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Counseling on Household-Scale Pharmaceutical Waste Disposal at Talise Public Health Center

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Abstract

Improper disposal of pharmaceutical waste can harm the environment and public health. Public knowledge regarding appropriate household-level drug disposal remains limited. This community engagement aimed to improve the knowledge, attitudes, and behavior of residents regarding the handling of expired and damaged medicines. The activity was conducted at Bumi Roviga Sub-Public Health Center, a unit under Talise Public Health Center, Palu City. A total of 24 respondents, selected randomly among parents attending child health checks or antenatal care, participated in the program. The counseling was delivered face-to-face and supplemented with printed educational flyers. A pre-test was administered at the location, while the post-test was distributed via WhatsApp using Google Forms one week later. Shapiro-Wilk normality tests indicated non-normal data distribution. Paired t-tests showed significant improvements ($p<0.05$) in knowledge ($p=0.000$), attitude ($p=0.000$), and behavior ($p=0.000$) scores, indicating the effectiveness of the intervention. This activity demonstrates that brief counseling supported by print media can effectively enhance public understanding of safe drug disposal at the household level. As a recommendation, household-level pharmaceutical waste education should be integrated into routine health promotion activities at community health centers, with periodic follow-ups and the empowerment of community health workers or pharmacy students as local facilitators to support long-term behavioral change.

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INTRODUCTION

Pharmaceutical household waste, primarily in the form of unused or expired medications, presents significant environmental and public health challenges. These medicines are often disposed of improperly, flushed down drains or thrown in household bins, leading to contamination of water systems and ecosystems. Conventional wastewater treatment plants are not equipped to eliminate pharmaceutical residues entirely, which can result in the feminization of aquatic species, behavioral changes in wildlife, and the emergence of antimicrobial-resistant bacteria. Additionally, the accumulation of unused medications increases the risk of accidental poisoning and intentional misuse while contributing to healthcare waste and economic loss. Factors such as demographic shifts, increased prevalence of chronic diseases, and broader access to pharmaceuticals are driving up the volume of this waste (OECD, 2022). The scoping review by Arke et al. (2025) highlights the growing issue of pharmaceutical waste, driven by increased production and consumption, which poses serious risks to both the environment and public health. It reveals major regulatory and infrastructure gaps, particularly in the Global South, where limited awareness and resources lead to improper disposal practices. To address these challenges, the study calls for coordinated efforts involving policy reform, public education, and innovative solutions to promote safer and more effective waste management globally.

Proper disposal of pharmaceutical waste has been studied by Alighardashi et al. (2024) from five hospitals in Tehran, revealing an average daily generation of 3,600 kg of solid waste, with over half being infectious. Using an economic model, it showed that disinfection accounted for the largest share of waste management costs (67.3%) and that changes in segregation and disinfection location could reduce costs by up to 37%. The findings highlight opportunities for hospitals and policymakers to adopt more cost-effective and environmentally sustainable waste management practices.

Improper disposal of unused or expired medications at the household level poses a significant threat to both environmental and public health. Pharmaceutical waste can contaminate water sources, harm ecosystems, and contribute to antimicrobial resistance when active compounds are exposed to the environment. Despite these risks, public awareness and practice regarding safe drug disposal remain low in many communities, particularly in developing regions. The challenges of hazardous waste management in Africa, including inadequate infrastructure, weak regulations, and high exposure risks to workers and communities. It identifies gaps in current health risk assessment models, such as limited real-time monitoring and poor integration with policies, and emphasizes the need for multi-stakeholder collaboration and technological innovation. The study recommends developing context-specific, data-driven approaches and regionally coordinated policies to improve risk assessment accuracy and exposure control, ultimately enhancing safety and environmental protection across the continent (Ozobu et al., 2025).

