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Community-Based Occupational Health Promotion for Rural Youth Through Ergonomic Education and Therapeutic Swimming Training

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Abstract

Occupational health issues in rural informal industries, particularly home-based garment production, are often overlooked despite the high risk of musculoskeletal disorders among young workers. This community service program aimed to improve occupational health literacy and physical well-being among rural youth through ergonomic education and therapeutic swimming training in Ngadirejo Village, Boyolali. Implemented in collaboration with Karang Taruna "Gambate," the program applied a community-based participatory approach over eight months. Interventions included ergonomic training on proper posture, simple workstation adjustments, micro-break and stretching routines, and therapeutic swimming to support muscle recovery. A one-group pre-test and post-test design using the Occupational Health Knowledge Scale and the Nordic Musculoskeletal Questionnaire was used for evaluation. Results showed a 28.8% increase in ergonomic knowledge and a 23.5% decrease in musculoskeletal complaints. In conclusion, participatory and low-cost ergonomic interventions effectively improved health awareness, reduced physical strain, and strengthened productive behavior among rural youth workers.

Keywords: *Ergonomics, Therapeutic swimming, Occupational health, Community-based approach, Musculoskeletal disorder.*

Introduction

Empowering rural youth should not only focus on economic and social dimensions but also incorporate occupational health as a foundation for sustaining their productive capacity. Productive work in the informal sector—such as small-scale garment enterprises in rural areas—tends to carry higher health risks due to the absence of regulation, inadequate facilities, and limited understanding of ergonomic principles (ILO, 2011)(Kemnaker, 2025). When occupational health is neglected, productivity declines, musculoskeletal complaints increase, and workers' overall well-being becomes compromised. As shown in Figure 1, the informal manufacturing activities in rural Boyolali reflect the characteristics of high manual labor intensity combined with low ergonomic awareness.

Figure 1 Example of garment production activities in rural informal sectors

In Indonesia, the informal sector employs a significant proportion of the workforce and plays a vital role in the local economy (Ministry of Environment and Forestry, 2020). However, most informal workers remain unprotected by formal occupational safety systems and basic labor regulations (Sholikin, 2024). In this context, small-scale garment businesses in rural areas represent a tangible example of the challenges in implementing occupational safety and health (OSH) at the grassroots level. Therefore, community-based interventions are urgently required to promote occupational health practices that are both feasible and sustainable in resource-limited settings.

Karang Taruna "Gambate", a youth organization in Ngadirejo Village, Boyolali Regency, manages a garment production unit involving young members in pattern cutting, sewing, and screen-printing activities. These tasks are performed manually in static positions for extended periods of time. Such repetitive sitting and standing postures are associated with a higher risk of musculoskeletal disorders (MSDs) such as lower back, shoulder, and neck

pain, as reported in various ergonomic studies on small industries (e.g., REBA analysis on small workshop workers). Despite their enthusiasm, the members have limited ergonomic literacy and do not routinely engage in physical exercise to mitigate these risks.

Several studies have demonstrated that even simple applications of ergonomic principles can yield significant benefits. Improvements in workplace design—such as optimizing table and chair height, and applying active rest or stretching routines—have been proven to reduce biomechanical load and enhance productivity (Gangopadhyay, 2018a; Lynch-Caris, 2016). For instance, (Hutagalung et al., 2022a) found that ergonomic intervention reduced L5/S1 spinal load by approximately 60% and increased productivity by 26%. Similarly, (Gangopadhyay, 2018b). (Jiraporn Tangkittipaporn & Worapun Jiangsathaporn, 2017) reported that ergonomic office environments lowered fatigue, reduced work errors, and improved concentration. However, despite these findings, ergonomic interventions have rarely been adapted systematically for rural informal sectors.

In addition to workplace modification, therapeutic swimming offers a promising form of *active recovery* that can enhance muscle flexibility, improve circulation, and alleviate musculoskeletal complaints. Swimming, as a low-impact exercise, provides buoyancy that minimizes joint strain and has long been used in physical rehabilitation therapy for musculoskeletal conditions (Becker, 2009), 2009. Although research on therapeutic swimming in the context of rural small-scale workers remains limited, the concept of *aquatic therapy* has been clinically recognized for its ability to accelerate recovery and prevent muscle injuries (Peng et al., 2022).

