



Improving blacksmith safety through protective equipment education and occupational health and safety program support

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ARTICLE INFO:

Received: 2024-05-08
Revised: 2024-06-16
Accepted: 2024-07-22
Published: 2024-08-30

Keywords:

Blacksmith,
Occupational health
and safety programs,
Protective equipment
education

ABSTRACT

Pande Besi or blacksmith craftsmen, is one of the small industries that has developed in Tabanan Regency, Bali Province. Blacksmith craftsmen are exposed to a hot, dusty, and smoky environment, posing potential hazards to occupational health and safety. They typically work on the floor with makeshift seats, adopting non-ergonomic postures that can lead to musculoskeletal complaints such as pain in the back, waist, neck, shoulders, and buttocks. The purpose of this service activity is to educate blacksmith craftsmen on the importance of using Personal Protective Equipment (PPE) and maintaining proper working postures to prevent accidents and occupational diseases. This activity involves training and mentoring, targeting 30 individuals, focusing on the use of PPE and improving work attitudes to reduce musculoskeletal complaints and occupational diseases. Results from 30 respondents showed that before counseling and assistance, the majority of the blacksmith craftsmen's knowledge was in the sufficient category (46.67 percent). After counseling, 90 percent of the respondents' knowledge was in the good category. Regarding work attitudes, before mentoring, the highest value was less than 70 percent, while after mentoring, 93.33 percent were categorized as having a good work attitude. The impact of this activity is an increase in knowledge and improvement in the work attitudes of blacksmith craftsmen in Tabanan Regency.

2024 Abdimas: Jurnal Pengabdian Masyarakat Universitas Merdeka Malang
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How to cite: Arjani, I. A. M. S., Sundari, C. D. W. H., Mastra, N., & Burhannuddin, B. (2024). Improving blacksmith safety through protective equipment education and occupational health and safety program support. *Abdimas: Jurnal Pengabdian Masyarakat Universitas Merdeka Malang*, 9(3), 588-600. <https://doi.org/10.26905/abdimas.v9i3.12954>

1. INTRODUCTION

The blacksmith industry is one of the small industries developing in the working area of the Sudimara Tabanan Public Health Center. These blacksmith artisans have been practicing their craft for generations, continuing their ancestral heritage. Blacksmiths work in dusty, hot, and smoky environments, particularly in the furnace section, due to the heating of iron before it is shaped into sharp objects such as large knives, small knives, machetes, sickles, crises, and others (Arjani et al., 2021). Exposure to this dusty, hot, and smoky environment poses significant potential hazards to occupational health and safety (Rahmadini et al., 2021).

Airborne dust exposure among blacksmiths in Gubug Village, Tabanan, reaches 0.23 mg/m^3 (Arjani et al., 2019), while the limit set by the Indonesian Ministry of Health (2016) is 0.15 mg/m^3 . This exposure can potentially cause occupational diseases such as shortness of breath and coughing, especially since many blacksmiths do not use masks. Airborne dust can enter the lungs through the respiratory tract and, over time, endanger the workers' health, increasing the risk of respiratory diseases. The dusty and uncomfortable working environment can also increase external stress on workers, exacerbate internal stress, increase pulse rates, cause fatigue more quickly, and ultimately reduce productivity. Poor air quality in the workplace has been proven to reduce productivity (Tarwaka, 2015).

The average environmental temperature for blacksmiths in the working area of the Sudimara Tabanan Public Health Center is 27.67°C with air humidity at 76.67 percent (Arjani et al., 2021). Heat stress in the workplace plays a crucial role, so the working environment must be made as comfortable as possible to increase efficiency and productivity. This must be a concern for every workplace to ensure occupational health and safety. Exposure to dust, heat, smoke, and extreme heat in the workplace can cause health problems for workers, becoming a common issue in the industry, and potentially leading to occupational accidents and reduced productivity (Arkundato et al., 2019).

