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12 **Work Fatigue and Musculoskeletal Disorders in Gas Station Operators** 13 **at Pontianak City, Indonesia**

14 **Abstract**

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

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

33 **1. Introduction**

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

41 ligaments, tendons, and joints [3].

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

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

61 **2. Methods**

62 *2.1 Participants*

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

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

74 *2.2 Research Instruments*

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

89 Never with a value of 1. The answers to each question are summed and adjusted for a
90 particular classification in determining the classification of fatigue groups. The
91 classifications given include: Score >55 = High Fatigue and Score ≤ 55 = Low Fatigue
92 [7]. The Nordic Body Map research instrument for collecting data on musculoskeletal
93 disorders in gas station workers. The Nordic Body Map Musculoskeletal Questionnaire
94 contains a body map that shows the parts of the body that have complaints of pain. These
95 body parts include the neck, shoulders, arms, back, waist, buttocks, elbows, wrists, hands,
96 thighs, knees, calves, ankles, and soles of the feet [8]. Assessment using the Nordic Body
97 Map questionnaire uses 4 Likert scales consisting of 1: not sick, 2: slightly ill, 3: ill, and
98 4: very ill. Workers who were research respondents were asked to provide an assessment
99 of the parts of their body that they felt sick during work activities according to a
100 predetermined likert scale [9].

101 *2.3 Procedure*

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

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

116 *2.4 Data analysis*

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

123 **3. Results**

124 Fuel Filling Stations for the Public (SPBU) are public infrastructure provided for the
125 people of Indonesia to meet their fuel needs. This research was conducted at 11 gas
126 stations in Pontianak City; in each sub-district, 50% were taken, including two gas
127 stations in North Pontianak District, one gas station in East Pontianak District, two gas
128 stations in Southeast District, one gas station in South Pontianak District, 2 West
129 Pontianak District. SPBU, and Pontianak Kota District with three gas stations. The
130 operating hours of gas stations in Pontianak City are divided into 2, namely 16 hours with
131 two work shifts and 24 hours with three work shifts. Table 1 shows the demographic
132 distribution of gas station operator workers. The demographic distribution of gas station
133 operator workers consists of 6 variables divided into several categories, as shown in Table
134 1. 120 (80%) gas station operator workers are <40 years old. A total of 144 (96%) gas
135 station operator workers have a high school educational background. 92 (61.3%) gas
136 station operators have worked for 1-5 years. Most workers, namely 78 (52%), have single
137 status. In addition, as many as 75 (50%) gas station operators experienced high work

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

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

145 The relationship between work fatigue and musculoskeletal events at gas stations workers
146 showed that high fatigue with high musculoskeletal disorders totaled 33 respondents
147 (22%), low fatigue events with low musculoskeletal numbers 69 respondents (46%), high
148 musculoskeletal events with low fatigue number of 39 respondents (26%) and extreme
149 musculoskeletal events with high work fatigue amounted to 42 respondents (28%). The
150 analysis results of the incidence of work fatigue and workers' musculoskeletal disorders
151 obtained a p-value of $0.000 < 0.05$, meaning that there is a relationship between the
152 incidence of fatigue and musculoskeletal disorders in gas station workers. The odds ratio
153 (OR) is 9.036, which means that fatigue can trigger musculoskeletal disorders 9.036 times
154 (Table 3).

155 **4. Discussion**

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

162 usually done by one worker and done in a standing position [10]. Gas station operators
163 work using a shift system, in 1 shift working 8 hours a day. This is done by standing to
164 serve consumers when refueling. The gas station operator said many consumers came to
165 fill up their fuel, and the officers had little time to sit and rest. Workers only rest when
166 going to drink and lunch. Every worker should have the right to rest for at least 30 minutes
167 after working for 4 hours continuously, and this break does not include working hours
168 [11]. Good rest can contract the thigh and calf muscles to hold the body in an upright
169 position during long-standing can be rested. Good rest can reduce muscle fatigue after
170 long-standing activities [12]. An uncomfortable work environment is also a cause of
171 fatigue felt by gas station operators, such as the temperature in the work environment.
172 During the study, the temperature in the gas station work environment in Pontianak City
173 was, on average, above the Threshold Limit, namely in the range of 30.1°C to 34.3°C.
174 The threshold value for the temperature in the work environment that is allowed is 18-
175 30°C [13]. The physical work environment can affect workers' health, especially the
176 physical work climate. A physical work climate that exceeds the threshold value can
177 cause functional changes in the body's organs. Hot working climate conditions can cause
178 drowsiness and fatigue and increase the number of work errors [14]. Exposure to heat
179 for hours can affect the body's balance and the body sweats. The body's heat center
180 originates in the brain, which regulates blood flow through the vessels in the skin. And
181 this heat source regulates the heat balance in the human body. At a temperature of 25°C,
182 human skin can sweat. And the loss of fluids caused by sweating causes fatigue [15], [16].
183 Exposure to gasoline caused by benzene concentrations can also cause fatigue, headaches,
184 coughing, and nausea due to prolonged exposure to benzene, which is inhaled and causes
185 chronic effects [17]. The maximum exposure limit for benzene is 8 hours a day or 40
186 hours a week [18]. So it is expected that workers can wear masks. The function of masks

