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Work Fatigue and Musculoskeletal Disorders in Gas Station Operators at Pontianak City, Indonesia

Abstract

Gas station operators are prone to work fatigue and musculoskeletal disorders due to their repetitive activities. This study aims to analyze the relationship between work fatigue and musculoskeletal disorders in gas station operators in Pontianak City. This study used an observational method with a cross-sectional approach. The sample consists of 150 gas station workers. Data collection was carried out by observing and interviewing research respondents. They collected data on the characteristics of respondents using interviews using a questionnaire. Data on work fatigue were obtained by interviews using the International Fatigue Research Committee of the Japanese Association of Industrial Health (IFRC) questionnaire and musculoskeletal data using the Nordic Body Map questionnaire. The study results were that 50% of research respondents of gas station operators experienced high work fatigue, and 26% of gas station operators experienced high musculoskeletal disorders. And there is a significant relationship between work fatigue and musculoskeletal diseases (p-value = 0.000). Interventions need to be carried out as a preventive measures using adequate rest periods, work shift arrangements, environmental monitoring, use of PPE, stretching, and improving ergonomic work positions for gas station operators.

Keywords: Gas station workers, musculoskeletal disorders, work fatigue.

1. Introduction

Musculoskeletal disorders are occupational diseases. Risk factors for musculoskeletal disorders are excessive fatigue, awkward postures, and repetitive movements [1]. Musculoskeletal disorders are an essential part that must be considered because they can affect health problems in workers and affect the quality of life and work efficiency among individual workers [2]. Musculoskeletal disorders are complaints on the part of the skeletal muscles (skeletal) that someone with mild complaints of pain feels. If the forces do repetitive work for a long time, it can cause complaints in the form of damage to the

ligaments, tendons, and joints [3].

Fuel Filling Stations for the Public, commonly known as gas stations, are public infrastructure provided by PT. Pertamina (Persero) for the broader community throughout Indonesia to meet vehicle fuel needs. Gas stations are one of the business activities that operate and carry out service processes 24 hours a day. Based on observations, operator workers at gas stations work by standing continuously and making repetitive movements to refuel consumer vehicles, thus allowing work fatigue and musculoskeletal disorders to occur.

Musculoskeletal disorders and work fatigue are common problems experienced by gas station operators, which can reduce their productivity of gas station operators [4]. Gas station operators standing for long periods continuously when refueling can cause work fatigue which results in impaired concentration and reduced productivity at work [5]. In addition to fatigue, the problems that often occur in gas station operators are musculoskeletal because they have to repeatedly open and close the vehicle's fuel tank, lift and insert the fuel nozzle into the vehicle's fuel tank, regulate fuel flow through the nozzle, replace the fuel nozzle and lock and compact vehicle fuel tank after filling. In addition to gas station operators having to stand for hours, their working positions include bending, twisting, and repeatedly standing in awkward situations. This activity is carried out to serve several vehicles to be refueled during working hours. This repetitive activity increases work on the musculoskeletal system's ligaments, muscles, and soft tissues. [6]

2. Methods

2.1 Participants

This type of research is an analytic observational study with a cross-sectional approach

conducted to analyze the relationship between fatigue and musculoskeletal disorders in gas station workers in Pontianak City, Indonesia. The study involved 150 gas station workers in Pontianak City, Indonesia as respondents who met the inclusion criteria as research respondents. The inclusion criteria for respondents in this study were gas station workers in Pontianak City who were willing to be respondents during the research and were aged <55 years. Respondents were selected through the Simple Random Sampling technique. Research ethics approval was obtained from the Health Research Ethics Committee of the Poltekkes Kemenkes Pontianak No 224/KEPK-PK.PKP/VIII/2022 and written consent (Informed Consent) was obtained from all gas station workers who were research respondents. Research activities will be carried out from March to July 2022.

2.2 Research Instruments

The types of data in this study are primary and secondary data obtained from interviews using a questionnaire and observation using a checklist. Data on work fatigue were obtained from interviews with respondents using the International Fatigue Research Committee of the Japanese Association of Industrial Health (IFRC) questionnaire. IFRC is a questionnaire that can measure subjective fatigue level, containing 30 questions about general fatigue symptoms. The first ten questions indicate a weakening of activity, the second ten questions a weakening of work motivation, and the third or last ten questions indicate physical fatigue or fatigue in several parts of the body. The higher the frequency of signs of fatigue occurring, the greater the level of fatigue. After conducting interviews and filling out the questionnaire, the next step is to calculate the score of the 30 questions asked, and the total becomes the individual's total score. Based on the subjective fatigue assessment design with 30 questions, the highest individual score was 120. Questionnaire answers were scored according to four Likert scales, divided into four categories, namely Very Often with a value of 4, Often with a value of 3, Sometimes with a value of 2 and

Never with a value of 1. The answers to each question are summed and adjusted for a particular classification in determining the classification of fatigue groups. The classifications given include: Score >55 = High Fatigue and Score ≤55 = Low Fatigue [7]. The Nordic Body Map research instrument for collecting data on musculoskeletal disorders in gas station workers. The Nordic Body Map Musculoskeletal Questionnaire contains a body map that shows the parts of the body that have complaints of pain. These body parts include the neck, shoulders, arms, back, waist, buttocks, elbows, wrists, hands, thighs, knees, calves, ankles, and soles of the feet [8]. Assessment using the Nordic Body Map questionnaire uses 4 Likert scales consisting of 1: not sick, 2: slightly ill, 3: ill, and 4: very ill. Workers who were research respondents were asked to provide an assessment of the parts of their body that they felt sick during work activities according to a predetermined likert scale [9].

2.3 Procedure

The Preparatory Stage starts with the management of health research ethics, secondary data collection, surveys, and field observations to identify problems and explore cooperation, arrange research permits, meetings of the research team and field officers for division of tasks, and common perceptions of research. The implementation stage of the study is the survey, observation, and inventory of gas station operator worker activities. Meetings with the company to explain the aims and objectives of the research as well as procedures for research activities, determining subjects for research respondents, and explaining the mechanism of research activities to respondents. Following the fatigue data collection guided by the data collector, research respondents were asked to complete the questionnaire. Data collection for the measurement of musculoskeletal disorders uses a questionnaire that presents a picture of the human body with nine anatomical body regions. Data collectors guided respondents to fill out the

questionnaire where the respondent's body had musculoskeletal symptoms such as pain or discomfort during the study.

2.4 Data analysis

Descriptive analysis to see the distribution characteristics of each dependent variable and independent variable. And the presentation of data in the form of tables and graphs with simple statistical calculations such as averages, ratios, and percentages. Furthermore, testing the research hypothesis uses the chi-square statistical test at the 95% confidence level to determine the relationship between research variables. The test was carried out at the significance level $\alpha = 0.05$; if $p < 0.05$, the test results are significant.

3. Results

Fuel Filling Stations for the Public (SPBU) are public infrastructure provided for the people of Indonesia to meet their fuel needs. This research was conducted at 11 gas stations in Pontianak City; in each sub-district, 50% were taken, including two gas stations in North Pontianak District, one gas station in East Pontianak District, two gas stations in Southeast District, one gas station in South Pontianak District, 2 West Pontianak District. SPBU, and Pontianak Kota District with three gas stations. The operating hours of gas stations in Pontianak City are divided into 2, namely 16 hours with two work shifts and 24 hours with three work shifts. Table 1 shows the demographic distribution of gas station operator workers. The demographic distribution of gas station operator workers consists of 6 variables divided into several categories, as shown in Table 1. 120 (80%) gas station operator workers are <40 years old. A total of 144 (96%) gas station operator workers have a high school educational background. 92 (61.3%) gas station operators have worked for 1-5 years. Most workers, namely 78 (52%), have single status. In addition, as many as 75 (50%) gas station operators experienced high work

fatigue. And as many as 111 (74%) workers have low-grade musculoskeletal disorders (Table 1).

The results of the hypothesis test between musculoskeletal events and worker fatigue obtained an r count value of 0.577 more than the r table with df = n-2=150-2=148 received r table 0.160 so that the value of r count (0.577) > r table (0.160) and p-value 0.000 <0.05 so that the hypothesis in the study was accepted, namely that there was a relationship between musculoskeletal events and fatigue in gas station workers (Table 2).

The relationship between work fatigue and musculoskeletal events at gas stations workers showed that high fatigue with high musculoskeletal disorders totaled 33 respondents (22%), low fatigue events with low musculoskeletal numbers 69 respondents (46%), high musculoskeletal events with low fatigue number of 39 respondents (26%) and extreme musculoskeletal events with high work fatigue amounted to 42 respondents (28%). The analysis results of the incidence of work fatigue and workers' musculoskeletal disorders obtained a p-value of 0.000 <0.05, meaning that there is a relationship between the incidence of fatigue and musculoskeletal disorders in gas station workers. The odds ratio (OR) is 9.036, which means that fatigue can trigger musculoskeletal disorders 9.036 times (Table 3).

4. Discussion

Based on the results of the study, gas station labor operators in Pontianak City experienced high work fatigue, as much as 50%. Work fatigue felt by gas station operators is partly due to long working hours, an uncomfortable work environment, and a long-standing working position while working. Triggers fatigue for gas station operators, namely activities in providing services starting from greeting, asking questions and serving consumers, pressing the automatic Factor pump, and giving change which is

usually done by one worker and done in a standing position [10]. Gas station operators work using a shift system, in 1 shift working 8 hours a day. This is done by standing to serve consumers when refueling. The gas station operator said many consumers came to fill up their fuel, and the officers had little time to sit and rest. Workers only rest when going to drink and lunch. Every worker should have the right to rest for at least 30 minutes after working for 4 hours continuously, and this break does not include working hours [11]. Good rest can contract the thigh and calf muscles to hold the body in an upright position during long-standing can be rested. Good rest can reduce muscle fatigue after long-standing activities [12]. An uncomfortable work environment is also a cause of fatigue felt by gas station operators, such as the temperature in the work environment. During the study, the temperature in the gas station work environment in Pontianak City was, on average, above the Threshold Limit, namely in the range of 30.1°C to 34.3°C. The threshold value for the temperature in the work environment that is allowed is 18-30°C [13]. The physical work environment can affect workers' health, especially the physical work climate. A physical work climate that exceeds the threshold value can cause functional changes in the body's organs. Hot working climate conditions can cause drowsiness and fatigue and increase the number of work errors [14]. Exposure to heat for hours can affect the body's balance and the body sweats. The body's heat center originates in the brain, which regulates blood flow through the vessels in the skin. And this heat source regulates the heat balance in the human body. At a temperature of 25°C, human skin can sweat. And the loss of fluids caused by sweating causes fatigue [15], [16]. Exposure to gasoline caused by benzene concentrations can also cause fatigue, headaches, coughing, and nausea due to prolonged exposure to benzene, which is inhaled and causes chronic effects [17]. The maximum exposure limit for benzene is 8 hours a day or 40 hours a week [18]. So it is expected that workers can wear masks. The function of masks

for gas station operators is to protect against exposure to chemicals produced by gasoline components at gas stations [19]. Based on the above, it is necessary to monitor the work environment of gas station workers to create a comfortable work environment.

Standing in a work position during working hours is one of the triggering factors for work fatigue at gas station operators [20]. Standing for a long time can cause changes in the body's work system. Veins have difficulty flowing blood from the legs to the heart, pressure on the joints, and muscle fatigue. When standing for a long time causes blood flow to the heart to be affected, resulting in muscle contractions and fatigue. Work fatigue is caused by prolonged standing because the thigh and calf muscles contract to hold the body in an upright position [21]. Based on the results of statistical tests, there is a relationship between work fatigue among gas station workers and musculoskeletal disorders p value 0.000 <0.05. Many factors influence the prevalence of musculoskeletal disorders among work fatigue [22]. The study's results that there is a relationship between work fatigue and musculoskeletal disorders are also in line with the research of Chavalitasukalchai and Shahnavaz. Fatigue is a decreased body endurance and work capacity that can reduce morale and the risk of work accidents. At the same time, musculoskeletal disorders can occur due to work fatigue that workers feel continuous [23]. The results of the study showed that the OR value was 9.036. That is, every increase in the incidence of fatigue by 1 point would increase the musculoskeletal point 9.036 times. So this must receive attention through various efforts, pay attention to the age of workers, and not choose old workers. In general, skeletal muscle complaints begin to be felt at working age 25-65 years. The first complaint is usually handled at the age of 35, and the level of complaints will continue to increase with age because, in middle age, muscle strength and endurance begin to decrease, so the risk of muscle complaints begins to grow [24]. Increasing age, followed by a decrease in VO2 max intake, will reduce work

capacity. Decreased work capacity will be marked by physical fatigue caused by muscle weakness.

Muscles need oxygen and adequate blood supply to carry out metabolic processes and regulate muscle contractions to keep them going [25]. At 30, there is degeneration in the form of tissue damage and fluid reduction. This causes the stability of the bones and muscles to be reduced. In other words, the older a person is, the higher the risk of that person experiencing a decrease in bone elasticity which triggers musculoskeletal disorders [26]. Gender is closely related to musculoskeletal complaints. Physiologically the ability of male muscles is more vital than that of female forces. Different hormonal influences between men and women cause this. Female hormones make women physically more vulnerable [27]. Gender shows a significant effect on the risk of muscle complaints. Female muscles are smaller in size and only two-thirds (60%) more potent than male muscles, especially the arms, back, and legs [28]. Musculoskeletal is a chronic disease that takes a long time to develop and manifest [29]. The working period must also be considered because it is a musculoskeletal risk factor. The longer a person is exposed to risk factors, the greater a person feels physical complaints due to his work [30].

Musculoskeletal disorders do not appear spontaneously but gradually until the human body begins to respond to pain [25]. Gas station workers do repetitive work every day. If these activities take place continuously, there will be a risk of complaints of musculoskeletal disorders [31]. Musculoskeletal disorders can increase if the individual's working period increases, and they will experience physical and psychological boredom. The working period represents a risk factor that affects individuals at work, which can increase the risk of developing musculoskeletal disorders, especially in types of activities that utilize large amounts of work energy [27]. Interventions with shift changes (active

rest) and position changes shorten recovery time and reduce neck and low back pain recurrence among high-risk workers [32]. Various risks to workers' health and risk management practices of Occupational Health and Safety in the workplace still need to be addressed. So it is necessary to take concrete steps to maintain the occupational health of gas station workers, which can only be achieved through appropriate interventions based on existing conditions [33].

Many factors influence the prevalence of musculoskeletal disorders in workers, namely the shift system, abnormal working positions, forward tilt of the neck, maximum strength operations in a short time, repetitive movements of the upper arms or fingers, work under varying conditions of temperature, and work fatigue [22]. The work demands of gas station operators require gas station operators to stand static while pressing a button on the computer display to calculate the fuel flow to enter customer fuel order data, put the nozzle into the consumer's gas tank, close the car's tank, and receive and return payments. In addition, the condition will be exacerbated when long queues occur during peak hours, resulting in musculoskeletal complaints felt by gas station operators getting worse because the more extended gas station operators stand static or awkward, the longer the muscles contract and the longer the pressure will be received by muscles [34]. So it is necessary to apply for work positions unrelated to work shifts and stretch regularly. Changing work positions will make the body more flexible, dividing the workload evenly on some parts of the body to reduce pressure on joints and muscles. Besides, workers who stretch their necks, shoulders, and hands minimize complaints. [35], [36]. Working more than 8 hours can increase musculoskeletal disorders in the lower back and shoulders. Therefore, working arrangements with sufficient daily duration are necessary to minimize the impact of poor occupational health on workers [37]. Improvement of the work environment needs to be done to minimize musculoskeletal

disorders and fatigue to increase productivity [38]. According to Nneka, gas station operators have a lot of risk of experiencing fatigue, so the company's role is to identify workplace hazards, provide regular training for workers regarding workplace safety, and provide PPE [39]. Apart from that, by introducing a mechanism for occupational safety and health rules, setting standards, and limiting exposure to environmental factors for workers [40].

5. Conclusion

There is a relationship between work fatigue and musculoskeletal disorders in gas station operators (p-value = 0.000). Based on the results of this study, the authors suggest the need for sufficient rest time, work shift arrangements, environmental monitoring, use of PPE, stretching, and improving ergonomic work positions for gas station operators.

Competing Interest

there were no conflicts of interest.

Availability of Data and Materials

Data supporting the findings on this study on request due to privacy/ethical restrictions.

Authors Contribution

Conceptualization : S ; Data Collection and analysis : ZA, SH ; Methodology : S, ZA, SH ; Draft : S ; Review : S ; Manuscript Preparation : S.

Disclosure

Approval of the research protokol : The study was approved by the Poltekkes Kemenkes Pontianak Ethics Committee No 224/KEPK-PK.PKP/VIII/2022 ; Informed Consent : All

respondents signed an informed consent form; Registry and the registration No of the study/trial : N/A ; Animal Studies : N/A ; Conflict Interest : N/A.

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Work Fatigue and Musculoskeletal Disorders in Gas Station Operators at Pontianak City, Indonesia

Abstract

Gas station operators are prone to work fatigue and musculoskeletal disorders due to their repetitive activities. This study aims to analyze the relationship between work fatigue and musculoskeletal disorders in gas station operators in Pontianak City. This study used an observational method with a cross-sectional approach. The sample consists of 150 gas station workers. Data collection was carried out by observing and interviewing research respondents. They collected data on the characteristics of respondents using interviews using a questionnaire. Data on work fatigue were obtained by interviews using the International Fatigue Research Committee of the Japanese Association of Industrial Health (IFRC) questionnaire and musculoskeletal data using the Nordic Body Map questionnaire. The study results were that 50% of research respondents of gas station operators experienced high work fatigue, and 26% of gas station operators experienced high musculoskeletal disorders. And there is a significant relationship between work fatigue and musculoskeletal diseases (p-value = 0.000). Interventions need to be carried out as a preventive measures using adequate rest periods, work shift arrangements, environmental monitoring, use of PPE, stretching, and improving ergonomic work positions for gas station operators.

Keywords: Gas station workers, musculoskeletal disorders, work fatigue.

1. Introduction

Musculoskeletal disorders are occupational diseases. Risk factors for musculoskeletal disorders are excessive fatigue, awkward postures, and repetitive movements [1].

Musculoskeletal disorders are an essential part that must be considered because they can affect health problems in workers and affect the quality of life and work efficiency among individual workers [2]. Musculoskeletal disorders are complaints on the part of the skeletal muscles (skeletal) that someone with mild complaints of pain feels. If the forces do repetitive work for a long time, it can cause complaints in the form of damage to the ligaments, tendons, and joints [3].

Fuel Filling Stations for the Public, commonly known as gas stations, are public infrastructure provided by PT. Pertamina (Persero) for the broader community throughout Indonesia to meet vehicle fuel needs. Gas stations are one of the business activities that operate and carry out service processes 24 hours a day. Based on observations, operator workers at gas stations work by standing continuously and making repetitive movements to refuel consumer vehicles, thus allowing work fatigue and musculoskeletal disorders to occur.

Musculoskeletal disorders and work fatigue are common problems experienced by gas station operators, which can reduce their productivity of gas station operators [4]. Gas station operators standing for long periods continuously when refueling can cause work fatigue which results in impaired concentration and reduced productivity at work [5]. In addition to fatigue, the problems that often occur in gas station operators are musculoskeletal because they have to repeatedly open and close the vehicle's fuel tank, lift and insert the fuel nozzle into the vehicle's fuel tank, regulate fuel flow through the nozzle, replace the fuel nozzle and lock and compact vehicle fuel tank after filling. In addition to gas station operators having to stand for hours, their working positions include bending, twisting, and repeatedly standing in awkward situations. This activity is carried out to serve several vehicles to be refueled during working hours. This repetitive activity increases work on the musculoskeletal system's ligaments, muscles, and soft tissues. [6]

2. Methods

2.1 Participants

This type of research is an analytic observational study with a cross-sectional approach conducted to analyze the relationship between fatigue and musculoskeletal disorders in gas station workers in Pontianak City, Indonesia. The study involved 150 gas station workers in Pontianak City, Indonesia as respondents who met the inclusion criteria as research respondents. The inclusion criteria for respondents in this study were gas station workers in Pontianak City who were willing to be respondents during the research and were aged <55 years. Respondents were selected through the Simple Random Sampling technique. Research ethics approval was obtained from the Health Research Ethics Committee of the Poltekkes Kemenkes Pontianak No 224/KEPK-PK.PKP/VIII/2022 and written consent (Informed Consent) was obtained from all gas station workers who were research respondents. Research activities will be carried out from March to July 2022.

2.2 Research Instruments

The types of data in this study are primary and secondary data obtained from interviews using a questionnaire and observation using a checklist. Data on work fatigue were obtained from interviews with respondents using the International Fatigue Research Committee of the Japanese Association of Industrial Health (IFRC) questionnaire. IFRC is a questionnaire that can measure subjective fatigue level, containing 30 questions about general fatigue symptoms. The first ten questions indicate a weakening of activity, the second ten questions a weakening of work motivation, and the third or last ten questions indicate physical fatigue or fatigue in several parts of the body. The higher the frequency of signs of fatigue occurring, the greater the level of fatigue. After conducting interviews and filling out the questionnaire, the next step is to calculate the score of the 30 questions

asked, and the total becomes the individual's total score. Based on the subjective fatigue assessment design with 30 questions, the highest individual score was 120. Questionnaire answers were scored according to four Likert scales, divided into four categories, namely Very Often with a value of 4, Often with a value of 3, Sometimes with a value of 2 and Never with a value of 1. The answers to each question are summed and adjusted for a particular classification in determining the classification of fatigue groups. The classifications given include: Score >55 = High Fatigue and Score ≤55 = Low Fatigue [7]. The Nordic Body Map research instrument for collecting data on musculoskeletal disorders in gas station workers. The Nordic Body Map Musculoskeletal Questionnaire contains a body map that shows the parts of the body that have complaints of pain. These body parts include the neck, shoulders, arms, back, waist, buttocks, elbows, wrists, hands, thighs, knees, calves, ankles, and soles of the feet [8]. Assessment using the Nordic Body Map questionnaire uses 4 Likert scales consisting of 1: not sick, 2: slightly ill, 3: ill, and 4: very ill. Workers who were research respondents were asked to provide an assessment of the parts of their body that they felt sick during work activities according to a predetermined likert scale [9].

2.3 Procedure

The Preparatory Stage starts with the management of health research ethics, secondary data collection, surveys, and field observations to identify problems and explore cooperation, arrange research permits, meetings of the research team and field officers for division of tasks, and common perceptions of research. The implementation stage of the study is the survey, observation, and inventory of gas station operator worker activities. Meetings with the company to explain the aims and objectives of the research as well as procedures for research activities, determining subjects for research respondents, and explaining the mechanism of research activities to respondents.

Following the fatigue data collection guided by the data collector, research respondents were asked to complete the questionnaire. Data collection for the measurement of musculoskeletal disorders uses a questionnaire that presents a picture of the human body with nine anatomical body regions. Data collectors guided respondents to fill out the questionnaire where the respondent's body had musculoskeletal symptoms such as pain or discomfort during the study.

2.4 Data analysis

Descriptive analysis to see the distribution characteristics of each dependent variable and independent variable. And the presentation of data in the form of tables and graphs with simple statistical calculations such as averages, ratios, and percentages. Furthermore, testing the research hypothesis uses the chi-square statistical test at the 95% confidence level to determine the relationship between research variables. The test was carried out at the significance level $\alpha = 0.05$; if $p < 0.05$, the test results are significant.

3. Results

Fuel Filling Stations for the Public (SPBU) are public infrastructure provided for the people of Indonesia to meet their fuel needs. This research was conducted at 11 gas stations in Pontianak City; in each sub-district, 50% were taken, including two gas stations in North Pontianak District, one gas station in East Pontianak District, two gas stations in Southeast District, one gas station in South Pontianak District, 2 West Pontianak District. SPBU, and Pontianak Kota District with three gas stations. The operating hours of gas stations in Pontianak City are divided into 2, namely 16 hours with two work shifts and 24 hours with three work shifts. Table 1 shows the demographic

distribution of gas station operator workers. The demographic distribution of gas station operator workers consists of 6 variables divided into several categories, as shown in Table 1. 120 (80%) gas station operator workers are <40 years old. A total of 144 (96%) gas station operator workers have a high school educational background. 92 (61.3%) gas station operators have worked for 1-5 years. Most workers, namely 78 (52%), have single status. In addition, as many as 75 (50%) gas station operators experienced high work fatigue. And as many as 111 (74%) workers have low-grade musculoskeletal disorders (Table 1).

The results of the hypothesis test between musculoskeletal events and worker fatigue obtained an r count value of 0.577 more than the r table with df = n-2=150-2=148 received r table 0.160 so that the value of r count (0.577) > r table (0.160) and p-value 0.000 <0.05 so that the hypothesis in the study was accepted, namely that there was a relationship between musculoskeletal events and fatigue in gas station workers (Table 2).

The relationship between work fatigue and musculoskeletal events at gas stations workers showed that high fatigue with high musculoskeletal disorders totaled 33 respondents (22%), low fatigue events with low musculoskeletal numbers 69 respondents (46%), high musculoskeletal events with low fatigue number of 39 respondents (26%) and extreme musculoskeletal events with high work fatigue amounted to 42 respondents (28%). The analysis results of the incidence of work fatigue and workers' musculoskeletal disorders obtained a p-value of 0.000 <0.05, meaning that there is a relationship between the incidence of fatigue and musculoskeletal disorders in gas station workers. The odds ratio (OR) is 9.036, which means that fatigue can trigger musculoskeletal disorders 9.036 times (Table 3).

