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# Knowledge, Attitudes and Practice toward the Disposal of Unused Expired Medicines and Associated Factors: A Cross-Sectional Survey in Yogyakarta Primary Health Care

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**ABSTRACT**

**Introduction:** The accumulation and inappropriate disposal of unused and expired drugs lead to significant risks to public health and the environment. Unsafe disposal behaviors contribute to the water and soil contamination and increase the potential for drug misuse. Recognizing community knowledge, attitudes, and practices (KAP) is essential for developing effective health promotion strategies to improve pharmaceutical waste management at primary care level. This study primarily aimed to assess the public's KAP toward disposal of unused and expired drugs and its implications for health promotion in Indonesian primary health care settings.

**Methods:** A cross-sectional survey was conducted among 358 participants selected through purposive sampling at Banguntapan II, Danurejan II, and Mlati II primary healthcare centers in the Special Region of Yogyakarta, Indonesia. Data were technically collected using a prior validated questionnaire. Descriptive statistics, Chi-square tests, Spearman correlation and multivariate logistic regression were used to analyse data.

**Results:** 89.3% of participants reported they had unused or expired drugs stored in their home, and the main reason for storage was better health (52%) or excess medicine (43%). Although 64% have reported excellent knowledge and 98.3% positive attitudes, only 27.7% practiced proper disposal. ($p < 0.05$) Knowledge and attitudes were significantly influenced by, education income and medical history In addition, knowledge and attitude were significantly associated with disposal practices ($p < 0.05$).

**Conclusion:** While public awareness, understanding and attitude were favorable, there are deficiencies in disposal practices. The implementation of pharmacist-led education, drug take-back programs and primary care services for health promotion should be strengthened in the community to raise awareness of CS use, reduce inappropriate disposal practices and protect public health through improved environmental conditions.

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## INTRODUCTION

Access to medicines has improved worldwide due to advances in pharmaceutical distribution and the expansion of primary health care services, including *Pusat Kesehatan Masyarakat* (*Puskesmas*). This progress has improved health outcomes. However, it has also contributed to the growing accumulation of unused medicines in households (1). Improper storage and disposal of medicines represent major public health and environmental concerns. Residual medicines kept beyond their intended use, discarded carelessly, or repurposed by others may lead to accidental poisoning, therapeutic failure, antimicrobial resistance, and environmental contamination of soil and water systems (2,3).

In Indonesia, issue of unused drug management has become increasingly relevant as self-medication and over-the-counter (OTC) access to pharmaceuticals rise in both urban and rural communities (4,5). A recent report of Riset Kesehatan Dasar 2018 found that approximately 35% of Indonesian households stored leftover drugs, most of which were kept for future use or because the prescribed therapy was discontinued before its completion (6). This pattern can be attributed to multiple causes including but not limited to noncompliance, changing dosage, feeling of recovery and adverse drug reaction. Indeed, previous studies confirmed that people frequently store or dispose of unused drugs with a lack of consideration for safety implications or environmental impact (7,8). From a practical level, untreated clinical waste that lands up in the home water environmental systems, ground water or soil can bring about and upset to aquatic ecosystems and pollutants of food chains (9). Public education about how to safely handle drugs as a preventive strategy is encouraged by the World Health Organization and national health authorities. Unused drugs should be destroyed or disposed of separately from the packaging, which could be mixed with soil coffee grounds or other waste materials as recommended by the Indonesian Ministry of Health (10). However, despite the regulations, the implementation of the practices remains heterogeneous, especially at community level (11).

Knowledge, attitudes, and practices (KAP) are important behavioral determinants of how the population is disposed of unused drugs. Poor knowledge drives negative disposal habits whereas positive attitude and awareness of environmental hazards motivate appropriate disposal practices (12,13). n Indonesia and other low- and middle-income countries (LMICs), previous research revealed improved public awareness about drug safety, but inappropriate disposal practices persist due to limited public health education, inadequate implementation of structured drug return programs, and insufficient involvement of pharmacists in medical counseling (14,15). Fortunately, health promotion plays a key role in addressing these gaps. By integrating both behavioral and educational approaches, the promotion can help enhancing community awareness, modifying attitudes, and encouraging responsible practices on the drug management. Primary healthcare centers in Indonesia serve as ideal platforms for implementing such initiatives, given its direct engagement with the community members and their function in promoting rational drug use (16).