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

190 Standing in a work position during working hours is one of the triggering
191 factors for work fatigue at gas station operators [20]. Standing for a long time can cause
192 changes in the body's work system. Veins have difficulty flowing blood from the legs to
193 the heart, pressure on the joints, and muscle fatigue. When standing for a long time causes
194 blood flow to the heart to be affected, resulting in muscle contractions and fatigue. Work
195 fatigue is caused by prolonged standing because the thigh and calf muscles contract to
196 hold the body in an upright position [21]. Based on the results of statistical tests, there is
197 a relationship between work fatigue among gas station workers and musculoskeletal
198 disorders p value 0.000 <0.05. Many factors influence the prevalence of musculoskeletal
199 disorders among work fatigue [22]. The study's results that there is a relationship between
200 work fatigue and musculoskeletal disorders are also in line with the research of
201 Chavalitasukalchai and Shahnavaz. Fatigue is a decreased body endurance and work
202 capacity that can reduce morale and the risk of work accidents. At the same time,
203 musculoskeletal disorders can occur due to work fatigue that workers feel continuous
204 [23]. The results of the study showed that the OR value was 9.036. That is, every increase
205 in the incidence of fatigue by 1 point would increase the musculoskeletal point 9.036
206 times. So this must receive attention through various efforts, pay attention to the age of
207 workers, and not choose old workers. In general, skeletal muscle complaints begin to be
208 felt at working age 25-65 years. The first complaint is usually handled at the age of 35,
209 and the level of complaints will continue to increase with age because, in middle age,
210 muscle strength and endurance begin to decrease, so the risk of muscle complaints begins
211 to grow [24]. Increasing age, followed by a decrease in VO2 max intake, will reduce work

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

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

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

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

243 Many factors influence the prevalence of musculoskeletal disorders in
244 workers, namely the shift system, abnormal working positions, forward tilt of the neck,
245 maximum strength operations in a short time, repetitive movements of the upper arms or
246 fingers, work under varying conditions of temperature, and work fatigue [22]. The work
247 demands of gas station operators require gas station operators to stand static while
248 pressing a button on the computer display to calculate the fuel flow to enter customer fuel
249 order data, put the nozzle into the consumer's gas tank, close the car's tank, and receive
250 and return payments. In addition, the condition will be exacerbated when long queues
251 occur during peak hours, resulting in musculoskeletal complaints felt by gas station
252 operators getting worse because the more extended gas station operators stand static or
253 awkward, the longer the muscles contract and the longer the pressure will be received by
254 muscles [34]. So it is necessary to apply for work positions unrelated to work shifts and
255 stretch regularly. Changing work positions will make the body more flexible, dividing
256 the workload evenly on some parts of the body to reduce pressure on joints and muscles.
257 Besides, workers who stretch their necks, shoulders, and hands minimize complaints.
258 [35], [36]. Working more than 8 hours can increase musculoskeletal disorders in the lower
259 back and shoulders. Therefore, working arrangements with sufficient daily duration are
260 necessary to minimize the impact of poor occupational health on workers [37].
261 Improvement of the work environment needs to be done to minimize musculoskeletal

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

268 **5. Conclusion**

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

273

274 **Competing Interest**

275 there were no conflicts of interest.

276

277 **Availability of Data and Materials**

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

279

280 **Authors Contribution**

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

283

284 **Disclosure**

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

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

289

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1 **Work Fatigue and Musculoskeletal Disorders in Gas Station Operators** 2 **at Pontianak City, Indonesia**

3 4 **Abstract**

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

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

22 **1. Introduction**

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

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

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

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

50 **2. Methods**

51 *2.1 Participants*

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

63 *2.2 Research Instruments*

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

74 asked, and the total becomes the individual's total score. Based on the subjective fatigue
75 assessment design with 30 questions, the highest individual score was 120. Questionnaire
76 answers were scored according to four Likert scales, divided into four categories, namely
77 Very Often with a value of 4, Often with a value of 3, Sometimes with a value of 2 and
78 Never with a value of 1. The answers to each question are summed and adjusted for a
79 particular classification in determining the classification of fatigue groups. The
80 classifications given include: Score >55 = High Fatigue and Score ≤ 55 = Low Fatigue
81 [7]. The Nordic Body Map research instrument for collecting data on musculoskeletal
82 disorders in gas station workers. The Nordic Body Map Musculoskeletal Questionnaire
83 contains a body map that shows the parts of the body that have complaints of pain. These
84 body parts include the neck, shoulders, arms, back, waist, buttocks, elbows, wrists, hands,
85 thighs, knees, calves, ankles, and soles of the feet [8]. Assessment using the Nordic Body
86 Map questionnaire uses 4 Likert scales consisting of 1: not sick, 2: slightly ill, 3: ill, and
87 4: very ill. Workers who were research respondents were asked to provide an assessment
88 of the parts of their body that they felt sick during work activities according to a
89 predetermined likert scale [9].