4. Discussion

Based on the results of the study, gas station labor operators in Pontianak City experienced high work fatigue, as much as 50%. Work fatigue felt by gas station operators is partly due to long working hours, an uncomfortable work environment, and a long-standing working position while working. Triggers fatigue for gas station operators, namely activities in providing services starting from greeting, asking questions and serving consumers, pressing the automatic Factor pump, and giving change which is usually done by one worker and done in a standing position [10]. Gas station operators work using a shift system, in 1 shift working 8 hours a day. This is done by standing to serve consumers when refueling. The gas station operator said many consumers came to fill up their fuel, and the officers had little time to sit and rest. Workers only rest when going to drink and lunch. Every worker should have the right to rest for at least 30 minutes after working for 4 hours continuously, and this break does not include working hours [11]. Good rest can contract the thigh and calf muscles to hold the body in an upright position during long-standing can be rested. Good rest can reduce muscle fatigue after long-standing activities [12]. An uncomfortable work environment is also a cause of fatigue felt by gas station operators, such as the temperature in the work environment. During the study, the temperature in the gas station work environment in Pontianak City was, on average, above the Threshold Limit, namely in the range of 30.1°C to 34.3°C. The threshold value for the temperature in the work environment that is allowed is 18-30°C [13]. The physical work environment can affect workers' health, especially the physical work climate. A physical work climate that exceeds the threshold value can cause functional changes in the body's organs. Hot working climate conditions can cause drowsiness and fatigue and increase the number of work errors [14]. Exposure to heat for hours can affect the body's balance and the body sweats. The body's heat center

originates in the brain, which regulates blood flow through the vessels in the skin. And this heat source regulates the heat balance in the human body. At a temperature of 25°C, human skin can sweat. And the loss of fluids caused by sweating causes fatigue [15], [16]. Exposure to gasoline caused by benzene concentrations can also cause fatigue, headaches, coughing, and nausea due to prolonged exposure to benzene, which is inhaled and causes chronic effects [17]. The maximum exposure limit for benzene is 8 hours a day or 40 hours a week [18]. So it is expected that workers can wear masks. The function of masks for gas station operators is to protect against exposure to chemicals produced by gasoline components at gas stations [19]. Based on the above, it is necessary to monitor the work environment of gas station workers to create a comfortable work environment.

Standing in a work position during working hours is one of the triggering factors for work fatigue at gas station operators [20]. Standing for a long time can cause changes in the body's work system. Veins have difficulty flowing blood from the legs to the heart, pressure on the joints, and muscle fatigue. When standing for a long time causes blood flow to the heart to be affected, resulting in muscle contractions and fatigue. Work fatigue is caused by prolonged standing because the thigh and calf muscles contract to hold the body in an upright position [21]. Based on the results of statistical tests, there is a relationship between work fatigue among gas station workers and musculoskeletal disorders p value 0.000 <0.05. Many factors influence the prevalence of musculoskeletal disorders among work fatigue [22]. The study's results that there is a relationship between work fatigue and musculoskeletal disorders are also in line with the research of Chavalitasukalchai and Shahnavaz. Fatigue is a decreased body endurance and work capacity that can reduce morale and the risk of work accidents. At the same time, musculoskeletal disorders can occur due to work fatigue that workers feel continuous [23]. The results of the study showed that the OR value was 9.036. That is, every increase

in the incidence of fatigue by 1 point would increase the musculoskeletal point 9.036 times. So this must receive attention through various efforts, pay attention to the age of workers, and not choose old workers. In general, skeletal muscle complaints begin to be felt at working age 25-65 years. The first complaint is usually handled at the age of 35, and the level of complaints will continue to increase with age because, in middle age, muscle strength and endurance begin to decrease, so the risk of muscle complaints begins to grow [24]. Increasing age, followed by a decrease in VO2 max intake, will reduce work capacity. Decreased work capacity will be marked by physical fatigue caused by muscle weakness.

Muscles need oxygen and adequate blood supply to carry out metabolic processes and regulate muscle contractions to keep them going [25]. At 30, there is degeneration in the form of tissue damage and fluid reduction. This causes the stability of the bones and muscles to be reduced. In other words, the older a person is, the higher the risk of that person experiencing a decrease in bone elasticity which triggers musculoskeletal disorders [26]. Gender is closely related to musculoskeletal complaints. Physiologically the ability of male muscles is more vital than that of female forces. Different hormonal influences between men and women cause this. Female hormones make women physically more vulnerable [27]. Gender shows a significant effect on the risk of muscle complaints. Female muscles are smaller in size and only two-thirds (60%) more potent than male muscles, especially the arms, back, and legs [28]. Musculoskeletal is a chronic disease that takes a long time to develop and manifest [29]. The working period must also be considered because it is a musculoskeletal risk factor. The longer a person is exposed to risk factors, the greater a person feels physical complaints due to his work [30].

Musculoskeletal disorders do not appear spontaneously but gradually until

the human body begins to respond to pain [25]. Gas station workers do repetitive work every day. If these activities take place continuously, there will be a risk of complaints of musculoskeletal disorders [31]. Musculoskeletal disorders can increase if the individual's working period increases, and they will experience physical and psychological boredom. The working period represents a risk factor that affects individuals at work, which can increase the risk of developing musculoskeletal disorders, especially in types of activities that utilize large amounts of work energy [27]. Interventions with shift changes (active rest) and position changes shorten recovery time and reduce neck and low back pain recurrence among high-risk workers [32]. Various risks to workers' health and risk management practices of Occupational Health and Safety in the workplace still need to be addressed. So it is necessary to take concrete steps to maintain the occupational health of gas station workers, which can only be achieved through appropriate interventions based on existing conditions [33].

Many factors influence the prevalence of musculoskeletal disorders in workers, namely the shift system, abnormal working positions, forward tilt of the neck, maximum strength operations in a short time, repetitive movements of the upper arms or fingers, work under varying conditions of temperature, and work fatigue [22]. The work demands of gas station operators require gas station operators to stand static while pressing a button on the computer display to calculate the fuel flow to enter customer fuel order data, put the nozzle into the consumer's gas tank, close the car's tank, and receive and return payments. In addition, the condition will be exacerbated when long queues occur during peak hours, resulting in musculoskeletal complaints felt by gas station operators getting worse because the more extended gas station operators stand static or awkward, the longer the muscles contract and the longer the pressure will be received by muscles [34]. So it is necessary to apply for work positions unrelated to work shifts and

stretch regularly. Changing work positions will make the body more flexible, dividing the workload evenly on some parts of the body to reduce pressure on joints and muscles. Besides, workers who stretch their necks, shoulders, and hands minimize complaints. [35], [36]. Working more than 8 hours can increase musculoskeletal disorders in the lower back and shoulders. Therefore, working arrangements with sufficient daily duration are necessary to minimize the impact of poor occupational health on workers [37]. Improvement of the work environment needs to be done to minimize musculoskeletal disorders and fatigue to increase productivity [38]. According to Nneka, gas station operators have a lot of risk of experiencing fatigue, so the company's role is to identify workplace hazards, provide regular training for workers regarding workplace safety, and provide PPE [39]. Apart from that, by introducing a mechanism for occupational safety and health rules, setting standards, and limiting exposure to environmental factors for workers [40].

5. Conclusion

There is a relationship between work fatigue and musculoskeletal disorders in gas station operators (p-value = 0.000). Based on the results of this study, the authors suggest the need for sufficient rest time, work shift arrangements, environmental monitoring, use of PPE, stretching, and improving ergonomic work positions for gas station operators.

Competing Interest

there were no conflicts of interest.

Availability of Data and Materials

Data supporting the findings on this study on request due to privacy/ethical restrictions.

Authors Contribution

Conceptualization : S ; Data Collection and analysis : ZA, SH ; Methodology : S, ZA, SH ; Draft : S ; Review : S ; Manuscript Preparation : S.

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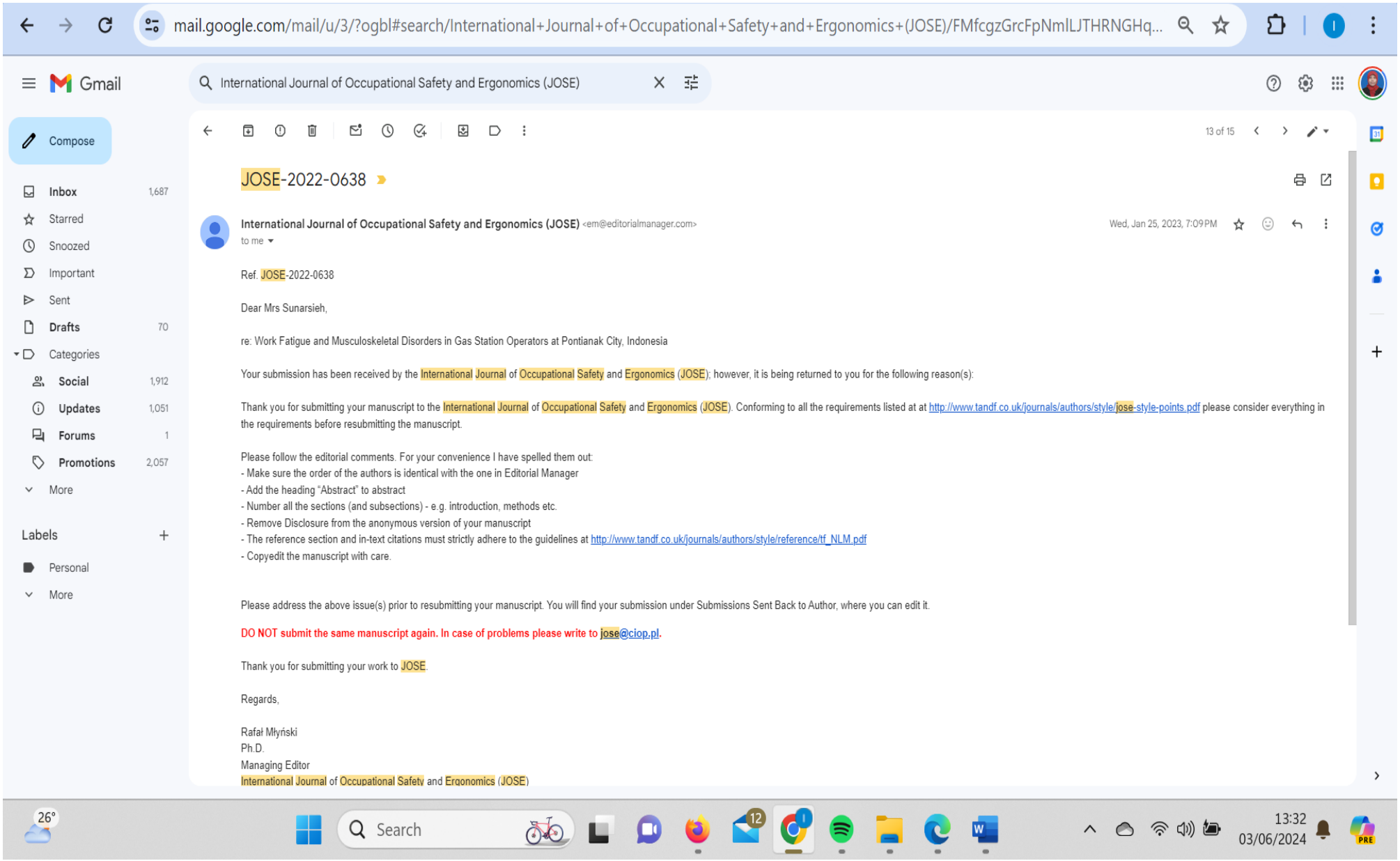
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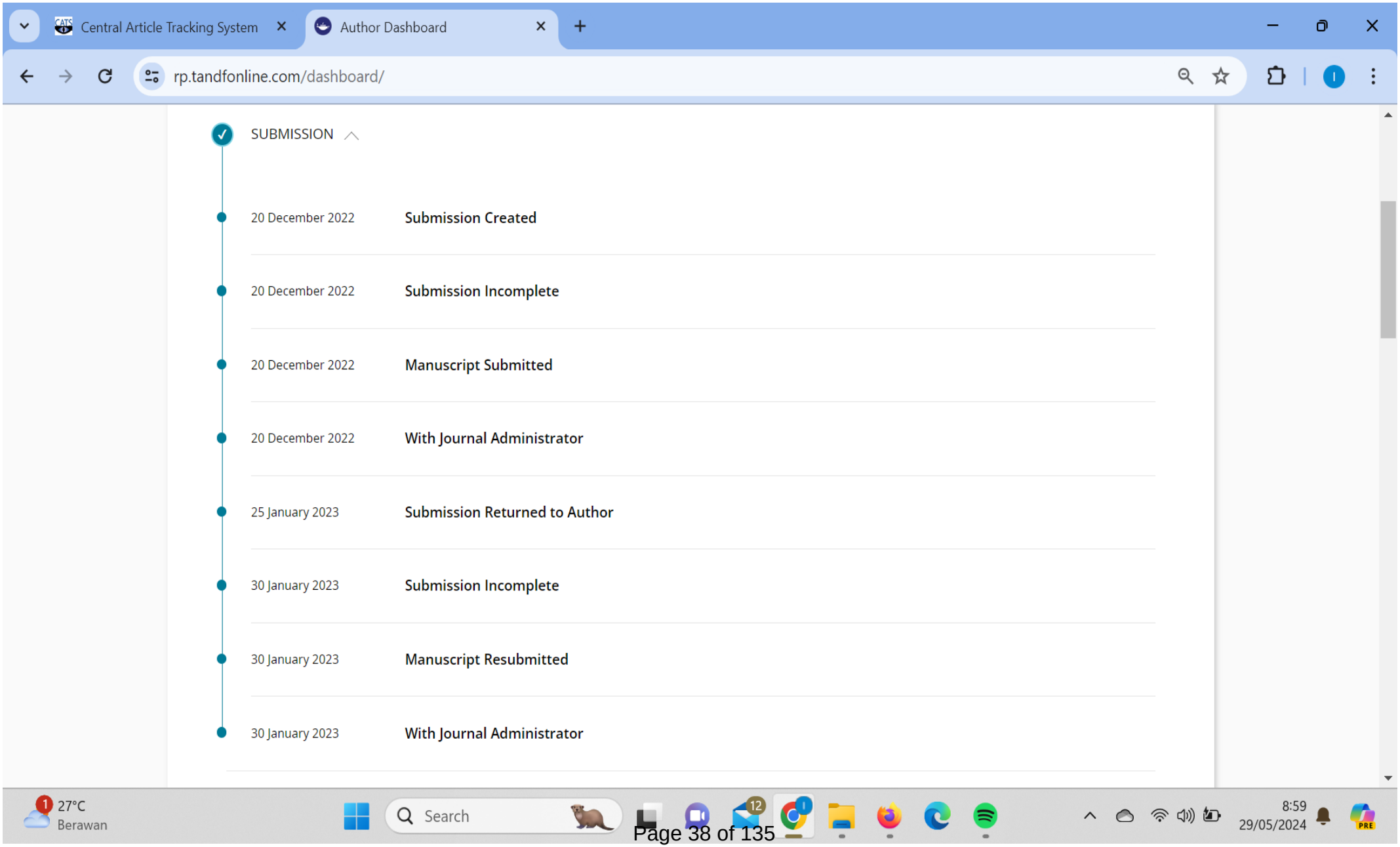
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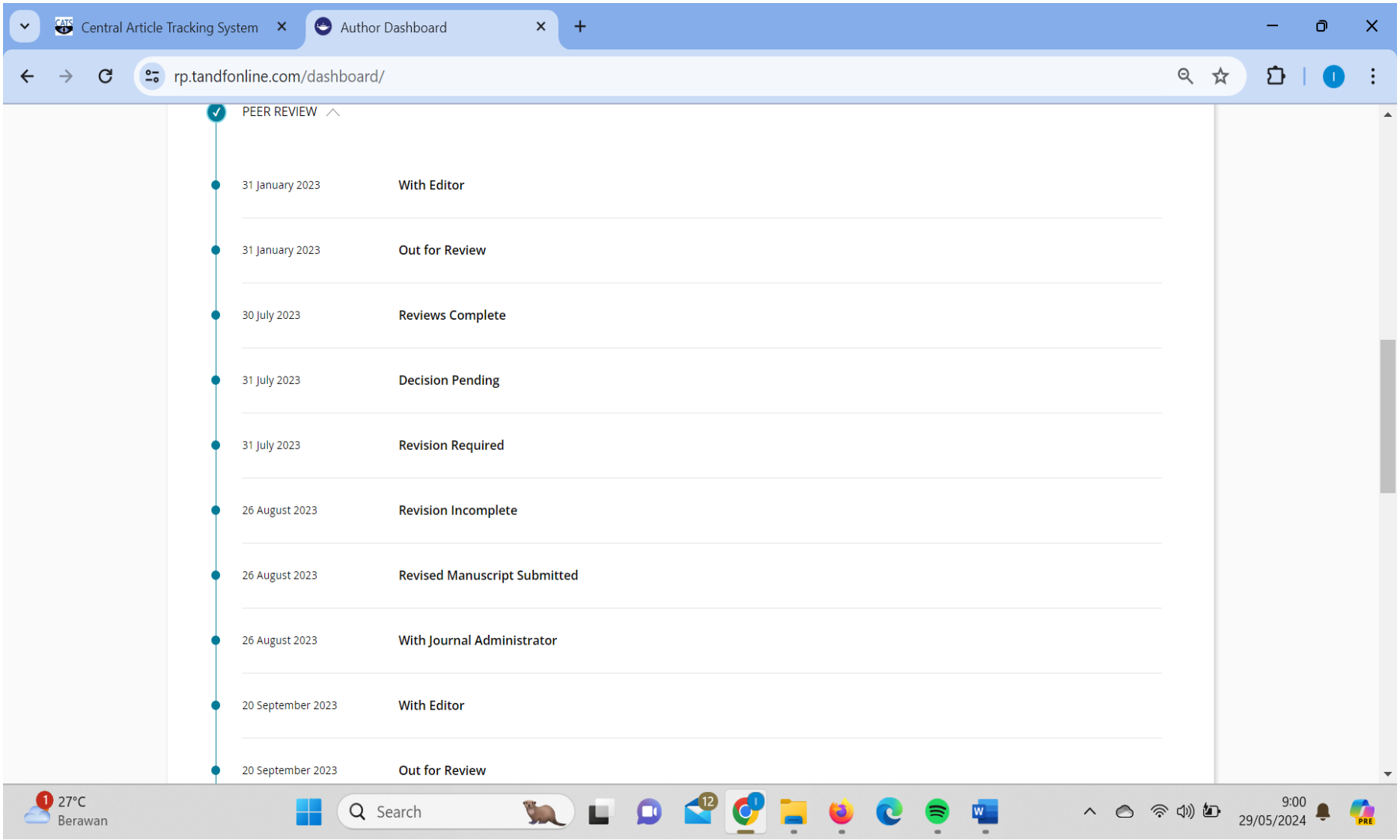
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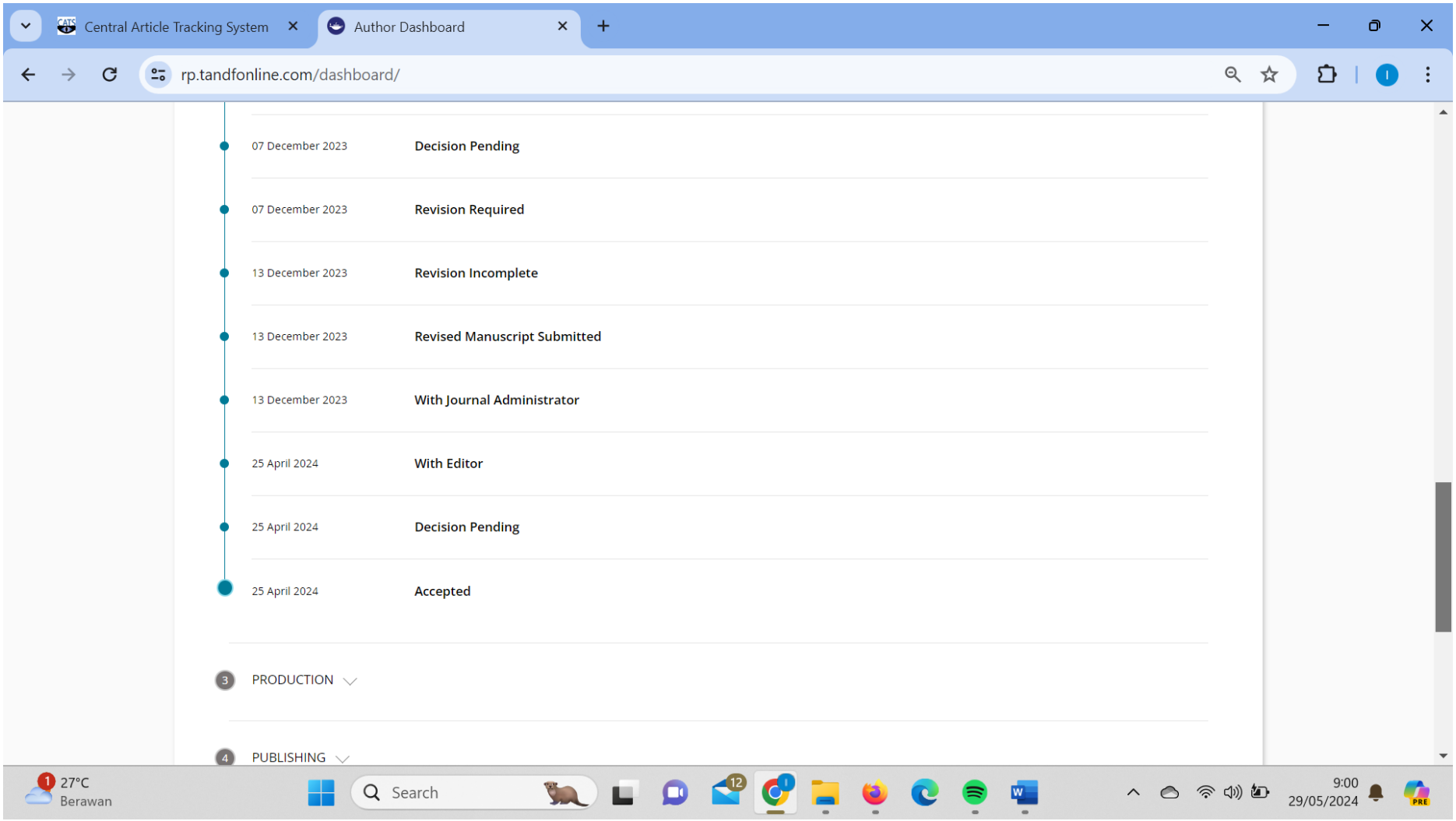
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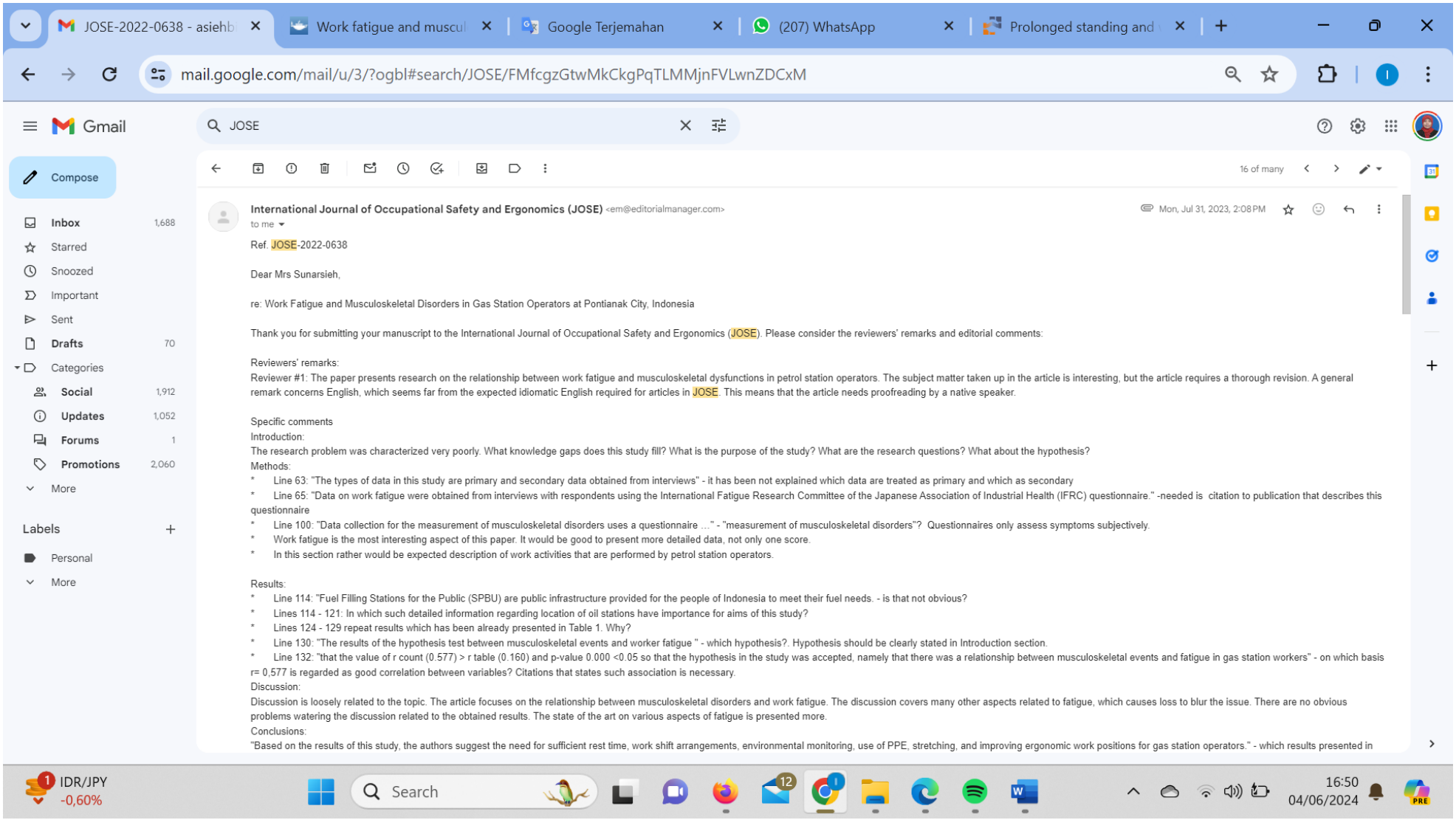
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International Journal of Occupational Safety and Ergonomics (JOSE) <em@editorialmanager.com>
to me
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Ref. JOSE-2022-0638
Dear Mrs Sunarsieh,
re: Work Fatigue and Musculoskeletal Disorders in Gas Station Operators at Pontianak City, Indonesia
Thank you for submitting your manuscript to the International Journal of Occupational Safety and Ergonomics (JOSE). Please consider the reviewers' remarks and editorial comments:
Reviewers' remarks:
Reviewer #1: The paper presents research on the relationship between work fatigue and musculoskeletal dysfunctions in petrol station operators. The subject matter taken up in the article is interesting, but the article requires a thorough revision. A general remark concerns English, which seems far from the expected idiomatic English required for articles in JOSE. This means that the article needs proofreading by a native speaker.
Specific comments
Introduction:
The research problem was characterized very poorly. What knowledge gaps does this study fill? What is the purpose of the study? What are the research questions? What about the hypothesis?
Methods:
* Line 63: "The types of data in this study are primary and secondary data obtained from interviews" - it has been not explained which data are treated as primary and which as secondary
* Line 65: "Data on work fatigue were obtained from interviews with respondents using the International Fatigue Research Committee of the Japanese Association of Industrial Health (IFRC) questionnaire." -needed is citation to publication that describes this questionnaire
* Line 100: "Data collection for the measurement of musculoskeletal disorders uses a questionnaire ..." - "measurement of musculoskeletal disorders"? Questionnaires only assess symptoms subjectively.
* Work fatigue is the most interesting aspect of this paper. It would be good to present more detailed data, not only one score.
* In this section rather would be expected description of work activities that are performed by petrol station operators.
Results:
* Line 114: "Fuel Filling Stations for the Public (SPBU) are public infrastructure provided for the people of Indonesia to meet their fuel needs. - is that not obvious?
* Lines 114 - 121: In which such detailed information regarding location of oil stations have importance for aims of this study?
* Lines 124 - 129 repeat results which has been already presented in Table 1. Why?
* Line 130: "The results of the hypothesis test between musculoskeletal events and worker fatigue " - which hypothesis?. Hypothesis should be clearly stated in Introduction section.
* Line 132: "that the value of r count (0.577) > r table (0.160) and p-value 0.000 <0.05 so that the hypothesis in the study was accepted, namely that there was a relationship between musculoskeletal events and fatigue in gas station workers" - on which basis r= 0,577 is regarded as good correlation between variables? Citations that states such association is necessary.
Discussion:
Discussion is loosely related to the topic. The article focuses on the relationship between musculoskeletal disorders and work fatigue. The discussion covers many other aspects related to fatigue, which causes loss to blur the issue. There are no obvious problems watering the discussion related to the obtained results. The state of the art on various aspects of fatigue is presented more.
Conclusions:
"Based on the results of this study, the authors suggest the need for sufficient rest time, work shift arrangements, environmental monitoring, use of PPE, stretching, and improving ergonomic work positions for gas station operators." - which results presented in
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1.	Introduction The research problem was characterized very poorly. What knowledge gaps does this study fill? What is the purpose of the study? What are the research questions? What about the hypothesis?	Musculoskeletal disorders are occupational diseases. Risk factors for musculoskeletal disorders are excessive fatigue, awkward postures, and repetitive movements [1]. Musculoskeletal disorders and work fatigue are important parts that must be considered because they can affect health problems in workers, affect the quality of life and work efficiency of workers, and reduce worker productivity [2]–[4]. Musculoskeletal disorders affect the skeletal muscles and are experienced as mild to severe pain. Repeatedly using skeletal muscles for a long time at work, even if a person only experiences mild pain, can cause disorders in the form of damage to ligaments, tendons, and joints [5]. Fuel filling stations are public facilities provided by the government or the state, and foreign and private companies to meet the fuel needs of various types of motorized vehicles. In general, fuel filling stations sell Pertalite, Diesel, Pertamax, and Pertamax Plus fuels and make it easier for the public to obtain the fuel they need for their vehicles [6]. This research was conducted at 11 fuel filling stations in Pontianak City, West Kalimantan, Indonesia. In each sub-district, 50% of stations were studied, including North Pontianak Subdistrict with two fuel filling stations, East Pontianak District with one fuel filling station, Southeast Districts with two fuel filling stations, South Pontianak District with one fuel filling station, West Pontianak District with two fuel filling stations, and Pontianak Kota District with three fuel filling stations. Based on the results of interviews and observations, the gas stations provide a 24-hour service, with gas station operators working 8 hours per shift. Gas station operators work continuously in a standing position and carry out repetitive activities/movements to refuel	25-47 48-56

