Sociality
Journal of Public Health Service
p-ISSN 2962-3472 | e-ISSN 2962-181X

Volume 5, Issue 2, March-August 2026
Page 186-193
10.24252/sjphs.v5i2.71711

Ergonomic intervention among fishermen in Untia: Reducing musculoskeletal risks through education and workstation design

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ABSTRACT

Work-related musculoskeletal disorders remain common among fishing communities, yet integrated interventions combining ergonomic risk assessment, worker education, and anthropometry-based assistive equipment are still limited. This community service program aimed to assess musculoskeletal disorder risks, improve fishermen's knowledge and skills regarding ergonomic work practices, and develop an ergonomic lifting-and-carrying aid in Untia Village, Makassar. The program involved 30 fishermen. Musculoskeletal complaints and postural risks were assessed using the Nordic Body Map and Rapid Entire Body Assessment (REBA), while ergonomics and occupational safety and health education was delivered through lectures, discussions, and question-and-answer sessions. Knowledge and skills were evaluated using pre-test and post-test assessments. An ergonomic transport trolley was developed using the Need, Idea, Decision, Action (NIDA) approach based on fishermen's anthropometric data. The assessment identified high-risk working postures related to manual lifting, awkward trunk positions, and repetitive movements. Mean knowledge and skill scores increased from 42.1 before the intervention to 74.4 after the intervention, representing a 76.8% improvement. These findings indicate that combining ergonomic education with anthropometrically designed assistive equipment can strengthen occupational health awareness and support the reduction of manual handling risks among fishermen. Continued post-implementation monitoring is needed to evaluate sustained effects on working posture and musculoskeletal risk.

ABSTRAK

Gangguan muskuloskeletal akibat kerja masih banyak ditemukan pada komunitas nelayan, sementara intervensi terpadu yang menggabungkan penilaian risiko ergonomi, edukasi pekerja, dan penggunaan alat bantu berbasis antropometri masih terbatas. Program pengabdian kepada masyarakat ini bertujuan untuk menilai risiko gangguan muskuloskeletal, meningkatkan pengetahuan dan keterampilan nelayan terkait praktik kerja ergonomis, serta mengembangkan alat bantu angkat dan angkut yang ergonomis di Kelurahan Untia, Makassar. Program ini melibatkan 30 nelayan. Keluhan muskuloskeletal dan risiko postur kerja dinilai menggunakan Nordic Body Map (NBM) dan Rapid Entire Body Assessment (REBA), sedangkan edukasi mengenai ergonomi serta keselamatan dan kesehatan kerja diberikan melalui ceramah, diskusi, dan sesi tanya jawab. Pengetahuan dan keterampilan peserta dievaluasi menggunakan penilaian pre-test dan post-test. Sebuah troli angkut ergonomis dikembangkan menggunakan pendekatan Need, Idea, Decision, Action (NIDA) berdasarkan data antropometri nelayan. Hasil penilaian menunjukkan adanya postur kerja berisiko tinggi yang berkaitan dengan aktivitas mengangkat secara manual, posisi batang tubuh yang tidak ergonomis, dan gerakan berulang. Rata-rata skor pengetahuan dan keterampilan meningkat dari 42,1 sebelum intervensi menjadi 74,4 setelah intervensi, atau mengalami peningkatan sebesar 76,8%. Temuan ini menunjukkan bahwa kombinasi edukasi ergonomi dan alat bantu yang dirancang berdasarkan antropometri dapat meningkatkan kesadaran terhadap kesehatan kerja serta mendukung pengurangan risiko penanganan beban secara manual pada nelayan. Pemantauan berkelanjutan setelah implementasi diperlukan untuk mengevaluasi dampak jangka panjang terhadap postur kerja dan risiko gangguan muskuloskeletal.