Study in Asmara, Eritrea found that most households store unused or expired medications, mainly analgesics and anti-infectives, with improper disposal practices like discarding them in household garbage or soil being common. While participants showed moderate knowledge and a strong willingness to join a take-back system, barriers such as lack of awareness, stigma, and accessibility issues were identified. The findings highlight the urgent need for public education and the implementation of safe, structured disposal mechanisms (Habte et al., 2024). Another study of Hanafiah et al. (2024) analyzed pharmaceutical pollutants in three sewage treatment plants (STPs) with different catchment areas, detecting 13 compounds, most notably ciprofloxacin, venlafaxine, and citalopram, at concentrations indicating limited removal by current treatment processes. STP 1, serving a mixed development area, showed the highest pharmaceutical concentrations, likely due to socio-demographic factors. Ecotoxicological assessments revealed that venlafaxine and sulfamethoxazole pose high ecological risks, emphasizing the need for improved treatment technologies and environmental monitoring. Additionally, study in Vietnam revealed pharmaceutical residues in wastewater from 12 hospitals in Hanoi and nearby cities, detecting nine commonly used compounds, such as acetaminophen, caffeine, and sulfamethoxazole, at varying concentrations during both dry and rainy seasons. Acetaminophen, caffeine, SMX, and iopromide were consistently found at high levels in both influents and effluents, indicating incomplete removal by hospital wastewater treatment plants.

Risk assessment revealed that several of these compounds, particularly SMX, ACT, and CAF, pose potential ecological risks, underscoring the need for improved hospital waste and environmental management in Vietnam (Hoang et al., 2024).

Although improper disposal of unused and expired medications is a global issue, study in Thailand reveals a striking disconnect between knowledge and practice. While survey participants displayed a commendable understanding of how to properly manage pharmaceutical waste, most continued to discard expired medications with household trash and retain unused ones, indicating a low level of actual medication management. Factors such as age, education, attitude, and perception were found to positively influence proper disposal behavior, yet these were not enough to drive widespread responsible practices. The study highlights the urgent need for targeted interventions, such as public education, take-back programs, and improved infrastructure, to bridge the gap between awareness and behavior. These findings offer critical insights for policymakers aiming to mitigate the environmental and public health risks associated with pharmaceutical waste in Thailand and similar contexts (Srijuntrapun & Maluangnon, 2024).

In Indonesia, household pharmaceutical waste is often discarded along with domestic garbage, flushed into toilets, or stored indefinitely, which can result in accidental ingestion, misuse, or environmental damage. Recognizing this issue, the Indonesian Ministry of Health encourages public health efforts to educate communities on proper medication disposal methods.

Based on observations and interviews by Ernyasih et al. (2024), it was found that the management of solid medical waste at Cisoka Community Health Center does not yet comply with applicable regulations. Medical waste is only stored in a temporary holding area and has not been disposed of using environmentally friendly non-incineration methods. The health center lacks an independent waste disposal system and relies on third-party services for waste collection and destruction. In addition, routine checks are conducted on the condition of waste containers, which are replaced if found to be rusted or damaged. These findings indicate that the current waste management system is neither comprehensive nor sustainable.

Pharmaceutical waste remains a pressing environmental concern, particularly in community pharmacy settings where the destruction of expired or damaged drugs is often carried out independently. A descriptive study conducted between April and September 2021 across 47 pharmacies and primary clinics in East Bandung revealed that most facilities generated solid pharmaceutical waste, predominantly prescription drugs, over-the-counter medicines, and traditional remedies, averaging 330.2 items (41.9 g). Notably, 85.7% of these facilities destroyed waste on their own, while only 13.3% involved third parties, with many lacking formal partnerships for proper disposal. Although 59.6% of the facilities followed waste management procedures aligned with national guidelines, a significant portion, eleven pharmacies and three clinics, still failed to meet compliance standards. The findings highlight the need for better synchronization of regulatory frameworks and increased support for pharmacists to ensure the safe and professional handling of pharmaceutical waste (Nurfitria et al., 2022).

