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# Local Food Processing Based on Tempeh and Catfish for Diabetes Mellitus and Hypertension Sufferers and Creating Smoke-Free Areas

**Nurlailis Saadah[1], Budi Yulianto[2], Rahayu Sumaningsih[1], Lilis Prihastini[2], Uswatun Khasanah[1]**

[1]Department of Midwifery, Poltekkes Kemenkes Surabaya, Surabaya, Indonesia
[2]Department of Environmental Health, Poltekkes Kemenkes Surabaya, Surabaya, Indonesia

**Corresponding author:** Nurlailis Saadah (e-mail: nurlailis.saadah66@gmail.com)

**ABSTRACT** Non-communicable diseases (NCDs), particularly diabetes mellitus (DM) and hypertension, continue to rise and are driven by unhealthy lifestyles, unbalanced diets, and exposure to cigarette smoke. Despite their availability and nutritional value, local foods such as tempeh and catfish remain underutilized as healthy dietary options, and community education on healthy food preparation and Smoke-Free Areas (SFAs) is still limited. This community service program aimed to empower residents of Tambakrejo Village to build a healthy community and environment through training and mentoring in preparing low-sugar, low-salt, and low-fat dishes from tempeh and catfish for people with DM and hypertension, while promoting SFAs. A community empowerment approach was applied in four stages: preparation, health education, cooking training with demonstrations and hands-on practice, and mentoring with evaluation. Forty participants, including people with DM and hypertension, family members, health workers, and at-risk residents, took part. Knowledge was assessed using pre- and post-tests and analyzed descriptively. The proportion of participants in the good and very good categories increased for DM (25.0% to 85.0%), hypertension (30.0% to 85.0%), SFAs (20.0% to 82.5%), and healthy tempeh and catfish processing (15.0% to 87.5%), and no participant remained in the poor category after the intervention. Participants were able to prepare healthy menus independently. The community also formalized its commitment through a written agreement, a village regulation signed by the village head, the designation of a smoke-free area in RT 07 RW 02, and the installation of no-smoking signs. In conclusion, an empowerment approach that integrates education, training, and mentoring effectively improves community knowledge, skills, and commitment, and offers a sustainable model for NCD prevention at the village level. Further evaluation of long-term behavioral and clinical outcomes is recommended.

**INDEX TERMS** Diabetes Mellitus, Hypertension, Smoke-Free Areas, Community Empowerment, Tempeh and Catfish

## I. INTRODUCTION

Non-communicable diseases (NCDs) remain a major public health challenge worldwide, and diabetes mellitus (DM) is among the fastest-growing contributors to this burden, with global prevalence projected to rise substantially through 2050 [1]. DM and hypertension share modifiable risk factors, namely diets high in sugar, salt, and fat, physical inactivity, and tobacco exposure. Smoking damages the cardiovascular system and is associated with poorer general health, whereas cessation improves cardiovascular outcomes [2], [3]. Genetic evidence further supports a causal link between smoking, type 2 diabetes, and cardiovascular disease [4], and passive smoking has also been associated with a higher risk of type 2 diabetes [5]. Consequently, Smoke-Free Areas (SFAs) are a key environmental strategy for NCD prevention, yet their implementation in Indonesia still faces practical barriers [6].

Previous studies have approached NCD control through several complementary interventions. Behavioral interventions have been shown to reduce salt intake and blood pressure [7], [8], while structured education improves diabetes self-management [9], [10]. Participatory cooking demonstrations and culinary workshops have been used to strengthen healthy eating practices and food-preparation skills [11], [12]. At the community level, cadre training and integrated health posts have been used to extend NCD prevention to villages [13].