Although several studies have assessed the public's KAP regarding unused drugs, limited research has explored such behaviors within the context of Indonesian primary healthcare facilities while linking them to health promotion implications. Understanding how socio-demographic characteristics influence KAP can help design more effective educational interventions that address local needs and improve sustainable pharmaceutical practices. Therefore, this study primarily aims to evaluate public knowledge, attitudes, and practices toward the management of unused drugs among visitors to primary health care centers in the Special Region of Yogyakarta, Indonesia. Moreover, it seeks to identify key factors associated with behaviors and discuss their relevance to the community-based health promotion strategies. By presenting data to the scientific community from a population perspective, we hope this study will inform and facilitate educating programs and policies that foster safe drug practices in an environmentally friendly manner.

Though several local studies have investigated the knowledge, attitude and practices of the general public regarding unused and expired medicines in Indonesia, most have been limited to descriptive community-based surveys that were not integrated into primary health care settings nor involved advanced analytical approaches. This study adds to the current literature by studying KAP in accredited primary health care centers and uses multivariate regression analysis to determine independent determinants of disposal behavior. Also, findings have been intentionally framed upon health promotion paradigm and possible domains for pharmacist-driven actions and framework level pharmaceutical waste management.

## METHOD

### Study Design and Participants

This study conducted cross-sectional quantitative design in order to assess community KAP regarding the management of unused drugs among people at PKD in Yogyakarta Special Region, Indonesia. This research was based on the determinants of safe handling and disposal practices of unused pharmaceuticals as well as the implications of these determinants in relation to community level health promotion programs. Data was collected from January to March 2024 in three fully accredited primary health care centers (PHCC) Banguntapan II of I Bantul Regency, Danurejan II of Yogyakarta City and Mlati II Sleman Regency. We selected these facilities because they include a variety of communities with relatively high patient foot rates to allow for an overall assessment of drug management relevant health behaviors.

Study population Individuals who visited these centers during the study period constituted the population for this study. This study used purposive sampling with defined inclusion and exclusion criteria. Participants aged 18–65 years old (b) patients receiving treatment or accompanying those under treatment (c) voluntarily agreeing to participate and providing informed consent; and (d) did not possess any degree in health sciences. Conversely, those who had any communication barriers or cognitive impairment were excluded. According to cross sectional studies Lemeshow formula, this study also calculated a minimum sample of 350. To ensure representation, 358 participants were successfully enrolled.

### Research Instruments

Data were gathered using a self-administering and structured questionnaire that was modified from previous validated studies (17). The instrument included four main sections, i.e., Socio demographic details, knowledge (7 questions), attitudes (5 questions), and practices (7 questions) regarding the management of unused drugs. All items were designed by using close-ended response formats for consistency and clarity. The instrument underwent validity and reliability testing before data collection. The values of calculated correlation coefficient (r) exceeded the r-table threshold, indicating acceptable construct validity. Internal consistency reliability was confirmed with a Cronbach's alpha coefficient of 0.670, meeting the minimum acceptable standard for exploratory community-based studies.

The reliability coefficient obtained in this study is acceptable within the context of exploratory research. Methodological literature suggests that Cronbach's alpha values ≥0.60 may be considered adequate for exploratory or early-stage studies, particularly in social and behavioral research where constructs are multifaceted and context-dependent. Because this KAP study is exploratory and the heterogeneity of the study population, the reliability coefficient was considered sufficient for testing internal consistency.

### Data Collection Procedure

Participants were approached at the health care centers after receiving an explanation of the study's objectives, benefits, and confidentiality assurances. Practically, data collection was performed via direct interviews and guided self-completion of questionnaires under researcher supervision The interviewers had undergone perception alignment and applied a standardized protocol to offer neutral clarification without guiding respondents, thereby minimizing interviewer effects and response bias. Each questionnaire took around 10–15 min to fill out. Knowledge, attitude and practice scores of each respondent were calculated for correct or desirable responses. Technically, the scoring system allotted binary or scaled points (0–1 for knowledge and attitude while 0–2 for the practice). The scores were added and expressed in percentage (%) and classified as good (> 75%) or poor (< 75%) based on standard predetermined thresholds from previous studies.

All data collectors were provided with training to ensure methodological consistency among the mixed data collection modalities. standardized training prior to data collection. A uniform protocol and scripted guidance were used to minimize interviewer influence, and no interpretative explanations or leading prompts were permitted during questionnaire administration. Both interview-assisted and self-administered questionnaires used the same instruments, response options, and scoring procedures. For attenuation of context-induced variability, data were collected in similar clinical settings and over the same time periods to control for interviewers-collected bias, as well as to limit response variability.