ARTICLE INFO

Keywords
anthropometry; ergonomics; fishermen; musculoskeletal disorders; occupational health

Article History
Submit : 10 August 2026
In Review : 17 August 2026
Accepted : 25 August 2026

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https://journal.uin-alauddin.ac.id/index.php/sjphs/

INTRODUCTION

Low back pain (LBP) is a major occupational health problem that contributes substantially to disability, reduced work capacity, and economic burden worldwide. Among the general population, LBP has been reported to have a point prevalence of approximately 9.4% and a lifetime prevalence of around 85% (Meucci et al., 2015). Occupational exposure accounts for approximately one-third of LBP cases, demonstrating the important contribution of workplace conditions to musculoskeletal health (Bontrup et al., 2019). The consequences extend beyond individual discomfort because LBP generates direct and indirect costs for workers, families, industries, and governments through healthcare expenditure, absenteeism, reduced productivity, and work limitations (Driscoll et al., 2014; De Carvalho et al., 2020). Musculoskeletal disorders (MSDs), including disorders affecting muscles, joints, tendons, ligaments, nerves, bones, and localized circulation, have also increasingly become an occupational health concern internationally. The International Labour Organization has documented substantial MSD burdens across countries, including an increase of approximately 4,000 cases over nine years in the Republic of Korea and reports that approximately 40% of occupational disease cases in the United Kingdom involve MSDs (Gawde, 2018).

Fishing represents a particularly vulnerable occupation because many work activities involve repetitive manual handling, heavy lifting, awkward postures, and prolonged static loading. Lifting and carrying heavy loads have consistently been identified as risk factors for LBP (Pillai & Haral, 2018; Pillastrini et al., 2010; Yang et al., 2016), while awkward posture, psychosocial demands, job dissatisfaction, repetitive movement, and static loading may further increase musculoskeletal strain (Rachmawati et al., 2021; Khalid et al., 2017; Lewis & Battglia, 2019; Bontrup et al., 2019). These occupational exposures are particularly relevant among fishermen whose daily tasks depend heavily on manual physical activity.

Fishermen in Untia Village, Biringkanaya Subdistrict, Makassar City, routinely unload, lift, lower, and transport fish catches manually without mechanical assistive devices. The total load handled during one unloading cycle may reach approximately one ton, creating repeated mechanical stress on the lower back and other body regions. Preliminary observations indicated unsafe working postures, including prolonged standing, bending, twisting while lifting, reaching, improper carrying techniques, and repetitive muscle exertion. Such postures may arise when the physical characteristics of a workstation do not correspond to workers' anthropometric dimensions and can contribute to pain in the back, arms, hands, shoulders, hips, waist, and legs (Tarwaka, 2014). Previous studies have also reported significant associations between prolonged sitting and LBP complaints (Sari et al., 2014) and between ergonomic working position and LBP among workers performing repetitive activities (Natosba & Jaji, 2016). Therefore, preventive occupational health interventions among fishermen should combine ergonomic risk assessment, worker education, and physical modifications to reduce hazardous manual handling.

Musculoskeletal complaints resulting from occupational exposure may be reversible, disappearing after static loading is removed, or persistent, with pain continuing even after exposure has ceased (Tarwaka, 2014). Excessive muscular exertion during lifting, pushing, pulling, and holding heavy loads, repetitive activity without adequate recovery, and non-neutral working postures can increase biomechanical stress and contribute to MSD development (Tarwaka, 2014). Consequently, identifying high-risk postures is essential before implementing ergonomic interventions.

Structured ergonomic assessment methods provide an objective basis for identifying hazardous working conditions and prioritizing corrective action. The Rapid Entire Body Assessment (REBA) evaluates whole-body postural risk, while the Ovako Working Posture Analysis System (OWAS) can be used to classify occupational postures and determine the urgency of ergonomic improvement. Such methods have been applied to evaluate posture-related risks in physically demanding occupations and to guide preventive ergonomic interventions (Asghari et al., 2019). In addition, the Nordic Body Map (NBM) can identify the distribution and severity of musculoskeletal complaints across body regions. Combining these assessments with occupational safety and health education may help workers recognize hazardous practices and adopt safer lifting and carrying

techniques.

