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Efforts to Increase Public Knowledge Regarding Dagusibu (Obtain, Use, Store, and Dispose of Medicines) in Keteleng Village, Tragah District, Bangkalan Regency

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Abstrak

Pengelolaan obat yang tidak tepat masih menjadi permasalahan kesehatan masyarakat, terutama dalam praktik swamedikasi. Rendahnya pengetahuan mengenai cara memperoleh, menggunakan, menyimpan, dan membuang obat dapat meningkatkan risiko kesalahan penggunaan obat, kegagalan terapi, resistensi antibiotik, serta pencemaran lingkungan akibat limbah obat rumah tangga. Program DAGUSIBU (Dapatkan, Gunakan, Simpan, dan Buang Obat) merupakan salah satu upaya edukatif untuk meningkatkan literasi masyarakat dalam penggunaan obat yang rasional. Penelitian ini bertujuan untuk menganalisis peningkatan pengetahuan masyarakat setelah diberikan edukasi mengenai prinsip DAGUSIBU di Desa Keteleng, Kecamatan Tragah, Kabupaten Bangkalan. Kegiatan menggunakan pendekatan edukatif dengan desain one-group pretest-posttest. Intervensi dilakukan melalui penyuluhan menggunakan metode ceramah interaktif, diskusi, tanya jawab, serta media edukasi berupa PowerPoint, leaflet, dan poster. Evaluasi dilakukan menggunakan kuesioner pretest dan posttest yang terdiri atas 10 butir pertanyaan dan diikuti oleh 15 peserta. Hasil penelitian menunjukkan bahwa jumlah jawaban benar meningkat dari 127 (84,67%) pada pretest menjadi 129 (86,00%) pada posttest, sedangkan jumlah jawaban salah menurun dari 23 (15,33%) menjadi 21 (14,00%). Berdasarkan perubahan skor individu, sebanyak 5 peserta (33,3%) mengalami peningkatan nilai, 6 peserta (40,0%) memperoleh nilai yang tetap, dan 4 peserta (26,7%) mengalami penurunan nilai. Selain peningkatan hasil evaluasi, observasi selama kegiatan menunjukkan bahwa peserta lebih memahami prinsip memperoleh obat dari sarana kefarmasian yang resmi, menggunakan obat sesuai aturan, menyimpan obat berdasarkan karakteristik sediaannya, serta membuang obat rusak atau kedaluwarsa secara aman. Keberhasilan kegiatan didukung oleh partisipasi aktif masyarakat, dukungan pemerintah desa, serta penggunaan media edukasi yang bervariasi, meskipun pelaksanaannya masih menghadapi kendala berupa keterbatasan waktu penyuluhan dan perbedaan karakteristik peserta. Dengan demikian, edukasi berbasis DAGUSIBU dapat menjadi strategi promosi kesehatan yang efektif untuk meningkatkan pengetahuan masyarakat mengenai pengelolaan obat yang rasional dan perlu dilaksanakan secara berkelanjutan sebagai bagian dari upaya peningkatan derajat kesehatan masyarakat.

Kata Kunci: DAGUSIBU; Edukasi Kesehatan; Pengelolaan Obat; Pengetahuan Masyarakat; Penggunaan Obat Rasional.

Abstract

Improper medication management remains a public health problem, particularly in self-medication practices. Lack of knowledge about how to obtain, use, store, and dispose of medications can increase the risk of medication errors, therapeutic failure, antibiotic resistance, and environmental pollution from household drug waste. The DAGUSIBU (Obtain, Use, Store, and Dispose of Drugs) program is an educational effort to improve public literacy in the rational use of medications. This study aims to analyze the increase in community knowledge after being educated about the DAGUSIBU principles in Keteleng Village, Tragah District, Bangkalan Regency. The activity used an educational approach with a one-group pretest-posttest design. The intervention was carried out through counseling using interactive lectures, discussions, questions and answers, and educational media such as PowerPoint, leaflets, and posters. Evaluation was carried out using pretest and posttest questionnaires consisting of 10 questions and participated by 15 participants. The results showed that the number of correct answers increased from 127 (84.67%) in the pretest to 129 (86.00%) in the posttest, while the number of incorrect answers decreased from 23 (15.33%) to 21 (14.00%). Based on changes in individual scores, 5 participants (33.3%) experienced an increase in scores, 6 participants (40.0%) achieved a stable score, and 4 participants (26.7%) experienced a decrease in scores. In addition to the improvement in evaluation results, observations during the activity showed that participants had a better understanding of the principles of obtaining medicines from authorized pharmaceutical facilities, using medicines according to regulations, storing medicines based on their characteristics, and safely disposing of damaged or expired medicines. The success of the activity was supported by active community participation, village government support, and the use of various educational media, although its implementation still faced obstacles such as limited time for counseling and differences in participant characteristics. Thus, DAGUSIBU-based education can be an effective health promotion strategy to increase public knowledge about rational drug management and needs to be implemented sustainably as part of efforts to improve public health.