Local foods offer a practical entry point for such interventions. Tempeh, a fermented soybean product, has been reviewed for its health benefits and functional microbes [14], [15], and soy intake and isoflavones have been examined in relation to diabetes, cardiovascular risk, glycemic control, and lipid profile [16], [17]. Preclinical evidence also suggests that tempeh-based supplementation lowers blood glucose [18]. Fish consumption, in turn, is related to type 2 diabetes incidence and cardiovascular risk, although associations differ by fish type [19]–[21]. Importantly, cooking alters the nutrient composition of fish [22], so the preparation method determines whether catfish

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Vol. 5 No. 3, pp. 113-120, September 2026

and tempeh dishes are suitable for people with DM and hypertension.

Despite this evidence, several gaps remain. First, tempeh and catfish are commonly cooked by frying with abundant oil, salt, and flavor enhancers, so their potential as a healthy menu is underused. Second, the existing literature addresses nutrition education, cooking practice, and smoke-free policy separately, and few community programs combine them in a single village-level intervention. Third, scientific evidence on modified catfish-and-tempeh dishes for people with DM and hypertension is limited, and such dishes are better framed as nutritious, lower-sugar, lower-salt, and lower-fat menus than as treatment.

Therefore, this community service program aimed to empower the residents of Tambakrejo Village through education, training, and mentoring on DM, hypertension, SFAs, and the preparation of healthy tempeh and catfish menus, and to evaluate changes in participants' knowledge. The contributions of this article are as follows:

1) It presents an integrated community empowerment model that combines NCD education, healthy local food processing, and SFA promotion in one village-level program.
2) It provides a modified low-sugar, low-salt, and low-fat mangut lele and tempeh recipe that uses accessible local ingredients and healthier cooking methods.
3) It reports pre- and post-test evidence of improved knowledge on DM, hypertension, SFAs, and healthy food processing among 40 participants.
4) It documents concrete community commitments, including a written agreement, a village regulation, a designated smoke-free area, and no-smoking signage, together with sustainability recommendations.

The remainder of this article is organized as follows. Section II describes the community empowerment method, including the stages, participants, recipe, and evaluation. Section III presents the results, and Section IV discusses the findings and limitations. Section V concludes the article and offers recommendations.

## II. METHODS

### A. STUDY DESIGN

This community service program employed a prospective, single-group, pre-experimental design with pre- and post-intervention measurements, a design that has been used to evaluate nutrition education programs in Indonesia [23], [24]. Participants were not randomized, and no control group was included. A community empowerment approach combined health education, training, demonstrations, hands-on practice, and mentoring, in line with participatory cooking and cadre-based education models [11]–[13], [27].

### B. SETTING AND PARTICIPANTS

The program was conducted in Tambakrejo Village, the partner village. The study population consisted of 40 participants, namely people with diabetes mellitus (DM) and hypertension, their family members, health workers, and community members at risk of non-communicable diseases (NCDs). Participants were identified through coordination with the village government, the community health center, and health workers, which also set the schedule. Inclusion criteria and session dates are not reported.

### C. IMPLEMENTATION STAGES

The program was carried out in four stages.

1) Preparation. The team identified community health problems, developed training modules and educational media, prepared cooking equipment and ingredients, and coordinated with village stakeholders. Pre- and post-test questionnaires were also developed at this stage.
2) Health education. Interactive lectures, discussions, and question-and-answer sessions covered the definition, risk factors, prevention, and management of DM and hypertension, the importance of Smoke-Free Areas (SFAs), and the use of local foods in a healthy diet.
3) Training and demonstration. Participants received an explanation of the nutritional content of tempeh and catfish and of the principles of low-salt, low-sugar, and low-fat cooking. They then practiced preparing the dish in groups under the guidance of the team until they could produce a healthy menu.
4) Mentoring and evaluation. Mentoring consisted of discussions, consultations, and monitoring of how the material was applied. Evaluation was carried out using the pre- and post-tests described below.