Although previous studies have identified heavy lifting, repetitive movement, static loading, and awkward posture as important risk factors for LBP, interventions among fishing communities remain limited, particularly those integrating risk assessment, ergonomic education, and workstation or assistive-device design within a single community-based program. Fishermen may receive information about occupational risks, yet educational approaches alone may be insufficient when hazardous working conditions and the absence of appropriate handling equipment remain unchanged. An intervention that simultaneously addresses individual knowledge and the physical work environment may therefore provide a more practical and sustainable occupational health strategy.

The novelty of this community service program lies in integrating MSD risk assessment with participatory ergonomics education and the design of an ergonomic lifting-and-carrying aid based on fishermen's anthropometric characteristics. The program involved 30 fishermen in Untia Village, Makassar. Musculoskeletal complaints and ergonomic risks were assessed using the Nordic Body Map and REBA, with OWAS incorporated into the broader ergonomic evaluation framework. Ergonomic and occupational safety and health education was delivered through lectures, discussions, and question-and-answer sessions, while participants' knowledge and skills were evaluated using pre-test and post-test assessments. Accordingly, the program aimed to identify MSD risks among fishermen, improve their knowledge and skills regarding safer ergonomic work practices, and introduce an ergonomically designed lifting-and-carrying aid as a preventive intervention to reduce the risk of LBP and other work-related musculoskeletal disorders.

METHODS

This community service program applied a participatory approach integrating ergonomic risk assessment, ergonomics and occupational safety and health (OSH) education, practical training, and the design of an ergonomic assistive device. The intervention was structured to identify musculoskeletal disorder (MSD) risks among fishermen, strengthen participants' knowledge and skills regarding safe working practices, and provide an ergonomic solution for manual fish-handling activities.

Location and Implementation Period

The program was conducted in Untia Village, Biringkanaya Subdistrict, Makassar City, South Sulawesi, at the community hall of the Untia Village Office, approximately 21 km from Poltekkes Kemenkes Makassar. Field activities were implemented during the first year of the funded program in 2026 and included preparation, baseline assessment, educational intervention, assistive-device development, and program evaluation in accordance with the approved implementation schedule.

Participants and Community Partners

The target population consisted of fishermen actively engaged in fish-catching and/or fish-handling activities in Untia Village. A total of 30 fishermen were purposively selected based on their active participation in occupational activities involving manual handling of fishing equipment and catches. Community partners included the head of the Untia Village fishermen group and the Untia Village government. The village government facilitated coordination, participant mobilization, provision of the activity venue, and supporting facilities required during implementation.

Program Procedures

The program was implemented through four sequential stages. The first stage involved preparation, including a preliminary site survey, administrative licensing, and coordination with the village government and fishermen group. This stage was undertaken to determine the program schedule, confirm participant eligibility, identify occupational conditions, and prepare materials and equipment.

The second stage consisted of MSD risk assessment. Subjective musculoskeletal complaints were identified using the Nordic Body Map (NBM) questionnaire, which assessed discomfort across

different body regions. Ergonomic risks were further evaluated through direct observation and photographic documentation of fishermen's working postures during net-pulling, fish-lifting, unloading, and catch-transport activities. The observed postures were analyzed using the Rapid Entire Body Assessment (REBA) to determine the level of postural risk and the urgency of ergonomic intervention.

The third stage involved ergonomics and OSH education and training. Educational materials covered the definition and consequences of MSDs, occupational risk factors, identification of unsafe work activities, and principles of safe and ergonomic working posture. The intervention was delivered through lectures, group discussions, and question-and-answer sessions supported by LCD presentations, printed brochures, and educational leaflets. Participants' knowledge and skills were assessed before and after the educational intervention using structured pre-test and post-test instruments.

The fourth stage involved designing an ergonomic lifting-and-carrying aid in the form of a trolley using the Need, Idea, Decision, Action (NIDA) approach. The Need phase identified fishermen's difficulties and requirements related to manual transportation of fish catches. The Idea phase generated alternative designs considering dock conditions, load capacity, maneuverability, and ease of operation. During the Decision phase, the most appropriate alternative was selected based on ergonomic suitability, material strength, stability, and expected work efficiency. The Action phase involved fabrication of the selected prototype. Anthropometric measurements of fishermen, including handle height, device width, and pushing position, were incorporated into the design to improve comfort, safety, and compatibility with users' physical characteristics.