### Data Analysis

The data obtained were analyzed by using Statistical Package for the Social Sciences (SPSS) version 25.0. Descriptive statistics (frequency and percentage distributions) were used to summarize the socio-demographic characteristics and KAP scores. Inferential analyses were performed as follows: (a) the Chi-square test was applied to assess associations between participant's characteristics (e.g., age, gender, education, occupation, income, and medical history) and their KAP levels; (b) the Spearman rank correlation test was used to examine the relationship between all KAP scores; and (c) logistic regression analysis was employed to identify predictors influencing positive KAP outcomes. All statistical tests were two-tailed with a 95% confidence level, and $p < 0.05$ was considered statistically significant.

### Ethical Considerations

Ethical approval for this research was obtained from the Research Ethics Committee of the Universitas Jenderal Achmad Yani Yogyakarta (Approval No. SKep/679/KEP/XII/2024).

## RESULTS

### Characteristics of Study Participants

A total of 358 participants involved in this study, consisting of visitors of three accredited primary healthcare centers, i.e., Banguntapan II, Danurejan II, and Mlati II, representing both urban and peri-urban populations of the Special Region of Yogyakarta. Among all the participants, the majority were female (83.5%), and most were within the 20–44-year age group (56.7%), indicating that the drug handling at the household level is predominantly managed by women of productive age. This demographic trend fits with previous findings that women, especially housewives, commonly live under the assumption that they have the responsibility of main caregivers who store drugs and decide whether members in their family should take them or not (18).

**Table 1.** Demographic Data of Patients at the Primary Healthcare Center (n=358)

| Variable | Category | Frequency (%) |
|---|---|---|
| **Gender** | Female | 299 (83.5) |
| | Male | 59 (16.5) |
| **Age (years)** | 20–44 | 203 (56.7) |
| | 45–65 | 155 (43.3) |
| **Education** | Elementary | 29 (8.1) |
| | Junior high | 57 (15.9) |
| | Senior high | 174 (48.6) |
| | Diploma | 69 (19.3) |
| | Higher education | 29 (8.1) |
| **Occupation** | Student | 24 (7.0) |
| | Employee | 73 (20.4) |
| | Self-employed | 24 (7.0) |
| | Entrepreneur | 39 (10.9) |
| | Unemployed | 179 (50.0) |
| | Other | 19 (5.3) |
| **Role or Status in the Family** | Father | 51 (14.2) |
| | Mother | 246 (68.7) |
| | Child | 60 (16.7) |
| | Other | 1 (0.3) |
| **Income (IDR)** | <1,000,000 | 162 (45.3) |
| | 1,000,000–5,000,000 | 179 (50.0) |
| | >5,000,000 | 17 (4.8) |
| **Current or Previous Medical History** | Acid reflux | 18 (7.0) |
| | Allergies | 25 (9.7) |
| | Asthma | 11 (4,3) |
| | Kidney stones | 1 (0.4) |

| | | |
|---|---|---|
| | Diabetes | 27 (10.5) |
| | Endometriosis | 1 (0.4) |
| | Hypertension | 53 (20.5) |
| | Heart disease | 3 (1.2) |
| | Cancer | 5 (1.9) |
| | Cholesterol | 3 (1.2) |
| | Pinched nerve | 2 (0.8) |
| | Sinusitis | 1 (0.4) |
| | Gout | 3 (1.2) |
| | Keloids | 1 (0.4) |
| | Bronchitis | 1 (0.4) |
| | Bipolar disorder | 2 (0.8) |
| | Piles | 1 (0.4) |
| | Autoimmune disease | 1 (0.4) |
| | None | 199 (77.1) |
| **Frequently Visited Health Care Facilities** | Healthcare center | 266 (74.3) |
| | Hospital | 45 (12.6) |
| | Pharmacy | 23 (6.4) |
| | Clinic | 17 (4.7) |
| | Independent doctor practice | 7 (2.0) |
| **Number of Visits to Healthcare Facilities (per Month)** | 1–2 times | 243 (67.9) |
| | 3–5 times | 108 (30.2) |
| | >5 times | 7 (2.0) |

Regarding educational qualifications, almost half of the participants (48.6%) had attained senior high school level, with only a small proportion (8.1%) from a higher education background (university level). Also, the participants occupational profile showed that more than half (50.0%) of them were unemployed, due to most of them being housewives this is in agreement with cohort studies and characteristic sociodemographic pattern of patients visiting national community health services. Moreover, nearly half (45.3%) of participants had a monthly income of less than IDR 1,000,000 and one-fifth (50.0%) earned money between IDR 1,000,000 and IDR 5,000,000 per month indicating that most participants were in the lower-middle-income group. This distribution is consistent with national health statistics, which indicate that Indonesia's primary healthcare facilities primarily cater to low- and middle-income populations (19).