In response to these challenges, this community service program was designed as a dual intervention, combining ergonomic education with therapeutic swimming training for members of *Karang Taruna "Gambate"*. The ergonomic education component emphasizes correct working postures, workspace arrangement (e.g., table height, chair position, hand alignment), and simple stretching habits during working hours. Meanwhile, the therapeutic swimming sessions serve as a regular physical activity to maintain body fitness and mitigate musculoskeletal risks resulting from static work. This integrated design aims not only to raise awareness of occupational health but also to deliver tangible improvements in comfort, flexibility, and productivity.

This initiative also aligns with national and global development frameworks. It supports Indonesia's Nawacita V, which emphasizes improving citizens' quality of life, and contributes directly to Sustainable Development Goal (SDG) 3 — Good Health and Well-Being and SDG 8 — Decent Work and Economic Growth. By employing a community-based and technology-appropriate approach, *Karang Taruna "Gambate"* is expected to serve as a model for promoting occupational health in rural informal sectors — fostering a culture of safety, independence, and sustainable productivity that can be replicated in other villages.

Methods

This community service program was carried out in Ngadirejo Village, Simo Subdistrict, Boyolali Regency, Central Java Province, in collaboration with Karang Taruna "Gambate" as the main partner. The partner represents a youth organization managing a small-scale garment enterprise that typifies the informal sector with high ergonomic risk. The program was implemented over eight months (March–October 2025) under the coordination of lecturers and students from the Department of Mechanical Engineering, Faculty of Engineering, Universitas Wahid Hasyim Semarang. The village was selected because it features intensive manual work and prolonged static activity, yet lacks adequate occupational health practices (ILO, 2011b; Rahayu et al., 2021). The geographical location of the activity site and its distance from the university are illustrated in Figure 1.

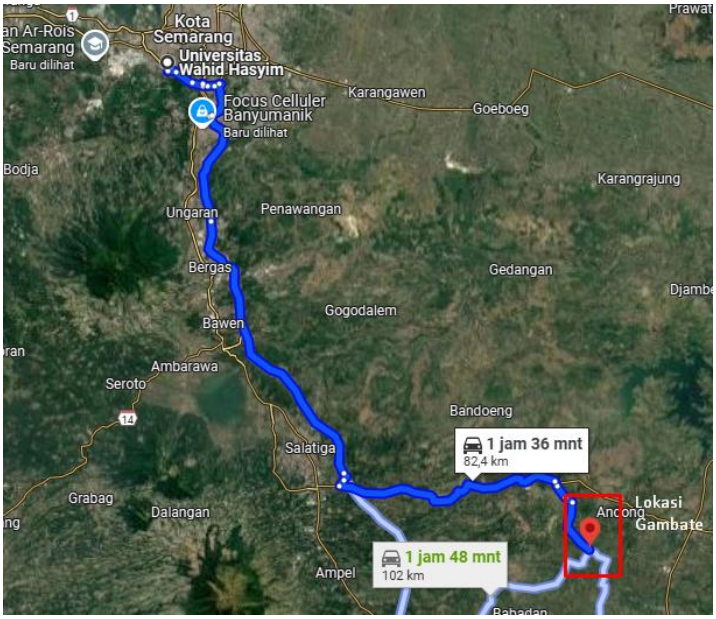

Figure 2 Location of Ngadirejo Village and Partner's Workshop Area (Source: Google Maps, 2025)

The program implementation adopted a Community-Based Participatory Approach (CBPA), emphasizing collaboration and active involvement of the community in every stage — from planning to evaluation. This participatory model was chosen to build ownership, enhance motivation, and ensure program sustainability (Collins et al., 2018; Page-Reeves, 2018). The intervention focused on two major components: (1) ergonomic education and practice, and (2) therapeutic swimming training, both designed as an integrative form of occupational health promotion (WHO, 2020).

The initial stage involved field observation and interviews with the members of *Karang Taruna "Gambate"* to identify dominant work postures, repetitive activities, and musculoskeletal complaints. Work processes were documented in photos and short videos for ergonomic risk analysis. Using the Rapid Entire Body Assessment (REBA) method (McAtamney & Nigel Corlett, 1993) the team evaluated working postures during sewing, cutting, and printing activities. This ergonomic assessment, shown in Figure 2, served as the foundation for designing tailored training materials addressing the most critical ergonomic risks among garment workers.

