

Paper

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1 **Research Article**

2

3 **Correlation between characteristics of fishermen and the perceived pain in grasping**
4 **activities**

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11

12 **Abstract**

13 Fishermen are essential to marine life. The dimension mismatches between a fisherman and their
14 fishing equipment, especially the boat engine steering lever, is a concern. The disparity in hand
15 and boat motor steering lever dimensions may put fishermen at risk of work-related injuries
16 and accidents. This research examined the correlation between fishermen's characteristics and
17 grasping hand musculoskeletal disorders (MSDs). Fifty fishermen from Baron Beach,
18 Gunungkidul, Yogyakarta, participated in this study. The independent variables were
19 individual characteristics of fishermen, including internal factors (such as body mass index
20 (BMI)) and external factors (such as work hours per day and work experience as a fisherman).
21 Meanwhile, the dependent variable was MSDs in the form of hand discomfort experienced by
22 fishermen during grasping activities, as measured by modified Indonesian translated
23 Standardized Nordic Questionnaires (SNQ) and Numeric Rating Scale (NRS) instruments.

24 Pearson correlation coefficient analysis was applied to analyze the relationship between

25 individual fisherman characteristics and MSDs on the hands caused by grasping activity.
26 Pearson correlation coefficient's analysis revealed a significant correlation between the
27 duration of a day's labor and discomfort in the thumbs and wrists of fishermen. There are also
28 significant correlations between work experience and thumb, palm, and wrist discomfort. The
29 study also revealed no correlation between BMI factors and the hand and wrist discomfort
30 experienced by fishermen. The findings of this study can be used as a basis for designing
31 ergonomic interventions for hand grasp aides based on anthropometric data collected from
32 fishermen. The design of the tool's hand handle uses a lightweight, durable material coated
33 with a soft, flexible material.

34

35 **Keywords:** Ergonomics, Hand grip, MSDs, Fishermen, Numerical Rating Scale (NRS),
36 Standardised Nordic Questionnaires (SNQ)

37

38 **1. Introduction**

39 Gunungkidul Regency is one of the regencies in Yogyakarta Province, with a coast length
40 of about 72 km [1]. With this condition, Gunungkidul Regency has potential in the maritime
41 sector, especially in marine fisheries, which is very promising. If calculated as far as 4 miles
42 from the coastline, the potential for capturing fisheries in this district covers an area of 518.56
43 square kilometers. The potential of Gunungkidul marine fisheries is supported by the length of
44 the coast, starting from the west end to the east end, which consists of seven beaches close to
45 each other. The seven beaches are Baron Beach, Kukup Beach, Sepanjang, Drini, Krakal, Slili,
46 Sundak, and Ngandong Beach.

47 Based on data from the Regional Planning and Development Agency of Yogyakarta, it is
48 explained that the number of marine fishermen in Gunungkidul in 2021 amounted to 4416
49 people, with marine fishery catch production of 5211.99 tons [2]. Based on previous study,

50 marine fisheries activities in developing countries including along the south coast of
51 Gunungkidul consist of several activities, such as controlling boats, dropping nets into the sea,
52 pulling nets, catching fish, carrying ice blocks, pouring ice blocks into ice storage boxes,
53 carrying and carrying fish in baskets or boxes, weighing fish, unloading caught fish, pushing
54 boats, and more [3].

55 One of the problems fishermen faces in carrying out their work is the mismatch between the
56 dimensions of the fisherman's body and the equipment used in his work. The mismatch between
57 the dimensions of the worker's body and work aids can cause workers to experience the risk of
58 work injuries or accidents [4]. One of the fishermen's activities that carries a risk of injury is
59 controlling a motorboat. Fishermen on the south coast of Gunungkidul operated outboard
60 motorboats with 315 boats in 2020 [1]. Fishermen control an outboard motorboat by grasping
61 the steering lever connected to the outboard motor propeller in a sitting position for a long time.
62 The steering lever of the outboard motor is made of cylindrical steel pipe, with the end of the
63 handrail section not coated with hand protection. This situation causes the tip of the outboard
64 motor steering lever to potentially injure the fisherman's palm because it has a sharp profile.
65 The sharp end profile of the steering lever handle can compress and injure the base of the
66 fisherman's palm. In addition, the long steering lever rod can also conduct vibrations
67 originating from the outboard motor to the hands of the motorboat driver. Workers operating
68 workplace vibration devices can suffer symptoms resembling Raynaud's phenomenon.
69 Raynaud's phenomenon is a condition that can cause several areas of the body, such as fingers
70 and toes, to feel numb. Although not dangerous, Raynaud's phenomenon can interfere with
71 daily activities and make the condition uncomfortable [5]. In addition to Raynaud's
72 phenomenon, the risk that fishermen will experience is the vibration white finger (VWF) [6].
73 This VWF is a condition of momentary numbness, tingling in the fingers, and fingers becoming
74 pale for a long time that occurs due to using vibrating devices for a long time [7].