In the grinding section, blacksmiths face a bent working posture due to non-ergonomic work surfaces and are exposed to loud noises and vibrations. Interviews revealed that most of them complained of pain in their backs, waists, necks, shoulders, chest buttocks, as well as tingling in their hands and hearing loss. This condition has a high potential to cause occupational diseases and accidents due to fatigue and workload. The workload of blacksmiths in the Sudimara Public Health Center area is recorded at 112.40 beats per minute, which falls into the category of moderate workload (100-125 beats/minute) (Arjani et al., 2021).

In grinding or sharpening knives, workers are faced with repetitive hand movements while carrying a rather heavy hammer, making the load on the right hand more dominant. Vibrations arise and travel from the tool to the hand or wrist when the grinding stone rotates and strikes the steel plate. Continuous exposure to vibrations while working can cause Hand Arm Vibration Syndrome (HAVS), a disease caused by vibration exposure to the hands. Hand-arm vibration exposure, prolonged work with bent wrists, and high repetition rates are also associated with Carpal Tunnel Syndrome (CTS) (Salawati & Syahrul, 2014). This work involves static posture in the lower body and repetitive movements in the hands (Putri & Tjahjono, 2022). In a static position, the body experiences restricted blood flow, resulting in a lack of oxygen and glucose in that area. Additionally, the body produces lactic acid, which causes pain. Muscles cannot work naturally if one works in a non-ergonomic posture, thus requiring more strength from the muscles to perform tasks, leading to fatigue and tension in the muscles and tendons (Kurniawan et al., 2022). It is difficult to find a correlation between complaints and the intensity, frequency, or duration of vibration exposure due to risk limitations. However, there is a strong correlation between working with vibrating tools and musculoskeletal symptoms (Azmir et al., 2018).

The overall work environment contributes to musculoskeletal symptoms through ergonomic factors, exposure to vibrations from grinding, grip strength, repetitive wrist movements, non-ergonomic hand and wrist postures, and long working hours (Adewusi et al., 2013). In jobs with high wrist risk, the prevalence of Carpal Tunnel Syndrome ranges from 5.6 percent to 15 percent. Musculoskeletal complaints found include tingling and pain in the fingers, reduced grip strength, and difficulty holding small objects (Brocal et al., 2017). Vascular and nerve disorders occur due to pressure on the median nerve passing through the carpal tunnel. This nerve disorder is associated with jobs involving repeated vibration exposure over long periods (Vihlborg et al., 2017).

Based on this background, improving the working environment, work posture, and the use of PPE needs to be provided to blacksmiths in the working area of the Sudimara Tabanan Public Health Center. The implemented solution includes training and assistance with education on the use of personal protective equipment (PPE) and assistance in occupational health and safety (OHS) programs (Mulia et al., 2023; Mursyid et al., 2022). Providing assistance in using PPE to blacksmiths can reduce accidents and exposure to dust/particles that are harmful to health (Zendrato & Sunardi, 2020). Improving blacksmiths' understanding through OHS outreach increases PPE use and health quality (Djalaluddin et al., 2023). OHS assistance and outreach can significantly enhance blacksmith artisans' understanding of OHS knowledge, PPE usage, and safe work behavior (Warisaura et al., 2022).

This community service program aims to improve the working environment, work posture, and correct PPE usage to achieve occupational health and safety for blacksmith artisans in the working area of the Sudimara Tabanan Public Health Center. This education is expected to increase blacksmiths' understanding of OHS, enabling them to avoid occupational diseases and work accidents.

2. METHODS

This community service was carried out in Gubug Village, Tabanan Regency, targeting 30 blacksmiths, with the majority aged around 40-60 years. Most of the artisans have an elementary school education level. The blacksmiths are exposed to uncomfortable working conditions while performing activities in the furnace section, such as heat, dust, smoke, sparks from iron burning, noise from repetitive hammering of iron, and standing continuously. They are also exposed to noise and vibrations during grinding activities, which can lead to hearing loss or eardrum damage. The low level of OHS knowledge among the artisans affects their health, resulting in hearing loss, tingling due to vibrations, and musculoskeletal complaints from improper working postures.