The accumulation of pharmaceutical waste in households poses serious environmental and health risks, largely due to improper storage and disposal practices. In Indonesia, many households still lack a clear understanding of how to manage pharmaceutical waste responsibly, including recognizing critical terms such as Expiration Date (ED) and Period After Opening (PAO). Study of Mellyana tried to evaluate the effectiveness of educational interventions in improving public knowledge on the safe storage and disposal of medications. Through pre- and post-intervention surveys, statistically significant improvements in participants' knowledge were observed ($p < 0.05$), confirming the vital role of education in promoting responsible pharmaceutical waste management. These findings underscore the need for widespread, accessible educational programs as a sustainable solution to household pharmaceutical waste, with the potential to enhance public awareness, improve waste handling practices, and protect both community health and the environment (Mellyana et al., 2025).

Public health centers, through programs like *Posyandu* (Pos Pelayanan Terpadu/Integrated Service Post), play a key role in educating the community on proper drug use and disposal. *Posyandu* is a community-based health service in

Indonesia that provides integrated services for mothers and children, including immunization, growth monitoring, nutritional counseling, and birth control program (KB) services, with the aim of reducing maternal and infant mortality rates. A community service activity at *Posyandu* Pisang in Semarang showed that counseling on *DAGUSIBU* (*Dapatkan-Gunakan-Simpan-Buang*; how to get a medicine, to use it, to save, and to dispose of which is intended to make the public more aware of medicines) and BUD (Beyond-Use Date, the last date a compounded medication, which is custom-made for a patient, can be safely used) significantly improved participants' knowledge ($p = 0.002$) (Ningrum et al., 2025). A counseling session held in Kampung Katomas significantly improved participants' understanding, as shown by a statistically significant increase in test scores ($p = 0.008$) (Annisya et al., 2024). In Desa Sobokerto, community outreach significantly increased awareness among local women about safe ways to obtain, use, store, and dispose of medications (Utomo et al., 2024). These events suggested that empowering communities through health education can effectively reduce drug waste and promote safer medication practices.

Another example of efforts to enhance public knowledge is demonstrated by Ainni et al. (2024). Education on BUD (Beyond Use Date) improves community understanding of expired and degraded medications by emphasizing the importance of proper storage and safe usage after packaging is opened. Through simulations and counseling sessions, participants learned how to calculate BUD for various household drug forms. The program led to a significant increase in knowledge, encouraging safer and more effective use of medications within the community.

Self-medication has become increasingly common due to easy access to health information, but it often leads to improper drug storage practices at the household level. To address this issue, community health volunteers (*Posyandu* cadres) were trained and empowered to educate local residents about proper household drug management. The program showed an improvement in cadres' knowledge after the training, although follow-up assistance is still needed, as some households continued to show improper storage and disposal practices (Susilo et al., 2025).

Improper disposal of unused and expired medications remains a significant environmental concern in Palu, Indonesia, where many residents lack adequate knowledge about responsible pharmaceutical waste management. A cross-sectional study by Ambianti, et al. involving 100 households revealed that while the majority of people purchase medicines from pharmacies (78%) and store them in medicine boxes (56%), a striking 78% dispose of unused or expired drugs in public trash bins. Despite 70% of respondents acknowledging the potential environmental harm caused by improper disposal, 65% had never received any education on the issue. This disconnect between awareness and informed action underscores the urgent need for public health initiatives that educate communities about the ecological and health risks of pharmaceutical waste and promote safe disposal practices (Ambianti et al., 2022).

This community service activity aimed to improve knowledge, attitudes, and behavior related to the destruction of expired and damaged medications at the household level. The intervention was conducted through health education and distribution of informative flyers at a community health center in Palu City, Indonesia. This paper presents the outcomes of the educational intervention and its impact on household pharmaceutical waste management practices.