75 Another factor affecting a worker's risk of MSDs is their characteristics. Components of
76 individual worker characteristics that affect worker productivity include age, gender, and
77 duration of work [8]. Previous research revealed that age, gender, duration of work per day,
78 and overall work experience were associated with MSDs in one or more upper extremities [9].
79 MSDs are one of the main causes of fatigue in workers. A higher risk of fatigue can have an
80 impact on decreasing worker productivity [8].

81 Furthermore, no previous study in Indonesia analyzed the correlation between individual
82 characteristic factors and the risk of MSDs in fishermen's hands due to grasping activities.
83 Therefore, the purpose of this study was to investigate the correlation between the
84 characteristics of individual fishermen and the pain in the hands that fishermen feel due to
85 grasping activities. The results of this study can be used as a basis for developing ergonomic
86 interventions in activities involving hand grip for fishermen.

87

88 **2. Materials and methods**

89

90 *2.1 Study Design*

91

92 This study used a cross-sectional design. The SNQ and NRS questionnaires, version
93 Indonesian [10], were used to collect respondents' demographic data and musculoskeletal
94 disorders of the thumb, index finger, middle finger, ring finger, little finger, palm, and wrist,
95 both left and right sides. This questionnaire was filled out independently by the respondents.
96 The pain data on the hands of the fishermen was obtained through direct measurements of 50
97 Baron Beach fishermen. The pain severity rating indicated by the respondent is recorded. The
98 scores include a range of values from 0 to 10, with the following cut points on the pain NRS
99 have been recommended: no pain (score 0), mild pain (score 1– 3), moderate pain (score

100 4 – 6), and severe pain (score 7 – 10) [11]. This data collection was carried out on October 11,
101 2022.

102

103 2.2. Respondents

104

105 The respondents of this study were all members of the fishermen's group located at Baron
106 Beach Gunungkidul, which amounted to 50 people. All fishermen meet the criteria to become
107 respondents in this study by having experience working as fishermen for at least one year.
108 Respondents were excluded from the study if they had a history of pain or surgery on the hands
109 and wrists. Before the farmers' participation, they were required to read and sign a consent
110 form. The grasping activities in this study were practiced in an actual field and were approved
111 by the Human Ethics Committee of Universitas Ahmad Dahlan.

112

113 2.3. Statistic Analysis

114

115 Descriptive statistics were used to analyze individual fishermen's factors and MSDs
116 variables. The independent variable used to conduct this study is the MSDs in the hands due to
117 grasping activities. Meanwhile the dependent variables include individual fishermen's factors.
118 There are two individual factors in the study, namely internal factors and external factors.
119 Internal factors include age, weight, height, and body mass index (BMI) [12]. External factors
120 that are the focus of this study include the duration of work per day and experience working as
121 a fisherman. The results of these internal and external individual factors are then analyzed by
122 mean and standard deviation (SD) [13]. Variables, including age, BMI, duration of work per
123 day, and work experience are presented in terms of quantity and percentage. Meanwhile, the
124 level of pain felt in hands are presented in a rating score. The Shapiro-Wilk test was used for

125 the normal distribution confirmation test for individual fishermen's factors and perceived pain
126 in hands in this study. The Pearson correlation coefficient analysis determines the relationship
127 between individual fishermen's factors and MSDs in the hands due to grasping activities.
128 Variables with a p-value of less than 0.05 are considered statistically significant. The data were
129 analyzed using the SPSS program version 26 [14].

130

131 *2.4. Hypothesis*

132

133 This study hypothesizes a significant correlation between individual fishermen's internal
134 and external factors and MSDs in fishermen's hands due to grasping activities when carrying
135 out fishermen's tasks.

136

137 **3. Results**

138

139 *3.1. Respondents' Demographics Characteristics Data*

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141 Data on respondents' demographic characteristics and descriptive statistics can be seen in
142 Table 1.