This community service was conducted using an assistance and service method that included several activities, with the activity flow diagram shown in Figure 1. First, education and training on the use of personal protective equipment (PPE) were provided, including assistance in the process of using PPE and protective clothing in the furnace and grinding sections, as well as guidance on proper PPE usage. Second, training on correct and proper working postures while sharpening knives in the grinding section was delivered. Third, outreach on occupational health and safety (OHS) was provided to raise awareness of the importance of OHS in the workplace. Additionally, posters on correct PPE usage were distributed to the workers.



Figure 1. Activity workflow

In this training activity, pre-test and post-test were conducted to measure the improvement of craftsmen's understanding of OHS. The stages of activities carried out in this training are shown in Table 1.

Evaluation of Community Service Activities with Pre-test and Post-test

The evaluation stage in this community service activity is crucial to measure the effectiveness of the training and assistance provided. The evaluation was carried out using pre-test and post-test

methods, aimed at assessing the improvement in the understanding and skills of the blacksmith artisans regarding the use of personal protective equipment (PPE), proper work posture, and occupational health and safety (OHS). Below is a detailed explanation of the evaluation stages:

The pre-test was conducted before the training and assistance began. The main goal of the pre-test was to measure the artisans' initial knowledge about the topics that would be covered in the training, namely PPE usage, ergonomic work posture, and OHS. This pre-test helps the service team understand the artisans' baseline knowledge, enabling the design of training that suits their needs. The pre-test typically consists of a series of questions or tasks covering basic knowledge about types of PPE and their usage, an understanding of proper work posture, awareness of the importance of OHS, and accident prevention measures.

Table 1. Activities carried out in community service

Activity 1: Education and Training on the Use of Personal Protective Equipment (PPE)	
Activities	: - Pre-testing - Ironsmiths are given information about the importance of PPE to protect themselves from hazards in the workplace, including the types of PPE that are appropriate for the job such as eye protection, gloves, masks, and protective clothing - The craftsmen are taught how to wear PPE correctly in the process of using PPE in the furnace/parapen and grinding sections to ensure maximum protection from dust, heat, and vibration
Goals	: - To increase workers' awareness and skills in using PPE to prevent work accidents and work-related diseases.
Implementation	: - Third week of May 2023
Activity 2: Good and Correct Work Attitude Training	
Activities	: - Craftsmen are taught how to position their bodies and hands to maintain ergonomics while working. - This training includes techniques to avoid poor posture, which can lead to injuries or musculoskeletal complaints. - Craftsmen are given knowledge about the importance of maintaining correct posture to reduce stress on the back, neck, and wrists. - Mentoring is carried out to ensure that craftsmen apply the correct techniques in their daily practice
Goals	: - Provides an understanding of the correct working attitude when sharpening knives in the grinding section
Implementation	: - Second week of June 2023
Activity 3: Counseling Stage Regarding Occupational Health and Safety (OHS)	
Activities	: - Craftsmen were provided with information about the risks associated with their work, such as exposure to dust, heat, vibration, and unergonomic working postures. - Craftsmen were taught how to identify hazards in the workplace and steps that can be taken to reduce these risks. - This counseling included a discussion on the importance of regular health checks and preventive measures that can be taken to maintain health and safety in the workplace. - Post-test
Goals	: - This counseling aims to increase the awareness of blacksmith craftsmen about the importance of OHS in their work.
Implementation	: - Second week of July 2023
Activity 4: Evaluation by Observation of Compliance in the Use of PPE	
Activities	: - Observation of compliance with the use of PPE through the implementation of work SOPs - Interviews about complaints felt before and after the implementation of PPE and paying attention to OHS
Goals	: - To evaluate the results of community service activities
Implementation	: - Fourth week of July to September 2023

The post-test was conducted after the training and assistance were completed. The main goal of the post-test was to assess the improvement in the artisans' knowledge and skills after the training. The post-test is designed similarly to the pre-test so that the results of both tests can be compared to evaluate the training's effectiveness. The post-test typically includes assessments of a deeper understanding of PPE usage, an evaluation of the artisans' ability to apply correct work posture, and measurements of increased awareness about OHS and the implementation of accident prevention measures.