### D. MATERIALS AND RECIPE

The intervention dish was a modified mangut lele (catfish stew) with tempeh. The ingredients were 4 catfish, 150 g of tempeh, 500 mL of thin coconut milk and 200 mL of thick coconut milk (each replaced with 3 and 7 candlenuts, respectively), 2 bay leaves, 2 kaffir lime leaves, 1 bruised lemongrass stalk, and 2 cm of bruised galangal. The ground spices comprised 5 shallots, 3 garlic cloves, 3–5 red chilies, 2 bird's eye chilies, 2 candlenuts, 2 cm of turmeric, and 1 cm of ginger.

The catfish were cleaned, rubbed with a little salt and lime juice, and left to stand for about 10 minutes. The catfish were then grilled or steamed rather than fried, and the tempeh was cut to the desired size. The ground spices were sautéed with the bay leaves, lime leaves, lemongrass, and galangal until fragrant, and the thin coconut milk substitute was added gradually while stirring. The catfish and tempeh were then added and simmered over low heat until the spices were absorbed. After the thick coconut milk substitute and seasoning were added, the sauce was cooked until it boiled, and the dish was served warm with rice and vegetables.

To obtain a low-sugar, low-salt, and low-fat menu, sugar was omitted, salt was limited to about ¼–½ teaspoon per recipe, and oil was kept to a minimum. Replacing coconut milk with candlenuts was intended to lower fat content. Culinary herbs and spices, namely turmeric, ginger, lemongrass, lime leaves, and chili, were used to maintain flavor without relying on salt, in line with evidence on herb- and spice-based salt reduction [7], [25], [26]. Grilling and steaming were selected because cooking methods alter the fatty acid composition of fish [22], [28].

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Vol. 5 No. 3, pp. 113-120, September 2026

### *E. OUTCOME MEASURES*

The primary outcome was the participants' knowledge level in four domains: DM, hypertension, SFAs, and healthy food processing using tempeh and catfish. Knowledge was measured with pre- and post-test questionnaires. The pre-test was administered before the counseling session, and the post-test was administered after the complete series of activities. Questionnaire validation and item numbers are not reported. Scores were classified into four categories: very good (86–100), good (76–85), sufficient (60–75), and poor (<60). Secondary outcomes were the participants' ability to practice healthy food preparation, observed during the practice sessions, and the formation of community commitment to SFAs and a healthy lifestyle, a type of outcome also used in cadre-based hypertension education programs [27].

### *F. DATA ANALYSIS*

Pre-test and post-test results were analyzed descriptively using frequency distributions, percentages, and changes in knowledge categories. No inferential statistical test was applied. Program success was defined as an increase in the proportion of participants in the good and very good categories, an improvement in participants' ability to prepare healthy food, and the formation of community commitment to implement SFAs and a healthy lifestyle in the village.

## III. RESULTS

The community service activities have proceeded according to plan. Some of the achievements include:

a) Coordination with village government and health centershas been implemented to determine targets, schedules, and mechanisms for implementing activities.
b) Health counselingInformation on diabetes mellitus, hypertension, healthy eating, and smoke-free areas was provided to the community, health workers, and families of patients. Participants demonstrated high enthusiasm throughout the activity.
c) Training in making processed foods from tempeh and catfishThe program was successfully implemented. Participants gained skills in preparing various healthy menus—low in salt, low in sugar, low in fat, high in protein, and high in fiber—suitable for people with diabetes and hypertension.
d) Community assistancecarried out through direct practice and consultation so that participants are able to produce processed foods independently by utilizing local food ingredients that are easy to obtain.
e) Improving community knowledge and skillsThis can be seen from the increasing understanding of participants regarding the importance of consuming healthy food, controlling risk factors for NCDs, and implementing a smoke-free environment.
f) Community commitment is formedtogether with the village government to support the implementation of healthy living behavior and the realization of a Smoke-Free Area as part of the effort to create a healthy village. The community's commitment to the implementation of a Smoke-Free Area is demonstrated through a joint agreement to create a smoke-free environment. This commitment is evidenced by a written community agreement, support and village regulations signed by the village head, the determination of a location in RT 07 RW 02 Tambakrejo village as a smoke-free area, in addition to the installation of signs/signs prohibiting smoking.