In terms of health status, 44.7% of participants reported having a chronic or recurrent illness, and the most cited were hypertension (20.5%), diabetes (10.5%) and allergies (9.7%). This study finding accounts for a large cohort of subjects taking prescribed drugs on a regular basis, thereby making it more likely that unused drugs will accumulate at home. Based on the main table above (Table 1), Health care center (74.3 % ) was the most common first source of health services, followed by hospitals:12.6 %, and pharmacies 6.4%.. Most of them (67.9%) attended health facilities for one to two times in a month, favorable towards moderate health seeking behavior and possible frequent exposure with health care professionals; The prime opportunity for pharmacist led health education activity.

**History of Unused Drug Management**

At the time of the survey, a high 88.3% reported having unused drugs in storage at home. Reasons for unused drugs were significantly reported as improved health condition (76.3%), over-prescribing (17.6%), and expired drugs (4.7%). A minority of respondents cited side effects, allergic reactions, or damaged labels as reasons for stopping them. Form of unused drugs were tablets in 84.2% followed by syrups (12.8%), ointments (5.6%) and eye or ear drops (<5%). In terms of pharmacological classification, analgesics and antipyretics (59.2%), such as paracetamol, were the most commonly reported, followed by vitamins (12.6%), cough medicines (12.9%), and antihypertensive drugs (6.1%), as presented in Table 2. It resonates with the public's penchant for buying and holding OTC or former prescribed medications to treat themselves. Prevalence of analgesics is consistent with studies in Malaysia and Ethiopia that found painkillers were the most commonly stored drugs as they are considered safe and used frequently. (20,21).

**Table 2.** History of Unused Drug Management among Study Participants (n = 358)

| Variables | Frequency (%) |
|---|---|
| **Do you currently have any unused drugs?** | |
| Yes | 316 (88.3) |
| No | 42 (11.7) |
| **Reasons for unused drugs** | |
| Change of medication | 21 (5.9) |
| Excess amount of drug | 58 (17.6) |
| Difficult to follow instructions for use | 0 (0.0) |
| The label on the drug is damaged/unclear | 3 (0.8) |
| Body condition has improved | 253 (69.3) |
| Past the expiration date | 17 (4.7) |
| Side effects or allergic reactions occur | 5 (1.4) |
| Do not know the benefits of the prescribed medicine | 1 (0.3) |
| **Choose the dosage form of unused drugs** | |
| Tablets | 245 (68,4) |
| Capsules | 17 (4.7) |
| Syrups | 46 (12.8) |
| Ointments | 20 (5.6) |
| Eye drops | 19 (5.3) |
| Ear drops | 6 (1.7) |
| Powdered mixture (*puyer*) | 2 (0.6) |
| Talcum powder | 3 (0.8) |
| Others | 0 (0.0) |
| **Types of unused drugs** | |
| Pain relievers | 212 (59.2) |
| Cough medicine | 17 (4.7) |
| Vitamins and nutritional supplements | 27 (7.5) |
| Anti-allergy medication | 15 (4.2) |
| Antibiotics | 13 (3.6) |
| Anti-diabetic drugs | 16 (4.5) |
| Herbal drugs | 9 (2.5) |
| Gastric disorder medication | 13 (3.6) |
| Anti-hypertension drug | 16 (4.5) |
| Others | 20 (5.6) |
| **Duration of drug storage** | |
| Less than 3 months | 240 (67,0) |
| 3–6 months | 97 (27.1) |
| 6–12 months | 12 (3,4) |
| More than 12 months | 9 (2,5) |
| **Actions taken for unused drugs** | |
| Discarded | 283 (79.1) |
| Stored | 62 (17.3) |
| Given to someone else | 10 (2.8) |
| Other | 3 (0.8) |
| **Received information on how to dispose of unused drugs** | |
| Yes | 275 (76.8) |
| No | 83 (23.2) |
| **Method of disposal for unused drugs** | |
| Flushed down the sink | 23 (6.4) |
| Put on the ground | 48 (13.4) |
| Flushed down the toilet | 8 (2.2) |
| Burned | 54 (15.1) |
| Returned to pharmacy | 6 (1.7) |
| Disposed in trash | 202 (56.4) |

| | |
|---|---|
| Other | 17 (4.7) |
| **Reason for choosing disposal method** | |
| Easy and practical | 275 (76.8) |
| Safe, does not pollute the environment | 83 (23.2) |