Figure 3 Observation of working posture and ergonomic assessment using REBA

The second stage consisted of workplace health education focusing on musculoskeletal disorder (MSD) prevention and ergonomic awareness. Materials were delivered through interactive media such as posters, visual infographics, and short educational videos to enhance comprehension among participants (Rachmah, 2025). Following the awareness session, participants engaged in practical ergonomic exercises, which included proper sitting and standing postures, *micro-break stretching* every two working hours, and demonstrations on adjusting table and chair height according to anthropometric data of Indonesian workers (Lestari & Fauzien, 2021) (Usman et al., 2025)(Yulianingtyas & Haqi, 2021). As shown in Figure 3, the training was conducted directly at the partner's production site using simple equipment and body movement simulations. This hands-on approach proved effective in improving awareness and comfort at work (Hutagalung et al., 2022).

The next phase involved therapeutic swimming (hydrotherapy) as a complementary physical intervention, as shown in Figure 4. Sessions were held once or twice a week at the village swimming pool. Training focused on breathing control, low-intensity movement in water, and muscle stretching to relieve tension caused by static work. This *low-impact aquatic exercise* has been widely recognized for improving flexibility and physical endurance without straining joints or muscles (Becker, 2009; Mooventhan & Nivethitha, 2014).

Figure 4 Ergonomic practice session on sitting posture and active stretching

Previous studies have also shown that therapeutic swimming can reduce lower back pain among sedentary workers by up to 30% (Sariningsih et al., 2024). The participants reported similar outcomes, feeling physically lighter and more relaxed after sessions.

Figure 5 Therapeutic Swimming Training

The program evaluation employed a quasi-experimental one-group pre-test and post-test design, which allowed assessment of changes in knowledge, attitude, and work behavior before and after the interventions. Ergonomic knowledge was measured using a 15-item pre–post questionnaire adapted from the *Occupational Health Knowledge Scale* (Kgakge et al., 2025), covering three main domains: understanding of MSD risks, knowledge of posture and stretching, and application of ergonomics for fitness. The instrument used

both multiple-choice and 5-point Likert scale formats and was validated by three experts with a Content Validity Index (CVI) of 0.91, indicating high relevance.

Musculoskeletal complaints were measured using the Nordic Musculoskeletal Questionnaire (NMQ) translated into Indonesian, covering nine body areas: neck, shoulders, upper back, lower back, arms, wrists, hips, knees, and ankles (Kgakge et al., 2025). Data collection was conducted twice — before and two weeks after the intervention. Data analysis employed descriptive and comparative methods, calculating mean pre- and post-scores, and percentage gain (Frank Wilkins, Luqman Hakeem; Batumalai, Pragathesh; Jasmi, 2019), which was categorized as *low (<15%)*, *moderate (15–25%)*, and *high (>25%)* improvement. The reduction of muscular discomfort across body areas was visualized in bar charts (see Figure 4 in the Results section).

To enrich the quantitative findings, qualitative data were also gathered through field observations and semi-structured interviews. Observations focused on behavioral changes in posture correction, stretching routines, and active rest habits, while interviews explored participants' subjective experiences. This combination of methods provided contextual insights and demonstrated the social transformation process among rural youth.

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Result

The community service program focusing on occupational health promotion through ergonomic education and therapeutic swimming was successfully implemented with the active participation of 20 youth members of Karang Taruna "Gambate" in Ngadirejo Village, Boyolali, Central Java. This activity series — including preliminary observation, counseling, ergonomic training, and structured therapeutic swimming sessions — took place over eight months and demonstrated high levels of engagement, reflected by an average attendance rate of 95 percent. Initial field observations at the partner's convection workshop revealed that most participants performed repetitive garment-sewing tasks while maintaining static sitting postures for more than four consecutive hours without performing stretching, postural correction, or micro-breaks. These conditions illustrate limited ergonomic practice and align with the International Labour Organization (ILO, 2011), which highlights that informal sector workers in developing

countries experience elevated musculoskeletal disorder (MSD) risk due to inadequate ergonomic awareness and poorly designed workstations.

Table 1. Comparison of Participants' Ergonomic Knowledge Scores (Pre–Post Test)

Knowledge Aspect	Pre-Test Mean	Post-Test Mean	Improvement (%)	Category
MSD Risk Awareness	62.0	80.3	29.5	High
Posture and Active Stretching	64.1	83.4	30.1	High
Ergonomic and Work Fitness Application	64.0	81.2	26.9	High
Overall Average	63.4	81.7	28.8	High

Results of the ergonomic knowledge assessment further demonstrated a positive outcome. As presented in Table 1, participants showed notable increases across all measured dimensions of knowledge, including MSD risk awareness, posture, and active stretching, and ergonomic and work-fitness application. The mean pre-test score of 63.4 improved to 81.7 in the post-test, representing a 28.8 percent increase and categorized as a high knowledge gain. These findings correspond with prior studies by (Sarji & Wibowo, 2021) and (Wijayanti et al., 2020), which show that structured ergonomic education and targeted training interventions significantly improve knowledge and awareness in occupational health settings. The combination of theoretical explanation, direct demonstration, and immediate practice allowed participants to internalize ergonomic concepts more effectively. This is consistent with (Hutagalung et al., 2022), who emphasize that community-based participatory learning approaches foster knowledge retention, encourage behavior adaptation, and strengthen community skill capacity.