Keywords : DAGUSIBU; Health Education; Drug Management; Public Knowledge; Rational Drug Use.

INTRODUCTION

Medication is a crucial component of healthcare services, playing a role in promotive, preventive, curative, and rehabilitative efforts. Ease of access to healthcare services, pharmacies, and various sources of health information has increased the practice of self-medication in the community (Monalisa, Fakih, dan Perbawati 2023). Self-medication can be an effective solution for minor health complaints when used rationally. Conversely,

medication use without adequate knowledge has the potential to lead to various problems, such as medication errors, therapeutic failure, side effects, and even antimicrobial resistance. Therefore, increasing public literacy regarding medication management is a crucial strategy to support safe and rational medication use.

The problem of inappropriate medication use remains a public health issue in various countries. The World Health Organization reports that irrational medication use is widespread and contributes to increasing medication errors, wasted healthcare costs, and the growing threat of antimicrobial resistance. This situation demonstrates that therapeutic success is not solely determined by drug availability but also by the community's ability to properly obtain, use, store, and dispose of medications (Jafarzadeh et al. 2021).

A similar situation persists in Indonesia. The 2023 Indonesian Health Survey showed that most households still stockpile medicines for self-medication. These include over-the-counter (OTC) drugs, restricted-prescription drugs, prescription drugs, antibiotics, and traditional medicines. However, household drug management practices are still not fully compliant with pharmaceutical regulations. People still purchase medicines from unauthorized sources, use antibiotics without a healthcare professional's prescription, store medicines without paying attention to storage temperature or expiration dates, and dispose of medicines directly in the trash or drains. This situation indicates that public literacy regarding proper medication management still needs to be strengthened through educational interventions (Lawal et al. 2025).

One national program developed to improve public literacy regarding drug use is the DAGUSIBU (Get, Use, Store, and Dispose of Drugs) program, initiated by the Indonesian Pharmacists Association (Fiskia, Rajih, dan Nur 2023). This program aims to develop public behavior to obtain drugs from authorized pharmaceutical facilities, use them according to regulations, store them based on their dosage characteristics, and dispose of damaged or expired drugs in a manner that is safe for health and the environment. The implementation of the DAGUSIBU program is a form of community empowerment to support rational drug use while preventing the negative impacts of improper drug management.

Various studies over the past five years have shown that public knowledge of the DAGUSIBU principles remains moderate to low. Research by Hiew dan Low (2024) indicates that drug storage and disposal are the most commonly misunderstood aspects. Similar findings were also reported by Srijuntrapun (2026), who stated that some people still reuse leftover medication from previous therapies, store antibiotics without considering their expiration dates, and dispose of medications with household waste. Research by Sanas dan Resky (2025) demonstrated that education using leaflets, interactive lectures, and discussions significantly increased public knowledge about the DAGUSIBU principles. These results demonstrate that health education is an effective strategy for increasing public literacy regarding medication management.

Similar issues were also found in Keteleng Village, Tragah District, Bangkalan Regency. Based on initial observations during the Community Service Program (KKN), the community still engaged in various practices inconsistent with the DAGUSIBU principles, including storing medications for long periods without checking expiration dates, reusing leftover medication from previous treatments, purchasing medications without consulting a

healthcare professional, and disposing of unused medications with household waste. These conditions indicate that public knowledge about proper medication management remains limited, potentially increasing the risk of medication errors, therapeutic failure, toxic effects from expired medications, antibiotic resistance, and environmental pollution from household pharmaceutical waste.