90 *2.3 Procedure*

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

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

105

106 *2.4 Data analysis*

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

113 **3. Results**

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

122 distribution of gas station operator workers. The demographic distribution of gas station
123 operator workers consists of 6 variables divided into several categories, as shown in Table
124 1. 120 (80%) gas station operator workers are <40 years old. A total of 144 (96%) gas
125 station operator workers have a high school educational background. 92 (61.3%) gas
126 station operators have worked for 1-5 years. Most workers, namely 78 (52%), have single
127 status. In addition, as many as 75 (50%) gas station operators experienced high work
128 fatigue. And as many as 111 (74%) workers have low-grade musculoskeletal disorders
129 (Table 1).

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

135 The relationship between work fatigue and musculoskeletal events at gas stations workers
136 showed that high fatigue with high musculoskeletal disorders totaled 33 respondents
137 (22%), low fatigue events with low musculoskeletal numbers 69 respondents (46%), high
138 musculoskeletal events with low fatigue number of 39 respondents (26%) and extreme
139 musculoskeletal events with high work fatigue amounted to 42 respondents (28%). The
140 analysis results of the incidence of work fatigue and workers' musculoskeletal disorders
141 obtained a p-value of $0.000 < 0.05$, meaning that there is a relationship between the
142 incidence of fatigue and musculoskeletal disorders in gas station workers. The odds ratio
143 (OR) is 9.036, which means that fatigue can trigger musculoskeletal disorders 9.036 times
144 (Table 3).

145 **4. Discussion**

146 Based on the results of the study, gas station labor operators in Pontianak
147 City experienced high work fatigue, as much as 50%. Work fatigue felt by gas station
148 operators is partly due to long working hours, an uncomfortable work environment, and
149 a long-standing working position while working. Triggers fatigue for gas station
150 operators, namely activities in providing services starting from greeting, asking questions
151 and serving consumers, pressing the automatic Factor pump, and giving change which is
152 usually done by one worker and done in a standing position [10]. Gas station operators
153 work using a shift system, in 1 shift working 8 hours a day. This is done by standing to
154 serve consumers when refueling. The gas station operator said many consumers came to
155 fill up their fuel, and the officers had little time to sit and rest. Workers only rest when
156 going to drink and lunch. Every worker should have the right to rest for at least 30 minutes
157 after working for 4 hours continuously, and this break does not include working hours
158 [11]. Good rest can contract the thigh and calf muscles to hold the body in an upright
159 position during long-standing can be rested. Good rest can reduce muscle fatigue after
160 long-standing activities [12]. An uncomfortable work environment is also a cause of
161 fatigue felt by gas station operators, such as the temperature in the work environment.
162 During the study, the temperature in the gas station work environment in Pontianak City
163 was, on average, above the Threshold Limit, namely in the range of 30.1°C to 34.3°C.
164 The threshold value for the temperature in the work environment that is allowed is 18-
165 30°C [13]. The physical work environment can affect workers' health, especially the
166 physical work climate. A physical work climate that exceeds the threshold value can
167 cause functional changes in the body's organs. Hot working climate conditions can cause
168 drowsiness and fatigue and increase the number of work errors [14]. Exposure to heat
169 for hours can affect the body's balance and the body sweats. The body's heat center

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

180 Standing in a work position during working hours is one of the triggering
181 factors for work fatigue at gas station operators [20]. Standing for a long time can cause
182 changes in the body's work system. Veins have difficulty flowing blood from the legs to
183 the heart, pressure on the joints, and muscle fatigue. When standing for a long time causes
184 blood flow to the heart to be affected, resulting in muscle contractions and fatigue. Work
185 fatigue is caused by prolonged standing because the thigh and calf muscles contract to
186 hold the body in an upright position [21]. Based on the results of statistical tests, there is
187 a relationship between work fatigue among gas station workers and musculoskeletal
188 disorders p value 0.000 <0.05. Many factors influence the prevalence of musculoskeletal
189 disorders among work fatigue [22]. The study's results that there is a relationship between
190 work fatigue and musculoskeletal disorders are also in line with the research of
191 Chavalitasukalchai and Shahnava. Fatigue is a decreased body endurance and work
192 capacity that can reduce morale and the risk of work accidents. At the same time,
193 musculoskeletal disorders can occur due to work fatigue that workers feel continuous
194 [23]. The results of the study showed that the OR value was 9.036. That is, every increase

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

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

219 Musculoskeletal disorders do not appear spontaneously but gradually until

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

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

245 stretch regularly. Changing work positions will make the body more flexible, dividing
246 the workload evenly on some parts of the body to reduce pressure on joints and muscles.
247 Besides, workers who stretch their necks, shoulders, and hands minimize complaints.
248 [35], [36]. Working more than 8 hours can increase musculoskeletal disorders in the lower
249 back and shoulders. Therefore, working arrangements with sufficient daily duration are
250 necessary to minimize the impact of poor occupational health on workers [37].
251 Improvement of the work environment needs to be done to minimize musculoskeletal
252 disorders and fatigue to increase productivity [38]. According to Nneka, gas station
253 operators have a lot of risk of experiencing fatigue, so the company's role is to identify
254 workplace hazards, provide regular training for workers regarding workplace safety, and
255 provide PPE [39]. Apart from that, by introducing a mechanism for occupational safety
256 and health rules, setting standards, and limiting exposure to environmental factors for
257 workers [40].