METHODS

The team first recognized that improper disposal of expired and unused medicines was a common issue in households. Previous observations and studies in Palu and other areas showed that most residents discarded drugs in trash bins, flushed them into toilets, or stored them indefinitely, which could harm health and the environment. This gap in knowledge and behavior justified the need for an educational intervention at the community level. The activity was conducted as part of the Apothecary Professional Practice (PKPA) program. The pharmacy student team coordinated with the Public Health Center staff to obtain approval and align the activity with ongoing community health services. The location chosen was the Bumi Roviga Sub-Public Health Center, under the Talise Public Health Center in Palu City. The target participants were parents attending child growth monitoring (*Posyandu*) or antenatal care services, as these groups regularly visit the facility and are directly responsible for medication use and disposal at home. The program was conducted in June 2025. The team prepared educational materials

(counseling content and printed flyers) that were simple, culturally appropriate, and easy to understand, even for participants with limited education. A structured questionnaire was developed and tested beforehand on a similar population to ensure validity and reliability. The questionnaire included sections on knowledge, attitudes, and behaviors related to drug disposal. Flyers and questionnaires were printed in advance. The pharmacy student facilitators prepared their counseling materials and rehearsed presentation delivery to ensure clarity. Digital tools (Google Forms and WhatsApp group) were set up for post-test data collection. A total of 24 respondents were selected randomly from among the parents present during the outreach activity. The intervention consisted of four phases: 1) Pre-test: Respondents completed a paper-based questionnaire assessing their baseline knowledge, attitudes, and behavior related to drug disposal. 2) Health Education: A face-to-face educational session was delivered, covering the environmental and health risks of pharmaceutical waste and proper disposal techniques. 3) Flyer Distribution: Each participant received a printed flyer containing step-by-step instructions on safe disposal practices to reinforce the learning at home. 4) Post-test: One week after the session, a follow-up assessment was conducted via Google Forms, distributed to respondents through WhatsApp. Statistical analysis was performed using Shapiro-Wilk to test data normality and paired t-tests to compare pre- and post-intervention scores in knowledge, attitude, and behaviour.

RESULTS

Among the 24 participants, 66.7% were female and 33.3% male, with an average age of approximately 54 years (range: 32–74 years). Educational backgrounds varied, with 29.2% completing elementary school, 20.8% middle school, 12.5% high school, and 37.5% higher education. The majority (62.5%) were self-employed, while the remainder included civil servants, police officers, and military personnel. This demographic spread indicates that the program successfully reached a broad segment of the community, including individuals with limited formal education, for whom accessible educational interventions are especially critical. The brief documentation can be seen on Youtube through this link https://youtu.be/WGSsBgY-4ME.

Table 1. Characteristic of the respondents

Characteristic	Category	Frequency (n)	Percentage (%)
Gender	Male	9	37.50%
	Female	15	62.50%
Age Group	30–39 years (Young Adult)	4	16.67%
	40–49 years (Middle Adult)	7	29.17%
	50–59 years (Pre-Senior)	4	16.67%
	60–69 years (Senior Adult)	6	25.00%
	≥70 years (Older Adult)	3	12.50%
Education Level	Elementary School	7	29.17%
	Junior High School (SMP)	5	20.83%
	Senior High School (SMA)	3	12.50%
	Higher Education (College/Univ.)	9	37.50%
Occupation	Self-employed	15	62.50%
	Civil Servant (PNS)	5	16.67%
	Military (TNI)	1	4.17%
	Police Officer	3	12.50%

Source: Primary Data



Figure 1. Health education session during the line

To assess participants' knowledge, attitudes, and behaviors regarding household pharmaceutical waste disposal, structured questionnaires were administered in two stages: pre-intervention and post-intervention. The questionnaire had previously undergone validity and reliability testing on a similar population at a different time, within the same public health center, to ensure the accuracy and consistency of the instrument. The pre-test was conducted in person at the health center prior to the educational session. Respondents were asked to complete a printed questionnaire that included 20 multiple-choice questions for each domain, knowledge, attitudes, and behaviors. The attitude and behavior sections used Likert-scale responses to measure the level of agreement with specific statements, while the knowledge section evaluated participants' understanding of correct disposal methods and associated risks. The questionnaire is stored and can be accessed through the link: https://drive.google.com/drive/folders/1Z8qt6qkqu94g-hRq_H9rWgusWzxj3-QH?usp=drive_link.