Although various DAGUSIBU educational activities have been conducted in various regions, the implementation of a similar program in Keteleng Village has not been scientifically reported. Furthermore, the social characteristics of rural communities, which are still dominated by self-medication practices, require an educational approach tailored to local conditions. Therefore, health education activities are needed that not only provide information but also increase public understanding of proper medication management based on DAGUSIBU principles.

Based on these issues, this community service activity aims to increase the knowledge of the people of Keteleng Village, Tragah District, Bangkalan Regency, regarding how to properly obtain, use, store, and dispose of medications according to DAGUSIBU principles. This increased knowledge is expected to encourage more rational medication use behaviors, reduce the risk of medication errors, reduce inappropriate medication use, and support sustainable improvements in public health.

METODE

This community service activity employed an educational approach with a one-group pretest-posttest design, measuring participants' knowledge levels before and after receiving an intervention in the form of counseling on DAGUSIBU (Obtain, Use, Store, and Dispose of Medicines). This design is widely used to evaluate the effectiveness of health education programs because it accurately reflects changes in participants' knowledge following the intervention (Melling, A. (2020).

Participants were residents of Keteleng Village who voluntarily attended the counseling session. Accidental sampling was used to select participants who met the attendance criteria during the activity and were willing to participate in the entire series of activities, from the pretest to the posttest. The primary target group was chosen because the community plays a direct role in obtaining, using, storing, and disposing of medicines in the household environment. Therefore, increased knowledge is expected to encourage changes in rational drug use behavior.

Evaluation of the effectiveness of the counseling was conducted using pretest and posttest instruments. The pretest was administered before the presentation of the material to identify participants' initial knowledge level regarding the DAGUSIBU principles, while the posttest was administered after all the material and discussion sessions were completed. The evaluation instrument consisted of a questionnaire containing questions on the proper acquisition, use, storage, and disposal of medications. The instrument's outline was based on the DAGUSIBU educational indicators developed by the Indonesian Pharmacists Association and adapted to the activity's objectives. Prior to use, the instrument was reviewed by the supervising lecturer and pharmacy staff to ensure content validity (Netere et al. 2026).

The data obtained were analyzed using descriptive analysis by comparing participants' pretest and posttest scores. The results are presented in the form of frequency distributions, percentages, average scores, and increases in knowledge scores after attending the counseling session. Descriptive analysis was chosen because it is appropriate for evaluating the achievements of community service activities focused on improving participants' knowledge. The evaluation results were then used as a basis for assessing the effectiveness of the DAGUSIBU educational program and as recommendations for implementing future health promotion activities in the community.

RESULTS AND DISCUSSION

An educational activity on DAGUSIBU (Obtain, Use, Store, and Dispose of Medicines) was held on June 25, 2026, in Keteleng Village, Tragah District, Bangkalan Regency, as part of a community service program. This activity was motivated by initial observations indicating that some residents still had limited understanding of medication management, particularly regarding obtaining medications from authorized pharmaceutical facilities, using medications according to regulations, storing medications based on their product characteristics, and disposing of damaged or expired medications. Based on these conditions, an educational activity was developed to increase public knowledge about the rational use of medications through the application of DAGUSIBU principles.

The activity began with coordination with the village government, followed by participant registration and a pre-test to assess the community's initial knowledge level. The DAGUSIBU material was then delivered using an interactive lecture method combined with discussions and questions and answers. The material covered how to legally obtain medications, using medications according to dosage and indications, storing medications based on their type, and safe medication disposal. The presentation was supported by educational media such as PowerPoint presentations, leaflets, posters, and LCD projectors to facilitate participant comprehension.

A total of 15 participants participated in all activities, including the post-test. Throughout the training, participants demonstrated high levels of enthusiasm through active participation in discussion sessions, particularly regarding antibiotic use, home medication storage, and the disposal of expired medications. This high level of participant engagement demonstrates that the material presented is relevant to community needs. According to Chen dan Hsieh (2021), active community participation in the education process is one indicator of successful health promotion because it can increase understanding and encourage behavioral changes in medication management.