		customers' vehicles, so they at risk of experiencing work fatigue and musculoskeletal disorders [7]. This study aimed to describe the demographics, work fatigue, and musculoskeletal disorders in gas station operators, and analyze the relationship between work fatigue and musculoskeletal disorders in gas station workers. The research question is what is the relationship between fatigue and musculoskeletal disorders in gas station operators in Pontianak City. The hypothesis is that there is a relationship between fatigue and musculoskeletal disorders in gas station workers in Pontianak City. This research aims to analyze fatigue and musculoskeletal disorders experienced by gas station workers, so that solutions and prevention efforts can be applied so that workers do not experience fatigue and musculoskeletal disorders.	
2	Methods Line 63: "The types of data in this study are primary and secondary data obtained from interviews" - it has been not explained which data are treated as primary and which as secondary	The type of data in this study is primary data consisting of social demographics, levels of work fatigue, and data on symptoms of musculoskeletal disorders and the work environment. Secondary data consists of data on the number of workers and the working hours of gas station operators	83-86

3.	Line 65: "Data on work fatigue were obtained from interviews with respondents using the International Fatigue Research Committee of the Japanese Association of Industrial Health (IFRC) questionnaire." -needed is citation to publication that describes this	Data on work fatigue were obtained from interviews with respondents using the International Fatigue Research Committee of the Japanese Association of Industrial Health (IFRC) questionnaire [8]	86-88
4.	questionnaire Line 100: "Data collection for the measurement of musculoskeletal disorders uses a questionnaire …" - "measurement of musculoskeletal disorders"? Questionnaires only assess symptoms subjectively.	Data collection for the assessment of symptoms of musculoskeletal disorders uses a questionnaire that presents a picture of the human body with nine anatomical parts of the body. Data collectors guided respondents to fill out the questionnaire to find out whether the respondent experienced musculoskeletal symptoms such as pain or discomfort in any part of the body when the study was conducted.	122-127
5.	Work fatigue is the most interesting aspect of this paper. It would be good to present more detailed data, not only one score.	Fatigue level classification is based on individual total scores. The separate full scores and classification levels of fatigue are 0–55 = low fatigue and 56–120 = high fatigue [8].	101-103
6.	In this section rather would be expected description of work activities that are performed by petrol station operators.	Gas station operators work 8 hours daily and rest for 1 hour each shift, six days a week. Workers work in a standing position continuously and perform repetitive movements to refuel customers' vehicles. If there are lots of vehicles refueling, gas station operators are forced to	72-81

		work in a standing position for 7 hours. Gas station operators are tasked with dealing directly with customers when refueling vehicles. The gas station operator is responsible for opening and closing the vehicle's fuel tank, lifting and inserting the fuel nozzle, and locking and closing the vehicle's fuel tank after filling. This work is carried out by gas station operators for hours in a bending and rotating position and standing for a long time.	
7.	Results: Line 114: "Fuel Filling Stations for the Public (SPBU) are public infrastructure provided for the people of Indonesia to meet their fuel needs. - is that not obvious?	Fuel filling stations are public facilities provided by the government or the state, and foreign and private companies to meet the fuel needs of various types of motorized vehicles. In general, fuel filling stations sell Pertalite, diesel, Pertamax, and Pertamax Plus fuels and make it easier for the public to obtain the fuel they need for their vehicles [6]. This research was conducted at 11 fuel filling stations in Pontianak City, West Kalimantan, Indonesia. In each sub-district, 50% of stations were studied, including North Pontianak Subdistrict with two fuel filling stations, East Pontianak District with one fuel filling station, Southeast Districts with two fuel filling stations, South Pontianak District with one fuel filling station, West Pontianak District with two fuel filling stations, and Pontianak Kota District with three fuel filling stations.	136-145
8	Lines 114 - 121: In which such detailed information regarding location of oil stations have importance for aims of this study?		
9	Lines 124 - 129 repeat results which has been already presented in Table 1. Why?	For reaffirmation of essential points	-
10	Line 130: "The results of the hypothesis test between musculoskeletal events and worker fatigue " - which hypothesis?. Hypothesis	The research hypothesis has been stated in the introduction.	-

	should be clearly stated in Introduction section.		
11	Line 132: "that the value of r count (0.577) > r table (0.160) and p-value 0.000 <0.05 so that the hypothesis in the study was accepted, namely that there was a relationship between musculoskeletal events and fatigue in gas station workers" - on which basis r= 0,577 is regarded as good correlation between variables? Citations that states such association is necessary.	The results of the test of the hypothesis on the relationship between musculoskeletal events and worker fatigue obtained an r count value of 0.577 more than the r table with df = n -2 = 150 - 2 = 148 obtaining an r table of 0.160 so that the value of r count (0.577) > r table (0.160) and p-value 0.001 so that the hypothesis in the study was accepted, namely that there was a relationship between musculoskeletal events and fatigue in gas station workers. This confirms the finding of Kremelberg (2014) that if the value of r count > r table, there is a correlation or a relationship between variables variables [11].	162-163
12	Discussion: Discussion is loosely related to the topic. The article focuses on the relationship between musculoskeletal disorders and work fatigue. The discussion covers many other aspects related to fatigue, which causes loss to blur the issue. There are no obvious problems watering the discussion related to the obtained results.	Based on the study's results, 50% of gas station operators in Pontianak City experienced work fatigue in the high category. Risk factors and triggers for work fatigue experienced by gas station operators include long working hours in a standing position while providing services to customers. This also supports Basri's study (2021) that standing at work for a long duration can increase the risk of work fatigue [12]. Based on the interview results, if there are many customers, the operators can only take breaks to eat and pray, so the operators stand for a long time. Standing for a long time can cause fatigue because it can cause changes	178-274

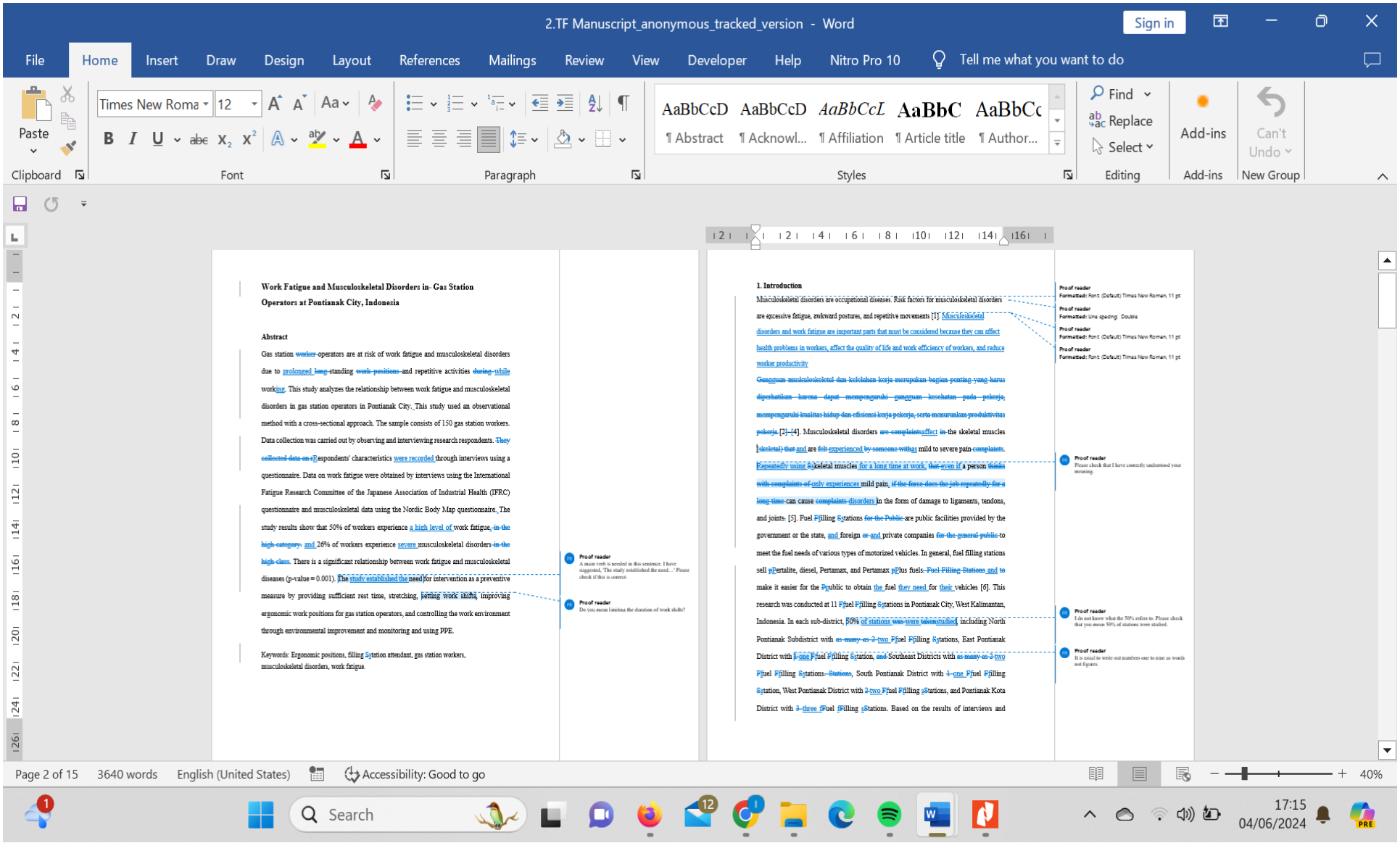
	The state of the art on various aspects of fatigue is presented more.	in the body's systems. The circulation of the blood from the legs to the heart becomes more difficult, with pressure on the joints, and muscle fatigue. Standing for a long time causes blood flow to the heart to be affected, resulting in muscle contractions and fatigue. Work fatigue is caused by prolonged standing because the thigh and calf muscles contract to hold the body upright [13]. The work demands of gas station operators require them to stand in static positions while pressing a button on the computer display to calculate the flow of fuel to enter the data for the customer's fuel purchase, putting the nozzle into the customer's gas tank, closing the car's tank, and receiving payments and returning change. In addition, the condition will be exacerbated when long queues occur during peak hours, resulting in musculoskeletal symptoms in gas station operators getting worse because the longer the gas station operators are standing in a static or awkward position, the longer the muscles contract, and the longer muscles will be under pressure [14]. Actions can be taken to ensure that working hours comply with the rules, namely 7 hours of work and 1 hour of rest in a day [15]. Activities/movements of gas station operators that are repeated and carried out continuously are also risk factors for fatigue. Repetitive movements can cause muscle fatigue, causing motor reorganization, and decreased performance [16]. Actions that can be taken include applying consistent work shifts and periodic stretching. Changing work positions will make the body more flexible, by spreading the workload evenly across parts of the body to reduce pressure on joints and muscles; in addition, workers who stretch the neck, shoulders, legs, and arms can minimize disorders [17], [18]. The results of the research show that musculoskeletal disorders in the high category were experienced by 26% of gas station operators.	

		Based on the results of the statistical tests, there is a relationship between work fatigue among gas station workers and musculoskeletal disorders with a p value 0.001 <0.05. This is in line with the research of Chavalitasukalchai and Shahnavaz. Fatigue reduces body endurance and work capacity that can reduce morale and increase the risk of work accidents. Musculoskeletal disorders can occur due to work fatigue that workers feel continuously [19]. The study's results showed that the OR value was 9.036. That is, every increase in the incidence of fatigue by 1 point would increase the musculoskeletal point 9.036 times. So this issue must receive attention through various efforts: 1) pay attention to the age of workers, avoid older workers because the level of skeletal muscle disorders will increase with age. In middle age, muscle strength and endurance begin to decrease so that the risk of muscle disorders begins to grow [20]. The VO2 max intake decreases with increasing age, which will reduce work capacity. Decreased work capacity will be marked by physical fatigue caused by muscle weakness. Muscles need oxygen and adequate blood supply to carry out metabolic processes and regulate muscle contractions to keep them going [21]. This is also in line with Bridger's research (2020). The older a person is, the higher the risk for that person to experience a decrease in bone elasticity which triggers musculoskeletal disorders [22]. In this study, 20% of operators were > 40 years old. It is hoped that in the future, workers > 50 years will not be employed in the gas station operator section by moving them to the administration.	

		2) Employ male workers rather than female gas station operators. Gender is closely related to musculoskeletal complaints. Physiologically, the muscles in men are stronger than in women, caused by differences in hormonal influences between men and women. Female hormones make women physically more vulnerable [23]. Gender shows a significant effect on the risk of muscle disorders. Female muscles are smaller and only two-thirds (60%) as strong as those of males, especially in the arms, back, and legs [24]. 3) Consider the duration of working periods of gas station operators because this is a musculoskeletal risk factor. The longer a person is exposed to risk factors, the more likely a person experiences physical disorders due to work [25]. Musculoskeletal disorders do not appear spontaneously but gradually until the human body begins to give a pain response [21]. Musculoskeletal disorders can increase if the individual's working period increases, and they will experience physical and psychological boredom. The working period represents a risk factor affecting individuals at work, which can increase the risk of developing musculoskeletal disorders, especially in work activities that utilize large amounts of energy [23]. Therefore, fuel station operators who have had a long working period should be transferred to the administration. 4) Pay attention to gas station operators' working hours, namely working according to the rule of 7 hours of work and 1 hour of rest. Working more than 8 hours can increase musculoskeletal disorders, hence the need for working arrangements of sufficient daily duration to minimize the impact of poor occupational health on workers [26]. And adjust the work shift system to affect the prevalence of	

		musculoskeletal disorders [27]. Another risk factor that causes fatigue is an uncomfortable work environment, which is also a cause of fatigue among gas station operators, such as the temperature of the work environment. During the study, the temperature in the gas station work environment in Pontianak City was, on average, above the Threshold Limit, namely in the range of 30.1°C to 34.3°C. The permitted threshold value for temperatures in the work environment is 18-30° C [28]. The physical work environment can affect workers' health, especially the climate for physical work. A physical work climate that exceeds the threshold value can cause functional changes in the body's organs. Hot working conditions can cause drowsiness, fatigue, and increase the number of work errors [29]. Exposure to heat for hours can affect the body's balance, and how the body sweats. The body's thermoregulation center originates in the brain, which regulates the blood flow through the vessels in the skin, regulating the heat balance in the human body. At a temperature of 25 °C, human skin can sweat. And the loss of fluids caused by sweating causes fatigue [30], [31]. Based on the above, it is necessary to modify the workplace to achieve more comfortable conditions by widening the roof to provide shelter and regulations on using work uniforms that can reduce body heat [32]. Exposure to gasoline caused by benzene concentrations can also cause fatigue, headaches, coughing, and nausea due to prolonged exposure to inhaled benzene, which also causes chronic effects [33]. It is hoped that gas station companies can identify the dangers of environmental factors through environmental control. One of the controls is using personal protective equipment (PPE) for	

		workers, namely gas station operators wearing masks. The function of PPE for gas station operators is to protect against exposure to chemicals produced by gasoline components at gas stations [34]. The work environment needs to be improved to minimize symptoms of musculoskeletal disorders and fatigue and increase productivity [35].	
13	Conclusions "Based on the results of this study, the authors suggest the need for sufficient rest time, work shift arrangements, environmental monitoring, use of PPE, stretching, and improving ergonomic work positions for gas station operators." - which results presented in this paper allow for such conclusions? The conclusion should be closely related to the aim of the study, research questions, hypotheses and presented research results.	The demographic description of gas station operator workers is as follows: 80% are under 40 years old; education level is 96% secondary education, namely junior high school and high school/vocational school; 61.3% have been employed for 1–5 years; 52% of workers are unmarried. High work fatigue was experienced by 50% of workers. Severe musculoskeletal disorders were experienced by 26% of workers. This study established a relationship between work fatigue and musculoskeletal disorders in gas station operators (p-value = 0.001). Based on the results of the study, the authors suggest that it is necessary to pay attention to the duration of work in the standing position, to limit the number of working hours through shift arrangements, provide adequate rest arrangements, along with stretching and improvement of ergonomic work positions for gas station operators. Modifying the work environment and monitoring and controlling working conditions are also essential to ensure that the work environment is safe and comfortable.	276-287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Work Fatigue and Musculoskeletal Disorders in Gas Station Operators at Pontianak City, Indonesia
Abstract
Gas station worker operators are at risk of work fatigue and musculoskeletal disorders due to prolonged long standing work positions and repetitive activities during while working. This study analyzes the relationship between work fatigue and musculoskeletal disorders in gas station operators in Pontianak City. This study used an observational method with a cross-sectional approach. The sample consists of 150 gas station workers. Data collection was carried out by observing and interviewing research respondents. They collected data on rRespondents' characteristics were recorded through interviews using a questionnaire. Data on work fatigue were obtained by interviews using the International Fatigue Research Committee of the Japanese Association of Industrial Health (IFRC) questionnaire and musculoskeletal data using the Nordic Body Map questionnaire. The study results show that 50% of workers experience a high level of work fatigue, in the high category, and 26% of workers experience severe musculoskeletal disorders in the high class. There is a significant relationship between work fatigue and musculoskeletal diseases (p-value = 0.001). The study established the need for intervention as a preventive measure by providing sufficient rest time, stretching, setting work shifts, improving ergonomic work positions for gas station operators, and controlling the work environment through environmental improvement and monitoring and using PPE.
Keywords: Ergonomic positions, filling Station attendant, gas station workers, musculoskeletal disorders, work fatigue.
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Do you mean limiting the duration of work shifts?
1. Introduction
Musculoskeletal disorders are occupational diseases. Risk factors for musculoskeletal disorders are excessive fatigue, awkward postures, and repetitive movements [1]. Musculoskeletal disorders and work fatigue are important parts that must be considered because they can affect health problems in workers, affect the quality of life and work efficiency of workers, and reduce worker productivity
Gangguan muskuloskeletal dan kelelahan kerja merupakan bagian penting yang harus diperhatikan karena dapat mempengaruhi gangguan kesehatan pada pekerja, mempengaruhi kualitas hidup dan efisiensi kerja pekerja, serta menurunkan produktivitas pekerja. [2]–[4]. Musculoskeletal disorders are complaintsaffect in the skeletal muscles skeletal) that and are felt experienced by someone withas mild to severe pain complaints. Repeatedly using Sskeletal muscles for a long time at work, that even if a person thinks with complaints of only experiences mild pain, if the force does the job repeatedly for a long time can cause complaints disorders in the form of damage to ligaments, tendons, and joints. [5]. Fuel Ffilling Sstations for the Public are public facilities provided by the government or the state, and foreign or and private companies for the general public to meet the fuel needs of various types of motorized vehicles. In general, fuel filling stations sell pPertalite, diesel, Pertamax, and Pertamax pPlus fuels. Fuel Filling Stations and to make it easier for the Ppublic to obtain the fuel they need for their vehicles [6]. This research was conducted at 11 Ffuel Ffilling Sstations in Pontianak City, West Kalimantan, Indonesia. In each sub-district, 50% of stations was were takenstudied, including North Pontianak Subdistrict with as many as 2 two Ffuel Ffilling Sstations, East Pontianak District with 1 one Ffuel Ffilling Sstation, and Southeast Districts with as many as 3 two Ffuel Ffilling Sstations. Stations, South Pontianak District with 1 one Ffuel Ffilling Sstation, West Pontianak District with 2 two Ffuel Ffilling sStations, and Pontianak Kota District with 3 three fFuel fFilling sStations. Based on the results of interviews and
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Work Fatigue and Musculoskeletal Disorders in Gas Station Operators at Pontianak City, Indonesia

Abstract

Gas station worker operators are at risk of work fatigue and musculoskeletal disorders due to prolonged long standing work positions and repetitive activities during while working. This study analyzes the relationship between work fatigue and musculoskeletal disorders in gas station operators in Pontianak City. This study used an observational method with a cross-sectional approach. The sample consists of 150 gas station workers. Data collection was carried out by observing and interviewing research respondents. They collected data on rRespondents' characteristics were recorded through interviews using a questionnaire. Data on work fatigue were obtained by interviews using the International Fatigue Research Committee of the Japanese Association of Industrial Health (IFRC) questionnaire and musculoskeletal data using the Nordic Body Map questionnaire. The study results show that 50% of workers experience a high level of work fatigue, in the high category. and 26% of workers experience severe musculoskeletal disorders in the high class. There is a significant relationship between work fatigue and musculoskeletal diseases (p-value = 0.001). The study established the need for intervention as a preventive measure by providing sufficient rest time, stretching, setting work shifts, improving ergonomic work positions for gas station operators, and controlling the work environment through environmental improvement and monitoring and using PPE.