Following the intervention, which involved health education and the distribution of informative flyers, the same questionnaire was administered again one week later via an online form shared through WhatsApp. This two-stage approach enabled both immediate and delayed assessment of the intervention's impact on improving public awareness and promoting responsible medication disposal behavior at the household level. Briefly, the respond can be seen in table below.

Table 2. Statistic parameter

Parameter	Attitude		Behavior		knowledge	
	Pre-	Post-	Pre-	Post-	Pre-	Post-
Respondent (n)	24	24	24	24	24	24
Mean	80.31	92.76	81.56	84.84	50.21	84.79
Median	80.00	92.50	80.63	85.00	50.00	87.50
Std. Deviation	3.64	3.15	4.33	3.09	13.63	9.61
Minimum	71.25	87.50	72.50	80.00	25.00	65.00
Maximum	87.50	98.75	88.75	91.25	85.00	100.00
Sum	1927.50	2226.25	1957.50	2036.25	1205.00	2035.00

Before conducting parametric statistical analyses, it is essential to verify whether the data follows a normal distribution, as this assumption underlies many inferential tests. To assess the normality of the data collected on attitudes, behaviors, and knowledge, both before and after the treatment, the Kolmogorov-Smirnov and Shapiro-Wilk tests were performed. These tests help determine whether the data significantly deviates from a normal distribution, guiding the appropriate selection of subsequent statistical procedures. The results of these normality tests are presented in the table below.

Table 3. Normality Test

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
attitude_pre_intervention	0.216	24	0.005	0.953	24	0.315
attitude_post_intervention	0.143	24	.200*	0.949	24	0.254

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
behavior_pre_intervention	0.141	24	.200*	0.953	24	0.320
behavior_post_intervention	0.109	24	.200*	0.962	24	0.484
knowledge_pre_intervention	0.131	24	.200*	0.968	24	0.613
knowledge _post_intervention	0.206	24	0.010	0.929	24	0.093

***. This is a lower bound of the true significance.**

a. Lilliefors Significance Correction

To evaluate the effectiveness of the intervention in improving participants' attitudes, behaviors, and knowledge, a paired samples t-test was conducted comparing pre- and post-intervention scores for each variable. This statistical test is appropriate for analyzing changes within the same group over time, offering insights into whether the differences observed before and after the intervention are statistically significant. The results of the paired samples t-test are summarized in the table below.

Table 4. Paired T-Test

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	attitude pre-post intervention	-12.44792	3.94389	0.80504	-14.11327	-10.78256	-15.462	23	0.000
Pair 2	behavior pre-post intervention	-3.28125	2.32579	0.47475	-4.26335	-2.29915	-6.912	23	0.000
Pair 3	knowledge pre-post intervention	-34.58333	12.93098	2.63952	-40.04361	-29.12306	-13.102	23	0.000

DISCUSSION

The Table 4 presented is a *Paired Samples Test* output from SPSS, used to analyze the difference in mean scores before and after an intervention for three variables: attitude, behavior, and knowledge. This test is particularly useful in within-subject designs where the same participants are measured twice, before and after the intervention. The aim is to determine whether the intervention produced statistically significant changes in each variable. The key columns to focus on include the Mean Difference, t-value, degrees of freedom (df), and Significance level (Sig. 2-tailed).