The effectiveness of educational activities regarding DAGUSIBU was evaluated by measuring participants' knowledge levels using pretest and posttest instruments. The evaluation instrument consisted of 10 questions covering four key aspects of the DAGUSIBU program: how to obtain medication correctly (get), how to use medication according to instructions (use), how to store medication properly (store), and how to dispose of medication safely (discard). All 15 participants participated in both stages of the evaluation so that all data could be analyzed comprehensively. The use of a one-group pretest-posttest design

aimed to illustrate changes in public knowledge levels after receiving the educational intervention.

Tabel 1. Participants' Knowledge Level Before and After DAGUSIBU Counseling

Indicators	*Pretest*	*Posttest*
Number of participants	15	15
Number of questions	10	10
Number of correct answers	127 (84,67%)	129 (86,00%)
Number of incorrect answers	23 (15,33%)	21 (14,00%)

Table 1 shows that the number of correct answers increased from 127 (84.67%) in the pretest to 129 (86.00%) in the posttest. Conversely, the number of incorrect answers decreased from 23 (15.33%) to 21 (14.00%). Although the increase was not significant, this change indicates an improvement in the community's knowledge level after participating in counseling on medication management based on the DAGUSIBU principles.

This change demonstrates that the educational intervention was able to provide participants with additional information regarding the correct use of medications. During the counseling process, participants received explanations regarding the importance of obtaining medications through legal pharmaceutical facilities, understanding the rules for using medications according to dosage and indications, learning how to store medications based on the characteristics of the formulation, and understanding safe medication disposal procedures to prevent misuse and environmental pollution. The systematic delivery of the material, combined with communicative educational media, enabled participants to connect the material to their experiences managing medications in their households.

In addition to comparing the overall number of correct and incorrect answers, changes in knowledge level were also analyzed based on changes in individual participant scores. The results of the analysis are presented in Table 2.

Tabel 1. Changes in Participant Scores After Attending DAGUSIBU Counseling

Category of Value Change	Number of Participants	Percentage
Value Increased	5	33,3%
Value Remained	6	40,0%
Value Decreased	4	26,7%
Total	15	100%

Table 2 shows that 5 participants (33.3%) experienced an increase in their scores after attending the counseling. Six participants (40.0%) maintained their scores, while 4 participants (26.7%) experienced a decrease in their scores during the posttest. The highest increase occurred in one participant, with a two-point increase, while the other four participants each experienced one-point increases. These results indicate that the impact of the education provided was not uniform across all participants, but was influenced by their initial conditions and individual characteristics (Oliveira et al. 2022).

Participants who achieved a stable score cannot be directly interpreted as a failure of the intervention. Based on the evaluation results, most participants in this group already had relatively high pretest scores, thus reducing the opportunity for score improvement after the counseling. This condition is known as the ceiling effect, which occurs when a participant's initial score approaches the maximum, limiting the scope for improvement after the intervention (Jennings dan Cribbie 2016). Therefore, a stable score indicates that participants were able to maintain their previous level of knowledge.

On the other hand, four participants experienced a decrease in their scores during the posttest. This decline is not thought to be due to ineffectiveness of the education materials, but rather to several factors, such as differences in concentration levels during the posttest, variations in comprehension ability, educational level, experience with medication use, and limited time available for reinforcement. Furthermore, the single-session education session meant that participants lacked the opportunity to continuously review the information. This situation suggests that changes in knowledge are influenced not only by the quality of the material but also by individual characteristics and the intensity of the education received.

The findings of this study align with those of Liu et al. (2020), who reported that DAGUSIBU education improved public knowledge about medication management after structured education. This study explained that the increase in knowledge occurred because participants received previously unknown information and were given the opportunity to discuss common medication use issues encountered in daily life. Similar results were also reported by Fokides dan Klaoudatou (2025), who showed that education using leaflets resulted in greater knowledge gains than oral information alone. Printed media allowed participants to review the material after the activity, thus extending information retention.

The increased knowledge gained in this study was also supported by the use of participatory learning methods. The delivery of material through interactive lectures combined with discussion sessions provided participants with the opportunity to share their experiences in obtaining, using, storing, and disposing of medications at home. This interaction made the learning process more contextual, making it easier for participants to understand the material. According to Bavishi et al. (2022), active participant involvement in the educational process is one factor contributing to increased understanding because people do not simply receive information passively but also reflect on their current habits.