After the post-test, the pre-test and post-test results were analyzed to determine the improvement in the artisans' knowledge and skills. This analysis involved comparing the pre-test and post-test scores for each individual. In addition to the pre-test and post-test activities, compliance in using PPE was also evaluated through observation. This was done by implementing PPE usage work SOPs and focusing on OHS, in collaboration with blacksmith business owners. Periodic observations were conducted by the service team. Interviews were held to understand the complaints felt by the blacksmith artisans before and after the application of PPE usage.

3. RESULTS AND DISCUSSION

Education and Training Activities on the Use of Personal Protective Equipment (PPE)

Educational and training activities on the use of personal protective equipment (PPE) carried out on blacksmith craftsmen in the work area of the Sudimara Tabanan Health Center showed positive results. Materials related to this activity can be accessed at <https://bit.ly/arjani>. An example of the use of PPE is as in Figure 2.

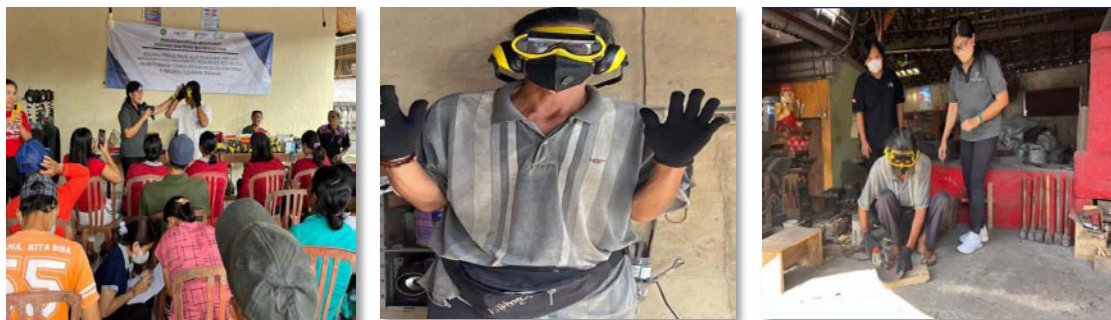


Figure 2. OHS training activities: (a) Education on the use of PPE; (b) Examples of the use of PPE; (c) Implementation of the use of PPE while working

After the training, the craftsmen showed a significant increase in their understanding of the types of PPE that are appropriate for their work. Previously, many craftsmen did not know the importance of using certain PPE or how to choose the right PPE for each task. The pre-test showed that only about 43.33 percent of craftsmen had good basic knowledge of PPE. After the training, the post-test results showed that 90 percent of craftsmen had a good understanding of the use of PPE (Figure 3).

The artisans not only learned about the importance of PPE but were also trained to use it correctly. Assistance in the process of using PPE in the furnace and grinding sections helped the artisans understand the proper way to wear it. Before the training, many artisans were using PPE incorrectly, such as masks that did not fully cover the nose and mouth or gloves that were not the right size. After the training, observations showed an improvement in the correct use of PPE among the artisans.

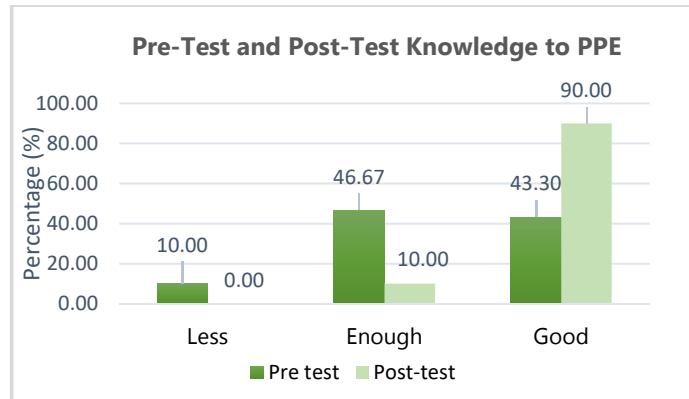


Figure 3. Pre-test and post-test results of blacksmith craftsmen’s knowledge of personal protective equipment

This activity raised the artisans’ awareness of the importance of workplace safety and personal protection. Many of them, who were previously unaware of the health risks associated with their work, now better understand the importance of using PPE to prevent injuries and occupational diseases. Discussions and Q&A sessions during the training allowed the artisans to share experiences and receive practical solutions to the problems they face at work.