258 **5. Conclusion**

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

263

264 **Competing Interest**

265 there were no conflicts of interest.

266

267 **Availability of Data and Materials**

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

269

270 **Authors Contribution**

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

273

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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.	<p>Introduction</p> <p>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?</p>	<p>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].</p> <p>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 Peralite, Diesel, Pertamina, and Pertamina 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</p>	<p>25-47</p> <p>48-56</p>

		<p>customers' vehicles, so they at risk of experiencing work fatigue and musculoskeletal disorders [7].</p> <p>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.</p>	
2	<p>Methods</p> <p>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</p>	<p>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</p>	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 Peralite, diesel, Pertamina, and Pertamina 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	136-145
8	Lines 114 - 121: In which such detailed information regarding location of oil stations have importance for aims of this study?	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.	
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

<p>The state of the art on various aspects of fatigue is presented more.</p>	<p>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.</p>	
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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 Shahnnavaz. 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

		<p>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].</p>	
13	<p>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.</p>	<p>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.</p>	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 leg**-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** 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, 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.

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 (kkeletal) that and are felt experienced by someone with mild to severe pain complaints. Repeatedly using skeletal muscles for a long time at work, that even if a person thinks with complaints of only experiences will 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 Filling Stations for the Public are public facilities provided by the government or the state, and 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 **petrolite**, diesel, Pertamina, and Pertamina plus fuel. Fuel-Filling-Stations and to 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 was were subordinated including North Pontianak Subdistrict with **as many as 2 two** Fuel Filling Stations, East Pontianak District with **5-one** Fuel Filling Station, and Southeast Districts with **as many as 2 two** Fuel Filling Stations—Stations, South Pontianak District with **1-one** Fuel Filling Station, West Pontianak District with **2-two** Fuel Filling Stations, and Pontianak Kota District with **3-three** Fuel Filling Stations. Based on the results of interviews and**

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Page 2 of 15 3640 words English (United States) Accessibility: Good to go

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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~~ 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, ~~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 ~~S~~station 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 withas mild to severe pain complaints.

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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 ~~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, ~~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 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 ~~motion positions~~ movements 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 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 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

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 was~~ to calculate the score ~~of for~~ 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 ~~O~~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 ~~have complaints of~~ ~~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 ~~sick~~ ~~painful~~, 2: slightly ~~ill~~ ~~painful~~, 3: ~~ill~~ ~~painful~~, and 4: very ~~ill~~ ~~painful~~. Workers who were research respondents were asked to provide an assessment of the parts of their body that ~~they~~ felt ~~sick~~ ~~painful~~ during work activities according to a predetermined ~~ill~~ Likert scale [10].

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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 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, Pertamina,

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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%

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	Mean	Standard deviation	Min	Max	r count	P value
Musculoskeletal Disorders	9,773	5,294	0	27	0,577	0,000
Work Fatigue	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
	<u>High</u>	Low	Total		
High	33(22%)	42(28%)	75(50%)	0.000	9.036
<u>Low</u>	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 consumerscustomers. This is also to-supports Basri's research-study (2021) that standing in-at working 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 ~~custoe~~ consumer's gas tank, ~~closing~~ the car's tank, and receiving ~~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 with~~ ~~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 for a work position inconsistent with~~ consistent work shifts and periodically 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 Shahnava. 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~~n 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 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 ~~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~~ temperatures 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~~ regulatinges 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 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 work fatigue was experienced by 50% of workers ~~is 50% in the high category~~. Severe 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

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.

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Authors' Contributions

Conceptualization : S ; Data Collection and [Analysis](#) : ZA, SH ; Methodology : S, ZA, SH ; Draft : S ; Review : S ; Manuscript Preparation : S.

