupational Safety and Health Statistics (OSH database)," 2022.

[4] Jan de Kok *et al.*, *Work-related MSDs: prevalence, costs and demographics in the EU*. 2020. doi: 10.2802/66947.

[5] A. A. Ance, N. C. Berek, and Y. R. Riwu, "The Factors Related to Musculoskeletal Disorders of Rice Milling Workers in Lembor District, West Manggarai," *Lontar J. Community Heal.*, vol. 3, no. 3, pp. 96–102, 2021, doi: 10.35508/ljch.v3i3.3852.

[6] D. S. F. de Souza, J. M. N. da Silva, J. V. de O. Santos, M. S. B. Alcântara, and M. G. L. Torres, "Influence of risk factors associated with musculoskeletal disorders on an inner population of northeastern Brazil," *Int. J. Ind. Ergon.*, vol. 86, 2021.

[7] A. Cieza, K. Causey, K. Kamenov, S. W. Hanson, S. Chatterji, and T. Vos, "Global estimates of the need for rehabilitation based on the Global Burden of Disease study 2019: a systematic analysis for the Global Burden of Disease Study 2019," *Lancet*, vol. 396, no. 10267, pp. 2006–2017, 2020, doi: 10.1016/S0140-6736(20)32340-0.

[8] Kemenkes RI, "Peraturan Menteri Kesehatan Republik Indonesia Nomor 56 Tahun 2016 Tentang Penyelenggaraan Pelayanan Penyakit Akibat Kerja," *Menteri Kesehat.*, pp. 1–35, 2016.

[9] Y. Adiratna, S. Astono, and M. Fertiaz, "Profil Kesehatan dan Keselamatan Kerja Nasional Indonesia Tahun 2022," Jakarta, 2022.

[10] Kemenkes RI, "Riset Kesehatan Dasar (RISKESDAS)," Jakarta, 2018.

[11] Noviyanti and D. C. Misriningsih, "Faktor–Faktor Risiko Ergonomi Terhadap Keluhan Nyeri Otot Pada Pekerja Pembuat Batu Bata Diwilayah Kerja Puskesmas X Kota Tanjungpinang," *J. Kesehat. Ibnu Sina*, vol. 1, no. 2, pp. 1–11, 2020.

[12] S. J. D. RI, "Pekerja Informal Dominasi Angka Pekerja," Jakarta, 2023.

[13] M. Ijaz, S. R. Ahmad, M. Akram, W. U. Khan, N. A. Yasin, and F. A. Nadeem, "Quantitative and qualitative assessment of musculoskeletal disorders and socioeconomic issues of workers of brick industry in Pakistan," *Int. J. Ind. Ergon.*, vol. 76, no. August 2019, p. 102933, 2020, doi: 10.1016/j.ergon.2020.102933.

[14] M. K. Sain and M. L. Meena, "Exploring the musculoskeletal problems and associated risk-factors among brick kiln workers," *Int. J. Work. Heal. Manag.*, vol. 11, no. 6, pp. 395–410, 2018, doi: 10.1108/IJWHM-05-2018-0061.

[15] W. I. B. Fernando, P. V. D. Silva, and S. M. T. D. Sundarapperuma, "Prevalence of Work Related Musculoskeletal Disorders in Brick Industry Workers in Chilaw Sri Lanka," *J. Ruhunu Clin. Soc.*,

