

<https://doi.org/10.48047/AFJBS.6.14.2024.11106-11119>



African Journal of Biological Sciences

Journal homepage: <http://www.afjbs.com>



Research Paper

Open Access

ANALYSIS OF FACTORS AFFECTING MUSCULOSKELETAL DISORDERS TO CONSTRUCTION WORKERS OF VERTICAL HOSPITAL BUILDING PROJECT IN MAKASSAR IN 2024

Sitti Fatimah Az-Zahra¹, Yahya Thamrin¹, Atjo Wahyu¹, Furqaan Naiem¹, Masyitha Muis¹, Irwandy²

¹Department of Occupational Safety and Health, Faculty of Public Health, Hasanuddin University, Makassar, Indonesia

²Department of Hospital Administration Management, Faculty of Public Health, Hasanuddin University Makassar, Indonesia

*Corresponding Author, [e-mail:Azzahratahir12@gmail.com](mailto:Azzahratahir12@gmail.com)

Volume 6, Issue 14, Aug 2024

Received: 15 June 2024

Accepted: 25 July 2024

Published: 29 Aug 2024

doi: [10.48047/AFJBS.6.14.2024.11106-11119](https://doi.org/10.48047/AFJBS.6.14.2024.11106-11119)

Abstract

The Construction Research and Training Center states that lifting and lowering materials causes 30% of *musculoskeletal* disorders among construction workers. Then excessive activity coupled with pushing, pulling, holding, carrying, and catching materials can add 37% of *musculoskeletal* complaints. The purpose of this study was to determine the effect of age, length of service, body mass index, physical fitness, and smoking habits on complaints of *musculoskeletal disorders* through work posture in construction workers of the Makassar vertical hospital construction. This type of research uses mixed method research with a cross sectional approach. The quantitative sample of this study using proportionate random sampling amounted to 243 respondents and the qualitative sample amounted to 6 main informants and 2 key informants. The results of this study indicate that the variables of age (0.041) and body mass index (0.047) have a direct and indirect effect on *musculoskeletal disorders* through work posture. Whereas working period (0.126), physical fitness (0.581) and smoking habits (0.366) affect *musculoskeletal disorders* directly without going through work postures. Therefore, both workers and management must work together in implementing health programs or work rules to minimize the risk of *musculoskeletal disorders* in construction workers.

Keywords : Musculoskeletal health, work posture, construction workers

1. Introduction

The development of facilities and infrastructure plays an important role in the progress of an area for the welfare of society. With the development of industrialization and urbanization, great changes have taken place in the field of labor production and production operation mode characterized by high workload, high intensity of repetitive work and poor working posture. (Li et al., 2021). Therefore, this urgently requires serious and systemized handling of occupational safety and health that involves human life. (Putra et al., 2021).

According to the *International Labor Organization* (ILO), the incidence of occupational accidents in the world reaches 430 million cases per year consisting of 270 million (62.8%) cases of occupational accidents and 160 million (37.2%) cases of occupational diseases. (Susanto et al., 2023).. BPJS Employment data recorded the number of occupational accidents and diseases in 2019 as many as 210,789 cases, then in 2020 as many as 221,740 cases, and in 2021 it increased again to 234,370 cases. (Indonesian Ministry of Manpower, 2022). The type of occupational disease that needs to be aware of the most is due to ergonomic exposure. (Ariningsih, 2021).

According to Etchinson (2007), Ergonomics is an applied science that explains the interaction between humans and their workplace. Ergonomics, among other things, examines the physical capabilities of workers, the workplace environment, and the tasks that are completed and applies this information to the design of models of tools, equipment, work methods that are needed to complete tasks safely. (Ertansyah, 2015). Occupational health problems that can be caused by ergonomic hazards are *Musculoskeletal Disorders* (Yuwantri et al., 2015). (Yuwantri et al., 2022)..

Musculoskeletal disorders (MSDs) are disorders of the musculoskeletal system that cause symptoms such as pain due to damage to the nerves, and blood vessels in various body locations such as the neck, shoulders, wrists, hips, knees, and heels. (Tarwaka et al., 2004).. The prevalence rate of *Musculoskeletal Disorders* in the world according to data from the *Labor Force Survey* (LFS) shows that MSDs in workers is very high at 1,144,000 cases with a distribution of cases affecting the back of 493,000 cases, upper limbs or neck 426,000 cases, and lower limbs 224,000 cases. (Cheisario & Wahyuningsih, 2022).. Research results Bandyopadhyay (2012) in (Hossain et al., 2018) mentioned that in India, *Musculoskeletal Disorders* accounted for 78.5% of all work-related diseases and disorders.

Musculoskeletal Disorders (MSDs) are classified into specific or nonspecific disorders. Specific musculoskeletal disorders have a clear clinical picture, while nonspecific musculoskeletal disorders present with pain without evidence of a clear specific disorder. (Krishnan et al., 2021).. Body parts that are often complained of include the neck, shoulders, arms, hands, back, waist, and lower muscles. (Fauziah et al., 2018).. Muscle complaints are unlikely to occur if muscle contractions only range between 15-20% of maximum muscle strength. However, if muscle contraction exceeds

20%, then blood circulation to the muscles decreases according to the level of contraction which is influenced by the amount of energy required, oxygen supply to the muscles decreases, carbohydrate metabolic processes are inhibited and as a result there is a buildup of lactic acid which causes muscle pain (Tarwaka et al., 2018). (Tarwaka et al., 2004)..

Musculoskeletal conditions are the highest contributor to global rehabilitation needs (Briggs et al., 2016).. Musculoskeletal conditions often co-occur with other non-communicable diseases and increase the risk of developing other non-communicable diseases, such as cardiovascular disease. The 2019 *Global Burden of Disease* (GBD) data shows that approximately 1.71 billion people worldwide are living with musculoskeletal conditions, including low back pain, neck pain, fractures, other injuries, *osteoarthritis*, amputations, and rheumatoid *arthritis*. (WHO, 2022). People with musculoskeletal conditions are also at higher risk of mental health problems (WHO, 2022).

The prevalence of *Musculoskeletal Disorders* in Indonesia diagnosed by health workers is 11.9%. According to the results of the Basic Health Research in 2018, the highest prevalence of *Musculoskeletal Disorder* based on occupation was among farmers, fishermen and laborers at 9.90%. In addition, the highest prevalence of *Musculoskeletal Disorder* in Aceh was 13.26%, followed by Bali at 10.46%, Bengkulu at 12.11%, and East Java at 6.72%, and South Sulawesi at 6.39%. (Indonesian Ministry of Health, 2018).

Disease or injury to the musculoskeletal system rarely occurs directly, but rather is a continuous accumulation of every activity that workers do when working for a relatively long period of time. (Thamrin et al., 2021). This is supported by research (Jatmika et al., 2022) related to *Musculoskeletal Disorders* complaints experienced by Yos Sudarso Tual port laborers showed that out of a total of 105 respondents (100%), there were 85 workers who experienced moderate MSDs complaints (81%) and 20 workers (19%) who experienced mild MSDs complaints.

There are several factors that can affect the onset of *Musculoskeletal Disorder* (MSDs) complaints. Individual factors such as age, gender, body mass index, smoking habits, exercise habits, anthropometry, length of service, and physical strength affect *Musculoskeletal Disorders* complaints. According to Hernandez and Peterson (2013), work factors such as work posture, force/load, frequency, and duration are also a factor. Environmental factors according to Handayani (2011) such as temperature, humidity, illumination, and vibration as well as psychosocial factors according to Johansson & Rubenowitz (1996) in Mayasari & Saftarina (2016). Mayasari & Saftarina (2016) are also factors that influence complaints of *Musculoskeletal Disorders*.

According to (Watiningsih et al., 2020) According to (Watiningsih et al., 2020), awkward or unnatural work postures can be one of the factors causing *musculoskeletal* complaints. The risk of skeletal muscle complaints will increase if the body position is

further away from the body's center of gravity. Research results (Cheisario & Wahyuningsih, 2022) obtained a *p* value of 0.004 ($p < 0.05$), which means there is a relationship between work posture and complaints of *musculoskeletal disorders*. The mismatch between the workstation and the worker can also result in complaints or disorders in the musculoskeletal system which includes joints and muscles due to an unergonomic body. (Sallri & Rifai, 2019).