The first row of the table 4 addresses the difference in attitudes before and after the intervention. The mean difference is -12.45, indicating that post-intervention attitude scores were higher (if higher scores mean improvement). The negative sign implies an increase in scores from pre- to post-test (depending on coding). The t-value of -15.462 is exceptionally high in absolute terms, and the p-value (Sig. 2-tailed) is 0.000, which is well below the standard alpha level of 0.05. This strongly suggests that the intervention had a statistically significant effect on participants' attitudes. The confidence interval of the mean difference (-14.11327 to -10.78256) does not cross zero, further confirming the result's significance.

The second row of Table 4 shows the pre-post comparison of behavior scores. The mean difference here is -3.28 with a standard deviation of 2.32, and a t-value of -6.912. Once again, the p-value is 0.000, suggesting a statistically significant change in behavior following the intervention.

Though the mean difference is smaller than for attitude, the result is still meaningful and statistically robust. This indicates that the intervention led to a measurable and consistent improvement in participant behavior, although the magnitude of change was less pronounced than for attitude and knowledge.

The third row of Table 4 represents the difference in knowledge before and after the intervention, with a striking mean difference of -34.58 and a relatively high standard deviation of 12.93. The associated t-value is -13.102, which is statistically very strong, and the p-value remains 0.000. This large difference implies the intervention had the most substantial impact on participants' knowledge levels compared to the other two variables. The 95% confidence interval (-40.045 to -29.123) clearly excludes zero, adding further confidence to the conclusion. This substantial change in knowledge is often expected in educational or informational interventions where knowledge acquisition is the primary aim.

In summary, the paired samples t-test demonstrates that the intervention significantly improved all three measured dimensions: attitude, behavior, and knowledge. The strongest effect was observed in knowledge, followed by attitude and then behavior. The consistent pattern of statistical significance across all variables, with very low p-values and confidence intervals that exclude zero, suggests that the intervention was effective in producing meaningful changes. These findings provide a strong empirical foundation for concluding that the intervention achieved its intended goals, and could support its replication or scaling in similar contexts.

The integration of direct counseling and printed educational materials proved effective in raising awareness and promoting behavioral change among the community members. Notably, participants with lower levels of education showed measurable improvements, suggesting that the intervention's design was accessible and easily understood.

The week-long interval between the intervention and the post-test allowed for practical application of the knowledge in daily routines, reinforcing long-term retention. Furthermore, the use of WhatsApp for follow-up assessments demonstrates the utility of combining traditional and digital approaches to community education.

The Theory of Planned Behavior (TPB) is particularly well-suited to explain the changes observed in your community service activity on household pharmaceutical waste disposal. TPB, developed by Icek Ajzen (1991), posits that a person's behavior is directly influenced by their intention to perform the behavior, which is in turn determined by three factors: 1) Attitude toward the behavior: belief that the behavior is beneficial or harmful.

Before the intervention: Many participants likely saw unused drugs as harmless or simply stored them out of habit. After the intervention: Through education on environmental and health risks, participants' attitudes became more positive toward proper drug disposal (e.g., no longer flushing or discarding into household waste). The flyer and counseling changed how they evaluated the consequences of improper disposal. 2) Subjective norms: perceived social pressure to perform or not perform the behavior. Group-based education in a public health setting created a shared perception: "this is what responsible community members should do." When people see others learning and engaging, they feel socially encouraged to adopt similar practices. Health workers and students acted as credible influencers, reinforcing new norms. 3) Perceived behavioral control: the belief that one has the ability and resources to carry out the behavior. Before the intervention, many participants may have believed they lacked knowledge or ability to safely dispose of drugs. The hands-on explanation and simple, printed steps (in the flyer) gave them confidence that they could do it themselves. Use of WhatsApp and Google Form also empowered them to engage digitally, boosting control perception.