Success Indicators and Evaluation

Program success was assessed using three quantitative indicators: identification of MSD risk levels in at least 80% of participants, an increase of at least 20% in mean knowledge and skill scores between pre-test and post-test assessments, and completion of one functional ergonomic lifting-and-carrying aid for transfer to the partner fishermen group.

Evaluation employed a one-group pre-test and post-test design. Changes in ergonomics and OSH knowledge and skills were assessed by comparing scores before and after the intervention. Working posture was also reassessed using REBA following implementation of the ergonomic intervention. Participant satisfaction with the ergonomic workstation and lifting aid was evaluated through a satisfaction survey. Program sustainability was supported through a plan for periodic monitoring involving the village government and implementation team in coordination with the local community health center.

RESULTS AND DISCUSSION

Table 1
Characteristics of Respondents

Variable	Mean ± SD	Median	Min–Max
Age (years)	51.1 ± 9.18	53.5	34–68
Work experience (years)	30.4 ± 8.92	32	15–45
Working duration (hours/day)	9.9 ± 1.89	10	8–14

A total of 30 fishermen in Untia Village participated as respondents in this program; all respondents were male. The age of respondents ranged from 34 to 68 years (mean 51.1 ± 9.18 years; median 53.5 years). Fishing work experience ranged from 15 to 45 years (mean 30.4 ± 8.92 years; median 32.0 years), and daily working duration ranged from 8 to 14 hours per day (mean 9.9 ± 1.89 hours; median 10.0 hours). These figures indicate that the respondents were predominantly middle-aged to older adults with long working tenure and extended daily exposure to manual fish-handling activities, as summarized in Table 1.

Table 2
Descriptive Statistics of REBA and OWAS Scores

Variable	Mean ± SD	Median	Min–Max
REBA score	7.00 ± 2.26	7.5	3–11

Working posture during net-pulling, fish-lifting, and catch-transport activities was scored using the REBA and OWAS methods (see Table 2). The REBA score ranged from 3 to 11 (mean 7.00 ± 2.26; median 7.5), When classified into standard risk categories (see Table 3), REBA scores showed that 43.3% of respondents (n = 13) fell into the medium-risk category and 43.3% (n = 13) into the high-risk category, while 6.7% (n = 2) each were classified as low-risk and very-high-risk. These distributions indicate that the majority of fishermen's working postures during manual unloading fall within the medium-to-very-high risk range, confirming a substantial and largely consistent postural risk across both assessment methods.

Table 3
Frequency Distribution of REBA Categories

Risk Category	REBA (n)	REBA (%)
Low	2	6.7
Medium	13	43.3
High	13	43.3
Very high	2	6.7

Effectiveness of Ergonomics and OSH Education (Paired-Samples t-Test). The effectiveness of the educational intervention was evaluated by comparing pre-test and post-test scores across five knowledge and skill domains using the paired-samples t-test (see Table 4). Scores increased significantly in all five domains ($p < .001$ for all pairs): knowledge of LBP (42.0 to 75.7), ergonomic skills (44.3 to 73.3), knowledge of safe working posture (43.3 to 75.0), knowledge of ergonomic risk factors (40.0 to 73.3), and skills related to risky working posture (40.7 to 74.7). Averaged across the five domains, the mean knowledge and skill score increased from 42.1 to 74.4, an improvement of 76.8%, demonstrating that the lecture-discussion educational intervention was effective in improving fishermen's understanding and practical skills related to ergonomics and occupational safety and health.