Keywords: Ergonomic positions, filling Sstation attendant, gas station workers, musculoskeletal disorders, work fatigue.

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1. Introduction

Musculoskeletal disorders are occupational diseases. Risk factors for musculoskeletal disorders are excessive fatigue, awkward postures, and repetitive movements [1]. Musculoskeletal disorders and work fatigue are important parts that must be considered because they can affect health problems in workers, affect the quality of life and work efficiency of workers, and reduce worker productivity

~~Gangguan muskuloskeletal dan kelelahan kerja merupakan bagian penting yang harus diperhatikan karena dapat mempengaruhi gangguan kesehatan pada pekerja, mempengaruhi kualitas hidup dan efisiensi kerja pekerja, serta menurunkan produktivitas pekerja~~ [2] [4]. Musculoskeletal disorders ~~are complaints~~affect ~~in~~ the skeletal muscles ~~(skeletal) that~~ and are ~~felt~~ experienced ~~by someone with~~as mild to severe pain ~~complaints~~. Repeatedly using ~~S~~skeletal muscles for a long time at work, ~~that~~ even if a person ~~thinks with complaints of~~ only experiences mild pain, ~~if the force does the job repeatedly for a long time~~ can cause ~~complaints~~ disorders in the form of damage to ligaments, tendons, and joints~~.~~ [5]. Fuel ~~F~~filling ~~S~~stations ~~for the Public~~ are public facilities provided by the government or the state, and foreign ~~or~~ and private companies ~~for the general public~~ to meet the fuel needs of various types of motorized vehicles. In general, fuel filling stations sell ~~p~~Pertalite, diesel, Pertamax, and Pertamax ~~p~~Plus fuels~~. Fuel Filling Stations~~ and ~~to~~ make it easier for the ~~P~~public to obtain the fuel they need for their vehicles [6]. This research was conducted at 11 ~~F~~fuel ~~F~~filling ~~S~~stations in Pontianak City, West Kalimantan, Indonesia. In each sub-district, 50% of stations ~~was~~ were ~~taken~~studied, including North Pontianak Subdistrict with ~~as many as 2~~ two ~~F~~fuel ~~F~~filling ~~S~~stations, East Pontianak District with ~~1~~ one ~~F~~fuel ~~F~~filling ~~S~~station, ~~and~~ Southeast Districts with ~~as many as 2~~ two ~~F~~fuel ~~F~~filling ~~S~~stations~~. Stations~~, South Pontianak District with ~~1~~ one ~~F~~fuel ~~F~~filling ~~S~~station, West Pontianak District with ~~2~~ two ~~F~~fuel ~~F~~filling s~~S~~tations, and Pontianak Kota District with ~~3~~ three f~~F~~uel f~~F~~illing s~~S~~tations. Based on the results of interviews and

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observations, the gas stations provide a 24-hour service, with gas station operators working ~~hours for~~ 8 hours per shift. Gas station operators work continuously in a standing position ~~continuously~~ and carry out repetitive activities/movements to refuel ~~consu~~customers' vehicles, so they at risk of experiencing work fatigue and musculoskeletal disorders [7]. This study aimed to describe the demographics, work fatigue, and musculoskeletal disorders in gas station operators, and analyze the relationship between work fatigue and musculoskeletal disorders in gas station workers. The research question is ~~how~~ what is the relationship between fatigue and musculoskeletal disorders in gas station operators in Pontianak City. The hypothesis is that there is a relationship between fatigue and musculoskeletal disorders in gas station workers in Pontianak City. This research ~~needs~~ aims to analyze fatigue and musculoskeletal disorders experienced by gas station workers., ~~S~~so that solutions and prevention efforts can be ~~found~~ applied so that workers do not experience fatigue and musculoskeletal disorders.

2. Methods

2.1 Participants

This type of research is an analytic observational study with a cross-sectional approach conducted to analyze the relationship between fatigue and musculoskeletal disorders in gas station workers in Pontianak City, Indonesia. The study involved 150 gas station workers in Pontianak City, Indonesia ~~as respondents~~ who met the inclusion criteria as research respondents. The inclusion criteria for respondents in this study were gas station workers in Pontianak City who were willing to be respondents during the research and were aged <55 years. Respondents were selected through the Simple Random Sampling technique.

Description of work activities ~~that are~~ performed by petrol station operators

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Gas sStation Ooperators work 8 hours daily and rest for 1 hour each shift, six days a week. Workers work in a standing position continuously and perform repetitive motion positionsmovements to refuel consumer customers' vehicles. If there are lots of vehicles refueling, gas station operators are forced to work in a standing position for 7 hours.. Gas station operators are tasked with dealing directly with consumers customers when refueling vehicles. The gas station operator is responsible for opening and closing the vehicle's fuel tank, lifting and inserting the fuel nozzle, and locking and closing the vehicle's fuel tank after filling. This work was is done carried out by gas station operators for hours in a bending and rotating working position bow, rotating working position and standing for a long time.

Research ethics approval was obtained from the Health Research Ethics Committee of the Poltekkes Kemenkes Pontianak No 224/KEPK-PK.PKP/VIII/2022 and written consent (Informed Consent) was obtained from all gas station workers who were research respondents.

2.2 Research Iinstruments

The type of data in this study is primary data consisting of social demographics, levels of work fatigue, and data on symptoms of musculoskeletal disorders and the work environment data. Secondary data consists of data on the number of workers and the working hours of gas station operators. Data on work fatigue were obtained from interviews with respondents using the International Fatigue Research Committee of the Japanese Association of Industrial Health (IFRC) questionnaire [8]. IFRC is a questionnaire that can measure subjective fatigue level, containing 30 questions about general fatigue symptoms. The first ten questions indicate a weakening of activity, the second ten questions a weakening of work motivation, and the third or last final ten questions indicate physical fatigue or fatigue in several various parts of the body. The

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2.3 Procedure

The ~~P~~preparatory ~~S~~stage ~~starts~~ began with the management of health research ethics, secondary data collection, surveys, and field observations to identify problems and explore cooperation, arrange research permits, meetings of the research team and field

officers ~~for~~ on the division of tasks, and common perceptions of research. The implementation stage of the study ~~is~~ was the survey, observation, and inventory of gas station operator worker activities. Then ~~M~~meetings were held with the company to explain the aims and objectives of the research as well as procedures for research activities, determining subjects for research respondents, and explaining the mechanism of research activities to the respondents. Following the fatigue data collection guided by the data collector, the research respondents were asked to complete the questionnaire. Data collection for the assessment of symptoms of musculoskeletal disorders uses a questionnaire that presents a picture of the human body with nine anatomical parts of the body. Data collectors guided respondents to fill out the questionnaire to find out whether the respondent ~~body of the respondent who had~~experienced musculoskeletal symptoms such as pain or discomfort in any part of the body when the study was conducted.

2.4 Data analysis

Descriptive analysis aimed to ~~see~~ determine the distribution characteristics of each dependent variable and independent variable~~. And the presentation of~~ The data was then presented in the form of tables and graphs with simple statistical calculations such as averages, ratios, and percentages. Furthermore, ~~testing~~ the research hypothesis was tested using~~es~~ the chi-square statistical test at the 95% confidence level to determine the relationship between research variables. The test was carried out at the significance level $\alpha = 0.05$; if $p < 0.05$, the test results are significant.

3. Results

~~Fuel Filling Stations for the Public are public facilities provided by the government or the state, foreign or private companies for the general public to meet the fuel needs of various types of motorized vehicles. In general, fuel filling stations sell pertalite, diesel, Pertamax,~~

~~and Pertamax plus fuels. Fuel Filling Stations to make it easier for people to obtain fuel oil for vehicles [6]. This research was conducted at 11 Fuel Filling Stations in Pontianak City, West Kalimantan, Indonesia. In each sub-district, 50% was taken, including North Pontianak Subdistrict with as many as 2 Fuel Filling Stations, East Pontianak District with 1 Fuel Filling Station, and Southeast Districts with as many as 2 Fuel Filling Stations. Stations, South Pontianak District with 1 Fuel Filling Station, West Pontianak District with 2 Fuel Filling Stations, and Pontianak Kota District with 3 Fuel Filling Stations.~~ Fuel filling stations are public facilities provided by the government or the state, and foreign and private companies to meet the fuel needs of various types of motorized vehicles. In general, fuel filling stations sell Pertalite, diesel, Pertamax, and Pertamax Plus fuels and make it easier for the public to obtain the fuel they need for their vehicles [6]. This research was conducted at 11 fuel filling stations in Pontianak City, West Kalimantan, Indonesia. In each sub-district, 50% of stations were studied, including North Pontianak Subdistrict with two fuel filling stations, East Pontianak District with one fuel filling station, Southeast Districts with two fuel filling stations, South Pontianak District with one fuel filling station, West Pontianak District with two fuel filling stations, and Pontianak Kota District with three fuel filling stations. Table 1 shows the demographic distribution of gas station operator workers~~. The demographic distribution of gas station operator workers~~ consist~~ings~~ of ~~6~~ six variables divided into several categories, as shown in

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Table 1. Demographic Distribution of Gas Station Operators in Pontianak City

Variable	Category	Results	
		n	%
age	< 40 years	120	80%

	≥ 40 years	30	20%
Education	Basic education	0	0%
	Middle education	144	96%
	Higher education	6	4%
Years of service	< 1 years	10	6,7%
	1-5 years	92	61,3%
	>5 years	48	32%
Marital status	Marriedy	72	48%
	Single	78	52%
Work fatigue	High	75	50%
	Low	75	50%
Musculoskeletal disorders	High	39	26%
	Low	111	74%

Table 1. 120 (80%) gas station operator workers are <40 years old. A total of 144 (96%) gas station operator workers have a high school educational background. 92 (61.3%) gas station operators have worked for 1– 5 years. Most workers, namely 78 (52%), have are single status. In addition, as many as 75 (50%) gas station operators experienced high work fatigue. And as many as 111 (74%) workers have low-grade musculoskeletal disorders.

Table 2. Analysis of Musculoskeletal Disorders and Work Fatigue in Gas Station Workers Operators in Pontianak City

Variable	mMean	Standard deviation	mMin	mMax	r count	P value
Musculoskeletal Ddisorders	9,773	5,294	0	27	0,577	0,000
Work Ffatigue	55,4	9,591	35	81		

The results of the test of the hypothesis on the relationship test between musculoskeletal events and worker fatigue obtained an r count value of 0.577 more than the r table with df = n -2 = 150 - 2 = 148 received obtaining an r table of 0.160 so that the value of r count (0.577) > r table (0.160) and p-value 0.001 so that the hypothesis in the study was accepted, namely that there was a relationship between musculoskeletal events and fatigue in gas station workers. This is confirms the opinion finding of Kremelberg (2014) that if the value of r count > r table, there is a correlation or a relationship between

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variables [11].

Table 3. Distribution of Work Fatigue and Musculoskeletal Disorders in Pontianak City Gas Station ~~Workers~~ Operators

Musculoskeletal Disorders	Work Fatigue			P Value	OR
	~~h~~High	Low	Total		
High	33(22%)	42(28%)	75(50%)	0.000	9.036
~~H~~Low	6(4%)	69(46%)	75(50%)		
Total	39(26%)	111(74%)	150(100%).		

The relationship between work fatigue and musculoskeletal ~~events~~ symptoms in ~~at~~ gas stations ~~workers~~ operators showed that high fatigue with high musculoskeletal disorders ~~totaled~~ was found in 33 respondents (22%), low fatigue ~~events~~ symptoms with low musculoskeletal ~~numbers~~ in 69 respondents (46%), high musculoskeletal ~~events~~ symptoms with low fatigue ~~number of~~in 39 respondents (26%), and extremely high musculoskeletal ~~events~~ symptoms with high work fatigue ~~amounted to~~in 42 respondents (28%). The results of the analysis ~~results~~ of the incidence of work fatigue and workers' musculoskeletal disorders obtained a p-value of 0.001, meaning that there is a relationship between the incidence of fatigue and musculoskeletal disorders in gas station workers. The odds ratio (OR) is 9.036, which means that fatigue can trigger musculoskeletal disorders 9.036 times.

4. Discussion

Based on the study's results, 50% of gas station operators in Pontianak City experienced work fatigue in the high category. Risk factors and triggers for work fatigue ~~felt~~ experienced by gas station operators include long working hours in a standing position while providing services to ~~consumers~~customers. This ~~is~~ also ~~to~~ supports Basri's ~~research~~ study (2021) that standing ~~in~~ at work~~ing jobs~~ for a long duration can increase the

risk of work fatigue [12]. Based on the interview results, if there are ~~a lot of~~many customers, the operators can only take breaks to eat and pray, so the operators stand for a long time. Standing for a long time can cause fatigue because it can cause changes in the body's ~~work~~ systems. ~~Veins have difficulty flowing~~The circulation of the blood from the legs to the heart becomes more difficult, with pressure on the joints, and muscle fatigue. ~~When s~~Standing for a long time causes blood flow to the heart to be affected, resulting in muscle contractions and fatigue. Work fatigue is caused by prolonged standing because the thigh and calf muscles contract to hold the body upright [13]. The work demands of gas station operators require ~~gas station operators~~them to stand in static positions while pressing a button on the computer display to calculate the flow of fuel ~~flow~~ to enter the data for the customer's fuel ~~order~~purchase ~~data~~, putting the nozzle into the custo~~consu~~mer's gas tank, closinge the car's tank, and receivinge payments and returning ~~payments~~change. In addition, the condition will be exacerbated when long queues occur during peak hours, resulting in musculoskeletal ~~complaints felt by~~symptoms in gas station operators getting worse because the longer the ~~more extended~~ gas station operators are standing in a static or awkward position, the longer the muscles contract, and the longer muscles will ~~receive the~~be under pressure [14]. Actions ~~that~~ can be ~~made~~ taken to ~~pay attention to~~ensure that working hours ~~only work withi~~comply~~n~~ with the rules, namely 7 hours of work and 1 hour of rest in a day [15]. Activities/movements of gas station operators that are repeated and carried out continuously are also risk factors for fatigue. Repetitive movements can cause muscle fatigue, causing motor reorganization, and decreased performance [16]. Actions that can be taken include applying ~~for a work position inconsistent with~~ consistent work shifts and periodic~~ally~~ stretching. Changing work positions will make the body more flexible, by ~~dividing~~ spreading the workload evenly ~~on~~ across ~~some~~ parts of the body to reduce pressure on joints and muscles;

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~~besides~~in addition, workers who stretch the neck, shoulders, legs, and arms can minimize ~~complaints~~ disorders [17,~~],~~ [18]. The results of the research show that ~~on~~ musculoskeletal disorders in the high category were ~~felt~~ experienced by 26% of gas station operators.

Based on the results of the statistical tests, there is a relationship between work fatigue among gas station workers and musculoskeletal disorders with a p value 0.001 <0.05. This is in line with the research of Chavalitasukalchai and Shahnavaz. Fatigue ~~is a decreased~~reduces body endurance and work capacity that can reduce morale and increase the risk of work accidents. Musculoskeletal disorders can occur due to work fatigue that workers feel continuously [19]. The study's results showed that the OR value was 9.036. That is, every increase in the incidence of fatigue by 1 point would increase the musculoskeletal point 9.036 times. So this issue must receive attention through various efforts: 1) pay attention to the age of workers, ~~do not choose~~avoid older workers because the level of skeletal muscle ~~complaints~~ disorders will ~~continue to~~ increase with age. ~~because, i~~In middle age, muscle strength and endurance begin to decrease so that the risk of ~~complaints~~ muscle disorders ~~start~~ begins to grow [20]. The VO2 max intake ~~A~~ decreases ~~follows~~ with increasing age ~~in VO2 max intake~~, which will reduce work capacity. Decreased work capacity will be marked by physical fatigue caused by muscle weakness.

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Muscles need oxygen and adequate blood supply to carry out metabolic processes and regulate muscle contractions to keep them going [21]. This is also in line with Bridger's research (2020). The older a person is, the higher the risk for that person to experience a decrease in bone elasticity which triggers musculoskeletal disorders [22].

In this study, 20% of operators were > 40 years old. It is hoped that in the future, ~~they will not employ~~ workers > 50 years will not be employed in the gas station operator

section by moving them to the administration ~~section~~.

2) Employ male workers ~~because there are~~rather than female gas station operators. Gender is closely related to musculoskeletal complaints. Physiologically, the ~~ability of male~~ muscles in men are~~is more vital~~stronger than in ~~female~~women ~~forces~~, caused by ~~.~~ ~~D~~differences~~t~~ in hormonal influences between men and women ~~cause this~~. Female hormones make women physically more vulnerable [23]. Gender shows a significant effect on the risk of muscle ~~complaints~~disorders. Female muscles are smaller and only two-thirds (60%) ~~more potent~~as strong as those of ~~than~~ males, especially in the arms, back, and legs [24]. 3) ~~They are considering~~Consider the duration of~~the~~ working periods of gas station operators because ~~it~~ this is a musculoskeletal risk factor. The longer a person is exposed to risk factors, the ~~greater~~ more likely a person ~~feels~~ experiences physical ~~complaints~~ disorders due to ~~his~~ work [25].

Musculoskeletal disorders do not appear spontaneously but gradually until the human body begins to give a pain response~~d to pain~~ [21]. Musculoskeletal disorders can increase if the individual's working period increases, and they will experience physical and psychological boredom. The working period represents a risk factor affecting individuals at work, which can increase the risk of developing musculoskeletal disorders, especially in work activities that utilize large amounts of ~~work~~ energy [23]. ~~So that~~Therefore, fuel station operators who have had a long working period ~~can~~ should be transferred to the administration ~~section~~. 4) Pay attention to gas station operators' working hours, namely working according to the rule of 7 hours of work and 1 hour of rest. Working more than 8 hours ~~of work~~ can increase musculoskeletal disorders, hence the need for working arrangements ~~with~~ of sufficient daily duration to minimize the impact of poor occupational health on workers [26]. And adjust the work shift system to affect the prevalence of musculoskeletal disorders [27].

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Another risk factor that causes fatigue is an uncomfortable work environment, which is also a cause of fatigue ~~felt~~ among ~~by~~ gas station operators, such as the temperature ~~in~~ of the work environment. During the study, the temperature in the gas station work environment in Pontianak City was, on average, above the Threshold Limit, namely in the range of 30.1°C to 34.3°C. The permitted threshold value for ~~the~~ temperature~~s~~ in the work environment ~~that is allowed~~ is 18-30° C [28]. The physical work environment can affect workers' health, especially the climate for physical work ~~climate~~. A physical work climate that exceeds the threshold value can cause functional changes in the body's organs. Hot working ~~climate~~ conditions can cause drowsiness, fatigue, and increase the number of work errors [29]. Exposure to heat for hours can affect the body's balance, ~~where~~ and how the body sweats. The body's ~~heat~~ thermoregulation center originates in the brain, which regulates the blood flow through the vessels in the skin. ~~And this heat source~~ regulat~~ing~~es the heat balance in the human body. At a temperature of 25 °C, human skin can sweat. And the loss of fluids caused by sweating causes fatigue [30~~]~~, ~~[~~31]. Based on the above, it is necessary to modify the workplace to ~~be~~ achieve more ~~adequate~~ comfortable conditions by widening the roof ~~for~~ to provide shelter and regulations on using work uniforms that can reduce body heat [32]. Exposure to gasoline caused by benzene concentrations can also cause fatigue, headaches, coughing, and nausea due to prolonged exposure to inhaled benzene, which also causes chronic effects [33]. It is hoped that gas station companies can identify the dangers of environmental factors through environmental control. One of the controls is using personal protective equipment (PPE) for workers, namely gas station operators wearing masks. The function of PPE ~~–~~ for gas station operators is to protect against exposure to chemicals produced by gasoline components at gas stations [34]. The work environment needs to be improved to minimize symptoms of musculoskeletal disorders and fatigue and increase productivity

[35].

5. Conclusion

The ~~D~~demographic description of gas station operator workers is as follows: 80% are under 40 years old; education level is 96% secondary education, namely junior high school and high school/vocational school; 61.3% ~~working period is~~have been employed for 1–5 years; 52% of workers ~~status is never~~are unmarried. High ~~W~~work fatigue was experienced by 50% of workers ~~is 50% in the high category~~. Severe ~~M~~musculoskeletal disorders ~~of~~ were experienced by 26% of workers ~~26% in the high sort~~. ~~There is~~This study established a relationship between work fatigue and musculoskeletal disorders in gas station operators (p-value = 0.001). Based on the results of the study, the authors suggest that it is necessary to pay attention to the ~~length~~ duration of work in the standing ~~work~~ position, to limit the number of ~~so as not to work more than~~ working hours through ~~work~~ shift arrangements, provide adequate rest arrangements, ~~and~~ along with stretching and improvement of ergonomic work positions for gas station operators. Modifying the work environment and monitoring and controlling working conditions ~~the work environment~~ are also ~~need to be done~~essential ~~so that~~to ensure that the work environment ~~becomes~~ is safe and comfortable.

Competing Interests

~~t~~There were no conflicts of interest.

Availability of Data and Materials

Data supporting the findings of~~n~~ this study are available on request due to privacy/ethical restrictions.

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Authors' Contributions

Conceptualization : S ; Data Collection and ~~a~~Analysis : ZA, SH ; Methodology : S, ZA, SH ; Draft : S ; Review : S ; Manuscript Preparation : S.

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Author(s): Sunarsieh, Zainal Akhmadi, Suharno

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Work Fatigue and Musculoskeletal Disorders in Gas Station Operators at Pontianak City, Indonesia

Abstract

Gas station operators are at risk of work fatigue and musculoskeletal disorders due to prolonged standing and repetitive activities while working. This study analyzes the relationship between work fatigue and musculoskeletal disorders in gas station operators in Pontianak City. This study used an observational method with a cross-sectional approach. The sample consists of 150 gas station workers. Data collection was carried out by observing and interviewing research respondents. Respondents' characteristics were recorded through interviews using a questionnaire. Data on work fatigue were obtained by interviews using the International Fatigue Research Committee of the Japanese Association of Industrial Health (IFRC) questionnaire and musculoskeletal data using the Nordic Body Map questionnaire. The study results show that 50% of workers experience a high level of work fatigue, and 26% of workers experience severe musculoskeletal disorders. There is a significant relationship between work fatigue and musculoskeletal diseases (p-value = 0.001). The study established the need for intervention as a preventive measure by providing sufficient rest time, stretching, setting work shifts, improving ergonomic work positions for gas station operators, and controlling the work environment through environmental improvement and monitoring and using PPE.

Keywords: Ergonomic positions, filling station attendant, gas station workers, musculoskeletal disorders, work fatigue.

1. Introduction

Musculoskeletal disorders are occupational diseases. Risk factors for musculoskeletal disorders are excessive fatigue, awkward postures, and repetitive movements [1]. Musculoskeletal disorders and work fatigue are important parts that must be considered because they can affect health problems in workers, affect the quality of life and work efficiency of workers, and reduce worker productivity [2]–[4]. Musculoskeletal disorders affect the skeletal muscles and are experienced as mild to severe pain. Repeatedly using skeletal muscles for a long time at work, even if a person only experiences mild pain, can cause disorders in the form of damage to ligaments, tendons, and joints [5].

Fuel filling stations are public facilities provided by the government or the state, and foreign and private companies to meet the fuel needs of various types of motorized vehicles. In general, fuel filling stations sell Pertalite, Diesel, Pertamax, and Pertamax Plus fuels and make it easier for the public to obtain the fuel they need for their vehicles [6]. This research was conducted at 11 fuel filling stations in Pontianak City, West Kalimantan, Indonesia. In each sub-district, 50% of stations were studied, including North Pontianak Subdistrict with two fuel filling stations, East Pontianak District with one fuel filling station, Southeast Districts with two fuel filling stations, South Pontianak District with one fuel filling station, West Pontianak District with two fuel filling stations, and Pontianak Kota District with three fuel filling stations. Based on the results of interviews and observations, the gas stations provide a 24-hour service, with gas station operators working 8 hours per shift. Gas station operators work continuously in a standing position and carry out repetitive activities/movements to refuel customers' vehicles, so they at risk of experiencing work fatigue and musculoskeletal disorders [7].