A study conducted by Hiew et al. (2025) exploring factors influencing Malaysian community pharmacists' intention to provide medication take-back services, using the Theory of Planned Behaviour. While pharmacists' attitudes had little impact, subjective norms (like patient demand) and external pressures (such as business competitiveness) positively influenced intention, whereas perceived barriers like cost, workload, and lack of authority had a negative effect. The findings suggest that improving safe medication disposal requires regulatory support, industry collaboration, and public education to empower community pharmacies.

A systematic review managed by Etim et al. (2025) by analyzing 42 studies across 17 countries

using the Theory of Planned Behaviour to understand household food waste behavior, highlighting the significant environmental and social costs of food waste. The findings show that attitudes, subjective norms, and perceived behavioral control all play key roles, and that effective reduction strategies must be holistic and tailored to different demographic and socioeconomic groups. The study recommends public education, supportive policies, and community initiatives to promote mindful consumption and reduce household food waste.

According to TPB, an individual's behavior is influenced by their intention to perform the behavior, which is shaped by three key components: attitudes, subjective norms, and perceived behavioral control. In Rasuna et al. (2025) study, the educational video and the "Gerakan Peduli Lansia" tracking book improved the elderly participants' attitudes by increasing their awareness and understanding of BPJS-covered dental services. The involvement of healthcare staff and community cadres helped strengthen subjective norms by creating social support and reinforcing the importance of dental care. Lastly, the empowerment approach enhanced perceived behavioral control by providing practical tools and knowledge, enabling the elderly to feel more capable of accessing and utilizing healthcare services. As a result, the intervention successfully influenced intentions and translated into actual improvements in health-related behaviors among elderly patients with hypertension.

The Theory of Planned Behavior (TPB) provides a strong framework for understanding the changes in attitudes and behaviors observed following the tuberculosis education program in Depok City. According to TPB, a person's intention to engage in a specific health behavior, such as TB case detection, is influenced by their attitudes toward the behavior, the perceived social pressure (subjective norms), and their confidence in their ability to perform the behavior (perceived behavioral control). The education delivered during this program successfully addressed all three components: it improved participants' attitudes by increasing their understanding of the importance of early TB detection, reinforced subjective norms by involving community support, and strengthened perceived behavioral control by equipping participants with the knowledge and tools needed to take action. As a result, participants showed measurable improvements in both knowledge and behavior related to TB case detection, aligning closely with the TPB framework (Fitriyani et al., 2025).

The results support the potential scalability of similar interventions in other regions and provide a practical model for community-level pharmaceutical waste education in Indonesia.

CONCLUSION

This community engagement initiative significantly enhanced the knowledge, attitudes, and behaviors of residents regarding proper household pharmaceutical waste disposal. The combination of face-to-face counseling and flyer-based reinforcement proved effective in a short period of time. Such models should be adopted more widely, particularly in primary healthcare settings, to prevent environmental contamination and improve public health safety.

SUGGESTION

Based on the outcomes of this community service activity, it is suggested that household-level education on pharmaceutical waste disposal be integrated into routine health promotion programs at primary healthcare centers. The significant improvement observed in participants' knowledge, attitudes, and behaviors indicates that even short, targeted interventions can be effective when culturally and contextually appropriate. Therefore, future initiatives should consider adopting similar educational strategies, combining face-to-face counseling with simple printed materials, to reach broader segments of the population. Moreover, engaging pharmacy students in delivering health education can enhance both community outreach and student professional development. To sustain behavioral change, it is recommended that periodic follow-ups and the inclusion of pharmaceutical waste topics in maternal and child health counseling sessions be explored. These findings support the importance of expanding educational outreach on drug disposal as part of environmental health and pharmaceutical care responsibilities at the community level.

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CONFLICTS OF INTEREST

The authors declare that there are no conflicts of interest related to the conduct of this community service activity or the preparation of this manuscript. This includes no financial, consulting, institutional, personal, or other relationships that could influence or bias the research process or its outcomes. The authors further confirm that they have not received any payments, services, or benefits from any third party that could be perceived as influencing the content of this manuscript.

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