The findings indicate that participants gained a stronger understanding of proper working postures, micro-break stretching, and workstation

adjustments. These results are consistent with (Rachmah, 2025) and (Hutagalung et al., 2022), who found that ergonomics-based training significantly reduces fatigue and discomfort among small-scale industrial workers. The use of visual media — including posters, demonstration videos, and direct mentoring — strengthened learning outcomes by engaging participants actively in the training process.

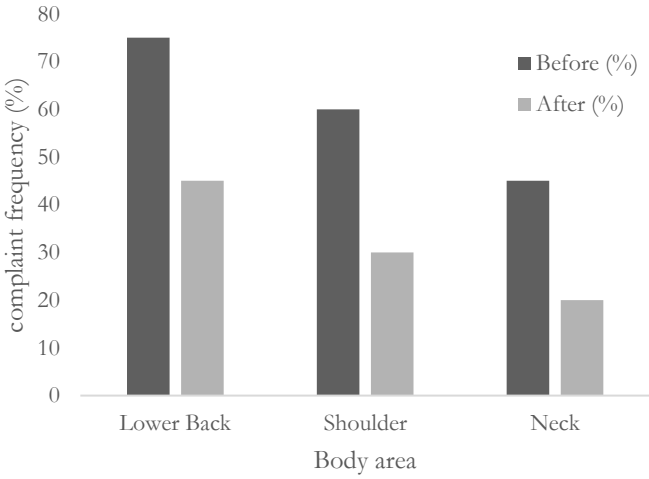

Figure 6 Comparison of Musculoskeletal Complaints Before and After Intervention

The positive outcome was further supported by musculoskeletal symptom assessment using the Nordic Musculoskeletal Questionnaire (NMQ). Prior to the intervention, musculoskeletal discomfort was most frequently reported in the lower back (75 percent), shoulders (60 percent), and neck (45 percent), reflecting the influence of static and repetitive work tasks. Following two weeks of ergonomic correction activities and therapeutic swimming sessions, these complaints decreased significantly, to 45 percent, 30 percent, and 20 percent, respectively, resulting in an overall reduction of 23.5 percent in MSD symptoms, as depicted in Figures 5 and 6. This outcome indicates that the dual intervention strategy-ergonomic education accompanied by hydrotherapy-based exercise-effectively enhanced flexibility, alleviated ergonomic strain, and improved overall physical comfort during work activities.

Discussion

The integration of ergonomic education with therapeutic swimming proved highly effective in enhancing both knowledge and musculoskeletal health among youth workers, reinforcing the theoretical foundation established by (McAtamney & Nigel Corlett, 1993), who state that posture improvement and workstation redesign directly reduce physical strain and increase productivity. Moreover, the program aligns with the World Health Organization (WHO, 2020), framework for community-based occupational health promotion and contributes to the achievement of Sustainable Development Goal (SDG) 3 on Good Health and Well-Being and SDG 8 on Decent Work and Economic Growth (Hosseini et al., 2023). Collectively, these results demonstrate the potential for participatory ergonomic intervention supported by appropriate physical therapy to create measurable and sustainable improvements in occupational health within rural informal workforce settings.

The implementation of ergonomic interventions in small-scale community enterprises such as the Karang Taruna "Gambate" convection workshop demonstrates that occupational health promotion can be effectively realized even in low-resource environments. This success illustrates that limited technological and financial capacity does not necessarily constrain the ability to enhance workplace well-being when programs are thoughtfully formulated and grounded in context. A critical factor contributing to this achievement is the participatory design of the intervention, which ensured that the training materials, delivery method, and activity sequences corresponded closely with the daily routines and needs of the youth workers. Such an approach resonates with findings by (Wijayanti et al., 2020) who emphasize that community-based participatory strategies foster stronger ownership, maintain motivation, and enhance sustainability of behavior change in health promotion programs.