Following the training, there was a significant increase in the implementation of PPE usage in the workplace. The artisans began routinely using eye protection, masks, gloves, and protective clothing when working in the furnace and grinding sections. Monitoring the implementation of PPE use was conducted in collaboration with the blacksmith business owners through the application of standard operating procedures and periodic observations. Field observations showed that compliance with PPE usage increased from 33.33 percent before the training to 76.67 percent after the training (Figure 4).

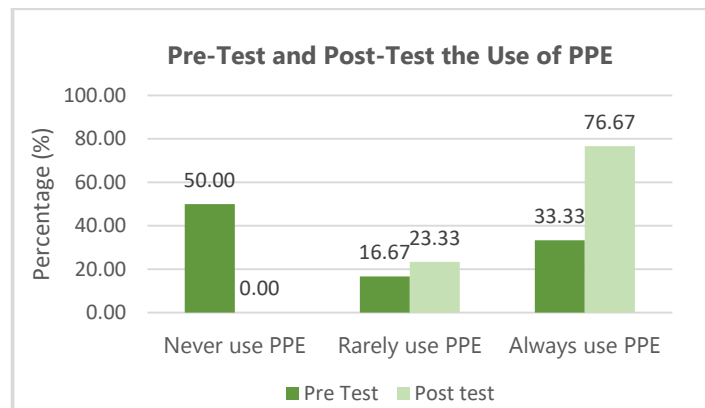


Figure 4. Blacksmith’s compliance with the use of PPE

The results of this training also include a reduction in health complaints related to exposure to dust, heat, and vibration. Based on interviews, craftsmen reported a decrease in cases of eye irritation, respiratory problems, and minor burns after routinely using appropriate PPE. Overall, the education and training activities on the use of personal protective equipment (PPE) have succeeded in increasing the knowledge, skills, and awareness of blacksmith craftsmen about the importance of PPE, as well as

improving work safety practices in their workplaces. These positive results indicate that the training and mentoring provided are effective in improving the occupational safety and health of craftsmen.

Work Attitude Training

Community service activities that focus on training good and correct work attitudes for blacksmith craftsmen in the work area of the Sudimara Tabanan Health Center show positive and significant results. This work attitude training is shown in Figure 5.



Figure 5. Mentoring and training in work attitudes

Before the training, many craftsmen were unaware of the importance of ergonomic work posture. Pre-test showed that only about 10 percent of craftsmen had basic knowledge of good work posture. After the training, post-test showed an increase in knowledge to 93.33 percent (Figure 6). Craftsmen now understand the importance of maintaining correct posture to reduce the risk of injury and musculoskeletal disorders.

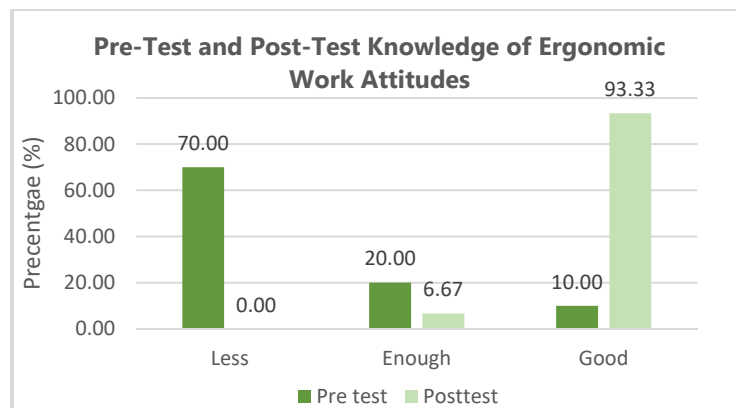


Figure 6. Pre-test and post-test results of blacksmith craftsmen's knowledge of ergonomic work attitudes

The training provided practical techniques on how to maintain proper posture when sharpening knives in the grinding section, including how to position the body and hands to reduce stress on the back, neck, and wrists. Post-training observations showed that 86.67 percent of craftsmen were able to apply ergonomic work posture techniques correctly during work, compared to only 20 percent before training (Figure 7).