One of the main causes of muscle disorders is awkward work postures that occur when good posture deviates significantly from its normal position while performing activities. (Vanissa et al., 2022).. This is because workplaces are often equipped with a number of equipment and job aids that force to maintain an incorrect posture (Gandolfi et al., 2021). (Gandolfi et al., 2021).. Research results (Mohammadipour et al., 2018) on risk factors and prevalence of *Musculoskeletal Disorders* in office workers in the country of Iran showed the results that 88.4% of employees experienced MSDs in at least one limb due to poor posture due to workplace conditions. Research reveals that awkward postures lead to the development of MSDs complaints. However, according to Marras *et. al* (2009) in (Thamrin et al., 2020) However, MSDs complaints can be caused not only from work positions but also from many other factors including work organization, psychosocial, tools, individuals, and the workplace itself. This is supported by the results of research (Abdillahtulkhaer et al., 2022) which shows that the factors associated with *musculoskeletal* complaints using the *chisquare* test and obtained age ($p=0.025$), smoking habits ($p=0.18$), exercise habits ($p=0.36$), BMI ($p=0.26$), length of service ($p=0.007$), work posture (0.003) and workload (0.004) and followed by work posture which is the most influential variable on complaints of *musculoskeletal disorders* with an *Exp (B)* value of 8.433. In line with this research, this is further strengthened by research (Darvishi et al., 2022) related to Risk Assessment of Occupational *Musculoskeletal Disorders* based on Individual Characteristics using *path* analysis techniques which show that individual factors both directly and indirectly can affect the presence of *Musculoskeletal Disorders* (MSDs) complaints.

Musculoskeletal Disorders (MSDs) in the workplace occur in a number of occupations with a high risk of musculoskeletal disease, including construction. (Aprianto et al., 2021). The construction sector is a labor-intensive workplace with a much higher rate of accidents and occupational diseases than the average of all industries (Utama & Widanarko, 2021). (Utama & Widanarko, 2022).. In the United States and several other European countries, there have been many epidemiologic studies conducted on industrial diseases reporting that musculoskeletal diseases are common among construction workers (S. Lee et al., 2022). (S. Lee et al., 2023).. Construction workers have a 16% higher rate of MSDs than workers in other industries due to high physical demands such as lifting, repetitive motions, and awkward work postures such as bending, twisting, kneeling, and working with hands higher than shoulders

(Boschman et al., 2023). (Boschman et al., 2015).. Construction Research and Training Center (2015) in (Kaur et al., 2021) also mentioned that lifting and lowering activities cause 30% of *musculoskeletal* disorders among construction workers. Then excessive activity coupled with pushing, pulling, holding, carrying, and catching materials can add 37% of *musculoskeletal* complaints.

The Makassar vertical hospital construction project is one of the construction projects that has a high risk. The construction of this hospital involves many workers with different characteristics and uses various tools with different work methods. Work risks in the construction sector that require workers to make repetitive movements such as sawing wood, nailing wood, cutting iron, installing ceramics, installing bricks, transporting sand, painting, breaking, transporting, as well as mechanical and electrical work that still uses *manual handling* can result in risks to posture. Different worker characteristics supported by postures that require workers to bend, kneel, hold tools, or tilt the body can be at risk of *musculoskeletal disorders*. (Syaputri, 2019).

The results of the observations made found information that there are differences in the characteristics of prospective respondents based on diverse ages, different body shapes, different levels of worker experience, and diverse worker habits such as smoking habits and exercise habits. This is because the backgrounds of the workers are also diverse, thus affecting their respective characteristics. Researchers also obtained information that each work item has a different *Work Methods Statement* (WMS) or work method guide so that the resulting work posture is also very diverse. In addition, based on the experience of researchers, workers also often complain of pain or muscle aches in some parts of their bodies when resting or after finishing their work. This is supported by data from visitors to the Makassar vertical hospital clinic who recorded complaints of *musculoskeletal disorders* symptoms from May 2023 - February 2024 as many as 107 cases. (PP-ADHI KSO, 2023).

According to Tarwaka, occupational health is carried out to improve the quality of life of the workforce, so that workers and businesses can feel and enjoy the results. In occupational health services in the business sector, it plays such an important role regarding human resources, productivity and welfare that success in realizing occupational health efforts will have a very positive impact on increasing company productivity and income and the welfare of the workforce. (Rahayu & Tri, 2021). Musculoskeletal health is also very important for maintaining an active, productive and prolonged working life (Briggs et al., 2021). (Briggs et al., 2016)..

Based on this background description, the researcher is interested in conducting research with the title "Analysis of Factors Affecting *Musculoskeletal Disorders* to Construction Workers of Vertical Hospital Building Project in Makassar in 2024".

2. Materials and Methods

The method used in this study is a combination of research data (*mixed method*). Quantitative data collection was carried out by observational analytics with a *cross sectional* approach to 243 samples who were construction workers in the Makassar vertical hospital development project. While qualitative sampling uses *indepth interviews*.

The variables in this study are age, length of service, body mass index, physical fitness and smoking habits as independent variables, complaints of musculoskeletal disorders as the dependent variable, and work posture as the intervening variable.

The instruments in this study used questionnaires to determine the characteristics of respondents, digital scales and height meters to determine body mass index, Nordic body map sheets, rapid whole body assessment sheets, and in-depth interview guides.

The data in this study were analyzed using the Smart PLS application to see the relationship between the independent variable and the dependent variable through the intervening variable and supported by informant statements through in-depth interviews .

3. Results and Discussion

Based on table 1, we can know that the majority of respondents are more than 30 years old, namely 133 respondents or 54.7%, and 110 respondents or 45.3% are less than 30 years old and all respondents are male. For the Education Level, the majority have a high school / vocational high school graduate education background, namely 114 people, and only 7 workers have a college education, besides that, there are also workers who only graduated from elementary school and did not graduate from elementary school. As for marital status, the majority of workers who were respondents were married, namely 145 people and the remaining 98 were not married.

For the respondent's work unit, it is known that the majority of respondents work in the architectural unit, namely 132 workers, then *mechanical, electrical and plumbing* workers as many as 104 workers and only 7 workers who work in the structure section. The majority of respondents have worked for more than 5 years, namely 133 respondents or 54.7% and only 110 respondents or 45.3% have worked for less than 5 years.

The body mass index of respondents was measured into 4 categories, where the majority of respondents' body mass index was between 18.5-25.0 or normal status, namely 138 respondents or 56.8%, thin category or less than 18.5 as many as 46 respondents or 18.9%, fat category or 25-27 as many as 40 respondents or 16.5% and obese category as many as 19 respondents or 7.8%. For physical fitness, most of them exercise less than 3 times a week, namely 209 respondents or 86.0% and only 34 respondents or 14.0% who exercise more than 3 times a week.

For smoking habits, it is known that the majority of respondents are smokers, namely 176 respondents or 72.4% and only 67 respondents who do not smoke. Regarding work posture which is an

intervening variable in this study, it is known that most respondents have non-ergonomic work postures, namely 169 respondents or only 74 respondents or 30.5% are ergonomic. For the dependent variable in this study, namely complaints of *musculoskeletal disorders*, it is known that most respondents have mild complaints, namely 124 respondents or 51% and those with severe complaints are 119 respondents or 49%.