However, the magnitude of the increase in knowledge in this study was relatively limited. One reason for this was the high level of participants' prior knowledge, as indicated by the percentage of correct answers on the pretest, which reached 84.67%. This situation reduced the likelihood of score improvement after the intervention compared to participants with lower prior knowledge. Furthermore, the relatively short duration of the counseling

session meant that the material was only presented in one session, preventing participants from strengthening their understanding through repetition or direct practice.

This interpretation is supported by research by Candradewi et al. (2021) explained that the level of community knowledge regarding the DAGUSIBU program is influenced by various factors, including education level, experience in obtaining health information, self-medication habits, and the intensity of education received. Therefore, increasing community knowledge will be more optimal if educational activities are conducted regularly and involve various parties, such as pharmacists, community health centers, health cadres, and the village government.

Overall, the evaluation results indicate that DAGUSIBU outreach has made a positive contribution to increasing the knowledge of the Keteleng Village community regarding proper medication management. Although the increase in posttest scores was not significant, the increase in the number of correct answers and the increase in participants who experienced improved scores indicate that health education remains an effective strategy for increasing community literacy regarding rational drug use. These findings reinforce the importance of implementing the DAGUSIBU education program sustainably as part of promotive and preventive efforts to improve public health.

CONCLUSION

Educational activities on DAGUSIBU (Obtain, Use, Store, and Dispose of Medicines) in Keteleng Village, Tragah District, Bangkalan Regency successfully increased community knowledge about proper medication management. Evaluation results showed an increase in the number of correct answers in the posttest compared to the pretest, indicating that the outreach through interactive lectures, discussions, and the use of educational media was able to provide additional community understanding on how to obtain, use, store, and dispose of medications in accordance with the principles of rational drug use. The program's success was supported by the synergy between the village government, KKN students, and active community participation throughout the program. The use of educational media such as PowerPoint presentations, leaflets, and posters facilitated the delivery of material and increased participant engagement in the learning process.

Based on these findings, DAGUSIBU-based education can be an effective health promotion strategy to increase community literacy in medication management at the household level. For optimal and sustainable impact, similar activities need to be implemented periodically, involving pharmaceutical personnel, community health centers, village governments, health cadres, and educational institutions. It is hoped that a continuous educational approach will encourage the formation of more rational drug use behavior and support improvements in public health.

DAFTAR PUSTAKA

Bavishi, Poyani, Alana Birnhak, John Gaughan, Jocelyn Mitchell-Williams, Dan Sangita Phadtare. 2022. “Education Sciences Active Learning : A Shift From Passive Learning To Student Engagement Improves Understanding And Contextualization Of Nutrition And Community Health.” *Education Sciences* 12 (430): 1–13.

Https://Doi.Org/Doi.Org/10.3390/Educsci12070430.

Candradewi, Susan Fitria, Ginanjar Zukhruf, Saputri Dwi, Sundari Iska, Dan Azkah Azizah. 2021. "Effects Of Active Learning And FGD Education Methods On The DAGUSIBU Knowledge Of MA Nurul Ummah Students , Yogyakarta." *Advances In Health Sciences Research* 33 (Icosihsn 2020): 608–13. Https://Doi.Org/10.2991/Ahsr.K.210115.115.

Chen, Hsuan-Hui, Dan Pei-Lin Hsieh. 2021. "Applying The Pender ' S Health Promotion Model To Identify The Factors Related To Older Adults ' Participation In Community-Based Health Promotion Activities." *International Journal Of Environmental Research And Public Health* 18 (9985): 1–17. Https://Doi.Org/Doi.Org/10.3390/Ijerph18199985.

Fiskia, Ermalyanti, Muhammad Fakhrur Rajih, Dan Amran Nur. 2023. "Introducing The Term DAGUSIBU (Get , Use , Save And Dispose) Medicine At Senior High School State 6 Of Ternate." *Abdimas Umtas: Jurnal Pengabdian Kepada Masyarakat* 6 (4): 4687–93.

Fokides, Emmanuel, Dan Dionysia Klaoudatou. 2025. "Using Tablets To Teach Basic Literacy Skills To Kindergarten Students : A Case Study." *Applied Science* 15 (2252): 1–25. Https://Doi.Org/10.3390/ App15052252.