This study aimed to describe the demographics, work fatigue, and musculoskeletal disorders in gas station operators, and analyze the relationship between work fatigue and

musculoskeletal disorders in gas station workers. The research question is what is the relationship between fatigue and musculoskeletal disorders in gas station operators in Pontianak City. The hypothesis is that there is a relationship between fatigue and musculoskeletal disorders in gas station workers in Pontianak City. This research aims to analyze fatigue and musculoskeletal disorders experienced by gas station workers, so that solutions and prevention efforts can be applied so that workers do not experience fatigue and musculoskeletal disorders.

2. Methods

2.1 Participants

This type of research is an analytic observational study with a cross-sectional approach conducted to analyze the relationship between fatigue and musculoskeletal disorders in gas station workers in Pontianak City, Indonesia. The study involved 150 gas station workers in Pontianak City, Indonesia who met the inclusion criteria as research respondents. The inclusion criteria for respondents in this study were gas station workers in Pontianak City who were willing to be respondents during the research and were aged <55 years. Respondents were selected through the Simple Random Sampling technique. Research ethics approval was obtained from the Health Research Ethics Committee of the Poltekkes Kemenkes Pontianak No 224/KEPK-PK.PKP/VIII/2022 and written consent (Informed Consent) was obtained from all gas station workers who were research respondents.

2.2 Description of work activities performed by petrol station operators

Gas station operators work 8 hours daily and rest for 1 hour each shift, six days a week. Workers work in a standing position continuously and perform repetitive movements to

refuel customers' vehicles. If there are lots of vehicles refueling, gas station operators are forced to work in a standing position for 7 hours. Gas station operators are tasked with dealing directly with customers when refueling vehicles. The gas station operator is responsible for opening and closing the vehicle's fuel tank, lifting and inserting the fuel nozzle, and locking and closing the vehicle's fuel tank after filling. This work is carried out by gas station operators for hours in a bending and rotating position and standing for a long time.

2.3 Research instruments

The type of data in this study is primary data consisting of social demographics, levels of work fatigue, and data on symptoms of musculoskeletal disorders and the work environment. Secondary data consists of data on the number of workers and the working hours of gas station operators. Data on work fatigue were obtained from interviews with respondents using the International Fatigue Research Committee of the Japanese Association of Industrial Health (IFRC) questionnaire [8]. IFRC is a questionnaire that can measure subjective fatigue level, containing 30 questions about general fatigue symptoms. The first ten questions indicate a weakening of activity, the second ten questions a weakening of work motivation, and the final ten questions indicate physical fatigue or fatigue in various parts of the body. The higher the frequency of signs of fatigue occurring, the greater the level of fatigue. After conducting interviews and filling out the questionnaire, the next step was to calculate the score for the 30 questions, and the total becomes the individual's total score. Based on the subjective fatigue assessment design with 30 questions, the highest individual score was 120. Questionnaire answers were scored according to four Likert scales, divided into four categories, namely 'Very often' with a value of 4, 'Often' with a value of 3, 'Sometimes' with a value of 2, and 'Never' with a value of 1. In determining the classification of fatigue levels, the answers to each

question are added up, and then the results of the sum score are adjusted to a particular category. Fatigue level classification is based on individual total scores. The separate full scores and classification levels of fatigue are 0–55 = low fatigue and 56–120 = high fatigue [8]. The Nordic Body Map research instrument was applied to collect data on symptoms of musculoskeletal disorders in the gas station workers. The Nordic Body Map Musculoskeletal Questionnaire contains a body map that shows the parts of the body that may experience pain. These body parts include the neck, shoulders, arms, back, waist, buttocks, elbows, wrists, hands, thighs, knees, calves, ankles, and soles of the feet [9]. Assessment using the Nordic Body Map questionnaire uses 4 Likert scales consisting of 1: not painful, 2: slightly painful, 3: painful, and 4: very painful. Workers who were research respondents were asked to provide an assessment of the parts of their body that felt painful during work activities according to a predetermined Likert scale [10].

2.4 Procedure

The preparatory stage began with the management of health research ethics, secondary data collection, surveys, and field observations to identify problems and explore cooperation, arrange research permits, meetings of the research team and field officers on the division of tasks, and common perceptions of research. The implementation stage of the study was the survey, observation, and inventory of gas station operator worker activities. Then meetings were held with the company to explain the aims and objectives of the research as well as procedures for research activities, determining subjects for research respondents, and explaining the mechanism of research activities to the respondents. Following the fatigue data collection guided by the data collector, the research respondents were asked to complete the questionnaire. Data collection for the assessment of symptoms of musculoskeletal disorders uses a questionnaire that presents a picture of the human body with nine anatomical parts of the body. Data collectors

guided respondents to fill out the questionnaire to find out whether the respondent experienced musculoskeletal symptoms such as pain or discomfort in any part of the body when the study was conducted.

2.5 Data analysis

Descriptive analysis aimed to determine the distribution characteristics of each dependent variable and independent variable The data was then presented in the form of tables and graphs with simple statistical calculations such as averages, ratios, and percentages. Furthermore, the research hypothesis was tested using the chi-square statistical test at the 95% confidence level to determine the relationship between research variables. The test was carried out at the significance level $\alpha = 0.05$; if $p < 0.05$, the test results are significant.

3. Results

Fuel filling stations are public facilities provided by the government or the state, and foreign and private companies to meet the fuel needs of various types of motorized vehicles. In general, fuel filling stations sell Pertalite, diesel, Pertamax, and Pertamax Plus fuels and make it easier for the public to obtain the fuel they need for their vehicles [6]. This research was conducted at 11 fuel filling stations in Pontianak City, West Kalimantan, Indonesia. In each sub-district, 50% of stations were studied, including North Pontianak Subdistrict with two fuel filling stations, East Pontianak District with one fuel filling station, Southeast Districts with two fuel filling stations, South Pontianak District with one fuel filling station, West Pontianak District with two fuel filling stations, and Pontianak Kota District with three fuel filling stations. Table 1 shows the demographic distribution of gas station operator workers consisting of six variables divided into several categories, as shown in Table 1. 120 (80%) gas station operator workers are <40 years old. A total of 144 (96%) gas station operator workers have a high

school educational background. 92 (61.3%) gas station operators have worked for 1–5 years. Most workers, namely 78 (52%), are single. In addition, as many as 75 (50%) gas station operators experienced high work fatigue. And as many as 111 (74%) workers have low-grade musculoskeletal disorders (Table 1).

events and worker fatigue obtained an r count value of 0.577 more than the r table with df = n -2 = 150 - 2 = 148 obtaining an r table of 0.160 so that the value of r count (0.577) > r table (0.160) and p-value 0.001 so that the hypothesis in the study was accepted, namely that there was a relationship between musculoskeletal events and fatigue in gas station workers. This confirms the finding of Kremelberg [11] that if the value of r count > r table, there is a correlation or a relationship between variables (Table 2).

The relationship between work fatigue and musculoskeletal symptoms in gas stations operators showed that high fatigue with high musculoskeletal disorders was found in 33 respondents (22%), low fatigue symptoms with low musculoskeletal in 69 respondents (46%), high musculoskeletal symptoms with low fatigue in 39 respondents (26%), and extremely high musculoskeletal symptoms with high work fatigue in 42 respondents (28%). The results of the analysis of the incidence of work fatigue and workers' musculoskeletal disorders obtained a p-value of 0.001, meaning that there is a relationship between the incidence of fatigue and musculoskeletal disorders in gas station workers. The odds ratio (OR) is 9.036, which means that fatigue can trigger musculoskeletal disorders 9.036 times (Table 3).

4. Discussion

Based on the study's results, 50% of gas station operators in Pontianak City experienced work fatigue in the high category. Risk factors and triggers for work fatigue experienced by gas station operators include long working hours in a standing position

while providing services to customers. This also supports Basri et al. [12] study that standing at work for a long duration can increase the risk of work fatigue. Based on the interview results, if there are many customers, the operators can only take breaks to eat and pray, so the operators stand for a long time. Standing for a long time can cause fatigue because it can cause changes in the body's systems. The circulation of the blood from the legs to the heart becomes more difficult, with pressure on the joints, and muscle fatigue. Standing for a long time causes blood flow to the heart to be affected, resulting in muscle contractions and fatigue. Work fatigue is caused by prolonged standing because the thigh and calf muscles contract to hold the body upright [13]. The work demands of gas station operators require them to stand in static positions while pressing a button on the computer display to calculate the flow of fuel to enter the data for the customer's fuel purchase, putting the nozzle into the customer's gas tank, closing the car's tank, and receiving payments and returning change. In addition, the condition will be exacerbated when long queues occur during peak hours, resulting in musculoskeletal symptoms in gas station operators getting worse because the longer the gas station operators are standing in a static or awkward position, the longer the muscles contract, and the longer muscles will be under pressure [14]. Actions can be taken to ensure that working hours comply with the rules, namely 7 hours of work and 1 hour of rest in a day [15]. Activities/movements of gas station operators that are repeated and carried out continuously are also risk factors for fatigue. Repetitive movements can cause muscle fatigue, causing motor reorganization, and decreased performance [16]. Actions that can be taken include applying consistent work shifts and periodic stretching. Changing work positions will make the body more flexible, by spreading the workload evenly across parts of the body to reduce pressure on joints and muscles; in addition, workers who stretch the neck, shoulders, legs, and arms can minimize disorders [17], [18].

The results of the research show that musculoskeletal disorders in the high category were experienced by 26% of gas station operators. Based on the results of the statistical tests, there is a relationship between work fatigue among gas station workers and musculoskeletal disorders with a p value 0.001. This is in line with the research of Chavalitasukalchai and Shahnavaz [19] Fatigue reduces body endurance and work capacity that can reduce morale and increase the risk of work accidents. Musculoskeletal disorders can occur due to work fatigue that workers feel continuously. The study's results showed that the OR value was 9.036. That is, every increase in the incidence of fatigue by 1 point would increase the musculoskeletal point 9.036 times. So this issue must receive attention through various efforts: 1) pay attention to the age of workers, avoid older workers because the level of skeletal muscle disorders will increase with age. In middle age, muscle strength and endurance begin to decrease so that the risk of muscle disorders begins to grow [20]. The VO2 max intake decreases with increasing age, which will reduce work capacity. Decreased work capacity will be marked by physical fatigue caused by muscle weakness.

Muscles need oxygen and adequate blood supply to carry out metabolic processes and regulate muscle contractions to keep them going [21]. This is also in line with Bridger's [22] research, The older a person is, the higher the risk for that person to experience a decrease in bone elasticity which triggers musculoskeletal disorders. In this study, 20% of operators were > 40 years old. It is hoped that in the future, workers > 50 years will not be employed in the gas station operator section by moving them to the administration.

2) Employ male workers rather than female gas station operators. Gender is closely related to musculoskeletal complaints. Physiologically, the muscles in men are stronger than in women, caused by differences in hormonal influences between men and

women. Female hormones make women physically more vulnerable [23]. Gender shows a significant effect on the risk of muscle disorders. Female muscles are smaller and only two-thirds (60%) as strong as those of males, especially in the arms, back, and legs [24]. 3) Consider the duration of working periods of gas station operators because this is a musculoskeletal risk factor. The longer a person is exposed to risk factors, the more likely a person experiences physical disorders due to work [25].

Musculoskeletal disorders do not appear spontaneously but gradually until the human body begins to give a pain response [21]. Musculoskeletal disorders can increase if the individual's working period increases, and they will experience physical and psychological boredom. The working period represents a risk factor affecting individuals at work, which can increase the risk of developing musculoskeletal disorders, especially in work activities that utilize large amounts of energy [23]. Therefore, fuel station operators who have had a long working period should be transferred to the administration. 4) Pay attention to gas station operators' working hours, namely working according to the rule of 7 hours of work and 1 hour of rest. Working more than 8 hours can increase musculoskeletal disorders, hence the need for working arrangements of sufficient daily duration to minimize the impact of poor occupational health on workers [26]. And adjust the work shift system to affect the prevalence of musculoskeletal disorders [27].

Another risk factor that causes fatigue is an uncomfortable work environment, which is also a cause of fatigue among gas station operators, such as the temperature of the work environment. During the study, the temperature in the gas station work environment in Pontianak City was, on average, above the Threshold Limit, namely in the range of 30.1°C to 34.3°C. The permitted threshold value for temperatures in the work environment is 18-30° C [28]. The physical work environment can affect workers' health, especially the climate for physical work. A physical work climate that exceeds the

threshold value can cause functional changes in the body's organs. Hot working conditions can cause drowsiness, fatigue, and increase the number of work errors [29]. Exposure to heat for hours can affect the body's balance, and how the body sweats. The body's thermoregulation center originates in the brain, which regulates the blood flow through the vessels in the skin, regulating the heat balance in the human body. At a temperature of 25 °C, human skin can sweat. And the loss of fluids caused by sweating causes fatigue [30], [31]. Based on the above, it is necessary to modify the workplace to achieve more comfortable conditions by widening the roof to provide shelter and regulations on using work uniforms that can reduce body heat [32]. Exposure to gasoline caused by benzene concentrations can also cause fatigue, headaches, coughing, and nausea due to prolonged exposure to inhaled benzene, which also causes chronic effects [33]. It is hoped that gas station companies can identify the dangers of environmental factors through environmental control. One of the controls is using personal protective equipment (PPE) for workers, namely gas station operators wearing masks. The function of PPE for gas station operators is to protect against exposure to chemicals produced by gasoline components at gas stations [34]. The work environment needs to be improved to minimize symptoms of musculoskeletal disorders and fatigue and increase productivity [35].

5. Conclusion

The demographic description of gas station operator workers is as follows: 80% are under 40 years old; education level is 96% secondary education, namely junior high school and high school/vocational school; 61.3% have been employed for 1–5 years; 52% of workers are unmarried. High work fatigue was experienced by 50% of workers. Severe musculoskeletal disorders were experienced by 26% of workers. This study established a relationship between work fatigue and musculoskeletal disorders in gas station operators

(p-value = 0.001). Based on the results of the study, the authors suggest that it is necessary to pay attention to the duration of work in the standing position, to limit the number of working hours through shift arrangements, provide adequate rest arrangements, along with stretching and improvement of ergonomic work positions for gas station operators. Modifying the work environment and monitoring and controlling working conditions are also essential to ensure that the work environment is safe and comfortable.

Competing Interests

There were no conflicts of interest.

Availability of Data and Materials

Data supporting the findings of this study are available on request due to privacy/ethical restrictions.

Authors' Contributions

Conceptualization : S ; Data Collection and Analysis : ZA, SH ; Methodology : S, ZA, SH ; Draft : S ; Review : S ; Manuscript Preparation : S.

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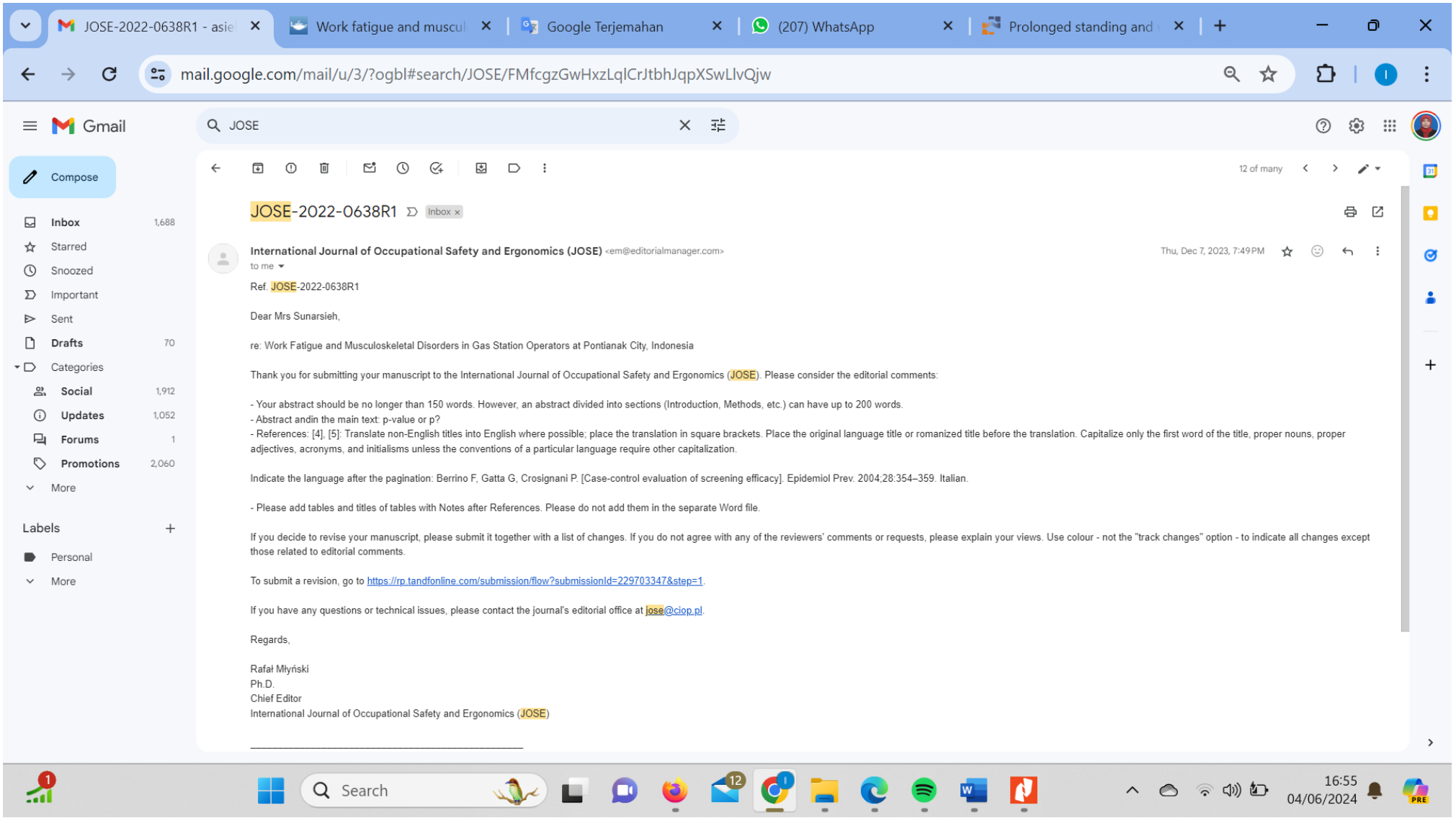
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Work Fatigue and Musculoskeletal Disorders in Gas Station Operators at Pontianak City, Indonesia

Abstract

This study analyzes the relationship between work fatigue and musculoskeletal disorders in gas station operators in Pontianak City. This study used with a cross-sectional approach. The sample consists of 150 gas station workers. Data collection was carried out by observing and interviewing. Respondents characteristics were recorded through interviews using a questionnaire. Data on work fatigue were obtained by interviews using the IFRC questionnaire and musculoskeletal data using the Nordic Body Map questionnaire. The study results show that 50% of workers experience a high level of work fatigue, and 26% of workers experience severe musculoskeletal disorders. There is a significant relationship between work fatigue and musculoskeletal diseases ($p = 0.001$). The study established the need for intervention as a preventive measure by providing sufficient rest time, stretching, setting work shifts, improving ergonomic work positions for gas station operators, and controlling the work environment through environmental improvement and monitoring and using PPE.

Keywords: Ergonomic positions, filling station attendant, gas station workers, musculoskeletal disorders, work fatigue.

1. Introduction

Musculoskeletal disorders are occupational diseases. Risk factors for musculoskeletal disorders are excessive fatigue, awkward postures, and repetitive movements [1]. Musculoskeletal disorders and work fatigue are important parts that must be considered because they can affect health problems in workers, affect the quality of life and work efficiency of workers, and reduce worker productivity [2]–[4]. Musculoskeletal disorders affect the skeletal muscles and are experienced as mild to severe pain. Repeatedly using

skeletal muscles for a long time at work, even if a person only experiences mild pain, can cause disorders in the form of damage to ligaments, tendons, and joints [5].

Fuel filling stations are public facilities provided by the government or the state, and foreign and private companies to meet the fuel needs of various types of motorized vehicles. In general, fuel filling stations sell Pertalite, Diesel, Pertamax, and Pertamax Plus fuels and make it easier for the public to obtain the fuel they need for their vehicles [6]. This research was conducted at 11 fuel filling stations in Pontianak City, West Kalimantan, Indonesia. In each sub-district, 50% of stations were studied, including North Pontianak Subdistrict with two fuel filling stations, East Pontianak District with one fuel filling station, Southeast Districts with two fuel filling stations, South Pontianak District with one fuel filling station, West Pontianak District with two fuel filling stations, and Pontianak Kota District with three fuel filling stations. Based on the results of interviews and observations, the gas stations provide a 24-hour service, with gas station operators working 8 hours per shift. Gas station operators work continuously in a standing position and carry out repetitive activities/movements to refuel customers' vehicles, so they at risk of experiencing work fatigue and musculoskeletal disorders [7].

This study aimed to describe the demographics, work fatigue, and musculoskeletal disorders in gas station operators, and analyze the relationship between work fatigue and musculoskeletal disorders in gas station workers. The research question is what is the relationship between fatigue and musculoskeletal disorders in gas station operators in Pontianak City. The hypothesis is that there is a relationship between fatigue and musculoskeletal disorders in gas station workers in Pontianak City. This research aims to analyze fatigue and musculoskeletal disorders experienced by gas station workers, so that solutions and prevention efforts can be applied so that workers do not experience fatigue and musculoskeletal disorders.

2. Methods

2.1 Participants

This type of research is an analytic observational study with a cross-sectional approach conducted to analyze the relationship between fatigue and musculoskeletal disorders in gas station workers in Pontianak City, Indonesia. The study involved 150 gas station workers in Pontianak City, Indonesia who met the inclusion criteria as research respondents. The inclusion criteria for respondents in this study were gas station workers in Pontianak City who were willing to be respondents during the research and were aged <55 years. Respondents were selected through the Simple Random Sampling technique. Research ethics approval was obtained from the Health Research Ethics Committee of the Poltekkes Kemenkes Pontianak No 224/KEPK-PK.PKP/VIII/2022 and written consent (Informed Consent) was obtained from all gas station workers who were research respondents.

2.2 Description of work activities performed by petrol station operators

Gas station operators work 8 hours daily and rest for 1 hour each shift, six days a week. Workers work in a standing position continuously and perform repetitive movements to refuel customers' vehicles. If there are lots of vehicles refueling, gas station operators are forced to work in a standing position for 7 hours. Gas station operators are tasked with dealing directly with customers when refueling vehicles. The gas station operator is responsible for opening and closing the vehicle's fuel tank, lifting and inserting the fuel nozzle, and locking and closing the vehicle's fuel tank after filling. This work is carried out by gas station operators for hours in a bending and rotating position and standing for a long time.

2.3 Research instruments

The type of data in this study is primary data consisting of social demographics, levels of work fatigue, and data on symptoms of musculoskeletal disorders and the work environment. Secondary data consists of data on the number of workers and the working hours of gas station operators. Data on work fatigue were obtained from interviews with respondents using the International Fatigue Research Committee of the Japanese Association of Industrial Health (IFRC) questionnaire [8]. IFRC is a questionnaire that can measure subjective fatigue level, containing 30 questions about general fatigue symptoms. The first ten questions indicate a weakening of activity, the second ten questions a weakening of work motivation, and the final ten questions indicate physical fatigue or fatigue in various parts of the body. The higher the frequency of signs of fatigue occurring, the greater the level of fatigue. After conducting interviews and filling out the questionnaire, the next step was to calculate the score for the 30 questions, and the total becomes the individual's total score. Based on the subjective fatigue assessment design with 30 questions, the highest individual score was 120. Questionnaire answers were scored according to four Likert scales, divided into four categories, namely 'Very often' with a value of 4, 'Often' with a value of 3, 'Sometimes' with a value of 2, and 'Never' with a value of 1. In determining the classification of fatigue levels, the answers to each question are added up, and then the results of the sum score are adjusted to a particular category. Fatigue level classification is based on individual total scores. The separate full scores and classification levels of fatigue are 0–55 = low fatigue and 56–120 = high fatigue [8]. The Nordic Body Map research instrument was applied to collect data on symptoms of musculoskeletal disorders in the gas station workers. The Nordic Body Map Musculoskeletal Questionnaire contains a body map that shows the parts of the body that may experience pain. These body parts include the neck, shoulders, arms, back, waist,

buttocks, elbows, wrists, hands, thighs, knees, calves, ankles, and soles of the feet [9]. Assessment using the Nordic Body Map questionnaire uses 4 Likert scales consisting of 1: not painful, 2: slightly painful, 3: painful, and 4: very painful. Workers who were research respondents were asked to provide an assessment of the parts of their body that felt painful during work activities according to a predetermined Likert scale [10].