Based on Table 2 above, we can know the effect of the independent variable on the dependent variable directly. The interpretation of the direct test results is given as follows:

- a. The effect of age on work posture is significant because the *p-value* is $0.000 < 0.05$. The magnitude of the effect of age on work posture is 0.263 and is positive, which means that as age increases, work postures have the potential to be unergonomic.
- b. The effect of age on Complaints of *Musculoskeletal Disorders* is significant because the *p-value* is $0.013 < 0.05$. The magnitude of the effect of age on Complaints of *Musculoskeletal Disorders* is 0.166 and has a positive value, which means that as age increases, Complaints of *Musculoskeletal Disorders* have the potential to have severe complaints.
- c. The effect of working period on work posture is significant because the *p-value* is $0.011 < 0.05$. The magnitude of the influence of the work period on work posture is 0.179 or a significant positive effect, which means that the more the work period increases, the work posture has the potential to be unergonomic.
- d. The effect of working period on complaints of *Musculoskeletal Disorders* is significant because the *p-value* of $0.032 < 0.05$. The magnitude of the effect of the working period on complaints of *Musculoskeletal Disorders* is 0.145 or a positive effect, which means that if the working period increases, complaints about *Musculoskeletal Disorders* will increase.
- e. The effect of body mass index on work posture is significant because the *p-value* is $0.000 < 0.05$. The effect of body mass index on work posture is 0.202 and has a positive value, which means that as age increases, work posture has the potential to be unergonomic.
- f. The effect of body mass index on complaints of *Musculoskeletal Disorders* is significant because the *p-value* is $0.021 < 0.05$. The effect of body mass index on complaints of *Musculoskeletal Disorders* is 0.142 and has a positive value, which means that the more the body mass index increases, the complaints of *Musculoskeletal Disorders* have the potential to have severe complaints.
- g. The effect of physical fitness on work posture is declared insignificant because the *p-value* is $0.539 > 0.05$.
- h. The effect of physical fitness on complaints of *Musculoskeletal Disorders* is stated to be significant because the *p-value* is $0.012 < 0.05$. The magnitude of the effect is 0.147 or a positive effect

which means that the more often you exercise, the lighter the complaints of *Musculoskeletal Disorders* will be.

- i. The effect of smoking habits on work posture is declared insignificant because the p -value is $0.228 > 0.05$.
- j. The effect of smoking habits on complaints of *Musculoskeletal Disorders* is significant because the p -value is $0.839 > 0.05$. The magnitude of the effect is -0.199 or a negative effect, which means that if the respondent is a smoker, the complaints of *Musculoskeletal Disorders* will be more severe.
- k. The effect of work posture on Complaints of *Musculoskeletal Disorders* is significant because the p -value is $0.045 < 0.05$. The magnitude of the effect of work posture on Complaints of *Musculoskeletal Disorders* is 0.126 and has a positive value, which means that the more work posture increases, the Complaints of *Musculoskeletal Disorders* have the potential to have severe complaints.

Based on table 3, we can know the indirect effect of independent variables on dependent variables through intervening variables.

- a. For the indirect effect of age on Complaints of *Musculoskeletal Disorders* through the intermediary of work posture variables, it is known that there is an indirect effect of age on Complaints of *Musculoskeletal Disorders* (p -value = $0.041 < 0.05$). The magnitude of the indirect effect is 0.032 or positive or means that if age increases, it will indirectly increase Complaints of *Musculoskeletal Disorders* through work posture variables.

- b. For the indirect effect of working period on *Musculoskeletal Disorders* through the intermediary variable of work posture, it is known that there is no indirect effect of working period on *Musculoskeletal Disorders* (p -value = $0.126 > 0.05$).
- c. For the indirect effect of body mass index on complaints of *Musculoskeletal Disorders* through the intermediary variable of work posture, it is known that there is an indirect effect of body mass index on complaints of *Musculoskeletal Disorders* (p -value = $0.048 < 0.05$). The amount of indirect effect is 0.04 or positive or means that if the body mass index increases, it will indirectly increase the complaints of *Musculoskeletal Disorders* through the work posture variable.
- d. For the indirect effect of physical fitness on *Musculoskeletal Disorders* through the intermediary variable of work posture, it is known that there is no indirect effect of physical fitness on *Musculoskeletal Disorders* (p -value = $0.74 > 0.05$).
- e. For the indirect effect of smoking habits on *Musculoskeletal Disorders* through the intermediary variable of work posture, it is known that there is no indirect effect of smoking habits on *Musculoskeletal Disorders* (p -value = $0.737 > 0.05$).

Table 1. Distribution of Respondent Characteristics of Construction Workers at Vertical Hospital Building Project in Makassar

Respondent Characteristics		Frequency	
		n	%
Age	≥ 30 years	133	54,7
	< 30 years	110	45,3
Gender	Male	243	100,0
Education	Not graduated from elementary school	6	2,5
	SD	43	17,7
	SMP	72	29,6
	SMA/SMK	115	47,3
	Higher Education	6	2,5
Marriage Status	Unmarried	98	40,3
	Married	145	59,7
Type of Work	Structure	7	2,9
	MEP	104	42,8
	Architecture	132	54,3
Length of Service	≥ 5 years	126	51,9
	< 5 years	117	48,1
Body Mass Index	< 18,5	46	18,9
	18,5 - 25,0	138	56,8
	> 25,0 - 27,0	40	16,5
	> 27,0	19	7,8

Physical Fitness	< 3x a week	209	86,0
	≥ 3x a week	34	14,0
Smoking Habit	No Smoking	67	27,6
	Smoking	176	72,4
Work Posture	Not Ergonomic	169	69,5
	Ergonomic	74	30,5
Complaints of Musculoskeletal Disorders	Severe Complaints	119	49,0
	Mild Complaints	124	51,0

Source: Primary Data 2024

Table 2. Direct Effect Analysis

	<i>Original Sample</i>	<i>Sample Mean</i>	<i>Standard Deviation</i>	<i>T Statistics</i>	<i>P Values</i>
Age→ Work Posture	0.263	0.262	0.067	3.937	0.000
Age→ Musculoskeletal Disorders	0.166	0.164	0.067	2.487	0.013
Length of Service→ Work Posture	0.179	0.179	0.070	2.568	0.011
Length of Service→ Musculoskeletal Disorders	0.145	0.142	0.068	2.144	0.032
Body Mass Index→ Work Posture	0.202	0.203	0.055	3.649	0.000
Body Mass Index→ Complaints of Musculoskeletal Disorders	0.142	0.141	0.061	2.320	0.021
Physical Fitness→ Work Posture	0.037	0.033	0.060	0.614	0.539
Physical Fitness→ Musculoskeletal Disorders	0.147	0.150	0.058	2.510	0.012
Smoking Habit→ Work Posture	-0.075	-0.075	0.062	1.208	0.228
Smoking Habit→ Complaints of Musculoskeletal Disorders	0.199	0.200	0.059	3.358	0.001
Work Posture→ Complaints of Musculoskeletal Disorders	0.126	0.128	0.062	2.013	0.045

Source: Primary Data 2024

Table 3. Indirect Effect Analysis

	Original Sample	Sample Mean	Standard Deviation	T Statistics	P Values
Age→ Work Posture→ Complaints of Musculoskeletal Disorders	0.032	0.03	0.016	2.042	0.041
Length of Service→ Work Posture→ Musculoskeletal Disorders Complaints	-0.023	-0.023	0.015	1,534	0.126
Body Mass Index→ Work Posture→ Complaints of Musculoskeletal Disorders	0.025	0.026	0.015	1.983	0.047
Physical Fitness→ Work Posture→ Musculoskeletal Disorders Complaints	0.005	0.004	0.008	0.552	0.581
Smoking Habit→ Work Posture→ Complaints of Musculoskeletal Disorders	-0.009	-0.010	0.010	0.904	0.366

Source: Primary Data 2024

1) Effect of Age on Musculoskeletal Disorders through Work Posture

The musculoskeletal system is the system that a person has to move by using the skeleton and muscles. This system plays a role in providing a form of stability, as well as motion in a person's body (Rianti et al., 2023). Posture stability can decrease with age up to 5 decades of human life and decline rapidly after the age of 70 years, depending on the conditions. (Liang et al., 2022).. The age of the worker affects how the system in the body works, because the increasing age will also have an impact on physiologis which also decreases such as the decreasing strength of the *vertebrae* muscles because they are no longer elastic like young age and continuous poor postural conditions that will cause disease disorders.