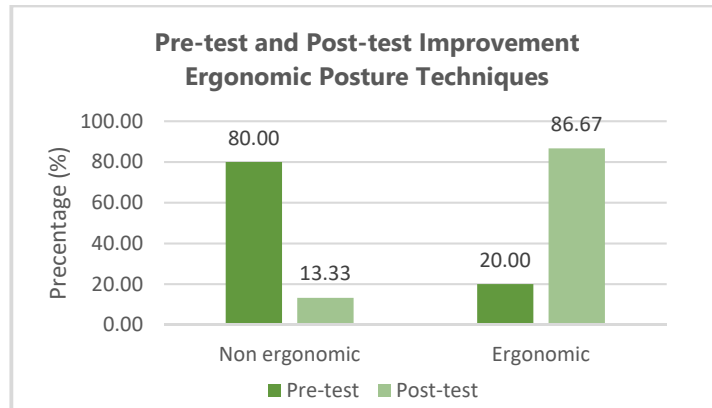


Figure 7. Improvement of blacksmith’s ergonomic posture techniques before and after the activity

Before the training, many artisans reported complaints such as back, neck, and wrist pain due to poor working posture. After the training, there was a significant decrease in these complaints. Feedback from the artisans indicated that they felt an improvement in comfort while working and experienced less pain and muscle tension. The training raised the artisans’ awareness of the importance of ergonomics in preventing injuries and improving work productivity. The interactive discussions during the training allowed the artisans to share experiences and learn from each other about safe work practices. Many artisans who previously did not care about their working posture now pay more attention and apply ergonomic principles in their daily work.

After the training, field observations showed that more artisans began to adjust their workplaces to be more ergonomic. This included adjusting the height of work tables, using tools to reduce body strain, and arranging work areas for better comfort. Monitoring was conducted by observing the implementation of ergonomic practices. Compliance with ergonomic work practices increased from 36.67 percent before the training to over 76.67 percent after the training (Figure 8).

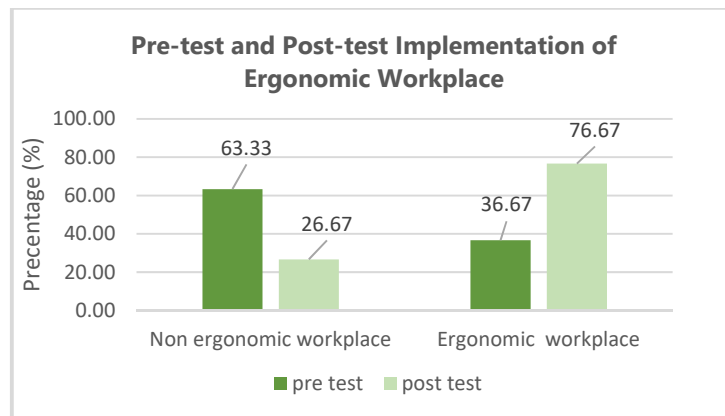


Figure 8. Implementation of ergonomic workplace before and after activities

With the implementation of proper working postures, the risk of injuries caused by poor posture was significantly reduced. Artisans reported feeling safer and more efficient in performing their tasks.

Work productivity also increased as they could work longer without feeling fatigued or experiencing excessive muscle tension. Overall, the training on proper work posture successfully improved the knowledge, skills, and awareness of blacksmith artisans regarding the importance of ergonomics in their work. These positive results demonstrate that the training and assistance provided were effective in reducing musculoskeletal complaints, preventing injuries, and enhancing productivity in the blacksmithing environment.

Results of Counseling on Occupational Health and Safety (OHS)

The counseling activities on occupational health and safety (OHS) carried out for blacksmith craftsmen in the work area of the Sudimara Tabanan Health Center showed various positive and significant results. The counseling activities are shown in Figure 9.