2.4 Procedure

The preparatory stage began with the management of health research ethics, secondary data collection, surveys, and field observations to identify problems and explore cooperation, arrange research permits, meetings of the research team and field officers on the division of tasks, and common perceptions of research. The implementation stage of the study was the survey, observation, and inventory of gas station operator worker activities. Then meetings were held with the company to explain the aims and objectives of the research as well as procedures for research activities, determining subjects for research respondents, and explaining the mechanism of research activities to the respondents. Following the fatigue data collection guided by the data collector, the research respondents were asked to complete the questionnaire. Data collection for the assessment of symptoms of musculoskeletal disorders uses a questionnaire that presents a picture of the human body with nine anatomical parts of the body. Data collectors guided respondents to fill out the questionnaire to find out whether the respondent experienced musculoskeletal symptoms such as pain or discomfort in any part of the body when the study was conducted.

2.5 Data analysis

Descriptive analysis aimed to determine the distribution characteristics of each dependent variable and independent variable The data was then presented in the form of tables and

graphs with simple statistical calculations such as averages, ratios, and percentages. Furthermore, the research hypothesis was tested using the chi-square statistical test at the 95% confidence level to determine the relationship between research variables. The test was carried out at the significance level $\alpha = 0.05$; if $p < 0.05$, the test results are significant.

3. Results

Fuel filling stations are public facilities provided by the government or the state, and foreign and private companies to meet the fuel needs of various types of motorized vehicles. In general, fuel filling stations sell Pertalite, diesel, Pertamax, and Pertamax Plus fuels and make it easier for the public to obtain the fuel they need for their vehicles [6]. This research was conducted at 11 fuel filling stations in Pontianak City, West Kalimantan, Indonesia. In each sub-district, 50% of stations were studied, including North Pontianak Subdistrict with two fuel filling stations, East Pontianak District with one fuel filling station, Southeast Districts with two fuel filling stations, South Pontianak District with one fuel filling station, West Pontianak District with two fuel filling stations, and Pontianak Kota District with three fuel filling stations. Table 1 shows the demographic distribution of gas station operator workers consisting of six variables divided into several categories, as shown in Table 1. 120 (80%) gas station operator workers are <40 years old. A total of 144 (96%) gas station operator workers have a high school educational background. 92 (61.3%) gas station operators have worked for 1–5 years. Most workers, namely 78 (52%), are single. In addition, as many as 75 (50%) gas station operators experienced high work fatigue. And as many as 111 (74%) workers have low-grade musculoskeletal disorders (Table 1).

events and worker fatigue obtained an r count value of 0.577 more than the r table with df = n -2 = 150 - 2 = 148 obtaining an r table of 0.160 so that the value of r count (0.577)

> r table (0.160) and p = 0.001 so that the hypothesis in the study was accepted, namely that there was a relationship between musculoskeletal events and fatigue in gas station workers. This confirms the finding of Kremelberg [11] that if the value of r count > r table, there is a correlation or a relationship between variables (Table 2).

The relationship between work fatigue and musculoskeletal symptoms in gas stations operators showed that high fatigue with high musculoskeletal disorders was found in 33 respondents (22%), low fatigue symptoms with low musculoskeletal in 69 respondents (46%), high musculoskeletal symptoms with low fatigue in 39 respondents (26%), and extremely high musculoskeletal symptoms with high work fatigue in 42 respondents (28%). The results of the analysis of the incidence of work fatigue and workers' musculoskeletal disorders obtained a p = 0.001, meaning that there is a relationship between the incidence of fatigue and musculoskeletal disorders in gas station workers. The odds ratio (OR) is 9.036, which means that fatigue can trigger musculoskeletal disorders 9.036 times (Table 3).

4. Discussion

Based on the study's results, 50% of gas station operators in Pontianak City experienced work fatigue in the high category. Risk factors and triggers for work fatigue experienced by gas station operators include long working hours in a standing position while providing services to customers. This also supports Basri et al. [12] study that standing at work for a long duration can increase the risk of work fatigue. Based on the interview results, if there are many customers, the operators can only take breaks to eat and pray, so the operators stand for a long time. Standing for a long time can cause fatigue because it can cause changes in the body's systems. The circulation of the blood from the legs to the heart becomes more difficult, with pressure on the joints, and muscle fatigue.

Standing for a long time causes blood flow to the heart to be affected, resulting in muscle contractions and fatigue. Work fatigue is caused by prolonged standing because the thigh and calf muscles contract to hold the body upright [13]. The work demands of gas station operators require them to stand in static positions while pressing a button on the computer display to calculate the flow of fuel to enter the data for the customer's fuel purchase, putting the nozzle into the customer's gas tank, closing the car's tank, and receiving payments and returning change. In addition, the condition will be exacerbated when long queues occur during peak hours, resulting in musculoskeletal symptoms in gas station operators getting worse because the longer the gas station operators are standing in a static or awkward position, the longer the muscles contract, and the longer muscles will be under pressure [14]. Actions can be taken to ensure that working hours comply with the rules, namely 7 hours of work and 1 hour of rest in a day [15]. Activities/movements of gas station operators that are repeated and carried out continuously are also risk factors for fatigue. Repetitive movements can cause muscle fatigue, causing motor reorganization, and decreased performance [16]. Actions that can be taken include applying consistent work shifts and periodic stretching. Changing work positions will make the body more flexible, by spreading the workload evenly across parts of the body to reduce pressure on joints and muscles; in addition, workers who stretch the neck, shoulders, legs, and arms can minimize disorders [17], [18].

The results of the research show that musculoskeletal disorders in the high category were experienced by 26% of gas station operators. Based on the results of the statistical tests, there is a relationship between work fatigue among gas station workers and musculoskeletal disorders with a $p = 0.001$. This is in line with the research of Chavalitasukalchai and Shahnavaz [19] Fatigue reduces body endurance and work capacity that can reduce morale and increase the risk of work accidents. Musculoskeletal

disorders can occur due to work fatigue that workers feel continuously. The study's results showed that the OR value was 9.036. That is, every increase in the incidence of fatigue by 1 point would increase the musculoskeletal point 9.036 times. So this issue must receive attention through various efforts: 1) pay attention to the age of workers, avoid older workers because the level of skeletal muscle disorders will increase with age. In middle age, muscle strength and endurance begin to decrease so that the risk of muscle disorders begins to grow [20]. The VO2 max intake decreases with increasing age, which will reduce work capacity. Decreased work capacity will be marked by physical fatigue caused by muscle weakness.

Muscles need oxygen and adequate blood supply to carry out metabolic processes and regulate muscle contractions to keep them going [21]. This is also in line with Bridger's [22] research, The older a person is, the higher the risk for that person to experience a decrease in bone elasticity which triggers musculoskeletal disorders. In this study, 20% of operators were > 40 years old. It is hoped that in the future, workers > 50 years will not be employed in the gas station operator section by moving them to the administration.

2) Employ male workers rather than female gas station operators. Gender is closely related to musculoskeletal complaints. Physiologically, the muscles in men are stronger than in women, caused by differences in hormonal influences between men and women. Female hormones make women physically more vulnerable [23]. Gender shows a significant effect on the risk of muscle disorders. Female muscles are smaller and only two-thirds (60%) as strong as those of males, especially in the arms, back, and legs [24]. 3) Consider the duration of working periods of gas station operators because this is a musculoskeletal risk factor. The longer a person is exposed to risk factors, the more likely a person experiences physical disorders due to work [25].

Musculoskeletal disorders do not appear spontaneously but gradually until the human body begins to give a pain response [21]. Musculoskeletal disorders can increase if the individual's working period increases, and they will experience physical and psychological boredom. The working period represents a risk factor affecting individuals at work, which can increase the risk of developing musculoskeletal disorders, especially in work activities that utilize large amounts of energy [23]. Therefore, fuel station operators who have had a long working period should be transferred to the administration. 4) Pay attention to gas station operators' working hours, namely working according to the rule of 7 hours of work and 1 hour of rest. Working more than 8 hours can increase musculoskeletal disorders, hence the need for working arrangements of sufficient daily duration to minimize the impact of poor occupational health on workers [26]. And adjust the work shift system to affect the prevalence of musculoskeletal disorders [27].

Another risk factor that causes fatigue is an uncomfortable work environment, which is also a cause of fatigue among gas station operators, such as the temperature of the work environment. During the study, the temperature in the gas station work environment in Pontianak City was, on average, above the Threshold Limit, namely in the range of 30.1°C to 34.3°C. The permitted threshold value for temperatures in the work environment is 18-30° C [28]. The physical work environment can affect workers' health, especially the climate for physical work. A physical work climate that exceeds the threshold value can cause functional changes in the body's organs. Hot working conditions can cause drowsiness, fatigue, and increase the number of work errors [29]. Exposure to heat for hours can affect the body's balance, and how the body sweats. The body's thermoregulation center originates in the brain, which regulates the blood flow through the vessels in the skin, regulating the heat balance in the human body. At a temperature of 25 °C, human skin can sweat. And the loss of fluids caused by sweating

causes fatigue [30], [31]. Based on the above, it is necessary to modify the workplace to achieve more comfortable conditions by widening the roof to provide shelter and regulations on using work uniforms that can reduce body heat [32]. Exposure to gasoline caused by benzene concentrations can also cause fatigue, headaches, coughing, and nausea due to prolonged exposure to inhaled benzene, which also causes chronic effects [33]. It is hoped that gas station companies can identify the dangers of environmental factors through environmental control. One of the controls is using personal protective equipment (PPE) for workers, namely gas station operators wearing masks. The function of PPE for gas station operators is to protect against exposure to chemicals produced by gasoline components at gas stations [34]. The work environment needs to be improved to minimize symptoms of musculoskeletal disorders and fatigue and increase productivity [35].

5. Conclusion

The demographic description of gas station operator workers is as follows: 80% are under 40 years old; education level is 96% secondary education, namely junior high school and high school/vocational school; 61.3% have been employed for 1–5 years; 52% of workers are unmarried. High work fatigue was experienced by 50% of workers. Severe musculoskeletal disorders were experienced by 26% of workers. This study established a relationship between work fatigue and musculoskeletal disorders in gas station operators ($p = 0.001$). Based on the results of the study, the authors suggest that it is necessary to pay attention to the duration of work in the standing position, to limit the number of working hours through shift arrangements, provide ad equate rest arrangements, along with stretching and improvement of ergonomic work positions for gas station operators. Modifying the work environment and monitoring and controlling working conditions are also essential to ensure that the work environment is safe and comfortable.

Competing Interests

There were no conflicts of interest.

Availability of Data and Materials

Data supporting the findings of this study are available on request due to privacy/ethical restrictions.

Authors' Contributions

Conceptualization : S ; Data Collection and Analysis : ZA, SH ; Methodology : S, ZA, SH ; Draft : S ; Review : S ; Manuscript Preparation : S.

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Table 1. Demographic Distribution of Gas Station Operators in Pontianak City

Variable	Category	Results	
		n	%
age	< 40 years	120	80%
	≥ 40 years	30	20%
Education	Basic education	0	0%
	Middle education	144	96%
	Higher education	6	4%
Years of service	< 1 years	10	6,7%
	1-5 years	92	61,3%
	>5 years	48	32%
Marital status	Married	72	48%
	Single	78	52%
Work fatigue	High	75	50%
	Low	75	50%
Musculoskeletal disorders	High	39	26%
	Low	111	74%

Note : Sources : Primary Data, 2022
n = The number of research respondents used as samples

Table 2. Analysis of Musculoskeletal Disorders and Work Fatigue in Gas Station Operators in Pontianak City

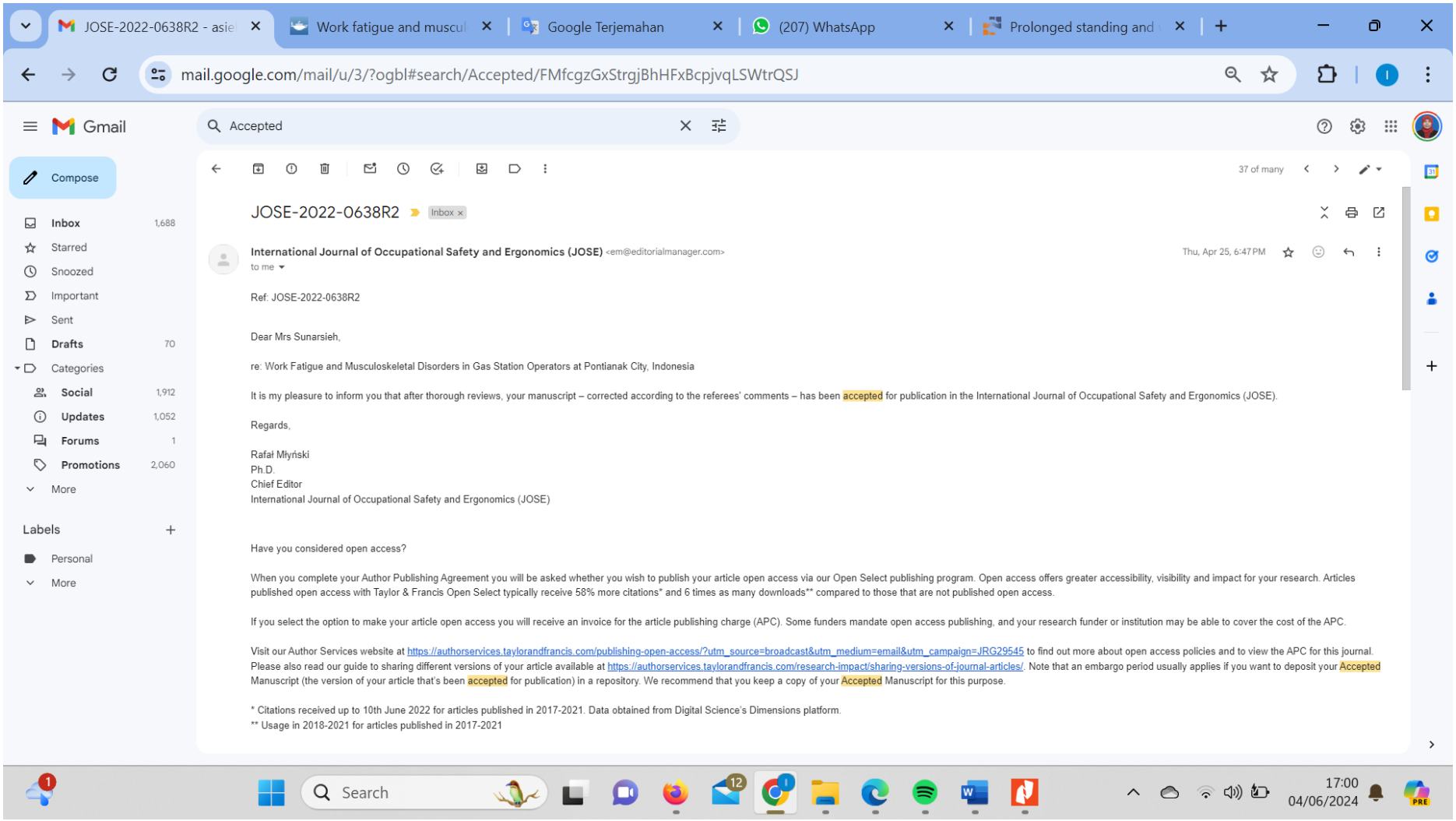
Variable	Mean	Standard deviation	Min	Max	r count	P value[a]
Musculoskeletal disorders	9.773	5.294	0	27	0.577	0.001
Work fatigue	55.4	9.591	35	81		

Note : Sources : Primary Data, 2022
[a] Chi-Square, α = 5%, *Significance p-value≤0.05

Table 3. Distribution of Work Fatigue and Musculoskeletal Disorders in Pontianak City Gas Station Operators

Musculoskeletal Disorders	Work Fatigue			P Value	OR
	High	Low	Total		
High	33(22%)	42(28%)	75(50%)	0.001	9.036
Low	6(4%)	69(46%)	75(50%)		
Total	39(26%)	111(74%)	150(100%).		

Note : Sources : Primary Data, 2022
[a] Chi-Square, α = 5%, *Significance p-value≤0.05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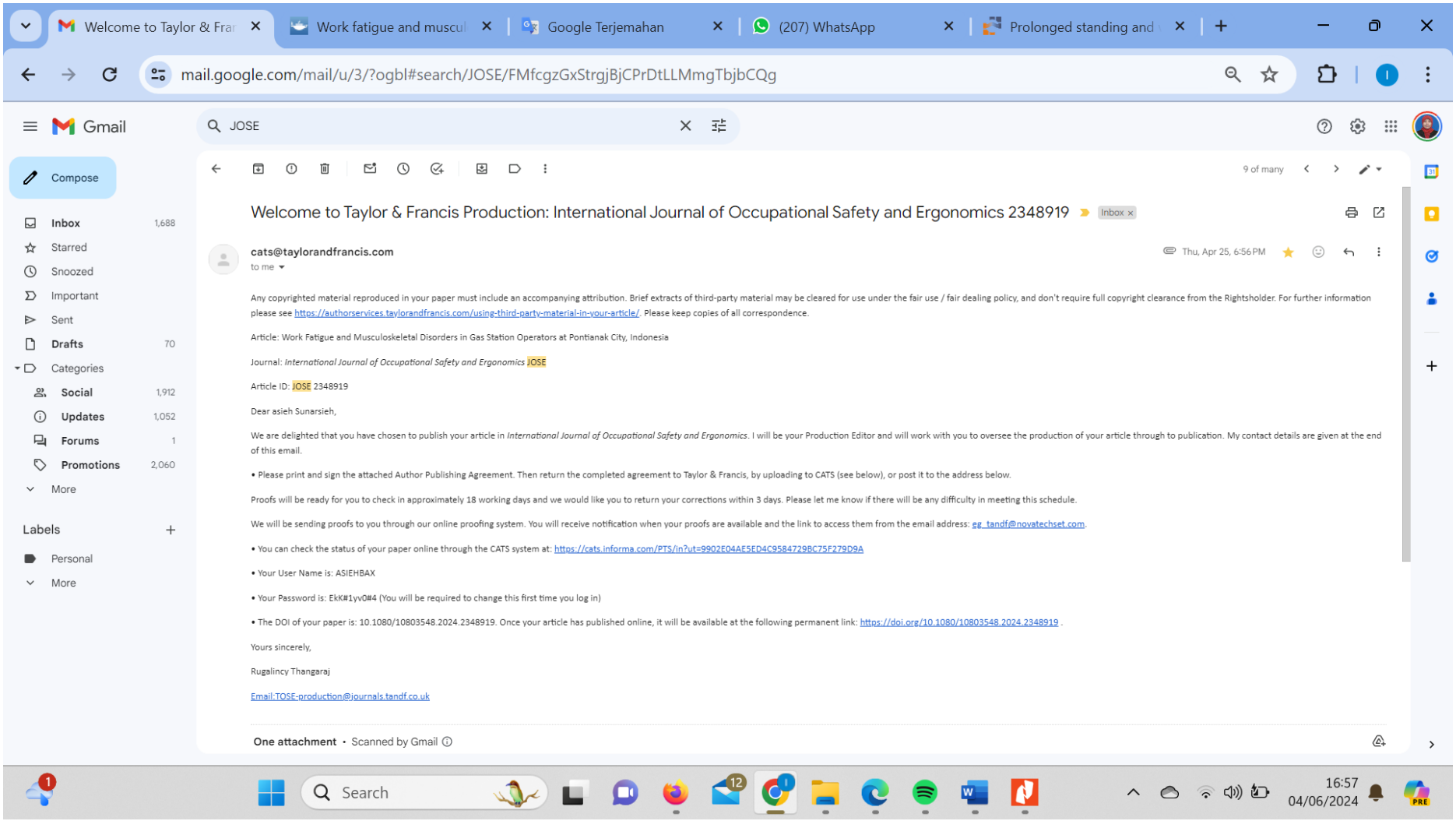
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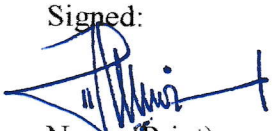

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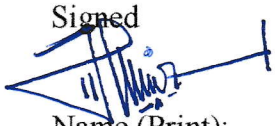