The human body consists of fat tissue, lean tissue (muscles and organs), bone and water. After the age of 30, people tend to lose lean tissue. Muscles, liver, kidneys, and other organs may lose some of their cells (Bethesda, 2020). Our bones, muscles and joints are part of the musculoskeletal system that determines posture. According to the *Medical University of South Carolina (MUSC)*, age has a great influence on these three elements as the back tends to curve forward over time, resulting in a hunched posture. Postures that are not ergonomic will increase the risk of *musculoskeletal* disorders. (Salcha et al., 2021).

This research is in line with research (Kibret et al., 2020) which states that it is known that age has a significant influence on *musculoskeletal disorder* complaints in bank employees where respondents aged between 30 and 39 years have a 5.6 times greater risk of experiencing *musculoskeletal disorder* complaints and

respondents over 40 years of age have a 5.7 times greater chance of experiencing *musculoskeletal disorder* complaints compared to those aged 20 to 29 years.

This is also reinforced by research (Lee et al., 2023) about the prevalence and factors associated with *musculoskeletal disorders* in construction workers in China which states that respondents aged more than 40 years have a 9.89 times higher chance of experiencing upper back pain when compared to respondents aged ≤ 25 years (AOR 9.89; 95% CI 1.25-78.20; $p < 0.05$). In this case, age is one of the factors that has a significant effect on *musculoskeletal disorders* because with increasing age, it affects the body's ability or the beginning of losing the balance of the body's muscles so that it is more susceptible to complaints or problems in the joints or muscles. (Fatmawati et al., 2023).

The results of observations and interviews with several respondents when filling out the questionnaire also show that respondents with an age at risk recognize the influence between age and complaints where respondents recognize the difference in working when they are young and in old age. As expressed by the following respondents:

"The aches and pains that you feel are normal because you are old and not as strong as you used to be" (AH, 47 years old).

This strengthens the results of statistical tests which state that the age variable is one of the variables that has a positive influence on complaints of *musculoskeletal disorders*. However, this study contradicts the research of (Ajhara et al., 2022) which shows no relationship between age and complaints of *musculoskeletal disorders*. This is due to the level of experience so that even though workers are used to doing their work.

Musculoskeletal disorders generally begin to be experienced at the age of more than 30 years with complaints increasing at the age of 35 years and continuing to increase at the age of 40 years and above. As we age, the risk of experiencing a decrease in bone elasticity increases. This will lead to complaints of *musculoskeletal disorders* (Indriyani et al., 2022)..

2) Effect of Working Period on Musculoskeletal Disorders through Work Posture

In general, tenure can influence performance both positively and negatively. Tenure has a positive effect if there is a good perception of carrying out tasks with full responsibility and being vigilant, especially with accidents and occupational diseases.

This research is in line with the results of research (Valipour et al., 2015) which states that there is a relationship between tenure and complaints of *musculoskeletal disorders*. According to the study, workers with a work period of less than 10 years were at risk of complaining of back pain 1.85 times greater ($P < 0.004$, $OR = 1.85$). while workers with a work period of more than 10 years were 2.33 times more likely to complain of neck disorders ($P < 0.004$, $OR = 2.33$). Too long a working period will cause boredom and repetitive heavy activities such as lifting, holding, and moving loads / goods resulting in complaints on the worker's body. (Triastuti et al., 2020)..

Symptoms of *musculoskeletal* complaints consist of three stages, namely the first stage, complaints in the form of pain or soreness and will disappear after resting, the second stage of symptoms appear right after finishing work and the third stage of symptoms or pain that is felt does not disappear even though it has rested. (Imens et al., 2023).. Complaints felt by respondents who are construction workers can result from the conditions of the workplace and supporting tools that vary such as the design of scaffolding, ladders, the burden of personal protective equipment such as *full body harness* or facilities that are inadequate and not in accordance with the body capacity of each respondent and these conditions are experienced for a long time.

This research is contradicted by research (Rahayu & Tri, 2021) which states that there is no relationship between length of service and complaints of *musculoskeletal disorders* ($p=0.729$). A high working period does not guarantee that a person is safe from disease, things like ignoring unsafe conditions and unsafe actions and prolonged exposure can be fatal to the worker himself. The length of service should no longer be a burden for workers, but make workers more skilled because they have been working for a long time and the experience gained is increasing so that they are considered to be able to minimize some of the circumstances that can make a negative impact on

their bodies (Fanjaniaina et al., 2015). (Fanjaniaina et al., 2022).

Tenure has a negative influence if the perception that arises is underestimating a task without thinking about the rules that the institution has made or even tends to do things that endanger yourself and others. (Joseph & Sumampouw, 2022).. This is one of the risk factors that greatly influences a worker to increase the risk of *musculoskeletal disorders*, especially for the type of work that uses very high work strength. (Taroreh et al., 2017).. The length of the work period will affect neck pain because the neck muscles become accumulated loading due to transport and lifting activities. The longer the working time or the longer a person is exposed to the risk of musculoskeletal complaints, the greater the risk of these complaints. (Manunel et al., 2022)..

The working period is one of the factors that can be a triggering factor for the appearance of musculoskeletal disorders caused by work. Workers with an increased work period will perform the same and repetitive movements. So that it can trigger tissue fatigue, in this case muscle tissue which can cause overuse, so that it can cause muscle spasm. The emergence of this condition is a physiological effect of the muscles to maintain or prevent further damage to a tissue. (Hidayati et al., 2023). This is supported by the following informant's statement:

"I have been working in this field for a long time, so it is natural that my body often hurts" (I, 38 years old).

According to information obtained by researchers, each type of work has its own guidelines or work methods called the *Work Methods Statement*. The document lists the correct working methods as well as the hazards and risks that can arise from the work performed. Although it is often socialized, a person with a longer working period will not only be more often exposed to the hazards of the work performed but also tends to deviate from the existing work methods, resulting in work postures that are not ergonomic and can be at risk of *musculoskeletal disorders*. In addition, information was obtained that some workers are accustomed to doing their work for a long time so that their bodies are resistant to pain or pain in some parts of the body.

3) Effect of Body Mass Index on Musculoskeletal Disorders through Work Posture

Being overweight is often highlighted as a risk factor for back pain and may play a direct influence role. A greater body mass index will reduce the speed of nerve flow to the hands, which may pose a risk of complaints (Aljonak & Tejamaya, 2022). (Aljonak & Tejamaya, 2022)..

The results of multivariate analysis using *path* analysis, it is known that body mass index has an influence on complaints of *musculoskeletal*

disorders through work posture. It can be concluded that there is an influence of body mass index on complaints of *musculoskeletal disorders* mediated by work posture with a positive influence. This means that the more the respondent's body mass index increases, the less ergonomic the work posture and the more at risk of *musculoskeletal disorders*.

This research is in line with research (Sethi et al., 2011) which states that there is a significant relationship between body mass index and the appearance of complaints of *musculoskeletal disorders* with (p value = 0.001) < 0.05. According to the study, being overweight results in decreased postural stability and has the potential to have a negative impact on movement control while working, especially when performing movements with high physical strength demands. In addition, if the body weight increases, the spine will receive an excessive load which causes mechanical stress on the body resulting in a reaction in the muscle tissue to support the weight of the load. If the position continues, it will cause pressure on the spinal nerve cushions which will cause many disorders, especially *herniated nucleus pulposus*. (Kasno, 2022). An increase in body mass index will affect the severity of musculoskeletal function and quality of life. (Afro & Paskarini, 2022)..

This is reinforced by research (Imens et al., 2023) which shows the relationship between body mass index and complaints of *musculoskeletal disorders* in *welding* operators in one of the companies in Indonesia with a p -value = 0.000 < 0.05. Individuals with a low body mass index have low bone density, making them prone to complaints. While individuals with excess body mass index will cause an increase in mechanical stress on the body structure that is responsible for supporting body mass. Tarwaka in (Wardani & Pasa, 2024) states that although it only has a relatively small influence, body weight, height, and body mass are causes of *musculoskeletal disorders* in a person.