Overall, the community service activities have achieved their targets. This program has benefited by increasing community capacity in managing healthy eating patterns, utilizing local foods, and strengthening healthy lifestyles as a sustainable effort to prevent and control diabetes mellitus and hypertension, as well as to create smoke-free areas [25].

To ensure the sustainability of the results of this community service, there needs to be a commitment from the Tambakrejo village head, village midwives, and village health post nurses by involving cadres in outreach and supervision, as well as the preparation of a periodic monitoring plan.These outcomes serve as concrete evidence that the community's commitment is not merely a statement, but has been realized in the form of policies, supporting facilities, community participation, and monitoring mechanisms that can be evaluated continuously by the village head and his staff, as well as the health workers in the village.

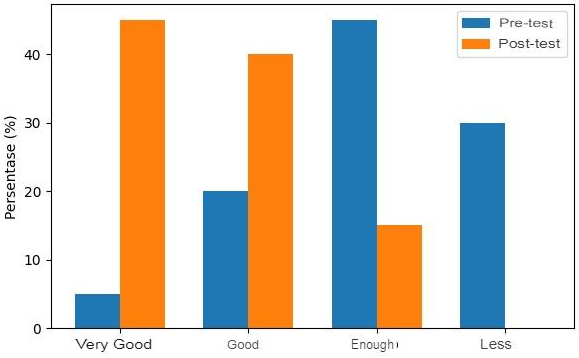



**FIGURE 1. Level of Knowledge about Diabetes Mellitus (DM)**

FIGURE 1 shows an increase in participants' knowledge of diabetes mellitus after participating in the counseling and training activities. Before the intervention, the majority of participants were in the adequate (45.0%) and poor (30.0%) categories. After the training, the proportion of participants in the good and very good categories increased to 85.0%, while the poor category was no longer found. These results indicate that the education and mentoring activities were effective in increasing public understanding of diabetes mellitus prevention and control.

FIGURE 2 shows the increase in participants' knowledge about hypertension after the program. Before the training, the majority of participants were in the adequate (42.5%) and poor (27.5%) categories. After the program, 85.0% of participants were in the good and very good categories, and there were no longer any participants in the poor category. These findings indicate that the outreach and training were successful in increasing public understanding of the risk factors, prevention, and control of hypertension.