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150 ¹ **Table 1** Demographic characteristics data and descriptive statistics of respondents (N = 50)

Characteristics	N (%)	Mean ± SD
Gender		
• Male	50 (100%)	
• Female	0 (0%)	
Age (years)		45.64 ± 8.33
Height (cm)		164.82 ± 4.97
Weight (kg)		62.72 ± 8.11
BMI (kg/m ²)		23.13 ± 2.71
Work hours/day (hour/day)		10.21 ± 2.01
Work experience (years)		24.54 ± 7.38

151

152 All respondents in this study were men aged between 31 and 68 (average 45.64 ± 8.33). The
 153 most dominant respondents had a normal 35 (70%) BMI. All respondents use their right hand
 154 for activities (100%). Respondents were reported to have worked as fishermen for 24.54 ± 7.38
 155 years, with a working duration of 10.21 ± 2.01 hours per day.

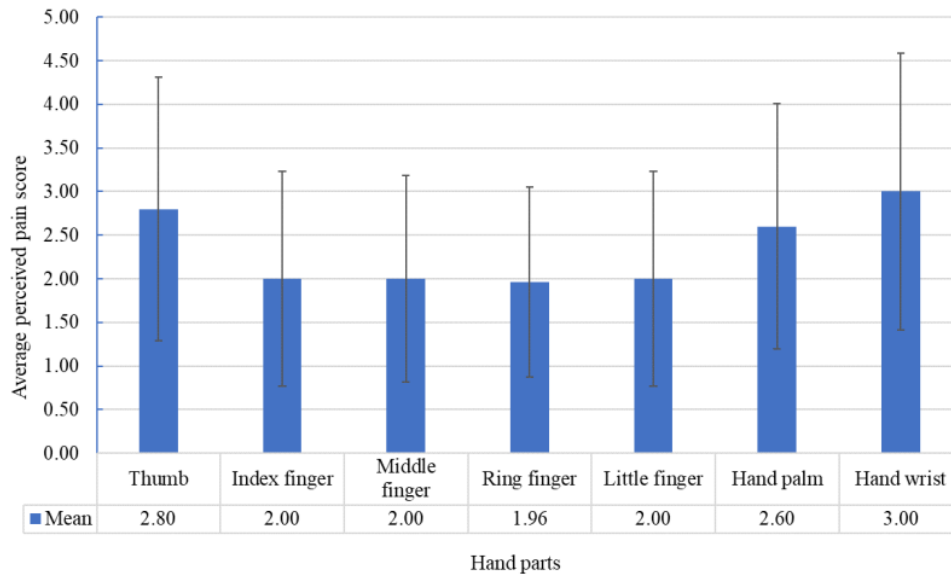
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157 3.2. Fisherman's Hand MSDs Data

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159 Data on the distribution of pain perceived by respondents ³ based on the results of the
 160 Standardized Nordic Questionnaire (SNQ) and Numerical Rating Scale (NRS) are presented in
 161 Figure 1.

162



163

164 **Figure 1** Distribution of pain perceived by respondents

165

166 The results of the modified Standardised Nordic Questionnaires (SNQ) and Numerical
 167 Rating Scale (NRS) showed that the part of the hand that experienced the most significant pain
 168 was the right hand, with severity levels in order being the wrist (average pain score $3.00 \pm$
 169 1.59), thumb (average pain score 2.80 ± 1.51), palm (average pain score 2.60 ± 1.41), index
 170 finger, middle finger, little finger (mean pain score 2.00 ± 1.23 ; mean 2.00 ± 1.18 ; mean 2.00
 171 ± 1.23 respectively), and ring finger (mean pain score 1.96 ± 1.09). The pain in the left hand is
 172 not as high as in the right hand because all respondents actively use the right hand as the
 173 dominant locomotor of movement.

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179 *3.3. Correlation Between Individual Factors and Complaints of Hand Pain in Fisherman*

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181 The correlation between individual factors and complaints of hand pain in fishermen is
 182 shown in Table 2.