However, the theory of some of these studies is not in line with research (I Putu et al., 2023) which states that there is no significant relationship between body mass index and *musculoskeletal disorders* because the level of musculoskeletal complaints can also be caused by the workload performed. In addition, no relationship can be caused by inappropriate work postures.

In accordance with the results of quantitative analysis, field observations show that respondents have different body sizes. This is due to differences in the lifestyle of each respondent which can affect body mass index such as eating habits and habits of doing sports / physical activity. In line with this, research (Nugroho et al., 2020) shows the results that the level of physical activity contributes to the incidence of excess body weight. In addition, a balanced nutritious diet is also needed by paying attention to the type, amount, and timing of meals

can also be a smart way to achieve and maintain a normal body mass index.

Seaman (2013) in (Patandung & Widowati, 2022) stated that an increase in body mass index is caused by an increase in body fat mass which then triggers adiposopathy. Adiposopathy is a condition where metabolism in adipose tissue develops into chronic inflammation or metabolic syndrome. A person with normal BMI has fewer macrophages in their adipose tissue and is in an inactive status. Increasing fat mass can make mast cells, lymphocytes, and macrophages actively enter adipose tissue (Harford, 2011) in (Patandung & Widowati, 2022). Macrophages that were originally inactive will turn active, resulting in metabolic syndrome. Metabolic syndrome is characterized by the appearance of at least 3 or all of the following symptoms, namely; increased fasting blood sugar, fasting triglycerides, blood pressure, and decreased HDL (*High Density Lipoprotein*) levels. Metabolic syndrome can be characterized by a wide variety of pain expressions including *musculoskeletal disorders*.

4) Effect of Physical Fitness on Musculoskeletal Disorders through Work Posture

Complaints of *musculoskeletal disorders* will increase due to lack of muscle flexibility due to increased physical activity without being followed by sufficient physical fitness. The results of multivariate analysis using *path* analysis show that the physical fitness variable has a direct effect on complaints of *musculoskeletal disorders* but there is no indirect effect through work posture so it can be concluded that the effect of physical fitness on complaints of *musculoskeletal disorders* is not mediated by work posture.

This research is supported by research (Widitia et al., 2020) which states that there is a significant relationship between physical fitness and the appearance of complaints of *musculoskeletal disorders* with a p -value = 0.041 < 0.05. This can be influenced by the level of a person's exercise habits, having time to exercise or vice versa. For workers who need a lot of energy every day and do not have enough time to rest will be at risk of experiencing muscle complaints. (Ramayanti & Koesyanto, 2021). However, this is contrary to research (Ajhara et al., 2022) which showed no relationship between physical fitness and complaints of *musculoskeletal disorders* p -value = 0.294 > 0.05. A level of body fitness accompanied by a body weight that is always maintained in a normal state will reduce the risk of developing cardiovascular and musculoskeletal diseases. (Dwiseptianto & Wahyuningsih, 2022).. Information obtained from respondents is known that:

"Muscle aches and pains often occur due to work. There is a healthy gymnastics program here on Fridays. Sometimes I feel the pain is reduced but sometimes there is still pain" (R, 22 years old).

The information obtained from respondents showed that most respondents did not have time to exercise because of the overtime system in some existing jobs so that the time after work was used to rest. In addition, respondents also feel that the work they do is also classified as a sports activity. The results of an *in-depth interview* with a key informant revealed that the company has taken steps to improve workers' physical fitness by holding a healthy exercise program that is conducted once a month. According to the researcher, the program is less effective in improving workers' physical fitness if it is only conducted once a month.

Health and Safety Executive (2004) in (Marcilin & Situngkir, 2020) states that exercise increases joint muscle flexibility which can reduce injury. Meanwhile, according to NIOSH (1997) regular exercise habits are closely related to physical fitness, if exercise is done regularly it will increase physical fitness and reduce the risk of complaints of *musculoskeletal disorders*. (Lestari & Ilmi, 2022). According to Giam (1993). Fitness status can be assessed from fitness components which are grouped into two groups, namely: 1) health-related fitness components, including: cardiopulmonary endurance, muscle strength and endurance, flexibility, body composition. 2). Skill-related fitness components, including: speed, coordination, power, and agility. (Sudiana, 2014).

The impact of low physical fitness for employees can cause fatigue which can cause decreased concentration so that it can interfere with concentration at work, decreased work efficiency and productivity, *human error* (errors in reporting tasks, increased absenteeism, and frequent late completion of tasks). (Fikar *et al.*, 2017). The decrease in physical fitness is due to the fact that when someone does work that requires exertion, they will get tired easily due to the low oxygen content in the blood which causes the burning of carbohydrates to be inhibited, resulting in a pile of lactic acid which eventually causes muscle pain (Hanif, 2020). (Hanif, 2020). Therefore, it is recommended to do exercises that increase muscle strength can improve postural stability, especially in older adults (Wang *et al.*, 2022). (Wang *et al.*, 2022).

Exercise habits that can improve physical fitness can also reduce a person's risk of experiencing *musculoskeletal disorders* and these habits that are carried out regularly can improve quality of life, prevent *osteoporosis*, and other bone diseases. (Abdillahtulkhaer *et al.*, 2022)..

5) Effect of Smoking Habit on Musculoskeletal Disorders through Work Posture

Muscle complaints are closely related to smoking habits where the longer and more often someone smokes, the complaints of *musculoskeletal disorders* will also increase. Where the risk of *musculoskeletal disorders* will increase by 20% for

every 10 cigarettes consumed per day. (Afro & Paskarini, 2022).

The results of multivariate analysis using *path* analysis show that there is an influence of smoking habits on complaints of *musculoskeletal disorders* but not through work posture. In this case it can be concluded that smoking habits on complaints of *musculoskeletal disorders* are not mediated by work posture variables. This can occur because workers who do not smoke have a great opportunity to inhale cigarette smoke called passive smoking. So that both workers who are active smokers and passive smokers can be at risk of developing musculoskeletal complaints. (Maudy *et al.*, 2021)..

This research is in line with research (Yuwantri *et al.*, 2022) about Factors Associated with Complaints of *Musculoskeletal Disorders* (MSDs) in Construction Workers of PT Housing Development at Manikin Dam with a *p-value* = 0.010 which means there is a relationship between smoking habits and complaints of *musculoskeletal disorders*. The higher a person's smoking frequency, the more complaints they feel. Cigarette smoke binds oxygen needed by muscle cells (Irhamma *et al.*, 2023).. Smoking habits can reduce lung capacity, when lung capacity decreases, the oxygen consumed is also less, so that the body's freshness will also decrease. Therefore, although the results of this study state that there is no effect of smoking habits with complaints of *musculoskeletal disorders* through work postures, smoking habits should still be avoided so as not to cause health problems, not only disorders of the *musculoskeletal* system but also other health problems that are long-term.

This is reinforced by the results of research (Rosemillen & Dwiyanti, 2023) with a *spearman rank* statistical test with a correlation coefficient of 0.028 which means that the relationship between smoking habits and complaints of *musculoskeletal disorders* is a weak relationship but has a positive correlation direction so that the higher the intensity of smoking habits, the greater the risk of *musculoskeletal disorders*. Ogawa (2006) in (Abdillahtulkhaer *et al.*, 2022) stated that smoking is an addictive habit, but can be defined as a habit of persistent tobacco use, usually more than half a pack per day, with additional distress caused by the need for tobacco repeatedly. According to (Maudy *et al.*, 2021)(Maudy *et al.*, 2021), smoking can increase muscle complaints by up to 20% for every 10 cigarettes/day.

Another risk factor that can cause *musculoskeletal* complaints is the smoking habit of workers. strenuous activities that require physical fitness and excellent health. Other studies have found a significant relationship between smoking and *musculoskeletal* pain in several parts of the body such as the back, shoulders, elbows, knees in smokers and ex-smokers. This is because the nicotine content contained in cigarettes can cause

reduced blood flow to the tissues. (Pratama, 2017). This is also supported by research Rahmawati & Dewi (2020) which states that the relationship between smoking habits and complaints of *musculoskeletal disorders* occurs because almost all workers are active smokers. The number of cigarettes consumed starts from 5 cigarettes to two packs of cigarettes in one day.