e-ISSN: 2827-8747 p-ISSN: 2829-3029
Vol. 5 No. 3, pp. 113-120, September 2026

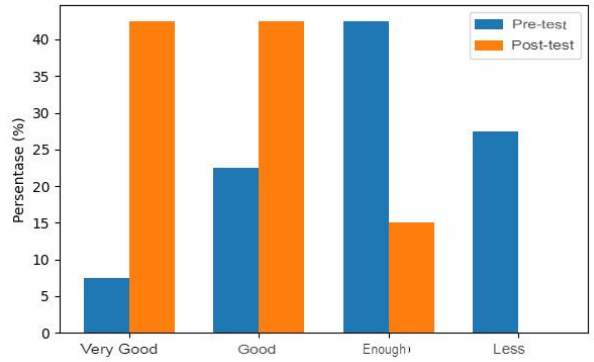



**FIGURE 2. Level of Knowledge about Hypertension**

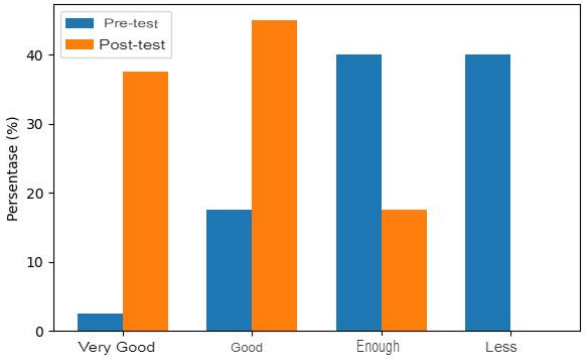



**FIGURE 3. Level of Knowledge about Smoke-Free Areas (SFA)**

FIGURE 3 shows the increase in public knowledge regarding the concept and implementation of Smoke-Free Areas (SFAs). Before the intervention, the majority of participants still had sufficient (40.0%) and insufficient (40.0%) knowledge. After the intervention, the proportion of participants with good and very good knowledge increased to 82.5%, while the proportion of participants with poor knowledge decreased to 0%. These results indicate that the education provided was able to raise public awareness about the importance of creating a smoke-free environment.

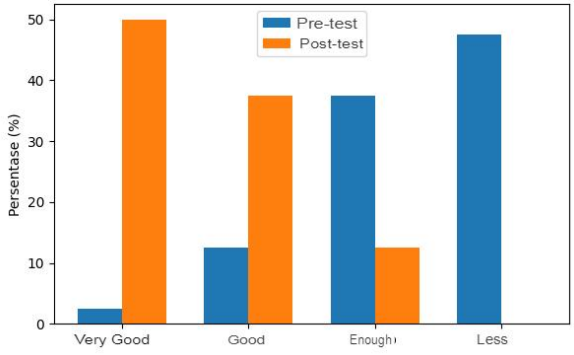



**FIGURE 4. Level of Knowledge about Processed Foods Made from Tempeh and Catfish**

FIGURE 4 shows the increase in participants' knowledge and skills regarding healthy food processing using tempeh and catfish for people with diabetes mellitus and hypertension. Before the training, nearly half of the participants (47.5%) were still in the poor category. After participating in the food processing demonstration and practice, 87.5% of participants were in the good and very good categories, while the poor category was no longer found. This improvement indicates that the practice-based training method is effective in improving the community's ability to utilize local foods as a healthy menu for people with non-communicable diseases.

## IV. DISCUSSION

### *A. INTERPRETATION OF THE FINDINGS*

This program aimed to improve community knowledge and skills related to the prevention of diabetes mellitus (DM) and hypertension, the implementation of Smoke-Free Areas (SFAs), and the preparation of healthy menus from tempeh and catfish. Knowledge was higher after the intervention in all four domains. The proportion of participants in the good and very good categories rose from 25.0% to 85.0% for DM, from 30.0% to 85.0% for hypertension, from 20.0% to 82.5% for SFAs, and from 15.0% to 87.5% for healthy food processing. Expressed in percentage points, the gains were 60.0, 55.0, 62.5, and 72.5, respectively, and no participant remained in the poor category after the intervention. These figures are descriptive and should not be read as evidence of a statistically significant effect, because no inferential test was applied.

The largest gain occurred in food processing. A plausible explanation is the format of this component. Participants did not only receive information on the nutritional content of tempeh and catfish but also prepared the dish in groups under guidance. Learning that combines explanation, demonstration, and practice is generally easier to retain than purely theoretical delivery, which is consistent with reports on participatory cooking demonstrations and culinary workshops [11], [12]. The lowest baseline was also found in this domain, where 47.5% of participants were in the poor category, which left the most room for improvement. Knowledge of DM and hypertension increased by similar margins, suggesting that the interactive lectures, discussions, and question-and-answer sessions were equally effective for both conditions. This finding is reasonable because the two diseases share dietary, lifestyle, and tobacco-related risk factors [2]–[5], and the material addressed them together.

Beyond knowledge, the program produced tangible outputs: participants prepared a low-sugar, low-salt, and low-fat menu independently, and the community and village government formalized a written agreement, a village regulation, a designated smoke-free area in RT 07 RW 02, and no-smoking signage. These outputs indicate that the intervention moved beyond information transfer toward local commitment, which is an essential precondition for sustained behavior change. They should, however, be interpreted as indicators of intention and enabling conditions rather than as proof of changed behavior.