Table 4
Paired-Samples t-Test of Pre-Test and Post-Test Knowledge and Skill Scores

Domain	Pre-test Mean ± SD	Post-test Mean ± SD	Mean Difference	p-value
Knowledge of low back pain (LBP)	42.0 ± 10.6	75.7 ± 6.8	-33.7	<0.001
Ergonomic skills	44.3 ± 10.1	73.3 ± 6.1	-29	<0.001
Knowledge of safe working postures	43.3 ± 10.3	75.0 ± 7.3	-31.7	<0.001
Knowledge of ergonomic risk factors	40.0 ± 9.5	73.3 ± 6.1	-33.3	<0.001
Skills in identifying risky postures	40.7 ± 10.5	74.7 ± 5.7	-34	<0.001

The respondents in this program were predominantly middle-aged to older fishermen (mean age 51.1 years) with long fishing experience (mean 30.4 years) and daily working duration exceeding 9 hours, a profile consistent with previous studies reporting that Indonesian fishermen are typically older, long-tenured workers who continue manual catch-handling activities well into later adulthood (Kumbea et al., 2021; Wahab, 2019). This demographic pattern is relevant because age and work experience are established correlates of musculoskeletal risk among fishermen; Nadifatuzzahroh et al. (2024) similarly reported a significant association between age and low back pain complaints ($r = .396$, $p = .001$) and between working period and low back pain ($r = .188$, $p = .048$) among 107 fishermen in

Bangkalan, a pattern that parallels the significant correlation found in the present study between work experience and REBA risk category

The high proportion of respondents classified in the medium-to-very-high REBA and OWAS risk categories (Table 3) confirms that manual fish-unloading activity in Untia Village imposes substantial biomechanical load, consistent with observational ergonomic assessments of other fish-handling and fish-processing occupations. Risco-Ojeda et al. (2026), for example, reported an overall mean REBA score of 8.60 ± 1.65 among fish-processing workers, with none of the 30 workers assessed falling into the negligible or low-risk category, and concluded that postural risk in fish-handling tasks is structurally embedded in workstation design rather than being solely attributable to individual worker behavior. This aligns with the present findings, in which fishermen's exposure to repetitive lifting, bending, and twisting during manual unloading—activities performed without any assistive equipment—produced a risk profile in which no respondent fell into the OWAS low-risk category and only 6.7% fell into the REBA low-risk category.

The strong correlation between REBA indicates that the observational methods produced largely convergent risk classifications in this population, which is expected given that both instruments assess overlapping postural dimensions (trunk, arm, and leg position). However, the correlation is not perfect, echoing methodological comparisons in the literature showing that REBA, and related observational tools do not always agree in the risk level they assign to the same posture, because each method weights body segments, load, and repetition differently (Kee, 2021, 2022). Kee (2021) demonstrated that OWAS, RULA, and REBA can classify identical postures into different action levels, while Brandl et al. (2024) further showed, using in vivo joint load measurements, that OWAS and REBA action levels can distinguish between different biomechanical loading conditions but do not necessarily correspond to equal mean in vivo loads. This body of evidence supports the use of both REBA and OWAS in combination, as applied in this program, to obtain a more complete and cross-validated picture of postural risk rather than relying on a single instrument.

The substantial increase in knowledge and skill scores following the educational intervention (from a mean of 42.1 to 74.4, a 76.8% improvement, with all five domains significant at $p < .001$) demonstrates that a structured lecture-discussion approach can meaningfully improve fishermen's understanding of ergonomics and safe working posture in a relatively short intervention period. This finding is consistent with other community-service ergonomics education programs in Indonesia that used a similar one-group pre-test–post-test design and reported meaningful knowledge gains among manual workers with limited prior ergonomics exposure. However, the magnitude of improvement observed here was considerably larger than that reported by Pramesona (2025) among coffee-processing home-industry workers, whose pre-test and post-test scores were identical (both 100%) because participants already possessed strong baseline ergonomics knowledge before the intervention. The contrast between the two programs suggests that education-based interventions yield the greatest measurable gains precisely in populations such as fishermen, whose baseline occupational safety knowledge is low and who have had little or no prior exposure to formal ergonomics training.