This research is not in line with research (Thamrin *et al.*, 2021) which shows a $p\text{-value} = 1,000$ where the $p\text{-value} > 0.05$, which means that there is no relationship between smoking habits and complaints of *musculoskeletal disorders*. In the study, the absence of a relationship may be due to one of the ingredients in cigarettes, namely nicotine, which is addictive and can trigger the hormone *dopamine* so that it can play a role in improving a person's mood for the better. In relation to this study, construction workers who are smokers but do not feel any complaints may be due to their good mood that makes all work easier to do. However, this can lead to other health problems that will arise in the future.

Information obtained by the researcher, the company has just issued a smoking ban policy in the project area and during working hours. This is one of the good steps to reduce workers' consumption of cigarettes, which will certainly be a danger to health. In this case, the company has taken precautions to protect workers and employees from health risks due to smoking habits, one of which is the risk of *musculoskeletal disorders*.

4. Conclusion

The conclusion of this study is that there is a direct or indirect effect of age and body mass index on complaints of *musculoskeletal disorders* in construction workers building a vertical hospital in Makassar. While tenure, physical fitness, and smoking habits only have a direct effect on complaints of *musculoskeletal disorders* without going through work posture. Therefore, workers must pay attention to the capacity of the body with the load being worked on and always follow the SOP that has been determined. In addition, workers and management together maximize fitness programs to minimize the risk of *musculoskeletal disorders*.

Reference

- Abdillahtulkhaer, M., Thamrin, Y., & Kalla, R. (2022). Analysis of Factors Associated with Musculoskeletal Disorder (MSDs) Complaints in Employees of LPG Filling Operators in Makassar City. *Journal of Muslim Community Health (JMCH)* 2022, 3(3), 144-154. <https://doi.org/10.52103/jmch.v3i3.996>JournalHomepage: <https://pasca-umi.ac.id/index.php/jmch>
- Afro, H. S., & Paskarini, I. (2022). The Relationship Between BMI and Smoking Habits with Musculoskeletal Disorders Among Rice Farmers in Doho Village, Madiun Regency, East Java. *Preventive: Journal of Public Health*, 13(1), 98-111. <https://doi.org/10.22487/preventif.v13i1.249>
- Ajhara, S., Novianus, C., & Muzakir, H. (2022). Factors Associated with Musculoskeletal Disorders (MSDs) Complaints in Sewing Section Workers at PT X in 2022. *Indonesian Journal of Physiotherapy and Health*, 2(2), 150-162.
- Aljonak, A. V., & Tejamaya, M. (2022). Influence of Individual Factors on Musculoskeletal Disorders in Office Workers Pt. X. *PREPOTIVE: Journal of Public Health*, 6(1), 812-819. <https://doi.org/10.31004/prepotif.v6i1.3296>
- Aprianto, B., Hidayatulloh, A. F., Zuchri, F. N., Seviana, I., & Amalia, R. (2021). Risk Factors Causing Musculoskeletal Disorders (MSDs) in Workers: A Systematic Review. *Tambusai Health Journal*, 2(2), 16-25. <https://doi.org/10.31004/jkt.v2i2.1767>
- Ariningsih. (2021). Occupational Diseases. *Hukermas Humas RSUP Persahabatan*. <https://rsuppersahabatan.co.id/artikel/read/penyakit-akibat-kerja->
- Bandyopadhyay, L. (2012). Musculoskeletal and Other Health Problems in Workers of Small Scale Garment Industry - An Experience from An Urban Slum, Kolkata. *IOSR Journal of Dental and Medical Sciences*, 2(6), 23-28. <https://doi.org/10.9790/0853-0262328>
- Bethesda. (2020). *Aging Changes in Body Shapes*. Medline Plus. <https://medlineplus.gov/>
- Boschman, J. S., Dresen, M. H. W. F., & Molen, H. F. V. Der. (2015). Use of Ergonomic Measures Related to Musculoskeletal Complaints among Construction Workers: A 2-year Follow-up Study. *Safety and Health at Work*, 90-96.
- Briggs, A. M., Cross, M. J., Hoy, D. G., Sánchez-Riera, L., Blyth, F. M., Woolf, A. D., & March, L. (2016). Musculoskeletal Health Conditions Represent a Global Threat to Healthy Aging: A Report for the 2015 World Health Organization World Report on Ageing and Health. *Gerontologist*, 56, S243-S255. <https://doi.org/10.1093/geront/gnw002>
- Cheisario, H. A., & Wahyuningsih, A. S. (2022). Factors Associated with the Occurrence of Musculoskeletal Disorder Complaints in Workers at PT X. *Indonesian Journal of Public Health and Nutrition*, 2(3), 329-338.
- Darvishi, E., Ghasemi, F., Sadeghi, F., Abedi, K., Rahmati, S., & Sadeghzade, G. (2022). Risk assessment of the work-related musculoskeletal disorders based on individual characteristics using path analysis models. *BMC Musculoskeletal Disorders*, 23(1), 1-12. <https://doi.org/10.1186/s12891-022-05573-6>
- Dwiseptianto, R. W., & Wahyuningsih, A. S. (2022). Musculoskeletal Complaints in Informal Sector Workers. *Indonesian Journal of Public Health and Nutrition*, 1(1), 102-111. <http://journal.unnes.ac.id/sju/index.php/IJPHN>
- Ertansyah, A. B. (2015). Analysis of Work Posture with the RULA Method for CV Workers. Cipta Usaha Mandiri. *Industrial Engineering Study Program*,