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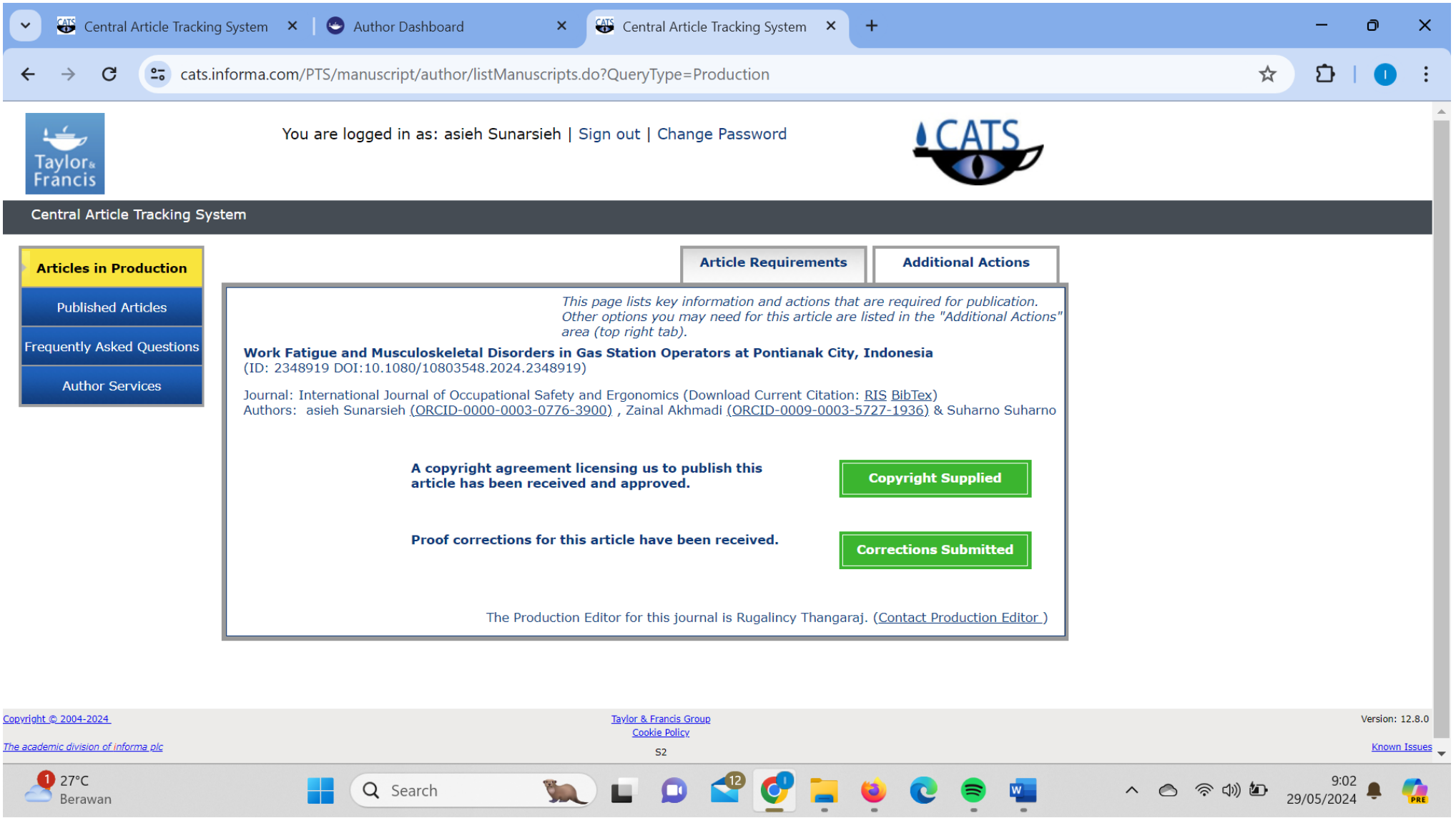
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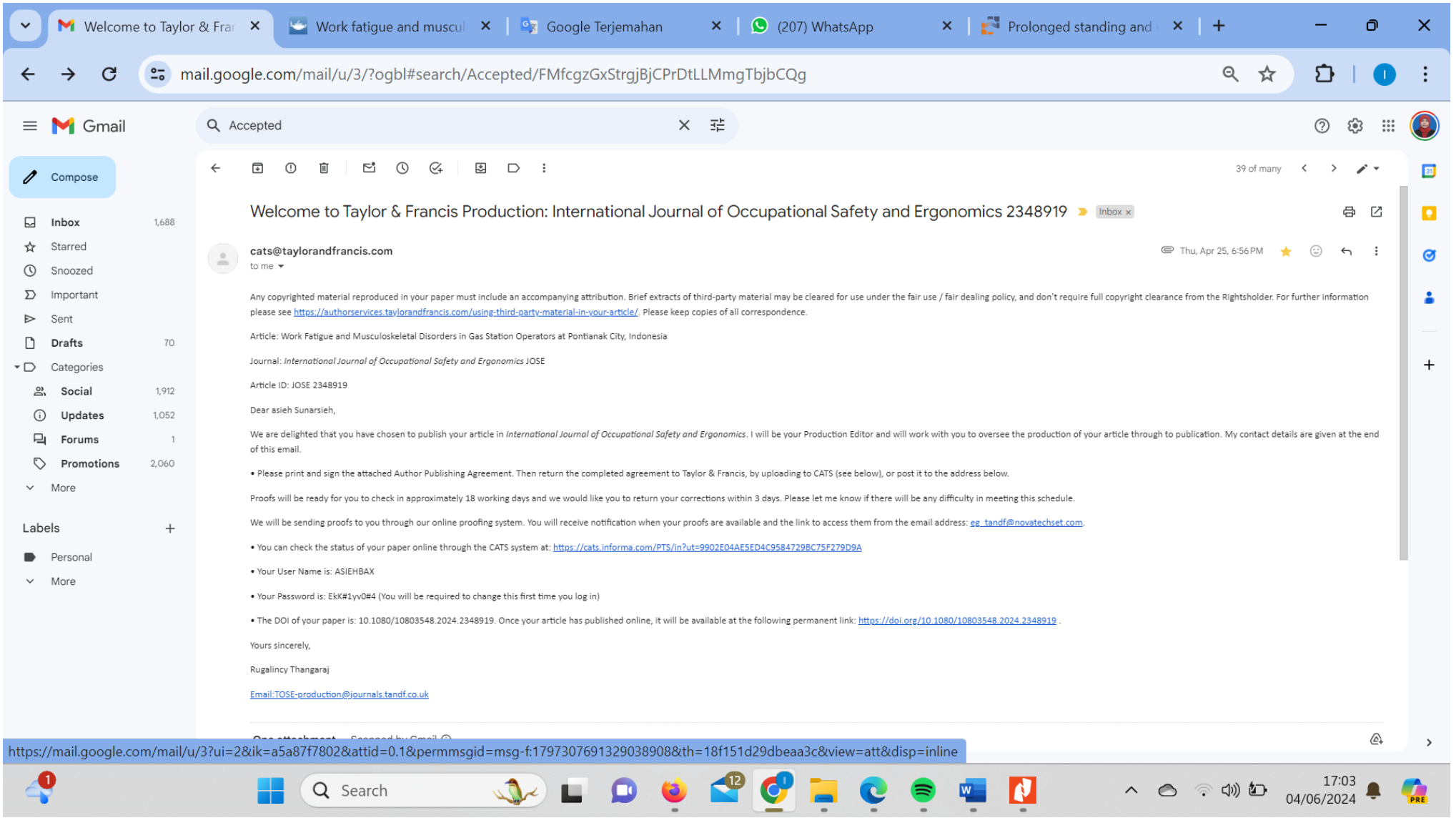
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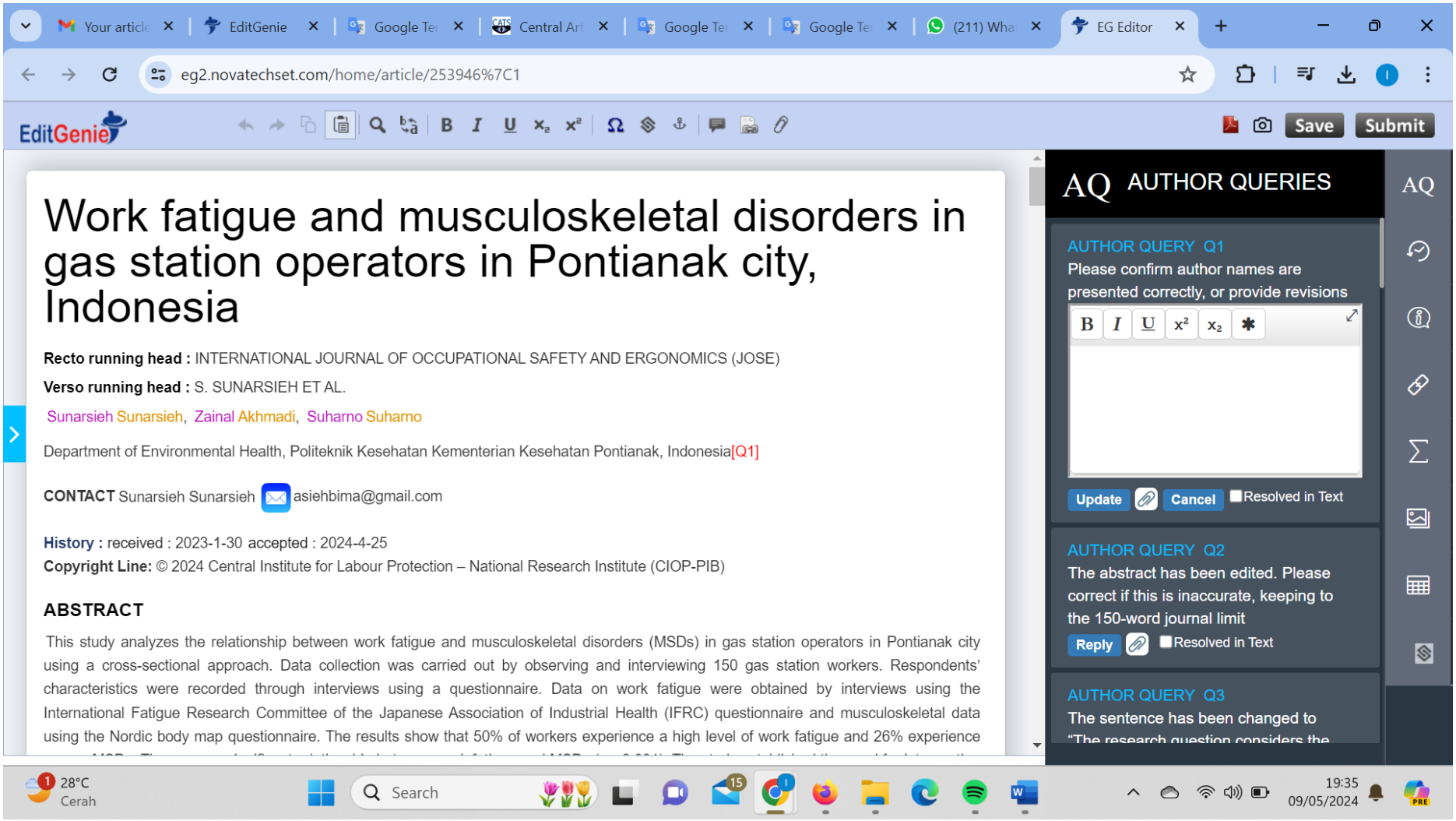
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ABSTRACT
This study analyzes the relationship between work fatigue and musculoskeletal disorders (MSDs) in gas station operators in Pontianak city using a cross-sectional approach. Data collection was carried out by observing and interviewing 150 gas station workers. Respondents' characteristics were recorded through interviews using a questionnaire. Data on work fatigue were obtained by interviews using the International Fatigue Research Committee of the Japanese Association of Industrial Health (IFRC) questionnaire and musculoskeletal data using the Nordic body map questionnaire. The results show that 50% of workers experience a high level of work fatigue and 26% experience
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Work fatigue and musculoskeletal disorders in gas station operators in Pontianak city, Indonesia

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ABSTRACT

This study analyzes the relationship between work fatigue and musculoskeletal disorders (MSDs) in gas station operators in Pontianak city using a cross-sectional approach. Data collection was carried out by observing and interviewing 150 gas station workers. Respondents' characteristics were recorded through interviews using a questionnaire. Data on work fatigue were obtained by interviews using the International Fatigue Research Committee of the Japanese Association of Industrial Health (IFRC) questionnaire and musculoskeletal data using the Nordic body map questionnaire. The results show that 50% of workers experience a high level of work fatigue and 26% experience severe MSDs. There was a significant relationship between work fatigue and MSDs (p = 0.001). The study established the need for intervention as a preventive measure by providing sufficient rest time, stretching, setting work shifts, improving ergonomic work positions for gas station operators, controlling **[Q2]** the work environment through environmental improvement and monitoring, and using personal protective equipment.

Keywords

- ergonomic positions
- filling station attendant
- gas station workers
- musculoskeletal disorders
- work fatigue

1. Introduction

Musculoskeletal disorders (MSDs) are occupational diseases. Risk factors for MSDs are excessive fatigue, awkward postures and repetitive movements [1]. MSDs and work fatigue are important factors that must be considered because they can affect health problems in workers, affect the quality of life and work efficiency of workers, and reduce worker productivity [2–4]. MSDs affect skeletal muscles and are experienced as mild to severe pain. Repeatedly using skeletal muscles for a long time at work, even if a person only experiences mild pain, can cause disorders in the form of damage to ligaments, tendons and joints [5].

Fuel filling stations are public facilities provided by the government or the state and foreign and private companies to meet the fuel needs of various types of motorized vehicles. In general, fuel filling stations sell Pertalite, Diesel, Pertamax and Pertamax Plus fuels and make it easier for the public to obtain the fuel they need for their vehicles [6]. This research was conducted at 11 fuel filling stations in Pontianak city, West Kalimantan, Indonesia. In each sub-district, 50% of stations were studied, including North Pontianak Subdistrict with two fuel filling stations, East Pontianak District with one fuel filling station, Southeast Districts with two fuel filling stations, South Pontianak District with one fuel filling station, West Pontianak District with two fuel filling stations and Pontianak Kota District with three fuel filling stations. Based on the results of interviews and observations, the gas stations provide a 24-h service, with gas station operators working 8 h per shift. Gas station operators work continuously in a standing position and carry out repetitive activities/movements to refuel customers' vehicles, so they are at risk of experiencing work fatigue and MSDs [7].

This study aimed to describe the demographics, work fatigue and MSDs in gas station operators, and to analyze the relationship between work fatigue and MSDs in gas station workers. The research question considers the relationship between fatigue and MSDs in gas station operators in Pontianak city. The hypothesis **[Q3]** is that there is a relationship between fatigue and MSDs in gas station workers in Pontianak city. This research aims to analyze fatigue and MSDs experienced by gas station workers, so that solutions and prevention efforts can be applied so that workers do not experience fatigue and MSDs.

2. Methods

2.1. Participants

This research was an analytic observational study with a cross-sectional approach conducted to analyze the relationship between fatigue and MSDs in gas station workers in Pontianak city, Indonesia. The study involved 150 gas station workers in Pontianak city, Indonesia who met the inclusion criteria as research respondents. The inclusion criteria for respondents in this study were gas station workers in Pontianak city who were willing to be respondents during the research and were aged <55 years. Respondents were selected through the simple random sampling technique. Research ethics approval was obtained from the Health Research Ethics Committee of the Poltekkes Kemenkes Pontianak (No. 224/KEPK-PK.PKP/VIII/2022) and written informed consent was obtained from all of the gas station workers who were research respondents.

2.2. Description of work activities performed by petrol station operators

Gas station operators work 8 h daily and rest for 1 h each shift, 6 days a week. Workers work in a standing position continuously and perform repetitive movements to refuel customers' vehicles. If there are lots of vehicles refueling, gas station operators are forced to work in a standing position for 7 h. Gas station operators are tasked with dealing directly with customers when refueling vehicles. The gas station operator is responsible for opening and closing the vehicle's fuel tank, lifting and inserting the fuel nozzle, and locking and closing the vehicle's fuel tank after filling. This work is carried out by gas station operators for hours in a bending and rotating position and standing for a long time.

2.3. Research instruments

The primary data in this study consist of social demographics, levels of work fatigue, and data on symptoms of MSDs and the work environment. Secondary data consist of the number of workers and the working hours of gas station operators.

Data on work fatigue were obtained from interviews with respondents using the International Fatigue Research Committee of the Japanese Association of Industrial Health (IFRC) questionnaire[8]. The IFRC is a questionnaire that can measure the subjective fatigue level, containing 30 questions about general fatigue symptoms. The first 10 questions indicate a weakening of activity, the second 10 questions a weakening of work motivation and the final 10 questions indicate physical fatigue or fatigue in various parts of the body. The higher the frequency of signs of fatigue occurring, the greater the level of fatigue. After conducting interviews and filling out the questionnaire, the next step was to calculate the score for the 30 questions, and the total becomes the individual's total score. Based on the subjective fatigue assessment design with 30 questions, the highest individual score was 120. Questionnaire answers were scored according to a 4-point Likert scale as follows: 4 = *very often*, 3 = *often*, 2 = *sometimes* and 1 = *never*. In determining the classification of fatigue **[Q4]** levels, the answers to each question are summed, and then the results of the sum score are adjusted to a particular category. Fatigue level classification is based on individual total scores. The separate full scores and classification levels of fatigue are 0–55 = low fatigue and 56–120 = high fatigue [8]. The Nordic body map research instrument was applied to collect data on symptoms of MSDs in the gas station workers. The Nordic body map musculoskeletal questionnaire contains a body map that shows the parts of the body that may experience pain. These body parts include the neck, shoulders, arms, back, waist, buttocks, elbows, wrists, hands, thighs, knees, calves, ankles and soles of the feet [9]. Assessment using the Nordic body map questionnaire uses a 4-point Likert scale as follows: 1 = *not painful*, 2 = *slightly painful*, 3 = *painful* and 4 = *very painful*. Workers who were research respondents were asked to provide an assessment of the parts of their body that felt painful during work activities according to a predetermined Likert scale [10].

2.4. Procedure

The preparatory stage began with the management of health research ethics, secondary data collection, surveys and field observations to identify problems and explore cooperation, arrange research permits, and arrange meetings of the research team and field officers on the division of tasks and common perceptions of the research. The implementation stage of the study was the survey, observation and inventory of gas station operator worker activities. Meetings were then held with the company to explain the aims and objectives of the research as well as procedures for research activities, determining subjects for research respondents and explaining the mechanism of research activities to the respondents. Following the fatigue data collection guided by the data collector, the research respondents were asked to complete the questionnaire. Data collection for the assessment of symptoms of MSDs uses a questionnaire that presents a picture of the human body with nine anatomical parts of the body. Data collectors guided respondents to fill out the questionnaire to determine whether the respondent experienced musculoskeletal symptoms such as pain or discomfort in any part of the body when the study was conducted.

2.5. Data analysis

Descriptive analysis aimed to determine the distribution characteristics of each dependent variable and independent variable. The data were then presented in the form of tables and graphs with simple statistical calculations such as averages, ratios and percentages. Furthermore, the research hypothesis was tested using the χ^2 statistical test at the 95% confidence level (CI) to determine the relationship between research variables. The test was carried out at a significance level of $\alpha = 0.05$; if $p < 0.05$, the test results are significant.

3. Results

Fuel filling stations are public facilities provided by the government or the state and foreign and private companies to meet the fuel needs of various types of motorized vehicles. In general, fuel filling stations sell Pertalite, diesel, Pertamax, and Pertamax Plus fuels and make it easier for the public to obtain the fuel they need for their vehicles [6]. This research was conducted at 11 fuel filling stations in Pontianak city, West Kalimantan, Indonesia. In each sub-district, 50% of stations were studied, including North Pontianak Subdistrict with two fuel filling stations, East Pontianak District with one fuel filling station, Southeast Districts with two fuel filling stations, South Pontianak District with one fuel filling station, West Pontianak District with two fuel filling stations and Pontianak Kota District with three fuel filling stations. Table 1 presents the demographic distribution of gas station operator workers consisting of six variables divided into several categories. A total of 120 (80%) gas station operator workers are <40 years old, 144 (96%) gas station operator workers have a high school educational background and 92 (61.3%) gas station operators have worked for 1–5 years. Most workers, i.e., 78 (52%), are single. In addition, as many as 75 (50%) gas station operators experience high work fatigue and as many as 111 (74%) workers have low-grade MSDs (Table 1).

Table 1. Demographic distribution of gas station operators **[Q5]** in Pontianak city.

Variable	Category	*n*	%
Age (years)	<40	120	80
	≥40	30	20
Education	Basic	0	0
	Middle	144	96
	Higher	6	4
Years of service	<1	10	6,7
	1–5	92	61.3
	>5	48	32
Marital status	Married	72	48
	Single	78	52
Work fatigue	High	75	50
	Low	75	50
Musculoskeletal disorders	High	39	26
	Low	111	74

Note: *n* = number of research respondents used as samples.

Source: Primary data, 2022.

Musculoskeletal events and worker fatigue obtained an *r* count value of 0.577, more than that of the *r* table with $df = n - 2$ (150 – 2 = 148) obtaining an *r* table of 0.160, so that the value of *r* count (0.577) > *r* table (0.160) and $p = 0.001$; therefore, the hypothesis in the study was accepted, i.e., there was a relationship between musculoskeletal events and fatigue in gas station workers. This confirms the finding of Kremelberg [11] that if the value of *r* count is greater than the value of the *r* table, then there is a correlation or a relationship **[Q6]** between variables (Table 2).

Table 2. Analysis of musculoskeletal disorders and work fatigue in gas station operators in Pontianak city.

Variable	Mean	Standard deviation	Minimum	Maximum	*r* count	*p*[a]
Musculoskeletal disorders	9.773	5.294	0	27	0.577	0.001
Work fatigue	55.4	9.591	35	81		

[a] χ^2 test, $\alpha = 5\%$.

*Significant at **[Q7]** $p \leq 0.05$.

Source: Primary data, 2022.

The relationship between work fatigue and musculoskeletal symptoms in gas station operators showed that high fatigue with high MSDs was found in 33 respondents (22%), low fatigue symptoms with low musculoskeletal in 69 respondents (46%), high musculoskeletal symptoms with low fatigue in 39 respondents (26%) and extremely high musculoskeletal symptoms with high work fatigue in 42 respondents (28%). The results of the analysis of the incidence of work fatigue and workers' MSDs obtained $p = 0.001$, meaning that there is a relationship between the incidence of fatigue and MSDs in gas station workers. The odds ratio (*OR*) is 9.036, which means that fatigue can trigger MSDs 9.036 times (Table 3).

Table 3. Distribution of work fatigue and musculoskeletal disorders in Pontianak city gas station operators.

	Work fatigue				
Musculoskeletal disorders	High	Low	Total	p [a]	Odds ratio
High	33 (22%)	42 (28%)	75 (50%)	0.001	9.036
Low	6 (4%)	69 (46%)	75 (50%)		
Total	39 (26%)	111 (74%)	150 (100%)		

[a] χ^2 test **[Q8]**, α = 5%.

*Significant at $p \leq 0.05$.

Source: Primary data, 2022.

4. Discussion

Based on the study's results, 50% of gas station operators in Pontianak city experienced work fatigue in the high category. Risk factors and triggers for work fatigue experienced by gas station operators include long working hours in a standing position while providing services to customers. This also supports Basri et al.'s[12] study reporting that standing at work for a long duration can increase the risk of work fatigue. Based on the interview results, if there are many customers, the operators can only take breaks to eat and pray, so the operators stand for a long time. Standing for a long time can cause fatigue because it can cause changes in the body's systems. The circulation of the blood from the legs to the heart becomes more difficult, with pressure on the joints and muscle fatigue. Standing for a long time causes blood flow to the heart to be affected, resulting in muscle contractions and fatigue. Work fatigue is caused by prolonged standing because the thigh and calf muscles contract to hold the body upright [13]. The work demands of gas station operators require them to stand in static positions while pressing a button on the computer display to calculate the flow of fuel to enter the data for the customer's fuel purchase, putting the nozzle into the customer's gas tank, closing the car's tank, and receiving payments and returning change. In addition, the condition will be exacerbated when long queues occur during peak hours, resulting in musculoskeletal symptoms in gas station operators getting worse because the longer the gas station operators are standing in a static or awkward position, the longer the muscles contract and the longer muscles will be under pressure [14]. Actions can be taken to ensure that working hours comply with the stated conditions, i.e., 7 h of work and 1 h of rest in a day [15]. Activities/movements of gas station operators that are repeated and carried out continuously are also risk factors for fatigue. Repetitive movements can cause muscle fatigue, causing motor reorganization and decreased performance [16]. Actions that can be taken include applying consistent work shifts and periodic stretching. Changing work positions will make the body more flexible, by spreading the workload evenly across parts of the body to reduce pressure on joints and muscles; in addition, workers who stretch the neck, shoulders, legs and arms can minimize disorders [17,18].

The results of the research show that MSDs in the high category were experienced by 26% of gas station operators. Based on the results of the statistical tests, there is a relationship between work fatigue among gas station workers and MSDs with p = 0.001. This is in line with the research by Chavalitsakulchai and Shahnavaz[19]. Fatigue reduces body endurance and work capacity, which can reduce morale and increase the risk of work accidents. MSDs can occur due to work fatigue that workers feel continuously. The study's results showed that the *OR* was 9.036, i.e., every increase in the incidence of fatigue by 1 point would increase the musculoskeletal point 9.036 times. So this issue must receive attention through various efforts. First, pay attention to the age of workers; avoid older workers because the level of skeletal muscle disorders will increase with age. In middle age, muscle strength and endurance begin to decrease so that the risk of muscle **[Q9]** disorders begins to grow [20]. The Maximum Oxygen Volume $\dot{V}_{O_2max}$ intake decreases with increasing age, which will reduce work capacity. Decreased work capacity will be marked by physical fatigue caused by muscle weakness.

Muscles need oxygen and adequate blood supply to carry out metabolic processes and regulate muscle contractions to keep them going [21]. This is also in line with Bridger's [22] research: the older a person is, the higher the risk for that person to experience a decrease in bone elasticity which triggers MSDs. In this study, 20% of operators were >40 years old. It is hoped that in the future, workers >50 years old will not be employed in the gas station operator section by moving them to administration.

A second effort is to employ male workers rather than female gas station operators. Gender is closely related to

musculoskeletal complaints. Physiologically, the muscles in men are stronger than those in women, caused by differences in hormonal influences between men and women. Female hormones make women physically more vulnerable [23]. Gender shows a significant effect on the risk of muscle disorders. Female muscles are smaller and only two-thirds (60%) as strong as those of males, especially in the arms, back and legs [24].

Third, consider the duration of working periods of gas station operators because this is a musculoskeletal risk factor. The longer a person is exposed to risk factors, the more likely a person experiences physical disorders due to work [25].

MSDs do not appear spontaneously but gradually until the human body begins to give a pain response[21]. MSDs can increase if the individual's working period increases, and they will experience physical and psychological boredom. The working period represents a risk factor affecting individuals at work, which can increase the risk of developing MSDs, especially in work activities that utilize large amounts of energy [23]. Therefore, fuel station operators who have had a long working period should be transferred to administration.

A fourth effort is to pay attention to gas station operators' working hours, i.e., working according to the rule of 7 h of work and 1 h of rest. Working for longer than 8 h can increase MSDs, hence the need for working arrangements of sufficient daily duration to minimize the impact of poor occupational health on workers [26]. Also, adjust the work shift system to affect the prevalence of MSDs [27].

Another risk factor that causes fatigue is an uncomfortable work environment, which is also a cause of fatigue among gas station operators, such as the temperature of the work environment. During the study, the temperature in the gas station work environment in Pontianak city was, on average, above the threshold limit, i.e., in the range 30.1–34.3 °C. The permitted threshold value for temperatures in the work environment is 18–30 °C [28]. The physical work environment can affect workers' health, especially the climate for physical work. A physical work climate that exceeds the threshold value can cause functional changes in the body's organs. Hot working conditions can cause drowsiness and fatigue, and increase the number of work errors [29]. Exposure to heat for hours can affect the body's balance and how the body sweats. The body's thermoregulation center originates in the brain, which regulates blood flow through the vessels in the skin, regulating the heat balance in the human body. At a temperature of 25 °C, human skin can sweat – and the loss of fluids caused by sweating causes fatigue [30,31]. Based on the aforementioned, it is necessary to modify the workplace to achieve more comfortable conditions by widening the roof to provide shelter and to provide regulations on using work uniforms that can reduce body heat [32]. Exposure to gasoline caused by benzene concentrations can also cause fatigue, headaches, coughing and nausea due to prolonged exposure to inhaled benzene, which also causes chronic effects [33]. It is hoped that gas station companies can identify the dangers of environmental factors through environmental control. One of the controls is using personal protective equipment (PPE) for workers, i.e., gas station operators wearing masks. The function of PPE for gas station operators is to protect against exposure to chemicals produced by gasoline components at gas stations [34]. The work environment needs to be improved to minimize symptoms of MSDs and fatigue and increase productivity [35].

5. Conclusion

The demographic description of gas station operator workers is as follows: 80% are under 40 years old; education level is 96% secondary education, i.e., junior high school and high school/vocational school; 61.3% have been employed for 1–5 years; and 52% of workers are unmarried. High work fatigue was experienced by 50% of workers. Severe MSDs were experienced by 26% of workers. This study established a relationship between work fatigue and MSDs in gas station operators (p = 0.001). Based on the results of the study, the authors suggest that it is necessary to pay attention to the duration of work in the standing position, to limit the number of working hours through shift arrangements and to provide adequate rest arrangements, along with stretching and improvement of ergonomic work positions for gas station operators. Modifying the work environment and monitoring and controlling working conditions are also essential to ensure that the work environment is safe and comfortable.

Disclosure statement

No potential conflict of interest was reported by the authors.