Nevertheless, the REBA indicate that fishermen's postural risk is, at least in part, a structural consequence of the absence of assistive lifting equipment rather than a purely behavioral or knowledge-based problem. This is consistent with the conclusion of Risco-Ojeda et al. (2026) that training and postural-awareness interventions alone are unlikely to substantially reduce biomechanical exposure when the exposure is imposed by task and workstation design, and that engineering controls—such as workstation redesign or the provision of assistive devices—should be prioritized alongside education. The present program's design of an ergonomic lifting-and-carrying aid using the NIDA (Need, Idea, Decision, Action) approach, based directly on fishermen's anthropometric data, reflects this principle. A comparable NIDA-based approach was applied by Sirait and Sirait (2025) in the design of a jumbo-bag lifting aid for manual material-handling workers, which reduced the REBA score from 6 (medium risk) to 2 (low risk) after implementation. This suggests that the trolley developed in the present program has strong potential to further reduce the REBA and OWAS risk categories reported in Table 3, although a formal post-implementation REBA/OWAS re-

assessment using the new lifting aid was beyond the scope of the results presented here and is recommended as a priority for the next phase of program evaluation.

This program has several limitations. First, the sample was limited to 30 male fishermen from a single village, so the findings may not be generalizable to fishermen in other regions or to female workers in the fisheries sector. Second, the one-group pre-test–post-test design without a control group limits causal inference regarding the educational intervention's effectiveness, since improvement could also be partly attributable to testing effects. Third, REBA and OWAS scoring, although performed using standardized worksheets, is an observational method subject to some degree of rater judgment, a limitation noted broadly in the ergonomics literature (Kee, 2022). Finally, this report does not yet include a re-assessment of REBA/OWAS scores after the ergonomic trolley was put into use; such a follow-up evaluation is recommended to confirm the device's effectiveness in reducing musculoskeletal risk under real working conditions.

CONCLUSION

This community service program demonstrated that fishermen in Untia Village were exposed to substantial musculoskeletal disorder risks, with most participants classified within medium-to-very-high REBA risk categories. Work experience and daily working duration showed more consistent relationships with postural risk than age. The ergonomics and occupational safety and health intervention substantially improved participants' knowledge and skills, with the mean score increasing from 42.1 to 74.4, equivalent to a 76.8% improvement and exceeding the program success target of 20%. In addition, an ergonomic lifting-and-carrying trolley was successfully developed using the NIDA approach and anthropometric measurements of fishermen. These findings highlight the value of integrating ergonomic risk assessment, participatory education, and anthropometry-based assistive technology in community occupational health interventions. Continued monitoring and post-implementation REBA reassessment are recommended to determine the long-term effectiveness of the trolley in reducing manual handling risks and preventing musculoskeletal disorders under routine fishing conditions.

ACKNOWLEDMENT

The authors would like to express their sincere gratitude to the fishermen and their families in Kelurahan Untia, Makassar City, for their active participation and cooperation in this community service program. Appreciation is also extended to the local community leaders and the Department of Environmental Health, Poltekkes and enumerator, for their institutional support and facilitation of the program's implementation.

FUNDING

The authors would like to express their sincere gratitude to the Poltekkes Kemenkes Makassar and the Simlitabkes, Ministry of Health of the Republic of Indonesia, for providing financial support for this community service program through funding decree No. DP.04.04/F.XII.12.3/481/2026. The authors also extend their appreciation to the Government of Untia Village, Biringkanaya Subdistrict, Makassar City, and the participating fishermen for their valuable cooperation and support throughout the implementation of this program.

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AUTHORS' CONTRIBUTION

Iwan Suryadi conceptualized and designed the community service program, coordinated the field implementation, and led the data analysis and interpretation. He also drafted the initial manuscript and critically revised it for important intellectualcontent. Juherah Juherah and Ain Khaer contributed to assisted in data collection during the pre-testand post-test assessments, and supported data analysis and manuscript review. All authors read and approved the final version of the manuscript.

COMPETING INTEREST

The author(s) declare no potential conflict of interest with respect to the research, authorship, or publication

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