24 August 2023

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Author(s): Sunarsieh, Zainal Akhmadi, Suharno

Format: American English

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22 **Keywords: Ergonomic positions, filling station attendant, gas station workers,**
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24 **1. Introduction**

25 Musculoskeletal disorders are occupational diseases. Risk factors for musculoskeletal
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28 because they can affect health problems in workers, affect the quality of life and work
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33 Fuel filling stations are public facilities provided by the government or the state, and
34 foreign and private companies to meet the fuel needs of various types of motorized
35 vehicles. In general, fuel filling stations sell Peralite, Diesel, Pertamina, and Pertamina
36 Plus fuels and make it easier for the public to obtain the fuel they need for their vehicles
37 [6]. This research was conducted at 11 fuel filling stations in Pontianak City, West
38 Kalimantan, Indonesia. In each sub-district, 50% of stations were studied, including
39 North Pontianak Subdistrict with two fuel filling stations, East Pontianak District with
40 one fuel filling station, Southeast Districts with two fuel filling stations, South Pontianak
41 District with one fuel filling station, West Pontianak District with two fuel filling stations,
42 and Pontianak Kota District with three fuel filling stations. Based on the results of
43 interviews and observations, the gas stations provide a 24-hour service, with gas station
44 operators working 8 hours per shift. Gas station operators work continuously in a standing
45 position and carry out repetitive activities/movements to refuel customers' vehicles, so
46 they at risk of experiencing work fatigue and musculoskeletal disorders [7].

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

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

56 **2. Methods**

57 *2.1 Participants*

58 This type of research is an analytic observational study with a cross-sectional approach
59 conducted to analyze the relationship between fatigue and musculoskeletal disorders in
60 gas station workers in Pontianak City, Indonesia. The study involved 150 gas station
61 workers in Pontianak City, Indonesia who met the inclusion criteria as research
62 respondents. The inclusion criteria for respondents in this study were gas station workers
63 in Pontianak City who were willing to be respondents during the research and were aged
64 <55 years. Respondents were selected through the Simple Random Sampling technique.
65 Research ethics approval was obtained from the Health Research Ethics Committee of
66 the Poltekkes Kemenkes Pontianak No 224/KEPK-PK.PKP/VIII/2022 and written
67 consent (Informed Consent) was obtained from all gas station workers who were research
68 respondents.

69 *2.2 Description of work activities performed by petrol station operators*

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

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

79 *2.3 Research instruments*

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

97 question are added up, and then the results of the sum score are adjusted to a particular
98 category. Fatigue level classification is based on individual total scores. **The separate full**
99 **scores and classification levels of fatigue are 0–55 = low fatigue and 56–120 = high**
100 **fatigue** [8]. The Nordic Body Map research instrument was applied to collect data on
101 symptoms of musculoskeletal disorders in the gas station workers. The Nordic Body Map
102 Musculoskeletal Questionnaire contains a body map that shows the parts of the body that
103 may experience pain. These body parts include the neck, shoulders, arms, back, waist,
104 buttocks, elbows, wrists, hands, thighs, knees, calves, ankles, and soles of the feet [9].
105 Assessment using the Nordic Body Map questionnaire uses 4 Likert scales consisting of
106 1: not painful, 2: slightly painful, 3: painful, and 4: very painful. Workers who were
107 research respondents were asked to provide an assessment of the parts of their body that
108 felt painful during work activities according to a predetermined Likert scale [10].

109 *2.4 Procedure*

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

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

125 2.5 Data analysis

126 Descriptive analysis aimed to determine the distribution characteristics of each dependent
127 variable and independent variable. The data was then presented in the form of tables and
128 graphs with simple statistical calculations such as averages, ratios, and percentages.
129 Furthermore, the research hypothesis was tested using the chi-square statistical test at the
130 95% confidence level to determine the relationship between research variables. The test
131 was carried out at the significance level $\alpha = 0.05$; if $p < 0.05$, the test results are significant.

132 3. Results

133 Fuel filling stations are public facilities provided by the government or the state, and
134 foreign and private companies to meet the fuel needs of various types of motorized
135 vehicles. In general, fuel filling stations sell Pertalite, diesel, Pertamina, and Pertamina
136 Plus fuels and make it easier for the public to obtain the fuel they need for their vehicles
137 [6]. This research was conducted at 11 fuel filling stations in Pontianak City, West
138 Kalimantan, Indonesia. In each sub-district, 50% of stations were studied, including
139 North Pontianak Subdistrict with two fuel filling stations, East Pontianak District with
140 one fuel filling station, Southeast Districts with two fuel filling stations, South Pontianak
141 District with one fuel filling station, West Pontianak District with two fuel filling stations,
142 and Pontianak Kota District with three fuel filling stations. Table 1 shows the
143 demographic distribution of gas station operator workers consisting of six variables
144 divided into several categories, as shown in Table 1. 120 (80%) gas station operator
145 workers are <40 years old. A total of 144 (96%) gas station operator workers have a high

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

150 events and worker fatigue obtained an r count value of 0.577 more than the r table with
151 $df = n - 2 = 150 - 2 = 148$ obtaining an r table of 0.160 so that the value of r count (0.577)
152 $>$ r table (0.160) and p-value 0.001 so that the hypothesis in the study was accepted,
153 namely that there was a relationship between musculoskeletal events and fatigue in gas
154 station workers. This confirms the finding of Kremelberg [11] that if the value of r count
155 $>$ r table, there is a correlation or a relationship between variables (Table 2).