Figure 9. OHS counseling and assistance

Before the counseling, many craftsmen had limited knowledge of OHS principles. The pre-test showed that only about 20 percent of craftsmen had good basic knowledge of OHS. After the counseling, the post-test results showed an increase in knowledge to more than 86.67 percent (Figure 10). Craftsmen now better understand the importance of OHS in protecting themselves from work risks.

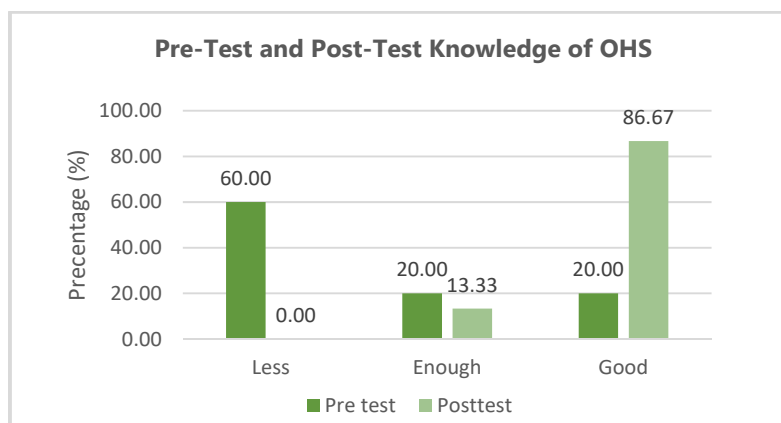


Figure 10. Pre-test and post-test results of blacksmith craftsmen's knowledge of OHS

This outreach successfully raised the artisans' awareness of various work-related risks, including exposure to dust, heat, vibration, and non-ergonomic postures. The artisans are now more aware of the

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dangers that can arise from their work and the importance of taking preventive measures to reduce these risks. Following the outreach, field observations showed a significant improvement in the application of occupational health and safety (OHS) measures in the workplace. Artisans began to use personal protective equipment (PPE) more frequently, such as masks, gloves, and eye protection. Additionally, they started adopting safer work practices, such as keeping the workspace clean to reduce dust exposure and using tools to lessen physical strain.

Before the outreach, many artisans reported health complaints such as shortness of breath, coughing, and skin irritation due to exposure to dust and heat. After the outreach, there was a significant reduction in these complaints. Furthermore, the number of workplace accidents decreased as the artisans implemented better OHS practices. The outreach also increased the artisans' active participation in OHS activities. They became more eager to attend additional training and participate in discussions on ways to improve workplace safety and health. The artisans also began to remind each other of the importance of OHS, fostering a safer and healthier work culture.

During the outreach, the artisans received various educational materials, such as posters and brochures on OHS. These materials served as reminders of the importance of OHS and the steps to take to protect themselves. The artisans were also taught how to properly use and maintain PPE to ensure it functions optimally and lasts longer. The results of the outreach showed that the artisans had a greater commitment to implementing OHS in their workplaces. They were more motivated to safeguard their own safety and health, as well as that of their colleagues. Feedback from the artisans indicated that they felt more valued and supported in maintaining workplace safety and health.

Overall, the OHS outreach successfully increased the knowledge, awareness, and application of OHS practices among blacksmith artisans. These positive outcomes demonstrate that the outreach was effective in creating a safer and healthier work environment, reducing health complaints and workplace accidents, and improving the productivity and well-being of the artisans.

Discussion

The community service program in the working area of the Sudimara Public Health Center, Tabanan, has shown various positive outcomes that will be discussed in this section. The focus of this program was on blacksmith artisans who are often exposed to occupational health and safety risks due to suboptimal working conditions and methods. The community service activities included education and training on the use of Personal Protective Equipment (PPE), training on ergonomic work postures, and counseling on occupational health and safety (OHS). The following is a detailed discussion of the results from each phase of the program.