- Faculty of Engineering - Diponegoro University, 12. Fanjaniaina, S., Cahyati, W. H., & Koesyanto, H. (2022). Relationship between Age, BMI, and Working Period with Musculoskeletal Disorders (MSDs) Complaints in Sales Promotion Girl (SPG). *Jppkmi*, 3(1), 62-70. <https://journal.unnes.ac.id/sju/index.php/jppkmi>
- Fatmawati, Fariyah Muhsanah, & Rezky Aulia Yusuf. (2023). Factors Associated with Complaints of Musculoskeletal Disorders of Farmers in Tallulolo Village, Kesu District, North Toraja Regency. *Window of Public Health Journal*, 4(4), 559-566. <https://doi.org/10.33096/woph.v4i4.1117>
- Fauziah, N., Karim, D., & Utami, S. (2018). The Relationship Between Body Position and Musculoskeletal Complaints in Rice Farmers in Silongo Village, Lubuk Tarok District, Sijunjung Regency. *JOM FKp*, 5(2), 244-250.
- Fikar, F. N., Suroto, S., & Widjasena, B. (2017). The Relationship of Body Mass Index, Work Duration, and Physical Workload to Physical Fitness of Construction Employees at Pt. X. *Journal of Public Health (Undip)*, 5(1), 358-368. <https://ejournal3.undip.ac.id/index.php/jkm/article/view/15588>
- Gandolfi, M. G., Zamparini, F., Spinelli, A., Risi, A., & Prati, C. (2021). Musculoskeletal disorders among Italian dentists and dental hygienists. *International Journal of Environmental Research and Public Health*, 18(5), 1-20. <https://doi.org/10.3390/ijerph18052705>
- Hanif, A. (2020). Relationship between Age and Smoking Habits with Musculoskeletal Disorders (MSDs) Complaints in Lift Workers of UD Maju Makmur Surabaya City. *Medical Technology and Public Health Journal*, 4(1), 7-15. <https://doi.org/10.33086/mtphj.v4i1.715>
- Hidayati, F., Aswin, B., & Rahmat, A. A. (2023). The Relationship of Work Posture and Individual Factors with Low Back Pain Complaints. *Journal of Industrial Hygiene and Occupational Health*, 7(2), 138-150.
- Hossain, M. D., Aftab, A., Al Imam, M. H., Mahmud, I., Chowdhury, I. A., Kabir, R. I., & Sarker, M. (2018). Prevalence of work related musculoskeletal disorders (WMSDs) and ergonomic risk assessment among readymade garment workers of Bangladesh: A cross sectional study. *PLoS ONE*, 13(7), 1-18. <https://doi.org/10.1371/journal.pone.0200122>
- I Putu, N. A. D., Wayan Rusni, N., & Made Hegard Sukmawati, N. (2023). Factors Associated with Musculoskeletal Disorders in Fish Lifting Workers at Mina Karya Trade Business Karangasem. *Aesculapius Medical Journal*, 3(1), 93-100.
- Imens, A., Rinawati, S., & Hastuti, H. (2023). Relationship between Work Posture and Individual Characteristics with Musculoskeletal Complaints in Welding Operators of PT Barata Indonesia Cilegon. *Proceedings Series on Health & Medical Sciences*, 4, 41-47. <https://doi.org/10.30595/pshms.v4i.552>
- Indriyani, I., Badri, P. R. A., Oktariza, R. T., & Ramadhani, R. S. (2022). Analysis of the Relationship between Age, Tenure and Knowledge to Musculoskeletal Disorders (MSDs). *Journal of Health*, 13(1), 186. <https://doi.org/10.26630/jk.v13i1.2821>
- Irhama, N. A., Arbitera, C., Utari, D., & Maharani, F. T. (2023). Work Posture and Musculoskeletal Disorders in Finishing Workers. *Journal of Health Research Suara Forikes*, 14(2), 321-325.
- Jatmika, L., Fachrin, S. A., & Sididi, M. (2022). Factors Associated with MSDS Complaints in Labor Workers at Yos Sudarso Port Tual. *Window of Public Health Journal*, 3(3), 563-574. <https://doi.org/10.33096/woph.v3i3.622>
- Joseph, G., & Sumampouw, O. J. (2022). Relationship between work position and age with musculoskeletal complaints in fishermen. *Journal of Health*, 11(1), 34-42.
- Kasno. (2022). The Effect of Exercise Habits, Body Mass Index (BMI) and Work Posture on Musculoskeletal Disorders (MSDs) Complaints for Operational Officers of the Central Jakarta Fire and Rescue Sub-Department in 2021. *Dohara Publisher Open Access Journal*, 02(01), 498-508.
- Kaur, H., Wurzelbacher, S. J., Bushnell, P. T., Grosch, J. W., Tseng, C.-Y., Scholl, J. C., Meyers, A. R., & Lampl, M. (2021). Workers' Compensation Claim Rates and Costs for Musculoskeletal Disorders Related to Overexertion Among Construction Workers - Ohio, 2007-2017. *MMWR. Morbidity and Mortality Weekly Report*, 70(16), 577-582. <https://doi.org/10.15585/mmwr.mm7016a1>
- Indonesian Ministry of Health. (2018). Basic Health Research Results 2018. *Ministry of Health*, 53(9), 1689-1699.
- Ministry of Labor. (2022). *Indonesia National Occupational Safety and Health Profile 2022*.
- Kibret, A., Fisseha Gebremeskel, B., Embaye Gezae, K., & Solomon Tsegay, G. (2020). Work-Related Musculoskeletal Disorders and Associated Factors Among Bankers in Ethiopia, 2018. *Pain Research & Management*, 2020, 8735169. <https://doi.org/10.1155/2020/8735169>
- Krishnan, K. S., Raju, G., & Shawkataly, O. (2021). Prevalence of work-related musculoskeletal disorders: Psychological and physical risk factors. *International Journal of Environmental Research and Public Health*, 18(17). <https://doi.org/10.3390/ijerph18179361>
- Lee, S., Kim, Y. J., Kim, Y., Kang, D., Kim, S. C., & Kim, S. Y. (2023). Incidence Rates of Injuries, Musculoskeletal, Skin, Pulmonary and Chronic Diseases among Construction Workers by Classification of Occupations in South Korea: A 1,027 Subject-Based Cohort of The Korean Construction Workers Cohort (KCWC). *Annals of Occupational and Environmental Medicine*, 35(1). <https://doi.org/10.35371/aoem.2023.35.e26>
- Lee, Y. C., Hong, X., & Man, S. S. (2023). Prevalence and Associated Factors of Work-Related Musculoskeletal Disorders Symptoms among

- Construction Workers: A Cross-Sectional Study in South China. *International Journal of Environmental Research and Public Health*, 20(5). <https://doi.org/10.3390/ijerph20054653>
- Lestari, P., & Fil Ilimi, A. (2022). The Relationship of Work Posture and Individual Factors with Msds Complaints in Convection Workers in Telaga Village, Cikupa Tangerang District Banten. *PREPOTIVE: Journal of Public Health*, 6(2), 1436-1440. <https://doi.org/10.31004/prepotif.v6i2.4399>
- Li, X., Yang, X., Sun, X., Xue, Q., Ma, X., & Liu, J. (2021). Associations of Musculoskeletal Disorders with Occupational Stress and Mental Health among Coal Miners in Xinjiang, China: a Cross-Sectional Study. *BMC Public Health*, 21(1), 1-10. <https://doi.org/10.1186/s12889-021-11379-3>
- Liang, H. W., Chi, S. Y., Tai, T. L., Li, Y. H., & Hwang, Y. H. (2022). Impact of age on the postural stability measured by a virtual reality tracker-based posturography and a pressure platform system. *BMC Geriatrics*, 22(1), 1-10. <https://doi.org/10.1186/s12877-022-03195-0>
- Manunel, E. S., Azizah, R., Mukono, H. J., Ruliati, L. P., & Landi, S. (2022). Ergonomic Risk Analysis with Complaints of Musculoskeletal Disorders in Red Brick Workers. *Scientific Journal of Health (JIKA)*, 4(2), 296-308. <https://doi.org/10.36590/jika.v4i2.382>
- Marcilin, M., & Situngkir, D. (2020). Factors associated with complaints of musculoskeletal disorders in the sorting unit at Pt. Indah Kiat Pulp and Paper Tangerang. Tbk in 2018. *Journal of Industrial Hygiene and Occupational Health*, 4(2). <https://doi.org/10.21111/jihoh.v4i2.3482>
- Maudy, C. K., Ruliati, L. P., & Doke, S. (2021). Musculoskeletal Disorders and Occupational Fatigue in Loading and Unloading Workers at Tenau Port. *Public Health Media*, 3(3), 312-321. <https://doi.org/10.35508/mkm.v4i3.3392>
- Mayasari, D., & Saftarina, F. (2016). Ergonomics as an Effort to Prevent Musculoskeletal Disorders in Workers. *Journal of Medicine, University of Lampung*, 1(2), 369-379. <https://juke.kedokteran.unila.ac.id/index.php/JK/article/download/1643/1601>
- Mohammadipour, F., Pourranjbar, M., Naderi, S., & Rafie, F. (2018). Work-related Musculoskeletal Disorders in Iranian Office Workers: Prevalence and Risk Factors. *Journal of Medicine and Life*, 11(4), 328-333. <https://doi.org/10.25122/jml-2018-0054>
- Nugroho, K., Natalia, G., & Masi, M. (2020). Changes in Body Mass Index in 2nd Semester Students of Nursing Science Study Program, Faculty of Medicine. *E-Journal of Nursing (e-Kp) July 2016*, 4(2), 1-5.
- Patandung, L. N., & Widowati, E. (2022). Body Mass Index, Occupational Fatigue, Physical Workload with Complaints of Musculoskeletal Disorders. *Higeia Journal of Public Health Research and Development*, 6(1), 126-135. <https://journal.unnes.ac.id/sju/higeia/article/view/51839>
- PP-ADHI KSO. (2023). *Weekly Health Overview*.
- Pratama, D. N. (2017). Risk Identification of Musculoskeletal Disorders (Msds) in Blacksmith Workers. *The Indonesian Journal of Occupational Safety and Health*, 6(1), 78. <https://doi.org/10.20473/ijosh.v6i1.2017.78-87>
- Putra, A. D., Syamsuir, E., & Wahyuni, F. I. (2021). Analysis of the Application of Occupational Health and Safety (K3) in Construction Services Companies in Payakumbuh City. *Rang Teknik Journal*, 4(1), 76-82. <https://doi.org/10.31869/rtj.v4i1.2034>
- Rahayu, & Tri. (2021). Analysis of Factors Associated with Occupational Diseases in Employees of Smelter 'X' Industry in 2020. *Journal of Baja Health Science*, 1(02), 156-167. <https://doi.org/10.47080/joubahs.v1i02.1488>
- Rahmawati, A. S., & Dewi, R. P. (2020). The Relationship Between Work Posture, Work Period and Smoking Habits with Musculoskeletal Disorders (MSDs) Complaints in Lurik Weaving Workers "KURNIA" Kraoyak Wetan, Sewon, Bantul. *UAD Repository*, 274-282.
- Ramayanti, A., & Koesyanto, H. (2021). Factors Associated with Complaints of Musculoskeletal Disorders in Convection Workers. *Indonesian Journal of Public Health and Nutrition*, 1(1), 472-478. <http://journal.unnes.ac.id/sju/index.php/IJPHN>
- Rianti, E. D. D., Soekanto, A., & Lystyawati, F. (2023). Analysis of the Incidence of Musculoskeletal Complaints with Age in the Work Area of Puskesmas Dukuh Kupang RW V Surabaya. *BIOSAPPHIRE: Journal of Biology and Diversity*, 2(1), 36-43. <https://doi.org/10.31537/biosapphire.v2i1.1014>
- Rosemillen, W., & Dwiyantri, E. (2023). Relationship between Age and Smoking Habit with Musculoskeletal Disorders in Gantry Luffing Crane Operators. *Public Health Nutrition Media*, 12(1), 160-164. <https://doi.org/10.20473/mgk.v12i1.2023.160-164>
- Salcha, M. A., Juliani, A., & Borotod. (2021). Relationship between Work Posture and Symptoms of Musculoskeletal Disorders in Rice Farmers. *MIRACLE Journal Of Public Health*, 4(2), 195-201. <https://doi.org/10.36566/mjph/vol4.iss2/260>
- Sari, R. O., & Rifai, M. (2019). Relationship between Work Posture and Working Period with Musculoskeletal Disorders (MSDs) Complaints in Giriloyo Batik Workers. *Journal of Chemical Information and Modeling*, 53(9), 1689-1699.
- Sethi, J., Sandhu, J. S., & Imbanathan, V. (2011). Effect of Body Mass Index on Work Related Musculoskeletal Discomfort and Occupational Stress of Computer workers in a Developed Ergonomic Setup. *Sports Medicine, Arthroscopy, Rehabilitation, Therapy & Technology*, 3(1), 1-7. <https://doi.org/10.1186/1758-2555-3-22>
- Sudiana, I. K. (2014). The Role of Physical Fitness for the Body. *National Seminar FMIPA UNDIKSHA IV*,