156 The relationship between work fatigue and musculoskeletal symptoms in gas stations
157 operators showed that high fatigue with high musculoskeletal disorders was found in 33
158 respondents (22%), low fatigue symptoms with low musculoskeletal in 69 respondents
159 (46%), high musculoskeletal symptoms with low fatigue in 39 respondents (26%), and
160 extremely high musculoskeletal symptoms with high work fatigue in 42 respondents
161 (28%). The results of the analysis of the incidence of work fatigue and workers'
162 musculoskeletal disorders obtained a p-value of 0.001, meaning that there is a relationship
163 between the incidence of fatigue and musculoskeletal disorders in gas station workers.
164 The odds ratio (OR) is 9.036, which means that fatigue can trigger musculoskeletal
165 disorders 9.036 times (Table 3).

166 **4. Discussion**

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

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

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

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

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

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

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

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

245 threshold value can cause functional changes in the body's organs. Hot working
246 conditions can cause drowsiness, fatigue, and increase the number of work errors [29].
247 Exposure to heat for hours can affect the body's balance, and how the body sweats. The
248 body's thermoregulation center originates in the brain, which regulates the blood flow
249 through the vessels in the skin, regulating the heat balance in the human body. At a
250 temperature of 25 °C, human skin can sweat. And the loss of fluids caused by sweating
251 causes fatigue [30], [31]. Based on the above, it is necessary to modify the workplace to
252 achieve more comfortable conditions by widening the roof to provide shelter and
253 regulations on using work uniforms that can reduce body heat [32]. Exposure to gasoline
254 caused by benzene concentrations can also cause fatigue, headaches, coughing, and
255 nausea due to prolonged exposure to inhaled benzene, which also causes chronic effects
256 [33]. It is hoped that gas station companies can identify the dangers of environmental
257 factors through environmental control. One of the controls is using personal protective
258 equipment (PPE) for workers, namely gas station operators wearing masks. The function
259 of PPE for gas station operators is to protect against exposure to chemicals produced by
260 gasoline components at gas stations [34]. The work environment needs to be improved to
261 minimize symptoms of musculoskeletal disorders and fatigue and increase productivity
262 [35].

263 **5. Conclusion**

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

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

276

277 **Competing Interests**

278 There were no conflicts of interest.

279

280 **Availability of Data and Materials**

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

283

284 **Authors' Contributions**

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

287

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1.	Your abstract should be no longer than 150 words. However, an abstract divided into sections (Introduction, Methods, etc.) can have up to 200 words.	We have changed the abstract to less than 150 words 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	4-16
2.	Abstract and in the main text: p-value or p?	we have changed it to p	12
3.	References: [4], [5]: Translate non-English titles into English where possible; place the translation in square brackets. Place the original language title or romanized title before the translation. Capitalize only the first word of the title, proper nouns, proper adjectives, acronyms, and initialisms unless	We have corrected it according to your input	292-300

	the conventions of a particular language require other capitalization.		
4.	Indicate the language after the pagination: Berrino F, Gatta G, Crosignani P. [Case-control evaluation of screening efficacy]. Epidemiol Prev. 2004;28:354–359. Italian	Can you show us in more detail which part we need to fix? because we couldn't find it	
5.	Please add tables and titles of tables with Notes after References. Please do not add them in the separate Word file.	We have added it according to the input you provided	415-427

1 **Work Fatigue and Musculoskeletal Disorders in Gas Station Operators** 2 **at Pontianak City, Indonesia**

3 **Abstract**

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

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

19 **1. Introduction**

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

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

28 Fuel filling stations are public facilities provided by the government or the state, and
29 foreign and private companies to meet the fuel needs of various types of motorized
30 vehicles. In general, fuel filling stations sell Pertalite, Diesel, Pertamina, and Pertamina
31 Plus fuels and make it easier for the public to obtain the fuel they need for their vehicles
32 [6]. This research was conducted at 11 fuel filling stations in Pontianak City, West
33 Kalimantan, Indonesia. In each sub-district, 50% of stations were studied, including
34 North Pontianak Subdistrict with two fuel filling stations, East Pontianak District with
35 one fuel filling station, Southeast Districts with two fuel filling stations, South Pontianak
36 District with one fuel filling station, West Pontianak District with two fuel filling stations,
37 and Pontianak Kota District with three fuel filling stations. Based on the results of
38 interviews and observations, the gas stations provide a 24-hour service, with gas station
39 operators working 8 hours per shift. Gas station operators work continuously in a standing
40 position and carry out repetitive activities/movements to refuel customers' vehicles, so
41 they are at risk of experiencing work fatigue and musculoskeletal disorders [7].

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

51 **2. Methods**

52 *2.1 Participants*

53 This type of research is an analytic observational study with a cross-sectional approach
54 conducted to analyze the relationship between fatigue and musculoskeletal disorders in
55 gas station workers in Pontianak City, Indonesia. The study involved 150 gas station
56 workers in Pontianak City, Indonesia who met the inclusion criteria as research
57 respondents. The inclusion criteria for respondents in this study were gas station workers
58 in Pontianak City who were willing to be respondents during the research and were aged
59 <55 years. Respondents were selected through the Simple Random Sampling technique.
60 Research ethics approval was obtained from the Health Research Ethics Committee of
61 the Poltekkes Kemenkes Pontianak No 224/KEPK-PK.PKP/VIII/2022 and written
62 consent (Informed Consent) was obtained from all gas station workers who were research
63 respondents.