Before the training, the knowledge and skills of blacksmith artisans regarding PPE use were very limited. Many artisans were unaware of the importance of PPE in protecting themselves from everyday occupational hazards. After the training, pre-test and post-test results showed a significant improvement in their understanding. As many as 90 percent of the artisans now understand the correct use of PPE. This indicates that the educational and training methods applied successfully increased their knowledge. Additionally, their awareness of the importance of workplace safety also increased. The artisans now better understand the health risks they face and the importance of PPE in preventing injuries and work-related illnesses. Field observations showed an increase in PPE compliance from 33.33 percent before training to more than 76.67 percent after training. The use of PPE such as masks, gloves, and eye protection has become more common among the artisans. This improvement is crucial as it contributes to the reduction of health complaints related to exposure to dust, heat, and vibrations, which often

occur in the blacksmith work environment (Sumiyati et al., 2020). The use of PPE is essential to protect blacksmiths from workplace accidents (Rizqi et al., 2020). Moving forward, the government's role is needed to provide supportive facilities for PPE for blacksmith artisans (Wardana et al., 2022).

The ergonomic posture training also showed positive results. The artisans' ergonomic knowledge increased from 10 percent before training to more than 93.33 percent after training. The artisans now understand the importance of correct body posture to reduce the risk of injury. They were taught how to adjust the height of their work tables, proper sitting techniques, and the use of assistive tools to reduce physical strain. Ergonomic work postures can prevent musculoskeletal injuries, which are often complained about by the artisans (Hafez & Jorgensen, 2024). The implementation of ergonomic work techniques in the workplace showed significant improvements. More than 86.67 percent of the artisans were able to correctly apply ergonomic work techniques after the training, compared to only 20 percent before the training. This includes adjusting the height of worktables and using assistive tools to reduce physical strain. Good ergonomic posture also leads to increased work productivity (Ghosh et al., 2011). As a result, there was a significant reduction in complaints of back, neck, and wrist pain. The artisans reported improvements in comfort while working and a reduction in muscle pain and tension. This increased comfort is critical for optimal work productivity (Salawati et al., 2022).

Occupational Health and Safety (OHS) counseling was a key part of this community service program. The artisans' knowledge of OHS principles increased from 20 percent before the counseling to more than 86.67 percent afterward. This counseling successfully raised the artisans' awareness of the various work-related risks they face and the importance of preventive measures. They are now more aware of the hazards inherent in their work and the importance of applying OHS measures to protect themselves.

Following the counseling, field observations showed improvements in the implementation of OHS measures. The artisans more frequently used PPE and applied safer work practices. There was a significant decrease in health complaints such as shortness of breath, coughing, and skin irritation, as well as a reduction in workplace accidents after the application of better OHS practices. This increased awareness also encouraged artisans to be more proactive in ensuring both their safety and that of their coworkers. Occupational Health and Safety (OHS) is crucial for blacksmith artisans because their work involves high risks that can lead to serious accidents and long-term health issues (Djalaluddin et al., 2023).

4. CONCLUSION AND RECOMMENDATIONS

The community service conducted in the working area of Puskesmas Sudimara Tabanan aimed to improve knowledge and enhance the working environment, ergonomics, and correct use of Personal Protective Equipment (PPE) to achieve better health and safety for blacksmith artisans. This initiative successfully increased understanding of OHS and PPE use, as evidenced by post-test results, observations, and interviews. The OHS counseling effectively raised artisans' awareness of the importance of OHS, making them more aware of the risks they face and the need for preventive measures. After the training, the application of ergonomic work techniques and correct PPE use became more common among the artisans, and field observations showed improved adherence to safe work practices. This program also succeeded in raising awareness within the blacksmith community about the importance of OHS, encouraging them to be more proactive in safeguarding their own and their coworkers' safety.

This activity program cannot fully carry out health checks and provide PPE to blacksmiths, so cooperation is needed between the Health Center and blacksmith entrepreneurs to carry out routine

health checks and emphasize the use of PPE on an ongoing basis. Additionally, increasing blacksmiths' awareness through regular health and safety training is recommended to strengthen compliance. Furthermore, seeking government support or funding can help ensure the availability of PPE and improve long-term safety practices.

ACKNOWLEDGEMENTS

We would like to express our gratitude to the Politeknik Kesehatan Kemenkes Denpasar for their financial support in the 2023 Community Service program through the Community Partnership Program scheme, under contract number: BJ.01.03/PPK/2109.1/2023.

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