In terms of storage duration, most participants (69.3%) stored drugs for less than 3 months and a small portion (27.1%) stored them for three-six months. Of relevance, 17.3% of participants confessed to re-storing unused drugs for future use instead of discarding them, whereas 79.1% disposed of them in different ways, and 2.8% gave to others The re-storage behavior can pose health risks such as misplacement, expiration, and confusion of active versus non-active drugs used in households with children or older adults. Regarding disposal methods, the most common in the household was throwing unused drugs directly into waste (56.4%), followed by burning (15.1%), burying (13.4%) and flushing in drains (6.4%). Participants returned drugs to pharmacies only 1.7% of the time.' They also confirmed they had received information about proper disposal methods (69.3%) but that many failed to also implement correct practices indicating a disconnect between what people knew and how they behaved. The most commonly reported reason for the use of improper methods, and which was selected by respondents without prompting, was ease and practicality (76.8%), while only a quarter attributed more appropriate uses to environmental safety (23.2%). The results of preliminary tests were consistent with previously examined studies in Indonesia (22,23) and Afghanistan (24), where the authors found that a lack of drug take-back systems and limited educational programs about safe disposal was a major contributing factor for poor global disposal of medicines.

**Knowledge, Attitude, and Practice (KAP) Toward Unused Drug Management**

Knowledge As shown in Table 1 and Figure 1, the knowledge on sleep dysfunction was considered good by 64.0% of participants whereas poor by only 36.0%. Ninety-eight point three per cent of the 394 people surveyed (for De Friesland) knew that drugs should be in a dry place and kept in their original packaging to maintain it quality. In contrast, fewer participants (72.3%) knew opened drug containers need to be used within a limited timeframe-and therefore that gaps in knowledge relating to stability and source contamination were evident. And just one in five (81.3%) correctly answered that solid drugs should first be crushed and mixed with other materials before being thrown away, while fewer than a quarter (76.5%) knew that liquid medicines should not be disposed of by pouring them directly into rivers or streams (Table 3)

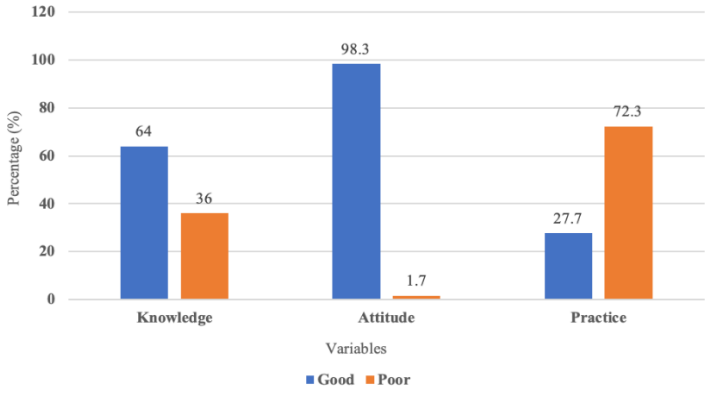


**Figure 1.** Distribution of Knowledge, Attitude and Practice categories among respondents

As shown in figure 1, good knowledge (64%) and good attitudes (98.3%) were found among respondents but a low practice was noted. The study showed that good practices were reported only in 27.7% of respondents, while most of them (72.3%) demonstrated poor practice. This shows a gap between knowledge, attitudes, and practices, where good knowledge and attitudes have not been fully applied in actual behavior. In Table 3, most rost respondents had good knowledge, as indicated by 98.0% knowing the correct way to store medicines and 91.6% understanding the importance of expiration dates. Respondents' attitudes were also very positive, with 97.2% aware that improper disposal of medicines can have negative impacts. However, practices were still low, with only 27.7% of respondents

demonstrating good practices. Many respondents still dispose of syrup in drains (36.9%) and do not separate ointment contents from their packaging (52.2%). These findings indicate a gap between knowledge, attitudes, and practices.