64 *2.2 Description of work activities performed by petrol station operators*

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

74

75 *2.3 Research instruments*

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

100 buttocks, elbows, wrists, hands, thighs, knees, calves, ankles, and soles of the feet [9].
101 Assessment using the Nordic Body Map questionnaire uses 4 Likert scales consisting of
102 1: not painful, 2: slightly painful, 3: painful, and 4: very painful. Workers who were
103 research respondents were asked to provide an assessment of the parts of their body that
104 felt painful during work activities according to a predetermined Likert scale [10].

105 *2.4 Procedure*

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

121 *2.5 Data analysis*

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

124 graphs with simple statistical calculations such as averages, ratios, and percentages.
125 Furthermore, the research hypothesis was tested using the chi-square statistical test at the
126 95% confidence level to determine the relationship between research variables. The test
127 was carried out at the significance level $\alpha = 0.05$; if $p < 0.05$, the test results are significant.

128 **3. Results**

129 Fuel filling stations are public facilities provided by the government or the state, and
130 foreign and private companies to meet the fuel needs of various types of motorized
131 vehicles. In general, fuel filling stations sell Pertalite, diesel, Pertamina, and Pertamina
132 Plus fuels and make it easier for the public to obtain the fuel they need for their vehicles
133 [6]. This research was conducted at 11 fuel filling stations in Pontianak City, West
134 Kalimantan, Indonesia. In each sub-district, 50% of stations were studied, including
135 North Pontianak Subdistrict with two fuel filling stations, East Pontianak District with
136 one fuel filling station, Southeast Districts with two fuel filling stations, South Pontianak
137 District with one fuel filling station, West Pontianak District with two fuel filling stations,
138 and Pontianak Kota District with three fuel filling stations. Table 1 shows the
139 demographic distribution of gas station operator workers consisting of six variables
140 divided into several categories, as shown in Table 1. 120 (80%) gas station operator
141 workers are <40 years old. A total of 144 (96%) gas station operator workers have a high
142 school educational background. 92 (61.3%) gas station operators have worked for 1–5
143 years. Most workers, namely 78 (52%), are single. In addition, as many as 75 (50%) gas
144 station operators experienced high work fatigue. And as many as 111 (74%) workers have
145 low-grade musculoskeletal disorders (Table 1).

146 events and worker fatigue obtained an r count value of 0.577 more than the r table with
147 $df = n - 2 = 150 - 2 = 148$ obtaining an r table of 0.160 so that the value of r count (0.577)

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

152 The relationship between work fatigue and musculoskeletal symptoms in gas stations
153 operators showed that high fatigue with high musculoskeletal disorders was found in 33
154 respondents (22%), low fatigue symptoms with low musculoskeletal in 69 respondents
155 (46%), high musculoskeletal symptoms with low fatigue in 39 respondents (26%), and
156 extremely high musculoskeletal symptoms with high work fatigue in 42 respondents
157 (28%). The results of the analysis of the incidence of work fatigue and workers'
158 musculoskeletal disorders obtained a $p = 0.001$, meaning that there is a relationship
159 between the incidence of fatigue and musculoskeletal disorders in gas station workers.
160 The odds ratio (OR) is 9.036, which means that fatigue can trigger musculoskeletal
161 disorders 9.036 times (Table 3).

162 **4. Discussion**

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

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

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

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

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

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

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

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

247 causes fatigue [30], [31]. Based on the above, it is necessary to modify the workplace to
248 achieve more comfortable conditions by widening the roof to provide shelter and
249 regulations on using work uniforms that can reduce body heat [32]. Exposure to gasoline
250 caused by benzene concentrations can also cause fatigue, headaches, coughing, and
251 nausea due to prolonged exposure to inhaled benzene, which also causes chronic effects
252 [33]. It is hoped that gas station companies can identify the dangers of environmental
253 factors through environmental control. One of the controls is using personal protective
254 equipment (PPE) for workers, namely gas station operators wearing masks. The function
255 of PPE for gas station operators is to protect against exposure to chemicals produced by
256 gasoline components at gas stations [34]. The work environment needs to be improved to
257 minimize symptoms of musculoskeletal disorders and fatigue and increase productivity
258 [35].

259 **5. Conclusion**

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

272 **Competing Interests**

273 There were no conflicts of interest.

274

275 **Availability of Data and Materials**

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

278

279 **Authors' Contributions**

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

282

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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%

416

Note : Sources : Primary Data, 2022

417

n = The number of research respondents used as samples

418

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

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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		

421

Note : Sources : Primary Data, 2022

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^aChi-Square, $\alpha = 5\%$, *Significance $p\text{-value} \leq 0.05$

423

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

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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%).		