### *B. COMPARISON WITH PREVIOUS STUDIES*

The results are consistent with other community-based programs that used pre- and post-test designs. A health education program on hypertension prevention in a hamlet in Gowa Regency reported that 90.0% of 30 participants had low knowledge before the session and 96.7% had adequate knowledge afterward [32]. A nutrition education study among Indonesian adults likewise found improved

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Vol. 5 No. 3, pp. 113-120, September 2026

knowledge and fewer perceived barriers to a healthy diet [23], and a cadre-based program on low-salt cooking reported significant pre-post differences in hypertension knowledge [27]. The present findings therefore reinforce the view that structured education, supported by local facilitators, can raise knowledge in village settings. Evidence from systematic reviews also suggests that community-based strategies and trained community health workers can support hypertension and cardiometabolic disease control in low- and middle-income countries [29], [33], and that education improves diabetes self-management [9], [10].

The present study differs from several of these reports in scope and in outcome measures. The cadre-based program cited above also measured blood pressure [27], and the reviews cited above, which synthesize broader evidence, examine clinical or health-related outcomes [29], [33], whereas this study assessed only knowledge and observed skills. Compared with studies that focus on a single topic, the present program integrated NCD education, local food processing, and SFA promotion. This integration is a strength, but it also means that the effect of each component cannot be separated. Studies of SFA implementation in Indonesia have identified barriers to implementation [6]. In contrast, the present program resulted in a village-level agreement and designated area, which suggests that involving the village government from the preparation stage may help overcome such barriers, although this inference needs to be tested in a comparative design.

With respect to the food component, the dish was designed around evidence that herbs and spices can support low-salt cooking [25], [26] and that behavioral interventions can reduce salt intake [7], [8]. Evidence on tempeh is encouraging but still limited. A systematic review of randomized trials has examined fermented botanical foods in metabolic syndrome and type 2 diabetes [30], a small quasi-experimental study in 16 menopausal women reported lower triglyceride levels and body mass index after tempeh smoothie consumption [31], and preclinical data suggest glucose-lowering effects [18]. These studies differ from the present one in population, product, and design, and none evaluated a catfish-and-tempeh dish for people with DM and hypertension. The current findings therefore support the use of tempeh and catfish as a nutritious local menu with modified preparation, not as a treatment for either disease.

### *C. LIMITATIONS AND IMPLICATIONS*

Several limitations should be acknowledged. First, the single-group pre-post design without randomization or a control group does not allow the improvement to be attributed solely to the intervention. Repeated testing, participants' familiarity with the questions, and the short interval between measurements may also have contributed to the gains. Second, only short-term knowledge was assessed, so the findings do not describe long-term behavior, dietary intake, blood pressure, blood glucose, or nutritional status. Third, the sample comprised 40 participants from one partner village, which limits generalizability. Fourth, the knowledge instrument was not reported with validation data or item numbers, and skills were observed rather than scored with a standardized checklist. Fifth, the analysis was limited to descriptive statistics. Future activities should therefore include a comparison group, a validated instrument, inferential testing, follow-up measurements, and clinical indicators such as blood pressure and blood glucose.

The findings have practical implications. For village governments, the written agreement and regulation provide a basis for enforcing SFAs and for allocating resources to health promotion. For health workers and cadres, the modified recipe and training modules offer a replicable, low-cost approach to nutrition education that uses accessible ingredients and can be incorporated into routine activities such as integrated health posts [13]. For program planners, the results suggest that practice-based sessions may be a worthwhile component of NCD education. Sustainability will depend on continued commitment from the village head, village midwives, and health post nurses, on cadre-led supervision, and on a periodic monitoring plan. If these conditions are met, the program may serve as a model that can be adapted to other villages, provided that its effects on behavior and health outcomes are confirmed in more rigorous evaluations.