- 389-398.
<https://ejournal.undiksha.ac.id/index.php/semnasmi/pa/article/download/10507/6718>
- Susanto, N., Lumbantobing, S. G., & Prastawa, H. (2023). Assessment of Occupational Safety Risk Perception on Construction Projects using the Rotterdam-Rijnmond Municipal Public Health Questionnaire Adaptation. *Engineering*, 44(1), 46-56.
<https://doi.org/10.14710/teknik.v44i1.50304>
- Syaputri, W. E. (2019). Proposed Work Posture Improvements for X Housing Building Construction Workers Using the Owas (Ovako Working Analysis System) Method. *Tanjungpura University TIN Journal*, 3(2), 89-92.
<https://jurnal.untan.ac.id/index.php/jtinUNTAN/article/view/36715>
- Taroreh, F. F., Joseph, W. B. S., & Kawatu, P. A. T. (2017). Relationship between Age and Working Period with Musculoskeletal Complaints in Bendi Drivers in Tomohon City. *Journal of Public Health, Sam Ratulangi University*, 6(3), 1-10.
- Tarwaka, Bakri, & Solichul. (2004). *Ergonomics for Safety, Health and Productivity*.
<http://shadibakri.uniba.ac.id/wp-content/uploads/2016/03/Buku-Ergonomi.pdf>
- Thamrin, Y., Pasinringi, S., Darwis, A. M., & Putra, I. S. (2021). Musculoskeletal Disorders Problems and Its Relation to Age, Working periods, and Smoking Habit among Fishermen. *Gaceta Sanitaria*, 35, S417-S420.
<https://doi.org/10.1016/j.gaceta.2021.10.065>
- Thamrin, Y., Wahyu, A., Russeng, S. S., Wahyuni, A., & Hardianti, A. (2020). Ergonomics and Musculoskeletal Disorders among Seaweed Workers in Takalar Regency: A Mixed Method Approach. *Medicina Clinica Practica*, 3, 100110.
<https://doi.org/10.1016/j.mcpsp.2020.100110>
- Triastuti, D., Afni, N., & Nur, A. R. A. C. (2020). Factors Associated with Musculoskeletal Disorders in Loading and Unloading Workers at Pantoloan Port, Palu. *Collaborative Journal of Science*, 3(3), 98-106.
<https://doi.org/10.56338/jks.v3i3.1699>
- Utama, B. A., & Widanarko, B. (2022). The Relationship between Safety Climate and Safety Behavior in Construction: A Literature Review. *PREPOTIVE: Journal of Public Health*, 6(2), 1233-1239.
<https://doi.org/10.31004/prepotif.v6i2.4462>
- Valipour, M., Hajibabaei, M., Saki, A., & Memari, Z. (2015). Prevalence of Musculoskeletal Disorders Among Office Workers. *Jundishapur Journal of Health Sciences*, 7(1), 1-5.
<https://doi.org/10.5812/jjhs.27157>
- Vanissa, A., Wahyudiono, Y. D. A., Yuliadarwati, N. M., Martiana, T., & Hartoyo, G. (2022). The Correlation of Working Posture toward Complaints of Musculoskeletal Disorders on Pipeline Installation Workers. *Indonesian Journal of Occupational Safety and Health*, 11(1), 115-123.
<https://doi.org/10.20473/ijosh.v11i1.2022.115-123>
- Wang, Q., Li, L., Mao, M., Sun, W., Zhang, C., Mao, D., & Song, Q. (2022). The relationships of postural stability with muscle strength and proprioception are different among older adults over and under 75 years of age. *Journal of Exercise Science and Fitness*, 20(4), 328-334.
<https://doi.org/10.1016/j.jesf.2022.07.004>
- Wardani, I., & Pasa, I. T. (2024). Correlation of Body Mass Index and Workload to Musculoskeletal Disorders in Ground Handling Operators. *Warta Ardhia*, 49(2), 69.
<https://doi.org/10.25104/wa.v49i2.518.69-76>
- Watiningsih, S., Triyanta, & Ani, N. (2020). The Relationship between Lighting and Work Posture and Work Climate with Musculoskeletal Disorders in Helper Workers at PT Semarang. *Journal of Periodic Public Health Sciences*, 4(1), 38-57.
- WHO. (2022). *Musculoskeletal Health*.
<https://www.who.int/news-room/fact-sheets/detail/musculoskeletal-conditions>
- Widitia, R., Entianopa, E., & Hapis, A. A. (2020). Factors associated with musculoskeletal complaints in workers at PT X in 2019. *Contagion: Scientific Periodical Journal of Public Health and Coastal Health*, 2(2), 76.
<https://doi.org/10.30829/contagion.v2i2.7241>
- Yuwantri, T., Ruliati, L. P., & Sahdan, M. (2022). Factors Associated with Complaints of Musculoskeletal Disorders (MSDs) in Construction Workers of PT Housing Development at Manikin Dam. *SEHATMAS: Scientific Journal of Public Health*, 1(4), 666-678.
<https://doi.org/10.55123/sehatmas.v1i4.970>