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Note : Sources : Primary Data, 2022

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^aChi-Square, $\alpha = 5\%$, *Significance $p\text{-value} \leq 0.05$

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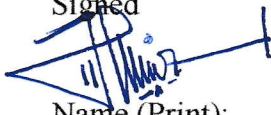
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Work fatigue and musculoskeletal disorders in gas station operators in Pontianak city, Indonesia

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ABSTRACT

This study analyzes the relationship between work fatigue and musculoskeletal disorders (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, Pertamina and Pertamina 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 Peralite, diesel, Pertamina, and Pertamina 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	<i>n</i>	%
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	<i>r</i> 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, $\alpha = 5\%$.

^b 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.

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 [Q8], $\alpha = 5\%$.

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 $V_{O_{2max}}$ 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

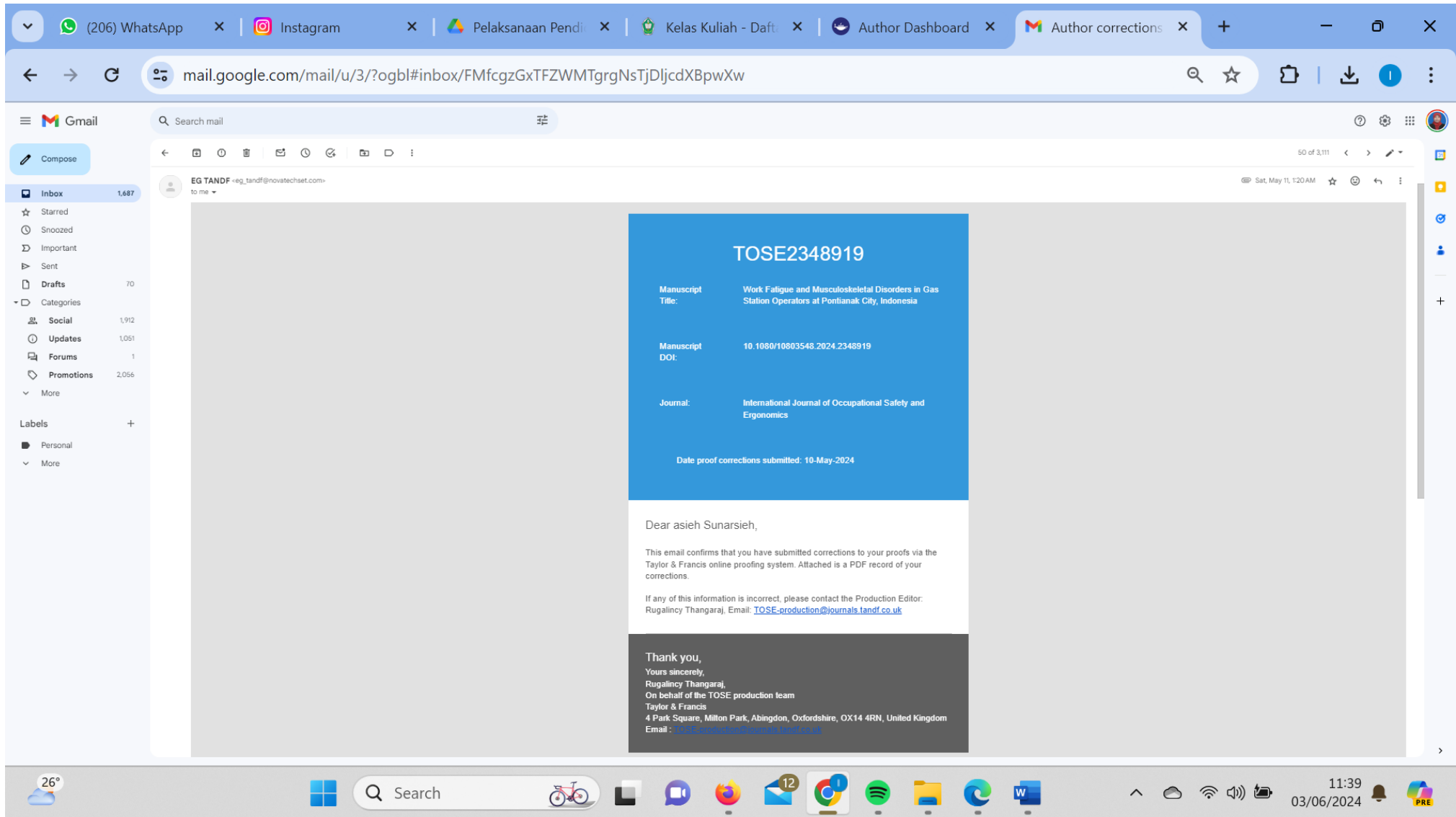
Supplemental data for this article can be accessed at <http://dx.doi.org/10.1080/10803548.2024.2348919> description of location. [Q10]

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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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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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 Peralite, Diesel, Pertamina and Pertamina 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

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 Peralite, diesel, Pertamina, and Pertamina 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	<i>n</i>	%
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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