## V. CONCLUSIONS

This community service program aimed to empower residents of Tambakrejo Village to build a healthy community and environment through education, training, and mentoring on diabetes mellitus (DM), hypertension, Smoke-Free Areas (SFAs), and the preparation of healthy menus from tempeh and catfish, and to evaluate the resulting changes in participants' knowledge. Among 40 participants, the proportion with good and very good knowledge increased from 25.0% to 85.0% for DM, from 30.0% to 85.0% for hypertension, from 20.0% to 82.5% for SFAs, and from 15.0% to 87.5% for healthy food processing, corresponding to gains of 60.0, 55.0, 62.5, and 72.5 percentage points, respectively. No participant remained in the poor category after the intervention. Participants were also able to prepare a low-sugar, low-salt, and low-fat mangut lele and tempeh menu independently, and the community formalized its commitment through a written agreement, a village regulation signed by the village head, a designated smoke-free area in RT 07 RW 02, and no-smoking signage. These results indicate that a community empowerment approach integrating counseling, demonstration, hands-on practice, and mentoring is a promising strategy for strengthening knowledge, skills, and local commitment to the prevention of non-communicable diseases, and that tempeh and catfish can serve as accessible local ingredients for a nutritious menu rather than as a treatment for DM or hypertension. However, these findings are limited by the single-group pre-post design, the short-term measurement of knowledge, the descriptive analysis, and the participation of a single village. Future work should therefore apply a controlled or comparative design with a validated instrument and inferential statistical analysis, extend the evaluation to a larger and more diverse population, and include follow-up assessments of dietary

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Vol. 5 No. 3, pp. 113-120, September 2026

behavior, smoking behavior, blood pressure, blood glucose levels, and nutritional status. Future programs should also strengthen sustainability through cadre-led supervision, periodic monitoring by the village government and health workers, and the replication of the model in other villages to assess its wider applicability.

## ACKNOWLEDGEMENTS

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## DATA AVAILABILITY

The data supporting the findings of this study are available from the corresponding author, Nurlailis Saadah, upon reasonable request. The data comprise aggregated pre-test and post-test knowledge scores of the 40 participants, and individual responses are withheld to protect participant privacy.

## AUTHOR CONTRIBUTION

Nurlailis Saadah contributed to conceptualization, project administration, and writing of the original draft. Budi Yulianto contributed to methodology, the smoke-free area component, and investigation. Rahayu Sumaningsih contributed to investigation, the health education and training activities, and data curation. Lilis Prihastini contributed to formal analysis and visualization. Uswatun Khasanah contributed to resources, mentoring, and validation. All authors participated in reviewing and editing the manuscript, and all have read and approved the final version.

## DECLARATIONS

### *ETHICAL APPPROVAL*

Ethical review and approval were waived for this activity as it constituted a community empowerment and health promotion program (Pengabdian kepada Masyarakat) conducted under an official institutional assignment from Poltekkes Kemenkes Surabaya and formal coordination with the Tambakrejo Village Government and Candirejo Community Health Center (Puskesmas). All procedures involving human participants adhered to standard ethical principles, including respect for persons, beneficence, and confidentiality. Written and verbal informed consent were obtained from all 40 participants prior to data collection (pre- and post-tests) and training activities. Participation was entirely voluntary, and all participant identities were anonymized during data analysis and reporting.

### *CONSENT FOR PUBLICATION PARTICIPANTS*

Participants consented to the use of their anonymized data and activity documentation for publication

### *COMPETING INTERESTS*

The authors declare that they have no known competing financial interests or personal relationships that could have influenced the work reported in this article.

## *DOCUMENTATION*

Documentation of the Community Service activity titled: "Empowering Partner Villages to Foster a Healthy Community and Environment through Smoke-Free Zones: Training and Mentoring on Preparing Tempeh- and Catfish-Based Foods for Individuals with Diabetes and Hypertension"



Opening of the Community Service Activity





Implementation of Community Service Activities on Diabetes and Hypertension Diets

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Implementation of Community Service Activities on Healthy Home Environments



Closing of the Community Service Activity

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