DOI: http://dx.doi.org/10.35730/jk.v16i2.1285

vol. 21, no. 1, pp. 9–15, 2016, doi: 10.4038/jrcs.v21i1.15.
[16] A. M. Dale, D. T. Ryan, L. S. Welch, M. A. Olsen, B. Buchholz, and B. Evanoff, "Comparison of Musculoskeletal Disorder Health Claims Between Construction Floor Layers and a General Working Population," *Occup. Environ. Med.*, vol. 72, no. 1, pp. 15–20, 2014, doi: 10.1136/oemed-2014-102313.
[17] S. Shrestha and S. M. Thygerson, "Brick Kilns of Nepal: A Non-Governmental Organization Perspective," *Open J. Saf. Sci. Technol.*, vol. 09, no. 01, pp. 1–6, 2019, doi: 10.4236/ojsst.2019.91001.
[18] S. Sanjel, S. M. Thygerson, S. N. Khanal, and S. K. Joshi, "Environmental and Occupational Pollutants and Their Effects on Health Among Brick Kiln Workers," *Open J. Saf. Sci. Technol.*, vol. 06, no. 04, pp. 81–98, 2016, doi: 10.4236/ojsst.2016.64008.
[19] M. I. Muhib, M. Shawkut, and A. H. Khan, "An Overview of Health and Environmental Threats From the Brick Kiln Industry Around the Capital of Bangladesh," *Am. Int. J. Sci. Eng. Res.*, pp. 16–22, 2022, doi: 10.46545/aijser.v5i1.259.
[20] M. M. Hassan, L. Juhász, and J. Southworth, "Mapping Time-Space Brickfield Development Dynamics in Peri-Urban Area of Dhaka, Bangladesh," *Isprs Int. J. Geo-Information*, vol. 8, no. 10, p. 447, 2019, doi: 10.3390/ijgi8100447.
[21] O. Adiyanto, E. Mohamad, R. Jaafar, and M. Faishal, "Identification of Musculoskeletal Disorder Among Eco-Brick Workers in Indonesia," *Int. J. Occup. Saf. Heal.*, vol. 13, no. 1, pp. 29–40, 2023, doi: 10.3126/ijosh.v13i1.44575.
[22] T. Budiyanto, O. Adiyanto, F. Ma'ruf, and H. Haryadi, "Assessing Musculoskeletal Disorders (Msds) of Workers of Fired Clay Bricks Industry," *Log. J. Ranc. Bangun Dan Teknol.*, vol. 24, no. 1, pp. 24–30, 2024, doi: 10.31940/logic.v24i1.24-30.
[23] A.-S. AA and S. KM, "Respiratory Health Study of Brick Industry Workers, Survey and Environmental Assessment," *Egypt. J. Occup. Med.*, vol. 47, no. 3, pp. 1–15, 2023, doi: 10.21608/ejom.2023.176107.1299.
[24] S. Bajracharya, K. Gurung, L. Mathema, S. Sharma, and A. Mishra, "Forgotten Contributors in the Brick Sector in Nepal," *Int. J. Environ. Res. Public Health*, vol. 18, no. 12, p. 6479, 2021, doi: 10.3390/ijerph18126479.
[25] M. K. Sain and M. L. Meena, "Identifying Musculoskeletal Issues and Associated Risk Factors Among Clay Brick Kiln Workers," *Ind. Health*, vol. 57, no. 3, pp. 381–391, 2019, doi: 10.2486/indhealth.2018-0096.
[26] S. Sunny, F. N. Fathima, J. Joy, B. L. Passah, J. C. Thomas, and T. Agrawal, "Occupational Risk Assessment and Selected Morbidities Among Cement Brick Unit Workers in a Rural Area of Bangalore District, India," *Int. J. Occup. Saf. Heal.*, vol. 12, no. 1, pp. 17–22, 2022, doi: 10.3126/ijosh.v12i1.41033.
[27] N. S. Lop, I. F. M. Kamar, M. N. A. Aziz, L. Abdullah, and N. M. Akhir, "Work-Related to Musculoskeletal Disorder Amongst Malaysian Construction Trade Workers : Bricklayers," 2017, vol. Vol. 1891., no. November.
[28] Tarwaka and S. H. A. Bakri, *Ergonomi untuk Keselamatan, Kesehatan Kerja dan Produktivitas*. 2016. [Online]. Available: http://shadibakri.uniba.ac.id/wp-content/uploads/2016/03/Buku-Ergonomi.pdf
[29] B. Aprianto, A. F. Hidayatulloh, F. N. Zuchri, I. Seviana, and R. Amalia, "Faktor Risiko Penyebab Musculoskeletal Disorders (MSDs) Pada Pekerja: A Systematic Review," *J. Kesehat. Tambusai*, vol. 2, no. 2, pp. 16–25, 2021, doi: 10.31004/jkt.v2i2.1767.

DOI: http://dx.doi.org/10.35730/jk.v16i2.1285