An important distinguishing feature of this program was the incorporation of therapeutic swimming as a complementary modality. While conventional ergonomic initiatives typically focus on posture correction, workstation redesign, and manual stretching exercises, the integration of low-impact hydrotherapy broadened the program's influence by supporting comprehensive physiological recovery and muscular reconditioning. The buoyancy and resistance of water facilitate active rehabilitation without

imposing excessive load on the joints, allowing participants to train flexibility, posture stability, and muscular endurance in a safe and controlled manner. These benefits are consistent with the evidence presented by (Becker, 2009) and (Mooventhan & Nivethitha, 2014), who identify aquatic therapy as an effective intervention for reducing muscle strain, improving postural balance, and promoting general musculoskeletal health. Participant feedback in this initiative, particularly the reported improvements in flexibility and reduction in fatigue after two weeks of regular sessions, further validates the therapeutic advantage of hydro-exercise.

The program yielded a dual impact at both the individual and organizational levels. At the individual level, participants developed positive work habits, including routine micro-break stretching and conscious maintenance of neutral sitting posture throughout sewing activities. Simultaneously, at the organizational level, Karang Taruna management initiated practical adjustments to workstation configuration, including optimizing table height and improving seating ergonomics. These adjustments reflect an emergent understanding that ergonomic principles should be embedded into operational culture rather than treated as peripheral technical procedures. Such outcomes align with (Collins-Sussman et al., 2011), who assert that ergonomic optimization improves productivity, reduces injury rates, and contributes to long-term workforce sustainability.

In addition to its physical and organizational effects, the program contributed to advancing experiential learning within the community. The training environment was intentionally informal and interactive, enabling participants to absorb information through demonstration, simulation, and peer-guided practice. This approach reinforced theoretical knowledge with real-time application, consistent with (Le et al., 2024), who found that hands-on learning techniques produce deeper comprehension and higher retention rates compared to conventional lecture-based instruction. The strategic use of visual aids—such as posters, instructional videos, and real-time demonstrations—helped bridge knowledge gaps among participants with varying educational backgrounds, ensuring inclusive and effective learning.

The social dimension of the intervention played a substantial role in sustaining the behavioral outcomes. As an existing youth community with strong internal cohesion, Karang Taruna "Gambate" served as a peer-support network that reinforced consistent practice of ergonomic behavior and

healthy routines. This dynamic supports the argument of Rachmah (2025), who highlights the importance of collective reinforcement and community culture in ensuring continuity of health-behavior adoption beyond program duration. The participants' continued initiative—evidenced by self-organized weekly swimming sessions and the consistent integration of stretching into daily work routines—provides tangible proof of behavioral internalization and autonomous health maintenance.

From a broader standpoint, this program contributes meaningfully to local capacity building while aligning with both national and global development mandates. At the national level, it supports the Nawacita agenda, emphasizing improved quality of life and empowerment of rural youth. Internationally, it advances Sustainable Development Goal (SDG) 3 on Good Health and Well-Being and SDG 8 on Decent Work and Economic Growth, demonstrating that occupational health initiatives can simultaneously elevate productivity and enhance social welfare. The experience further reinforces the premise that strengthening occupational health practices can become an entry point for comprehensive rural development.

Importantly, the model developed through this program offers potential for wider application. Its combination of ergonomic education, physical rehabilitation, and participatory engagement provides a scalable, culturally adaptable, and economically feasible framework suitable for other informal-sector enterprises such as furniture workshops, culinary microbusinesses, and traditional craft industries. Given that informal enterprises occupy a central role in Indonesia's labor market, the approach presents a valuable pathway for community-driven occupational health improvement. Future initiatives may build upon this foundation by integrating digital ergonomic monitoring tools, developing locally-innovated ergonomic equipment, and enhancing peer-trainer systems to strengthen long-term sustainability and self-reliance

Conclusion and Suggestion

This community service program, which integrates ergonomic education and therapeutic swimming, significantly enhanced occupational health awareness and practices among members of Karang Taruna "Gambate" in Ngadirejo Village, Boyolali. The intervention resulted in a 28.8% increase in ergonomic knowledge and a 23.5% reduction in musculoskeletal complaints, reflecting measurable cognitive and physical improvements. Behavioral changes—such as improved posture, routine stretching, and more balanced

work–rest patterns—further indicate the effectiveness of low-cost participatory strategies in informal rural industries.

Sustained mentoring and periodic monitoring are recommended to support long-term adherence to ergonomic practices. Future initiatives may integrate digital learning tools and broaden institutional collaboration to facilitate wider application of this model. These outcomes offer a scalable framework for the replication of similar community service programs in comparable youth-based rural settings.

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