Supplemental data

Supplemental data for this article can be accessed at http://dx.doi.org/10.1080/10803548.2024.2348919 description of location. **[Q10]**

Availability of data and materials

Data supporting the findings of this study are available on request due to privacy/ethical restrictions. **[Q11]**

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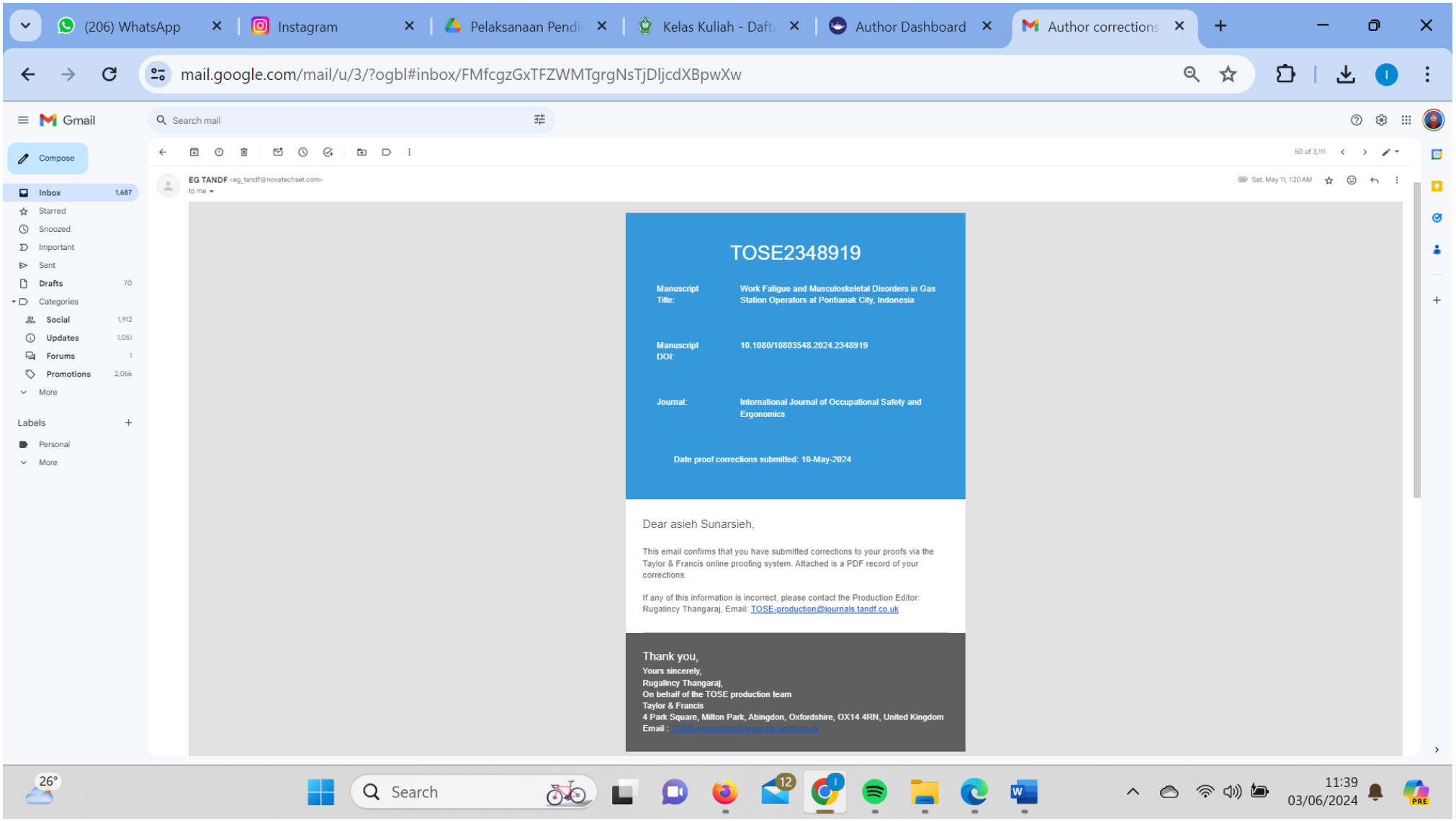
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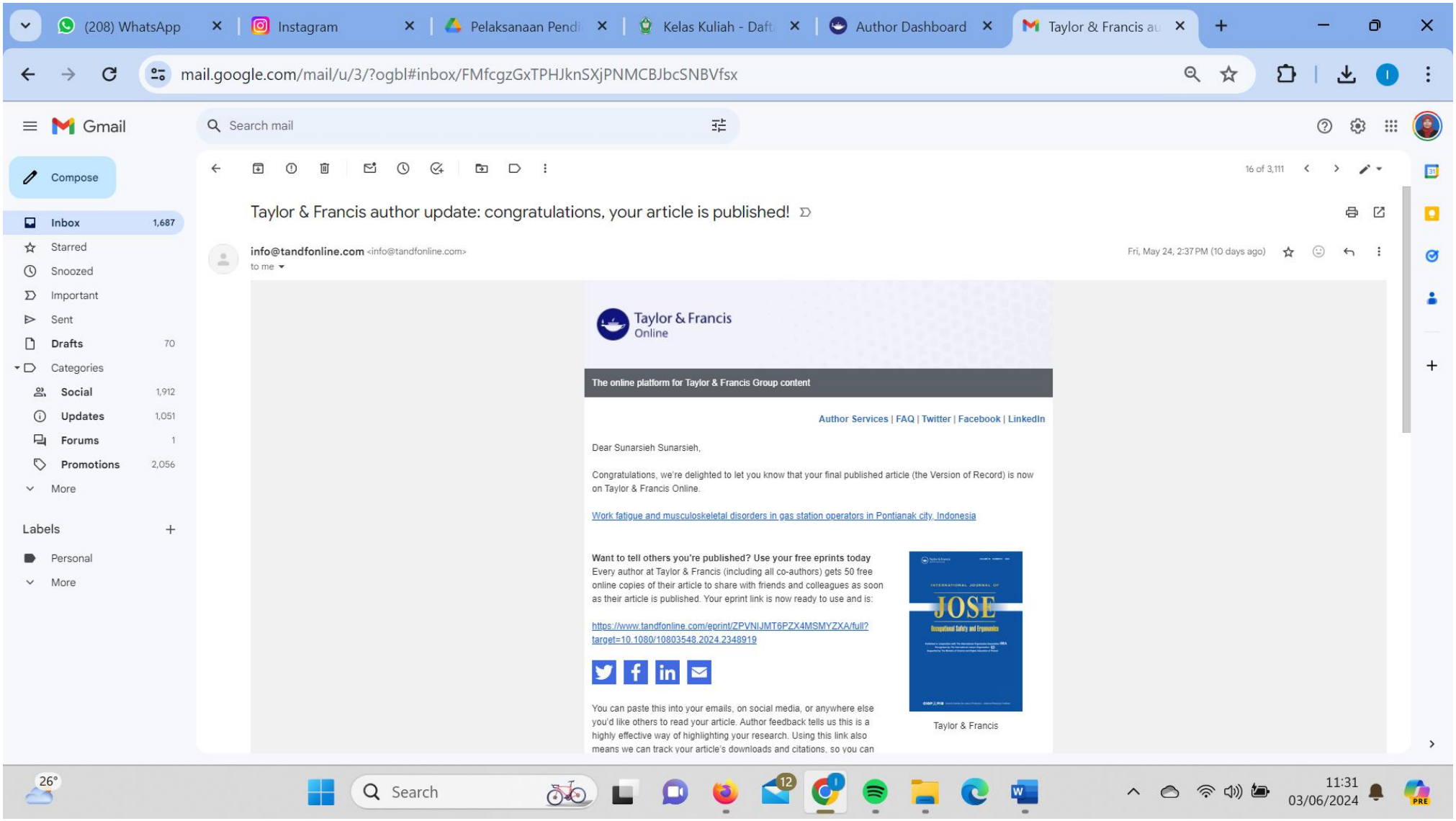
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Work fatigue and musculoskeletal disorders in gas station operators in Pontianak city, Indonesia

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ABSTRACT

This study analyzes the relationship between work fatigue and musculoskeletal disorders in gas station operators in Pontianak City. This study used with a cross-sectional approach. The sample consists of 150 gas station workers. Data collection was carried out by observing and interviewing. Respondents characteristics were recorded through interviews using a questionnaire. Data on work fatigue were obtained by interviews using the IFRC questionnaire and musculoskeletal data using the Nordic Body Map questionnaire. The study results show that 50% of workers experience a high level of work fatigue, and 26% of workers experience severe musculoskeletal disorders. There is a significant relationship between work fatigue and musculoskeletal diseases ($p = 0.001$). The study established the need for intervention as a preventive measure by providing sufficient rest time, stretching, setting work shifts, improving ergonomic work positions for gas station operators, and controlling the work environment through environmental improvement and monitoring and using personal protective equipment.

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1. Introduction

Musculoskeletal disorders (MSDs) are occupational diseases. Risk factors for MSDs are excessive fatigue, awkward postures and repetitive movements [1]. MSDs and work fatigue are important factors that must be considered because they can affect health problems in workers, affect the quality of life and work efficiency of workers, and reduce worker productivity [2–4]. MSDs affect skeletal muscles and are experienced as mild to severe pain. Repeatedly using skeletal muscles for a long time at work, even if a person only experiences mild pain, can cause disorders in the form of damage to ligaments, tendons and joints [5].

Fuel filling stations are public facilities provided by the government or the state and foreign and private companies to meet the fuel needs of various types of motorized vehicles. In general, fuel filling stations sell Pertalite, Diesel, Pertamax and Pertamax Plus fuels and make it easier for the public to obtain the fuel they need for their vehicles [6]. This research was conducted at 11 fuel filling stations in Pontianak city, West Kalimantan, Indonesia. In each sub-district, 50% of stations were studied, including North Pontianak Subdistrict with two fuel filling stations, East Pontianak District with one fuel filling station, Southeast Districts with two fuel filling stations, South Pontianak District with one fuel filling station, West Pontianak District with two fuel filling stations and Pontianak Kota District with three fuel filling stations. Based on the results of interviews and observations, the gas stations provide a 24-h service, with gas station operators working 8 h per shift. Gas station operators work continuously in a standing position and carry out repetitive activities/movements to refuel customers' vehicles, so they are at risk of experiencing work fatigue and MSDs [7].

This study aimed to describe the demographics, work fatigue and MSDs in gas station operators, and to analyze the relationship between work fatigue and MSDs in gas station workers. The research question considers the relationship between fatigue and MSDs in gas station operators in Pontianak city. The hypothesis is that there is a relationship between fatigue and MSDs in gas station workers in Pontianak city. This research aims to analyze fatigue and MSDs experienced by gas station workers, so that solutions and prevention efforts can be applied so that workers do not experience fatigue and MSDs.

2. Methods

2.1. Participants

This research was an analytic observational study with a cross-sectional approach conducted to analyze the relationship between fatigue and MSDs in gas station workers in Pontianak city, Indonesia. The study involved 150 gas station workers in Pontianak city, Indonesia who met the inclusion criteria as research respondents. The inclusion criteria for respondents in this study were gas station workers in Pontianak city who were willing to be respondents during the research and were aged < 55 years. Respondents were selected through the simple random sampling technique. Research ethics approval was obtained from the Health Research Ethics Committee of the Poltekkes Kemenkes Pontianak (No. 224/KEPK-PK.PKP/VIII/2022) and written informed consent was obtained from all of the gas station workers who were research respondents.

2.2. Description of work activities performed by petrol station operators

Gas station operators work 8 h daily and rest for 1 h each shift, 6 days a week. Workers work in a standing position

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continuously and perform repetitive movements to refuel customers' vehicles. If there are lots of vehicles refueling, gas station operators are forced to work in a standing position for 7 h. Gas station operators are tasked with dealing directly with customers when refueling vehicles. The gas station operator is responsible for opening and closing the vehicle's fuel tank, lifting and inserting the fuel nozzle, and locking and closing the vehicle's fuel tank after filling. This work is carried out by gas station operators for hours in a bending and rotating position and standing for a long time.

2.3. Research instruments

The primary data in this study consist of social demographics, levels of work fatigue, and data on symptoms of MSDs and the work environment. Secondary data consist of the number of workers and the working hours of gas station operators. Data on work fatigue were obtained from interviews with respondents using the International Fatigue Research Committee of the Japanese Association of Industrial Health (IFRC) questionnaire [8]. The IFRC is a questionnaire that can measure the subjective fatigue level, containing 30 questions about general fatigue symptoms. The first 10 questions indicate a weakening of activity, the second 10 questions a weakening of work motivation and the final 10 questions indicate physical fatigue or fatigue in various parts of the body. The higher the frequency of signs of fatigue occurring, the greater the level of fatigue. After conducting interviews and filling out the questionnaire, the next step was to calculate the score for the 30 questions, and the total becomes the individual's total score. Based on the subjective fatigue assessment design with 30 questions, the highest individual score was 120. Questionnaire answers were scored according to a 4-point Likert scale as follows: 4 = *very often*, 3 = *often*, 2 = *sometimes* and 1 = *never*. In determining the classification of fatigue levels, the answers to each question are summed, and then the results of the sum score are adjusted to a particular category. Fatigue level classification is based on individual total scores. The separate full scores and classification levels of fatigue are 0–55 = low fatigue and 56–120 = high fatigue [8]. The Nordic body map research instrument was applied to collect data on symptoms of MSDs in the gas station workers. The Nordic body map musculoskeletal questionnaire contains a body map that shows the parts of the body that may experience pain. These body parts include the neck, shoulders, arms, back, waist, buttocks, elbows, wrists, hands, thighs, knees, calves, ankles and soles of the feet [9]. Assessment using the Nordic body map questionnaire uses a 4-point Likert scale as follows: 1 = *not painful*, 2 = *slightly painful*, 3 = *painful* and 4 = *very painful*. Workers who were research respondents were asked to provide an assessment of the parts of their body that felt painful during work activities according to a predetermined Likert scale [10].

2.4. Procedure

The preparatory stage began with the management of health research ethics, secondary data collection, surveys and field observations to identify problems and explore cooperation, arrange research permits, and arrange meetings of the research team and field officers on the division of tasks and common perceptions of the research. The implementation stage of the study was the survey, observation and inventory of gas station operator worker activities. Meetings were then held with the company to explain the aims and objectives of the research as well as procedures for research activities, determining subjects for research respondents and explaining the mechanism of research activities to the respondents. Following the fatigue data collection guided by the data collector, the research respondents were asked to complete the questionnaire. Data collection for the assessment of symptoms of MSDs uses a questionnaire that presents a picture of the human body with nine anatomical parts of the body. Data collectors guided respondents to fill out the questionnaire to determine whether the respondent experienced musculoskeletal symptoms such as pain or discomfort in any part of the body when the study was conducted.

2.5. Data analysis

Descriptive analysis aimed to determine the distribution characteristics of each dependent variable and independent variable. The data were then presented in the form of tables and graphs with simple statistical calculations such as averages, ratios and percentages. Furthermore, the research hypothesis was tested using the χ^2 statistical test at the 95% confidence level (CI) to determine the relationship between research variables. The test was carried out at a significance level of $\alpha = 0.05$; if $p < 0.05$, the test results are significant.

3. Results

Fuel filling stations are public facilities provided by the government or the state and foreign and private companies to meet the fuel needs of various types of motorized vehicles. In general, fuel filling stations sell Pertalite, diesel, Pertamax, and Pertamax Plus fuels and make it easier for the public to obtain the fuel they need for their vehicles [6]. This research was conducted at 11 fuel filling stations in Pontianak city, West Kalimantan, Indonesia. In each sub-district, 50% of stations were studied, including North Pontianak Subdistrict with two fuel filling stations, East Pontianak District with one fuel filling station, Southeast Districts with two fuel filling stations, South Pontianak District with one fuel filling station, West Pontianak District with two fuel filling stations and Pontianak Kota District with three fuel filling stations. Table 1 presents the

Table 1. Demographic distribution of gas station operators in Pontianak city.

Variable	Category	*n*	%
Age (years)	< 40	120	80
	≥ 40	30	20
Education	Basic	0	0
	Middle	144	96
	Higher	6	4
Years of service	< 1	10	6,7
	1–5	92	61.3
	> 5	48	32
Marital status	Married	72	48
	Single	78	52
Work fatigue	High	75	50
	Low	75	50
Musculoskeletal disorders	High	39	26
	Low	111	74

Note: *n* = number of research respondents used as samples.
Source: Primary data, 2022.

Table 2. Analysis of musculoskeletal disorders and work fatigue in gas station operators in Pontianak city.

Variable	Mean	Standard deviation	Minimum	Maximum	*r* count	p^a
Musculoskeletal disorders	9.773	5.294	0	27	0.577	0.001
Work fatigue	55.4	9.591	35	81		

[a] χ^2 test, $\alpha = 5\%$.
Significant at $p \leq 0.05$.
Source: Primary data, 2022.

Table 3. Distribution of work fatigue and musculoskeletal disorders in Pontianak city gas station operators.

Musculoskeletal disorders	Work fatigue			p^a	Odds ratio
	High	Low	Total		
High	33 (22%)	42 (28%)	75 (50%)	0.001	9.036
Low	6 (4%)	69 (46%)	75 (50%)		
Total	39 (26%)	111 (74%)	150 (100%)		

[a] χ^2 test, $\alpha = 5\%$.
Significant at $p \leq 0.05$.
Source: Primary data, 2022.

demographic distribution of gas station operator workers consisting of six variables divided into several categories. A total of 120 (80%) gas station operator workers are < 40 years old, 144 (96%) gas station operator workers have a high school educational background and 92 (61.3%) gas station operators have worked for 1–5 years. Most workers, i.e., 78 (52%), are single. In addition, as many as 75 (50%) gas station operators experience high work fatigue and as many as 111 (74%) workers have low-grade MSDs (Table 1).

Musculoskeletal events and worker fatigue obtained an *r* count value of 0.577, more than that of the *r* table with $df = n - 2$ (150 – 2 = 148) obtaining an *r* table of 0.160, so that the value of *r* count (0.577) > *r* table (0.160) and $p = 0.001$; therefore, the hypothesis in the study was accepted, i.e., there was a relationship between musculoskeletal events and fatigue in gas station workers. This confirms the finding of Kremelberg [11] that if the value of *r* count is greater than the value of the *r* table, then there is a correlation or a relationship between variables (Table 2).

The relationship between work fatigue and musculoskeletal symptoms in gas station operators showed that high fatigue with high MSDs was found in 33 respondents (22%), low fatigue symptoms with low musculoskeletal in 69 respondents (46%), high musculoskeletal symptoms with low fatigue in 39 respondents (26%) and extremely high musculoskeletal symptoms with high work fatigue in 42 respondents (28%). The results of the analysis of the incidence of work fatigue and workers' MSDs obtained $p = 0.001$, meaning that there is a relationship between the incidence of fatigue and MSDs in gas station workers. The odds ratio (*OR*) is 9.036, which means that fatigue can trigger MSDs 9.036 times (Table 3).

4. Discussion

Based on the study's results, 50% of gas station operators in Pontianak city experienced work fatigue in the high category. Risk factors and triggers for work fatigue experienced by gas station operators include long working hours in a standing position while providing services to customers. This also supports Basri et al.'s [12] study reporting that standing at work for a long duration can increase the risk of work fatigue. Based on the interview results, if there are many customers, the operators can only take breaks to eat and pray, so the operators stand for a long time. Standing for a long time can cause fatigue because it can cause changes in the body's systems. The circulation of the blood from the legs to the heart becomes more difficult, with pressure on the joints and muscle fatigue. Standing for a long time causes blood flow to the heart to be affected, resulting in muscle contractions and fatigue. Work fatigue is caused by prolonged standing because the thigh and calf muscles contract to hold the body upright [13]. The work demands of gas station operators require them to stand in static positions while pressing a button on the computer display to calculate the flow of fuel to enter the data for the customer's fuel purchase, putting the nozzle into the customer's gas tank, closing the car's tank, and receiving payments and returning change. In addition, the condition will be exacerbated when long queues occur during peak hours, resulting in musculoskeletal symptoms in gas station operators getting worse because the longer the gas station operators are standing in a static or awkward position, the longer the muscles contract and the longer muscles will be under pressure [14]. Actions can be taken to ensure that working hours comply with the stated conditions, i.e., 7 h of work and 1 h of rest in a day [15]. Activities/movements of gas station operators that are repeated and carried out continuously are also risk factors for fatigue. Repetitive movements can cause muscle fatigue, causing motor reorganization and decreased performance [16]. Actions that can be taken include applying consistent work shifts and periodic stretching. Changing work positions will make the body more flexible, by spreading the workload evenly across parts of the body to reduce pressure on joints and muscles; in addition, workers who stretch the neck, shoulders, legs and arms can minimize disorders [17,18].

The results of the research show that MSDs in the high category were experienced by 26% of gas station operators. Based on the results of the statistical tests, there is a relationship between work fatigue among gas station workers and MSDs with $p = 0.001$. This is in line with the research by Chavalitsakulchai and Shahnavaz [19]. Fatigue reduces body endurance and work capacity, which can reduce morale and increase the risk of work accidents. MSDs can occur due to work fatigue that workers feel continuously. The study's results showed that the *OR* was 9.036, i.e., every increase in the incidence of fatigue by 1 point would increase the musculoskeletal point 9.036 times. So this issue must receive attention through various efforts. First, pay attention to the age of workers; avoid older workers because the level of skeletal muscle disorders will increase with age. In middle age, muscle strength and endurance begin to decrease so that the risk of muscle disorders begins to grow [20]. The maximum oxygen volume intake decreases with increasing age, which will reduce work capacity. Decreased work capacity will be marked by physical fatigue caused by muscle weakness.

Muscles need oxygen and adequate blood supply to carry out metabolic processes and regulate muscle contractions to

keep them going [21]. This is also in line with Bridger's [22] research: the older a person is, the higher the risk for that person to experience a decrease in bone elasticity which triggers MSDs. In this study, 20% of operators were > 40 years old. It is hoped that in the future, workers > 50 years old will not be employed in the gas station operator section by moving them to administration.

A second effort is to employ male workers rather than female gas station operators. Gender is closely related to musculoskeletal complaints. Physiologically, the muscles in men are stronger than those in women, caused by differences in hormonal influences between men and women. Female hormones make women physically more vulnerable [23]. Gender shows a significant effect on the risk of muscle disorders. Female muscles are smaller and only two-thirds (60%) as strong as those of males, especially in the arms, back and legs [24].

Third, consider the duration of working periods of gas station operators because this is a musculoskeletal risk factor. The longer a person is exposed to risk factors, the more likely a person experiences physical disorders due to work [25].

MSDs do not appear spontaneously but gradually until the human body begins to give a pain response [21]. MSDs can increase if the individual's working period increases, and they will experience physical and psychological boredom. The working period represents a risk factor affecting individuals at work, which can increase the risk of developing MSDs, especially in work activities that utilize large amounts of energy [23]. Therefore, fuel station operators who have had a long working period should be transferred to administration.

A fourth effort is to pay attention to gas station operators' working hours, i.e., working according to the rule of 7 h of work and 1 h of rest. Working for longer than 8 h can increase MSDs, hence the need for working arrangements of sufficient daily duration to minimize the impact of poor occupational health on workers [26]. Also, adjust the work shift system to affect the prevalence of MSDs [27].

Another risk factor that causes fatigue is an uncomfortable work environment, which is also a cause of fatigue among gas station operators, such as the temperature of the work environment. During the study, the temperature in the gas station work environment in Pontianak city was, on average, above the threshold limit, i.e., in the range 30.1–34.3 °C. The permitted threshold value for temperatures in the work environment is 18–30 °C [28]. The physical work environment can affect workers' health, especially the climate for physical work. A physical work climate that exceeds the threshold value can cause functional changes in the body's organs. Hot working conditions can cause drowsiness and fatigue, and increase the number of work errors [29]. Exposure to heat for hours can affect the body's balance and how the body sweats. The body's thermoregulation center originates in the brain, which regulates blood flow through the vessels in the skin, regulating the heat balance in the human body. At a temperature of 25 °C, human skin can sweat – and the loss of fluids caused by sweating causes fatigue [30,31]. Based on the aforementioned, it is necessary to modify the workplace to achieve more comfortable conditions by widening the roof to provide shelter and to provide regulations on using work uniforms that can reduce body heat [32]. Exposure to gasoline caused by benzene concentrations can also cause fatigue, headaches, coughing and nausea due to prolonged exposure to inhaled benzene, which also causes chronic effects [33]. It is hoped that gas station companies can identify the dangers of environmental factors through environmental control. One of the controls is using personal protective equipment (PPE) for workers, i.e., gas station operators wearing masks. The function of PPE for gas station operators is to protect against exposure to chemicals produced by gasoline components at gas stations [34]. The work environment needs to be improved to minimize symptoms of MSDs and fatigue and increase productivity [35].

5. Conclusion

The demographic description of gas station operator workers is as follows: 80% are under 40 years old; education level is 96% secondary education, i.e., junior high school and high school/vocational school; 61.3% have been employed for 1–5 years; and 52% of workers are unmarried. High work fatigue was experienced by 50% of workers. Severe MSDs were experienced by 26% of workers. This study established a relationship between work fatigue and MSDs in gas station operators ($p = 0.001$). Based on the results of the study, the authors suggest that it is necessary to pay attention to the duration of work in the standing position, to limit the number of working hours through shift arrangements and to provide adequate rest arrangements, along with stretching and improvement of ergonomic work positions for gas station operators. Modifying the work environment and monitoring and controlling working conditions are also essential to ensure that the work environment is safe and comfortable.

Disclosure statement

No potential conflict of interest was reported by the authors.

Supplemental data

Supplemental data for this article can be accessed at http://dx.doi.org/10.1080/10803548.2024.2348919 description of location.

Availability of data and materials

Data supporting the findings of this study are available on request due to privacy/ethical restrictions.

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