Hiew, Sheng Yuan, Dan Bee Yean Low. 2024. "The Knowledge , Attitude , And Practice Of The Public Regarding Household Pharmaceutical Waste Disposal : A Systematic Review (2013 – 2023)." *International Journal Of Pharmacy Practice* 32: 120–32. Https://Doi.Org/Doi.Org/10.1093/Ijpp/Riae001.

Jafarzadeh, Adineh, Alireza Mahboub-Ahari, Moslem Najafi, Mahmood Yousefi, Dan Koustuv Dalal. 2021. "Medicine Storage , Wastage , And Associated Determinants Among Urban Households : A Systematic Review And Meta-Analysis Of Household Surveys." *BMC Public Health* 21 (1127): 1–15. Https://Doi.Org/Doi.Org/10.1186/S12889-021-11100-4.

Jennings, Megan A., Dan Robert A. Cribbie. 2016. "Comparing Pre-Post Change Across Groups : Guidelines For Choosing Between Difference Scores , ANCOVA , And Residual Change Scores Comparing Pre-Post Change Across Groups :" *Journal Of Data Science* 14 (2): 205–30. Https://Doi.Org/10.6339/JDS.201604.

Lawal, Olabisi Promise, Hafeez Olayiwola Oyebamiji, Iregbu John Kelenna, Felix Jessica Chioma, Elizabeth Oyefeso, Bankole Israel Adeyemi, Evelyn Foster-Pagaebi, Dan Emmanuel Fidelix Moses. 2025. "R EVIEW A RTICLE A Review On Usage Of Digital Health Literacy To Combat Antibiotic Misuse And Misinformation In Nigeria." *JOURNAL OF PHARMA INSIGHTS AND RESEARCH* 03 (02): 258–69. Https://Doi.Org/10.69613/Dja1jc18.

Liu, Qian, Dan Luo, Joan E Haase, Qiaohong Guo, Xiao Qin Wang, Shuo Liu, Lin Xia, Zhongchun Liu, Jiong Yang, Dan Bing Xiang Yang. 2020. "Articles The Experiences Of Health-Care Providers During The COVID-19 Crisis In China : A Qualitative Study." *The Lancet Global Health* 8 (6): 790–98. Https://Doi.Org/10.1016/S2214-109X(20)30204-7.

Monalisa, Muhammad Fakih, Dan Candra Perbawati. 2023. "Relevance Of WHO Traditional Medicine Strategy (2014-2023) With Traditional Health Care Policy In The Perspective Of National Law And International Law." *JOURNAL OF ASIAN LEGAL*

STUDIES 1 (1): 25–34. Https://Doi.Org/Https://Doi.Org/10.53402/Ajls.V1i1.117.

Netere, Adeladlew K, Tony Hughes, Anna-Marie Babey Clare, Guilding Carolina, Martin Hawes, John P Kelly, Elvan Djouma, Jennifer Koenig, Dan Jacqueline E Mclaughlin. 2026. "Development And Validation Of Pharmacology Concept Inventory For Concept- - Based Learning : Leveraging Theory , Expert Insights , And Student Perspectives." *Pharmacology Research & Perspectives* 14 (70237): 1–15. Https://Doi.Org/10.1002/Prp2.70237.

Oliveira, Wilk, Juho Hamari, Sivaldo Joaquim, Armando M Toda, Paula T Palomino, Julita Vassileva, Dan Seiji Isotani. 2022. "The Effects Of Personalized Gamification On Students ' Flow Experience , Motivation , And Enjoyment." *Smart Learning Environments* 9 (16): 1–26. Https://Doi.Org/10.1186/S40561-022-00194-X.

Sanas, Nurhidayah Tiasya, Dan Shulystiawaty Desy Resky. 2025. "Interactive Nutrition Education For Pregnant Women : Strengthening Maternal Health And Environmental Sustainability In Stunting Prevention." *Ecovision: Journal Of Environmental Solutions* 2 (2): 117–35. Https://Doi.Org/Doi.Org/10.61511/Evojes.V2i2.2025.2235.

Srijuntrapun, Patranit. 2026. "Development Of Guidelines For Managing Unused And Expired Medications In Local Communities : An Engaged Stakeholder Waste Hierarchy Approach." *PLOS One* 3 (6): 1–18. Https://Doi.Org/10.1371/Journal.Pone.0343225.