183

184 **Table 2** Correlation of individual factors and complaints of hand pain in fishermen (N = 50)

Individual factors	Hand parts	Pearson coefficient (p-value)-
		right side
BMI	Thumb	0.011 (0.942)
	index finger	0.060 (0.679)
	middle finger	0.131 (0.363)
	ring finger	0.108 (0.456)
	little finger	0.028 (0.094)
	hand palm	0.025 (0.862)
	hand wrist	0.052 (0.721)
Work hours/day	Thumb	0.392 (0.005)*
	index finger	0.055 (0.706)
	middle finger	0.094 (0.614)
	ring finger	0.040 (0.781)
	little finger	0.042 (0.772)
	hand palm	0.222 (0.122)
	hand wrist	0.362 (0.010)*
Work experience	Thumb	0.391 (0.005)*
	index finger	0.106 (0.463)

Individual factors	Hand parts	Pearson coefficient (p-value)- right side
	middle finger	0.122 (0.398)
	ring finger	0.186 (0.197)
	little finger	0.221 (0.122)
	hand palm	0.284 (0.046)*
	hand wrist	0.307 (0.030)*

185 Asterisks represent significance (*p < 0.05)

186

187 ⁵ The results of Pearson correlation coefficient analysis showed a significant correlation
 188 between the duration of work in a day factor and pain in fishermen's thumbs (r = 0.392 at a p-
 189 value of 0.005) and pain in fishermen's wrists (r = 0.362 at a p-value of 0.010). The work
 190 experience factor also had a significant correlation with pain in the thumb, palm, and wrist (r
 191 = 0.391 at a p-value of 0.005, r = 0.284 at a p-value of 0.046, and r = 0.307 at a p-value of
 192 0.030, respectively). The study also revealed no significant influence between BMI factors and
 193 the pain perceived by fishermen in the hands and wrists.

194

195 4. Discussion

196

197 The respondents in this study were fishermen in a group of fishermen at Baron Beach,
 198 Gunungkidul, Yogyakarta. All respondents were male fishermen still actively using their right
 199 hand to drive a motorboat. Fishermen's activities involve many hand-gripping activities,
 200 including grasping bamboo pickets, grasping ship motor steering levers, lifting fish boxes, and
 201 others. The dominance of hand extremity dramatically affects the effectiveness of completing

202 a worker's job tasks [15]. Workers who predominantly move using the right hand will have
203 difficulty if they have to change their activities using the left hand, and vice versa.

204 The dominance of the right hand in doing work can often impact the onset of injury or
205 skeletal muscle disorders in the right-hand extremity, such as pain in the fingers and right wrist
206 [16]. The potential for injury and pain arising in the fingers and right wrist is caused by the
207 high force and muscle tension that must be generated by the right hand in its activities as a
208 consequence of the dominance of the use of the right hand [17]. Fishermen also experienced
209 the exertion of the right-hand muscle style as respondents in this study because all respondents
210 were fishermen who were dominant in right-handed activities. In addition to high muscle
211 exertion, the potential for injury to the right hand is also caused by an imperfectly circular
212 finger position [18]. In addition, injury is also caused by the hard and pointed surface of the
213 handrail [19], and the dimensions of the handrail diameter are too large [20].

214 This study investigates the influence of individual fishermen's factors on pain arising from
215 hand-grasping activities. The results of the modified SNQ and NRS questionnaires showed the
216 highest pain experienced in the right wrist, right thumb, and right palm, with a pain score of
217 3.00, 2.80, and 2.60, respectively. These three parts of the hand are indeed the most important
218 parts when doing grip activities [21].

219 The thumb is the essential part when grasping objects in a circular position grasping objects
220 [22]. The palm is sometimes to be the part of the hand that makes surface contact with the stem
221 with a pointed tip [23]. The hand wrist will suffer pain from bending the palm when doing an
222 imperfect hand grip [24]. In addition, the pain in the hands perceived by fishermen is also an
223 accumulation of pain arising from the duration of work over a long period of time [25].

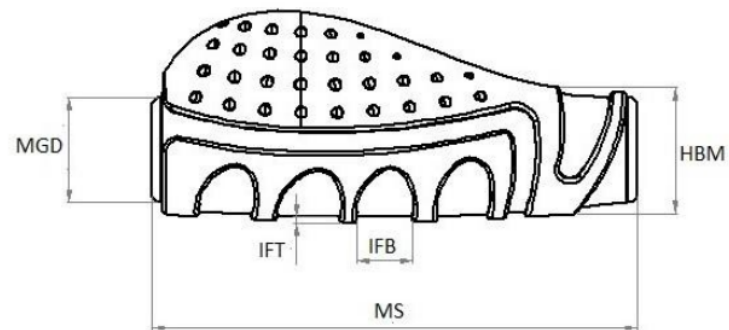
224 This fact reinforces the findings in this study that there is a significant correlation between
225 the duration of work in a day and pain in fishermen's thumbs and wrists. Work experience
226 factors also significantly correlate with thumb, palm, and wrist pain [26]. It is necessary to

227 carry out an ergonomic intervention in the form of a hand grip design to minimize pain in
228 fishermen's hands.

229 Ergonomic interventions can be grouped into three categories, namely (1) engineering
230 interventions, (2) administrative interventions, and (3) behavioral interventions [27].
231 Ergonomic interventions that are in accordance with the problems faced by fishermen are
232 engineering ergonomic interventions, namely the design of assistive devices for hand grip. This
233 assistive device for hand grip was designed using 50 anthropometric data directly measured
234 from fishermen's respondents.

235 The main hand anthropometric data needed to design an assistive device for hand grip
236 includes seven hand dimensions, namely handbreadth (across thumb) (HBT), palm length (PL),
237 maximum grip diameter (MGD), index finger breadth (IFB), index finger thickness (IFT), hand
238 breadth (metacarpal) (HBM), and maximum spread (MS) [28]. All hand anthropometric data
239 must meet the pre-requisite tests, which include normality tests meeting normal distribution
240 criteria ($p\text{-value} > 0.05$) [29], data adequacy tests by meeting the criteria of $N > N'$, where N is
241 the amount of data taken, and N' is the amount of data to be collected [30], and data uniformity
242 tests to ensure that no data lies outside the lower and upper limits of the distribution of these
243 data [31]. The analysis carried out on all anthropometric data from fishermen's hands is a
244 percentile calculation analysis. The calculation of percentiles of hand anthropometric data
245 follows the concept of calculating percentiles in previous studies [32].

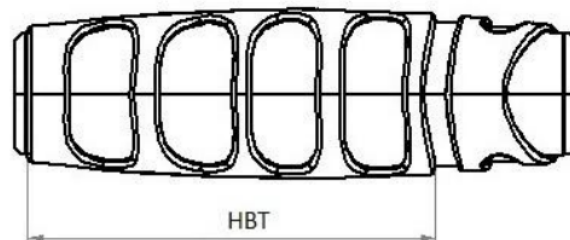
246 Based on the calculation of the percentile of hand anthropometric data, a proposal was made
247 to design an assistive device for hand grip that can minimize the pain perceived by fishermen.
248 The design of this assistive device for hand grip was designed using SolidWorks software, as
249 shown in figures 2-4.



250

251 **Figure 2** Proposed assistive device design for hand grip - front view

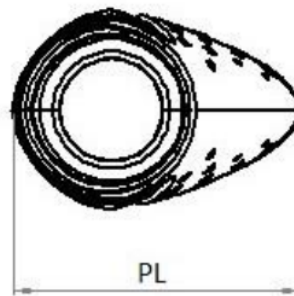
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254 **Figure 3** Proposed assistive device design for hand grip - top view

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256

257 **Figure 4** Proposed assistive device design for hand grip - side view

258 The proposed design of this assistive device for hand grip is recommended to use
 259 lightweight and strong materials coated with soft and soft materials [33]. The soft layer of

260 material can reduce the pressure concentration on the hand palm as a result of contact between
261 the skin surface of the hand palm and the hard grip surface of the hand [34].

262 The drawback of the present research is that it does not concentrate on the area of the body
263 conducting repeated motions while engaging in grasping activities, namely repetitive finger
264 movements. Another instrument is the Occupational Repetitive Action (OCRA), used to
265 measure repetitive activities. Future research will be more interesting, assuming direct
266 measuring techniques are employed, for example, surface Electromyography (sEMG), to
267 evaluate muscle usage for each position around the finger area and observation-based
268 evaluation tools. Another limitation of the present research is that most respondents are right-
269 handed. It may be more advantageous to include respondents who are likewise dominant in
270 using the left hand more equally to compare prior findings.

271

272 **5. Conclusions**

273

274 This study revealed that external individual characteristic factors significantly correlate with
275 the potential for MSDs pain in the hands perceived by fishermen when carrying out hand grip
276 activities. The factor of the duration of work per day has a significant relationship with pain in
277 the thumb and wrist of fishermen. Furthermore, the work experience factor was also
278 significantly correlated with pain in the thumb, hand palm, and hand wrist. The study also
279 found that none of the internal individual characteristic factors significantly correlated with the
280 pain of fishermen's hands and wrists.

281

282

283

284 **6. Acknowledgements**

285

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290

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