**Table 3.** Knowledge, Attitude and Practice about Unused Drug Management

| **Questions** | **Response** | **Frequency** (n=358) **(%)** |
|---|---|---|
| **Knowledge** | | |
| Drug is stored in a dry place with the original packaging and/or etiquette | True | 351 (98.04) |
| | False | 7 (1.96) |
| Drugs can be stored according to the expiration date | True | 328 (91.62) |
| | False | 30 (8.38) |
| If the drug has been opened, it can be stored according to the time limit for use | True | 258 (72.07) |
| | False | 100 (27.03) |
| The characteristics of damaged drugs are changes in color, taste, and odor | True | 338 (94.41) |
| | False | 20 (5.59) |
| Disposal of tablet/capsule preparations by crushing, mixing to soil, and throwing into trash | True | 291 (81.28) |
| | False | 67 (18.72) |
| Syrup form of drug is directly disposed into the water drain | True | 274 (76.54) |
| | False | 84(23.46) |
| Ointment form of drug is disposed by separating contents from packaging first | True | 261 (72.91) |
| | False | 97 (27.09) |
| **Attitude** | | |
| Drugs should be stored in a dry place with original packaging to maintain safety | Agree | 354 (98.88) |
| | Disagree | 4 (1.12) |
| Storage can affect the physical condition of the drug | Agree | 332 (92.74) |
| | Disagree | 26 (7.26) |
| Drug that has been opened can be stored according to time limit for use | Agree | 269 (75.14) |
| | Disagree | 89 (24.86) |
| Using drug beyond the expiry date is harmful | Agree | 350 (97.77) |
| | Disagree | 8 (2.23) |
| Improper disposal can cause misuse or unwanted effects | Agree | 348 (97.21) |
| | Disagree | 10 (2.79) |
| **Practice** | | |
| I store drugs in a dry place with original packaging/etiquette | Always | 331 (92.46) |
| | Sometimes | 22 (6.15) |
| | Never | 5 (1.40) |
| I store drugs according to expiry date | Always | 246 (68.72) |
| | Sometimes | 76 (21.23) |
| | Never | 41 (11.45) |
| I store opened medicines according to their time limit | Always | 190 (53.07) |
| | Sometimes | 78 21.79) |
| | Never | 90 (25.14) |
| I check drugs for color, taste, or odor changes during storage | Always | 202 (56.42) |
| | Sometimes | 69 (19.27) |
| | Never | 85 (23.74) |
| I dispose of tablets/capsules by crushing, mixing with soil, and discarding | Always | 90 (25.14) |
| | Sometimes | 74 (20.67) |
| | Never | 194 (54.19) |
| I dispose of syrup directly into the sewer | Always | 132 (36.87) |
| | Sometimes | 64 (17.88) |
| | Never | 162 (45.25) |
| I dispose of ointments by removing contents first | Always | 115 (32.12) |
| | Sometimes | 56 (15.64) |
| | Never | 187 (52.23) |

The presence of good attitudes but bad practice signifies that awareness does not guarantee the necessary changes. Based on the theory of Health Belief Mode(25), behavior modification involves not only cognitive understanding, but also perceived susceptibility and cues to action as well as structural support such as linear handling and disposal facilities; thus our finding highlights that pharmacist led health education interventions are essential.

**Relationship Between Socio-Demographic Factors and KAP**

Table 4 shows that the Chi-square test showed that education level, income, and illness history were all strongly linked to how much the participants knew and how they felt about the condition ($p < 0.05$). Those who were well-educated had more than double the odds of sufficient knowledge compared with their less educated counterparts (OR = 2.41; 95% CI: 1.53–3.80). In the same vein, some participants at higher wealth levels expressed more positive attitudes toward safe medication management, possibly due to greater health literacy and access to information. In fact, those without chronic disease scored better on knowledge tests than those with one, possibly because patients with long-standing need for medicine simply do not care as much about it. Statistically, the KAP had no significant correlations with age, gender, employment, or frequency of health facility visits ($p > 0.05$). In the most literal sense, it means that educational and socioeconomic factors which more than demographic considerations provide a better handle on how individuals manage their drugs.

**Table 4.** Relationship between Patient Characteristics and KAP on Unused Drug Management

| Characteristics | Knowledge | | | Attitude | | | Practice | | |
|---|---|---|---|---|---|---|---|---|---|
| | Poor | Good | p-value<br>OR<br>95% CI | Poor | Good | p-value<br>OR<br>95% CI | Poor | Good | p-value<br>OR<br>95% CI |
| Gender | | | | | | | | | |
| Male | 26 | 33 | 0.552 | 4 | 5 | 0.552 | 46 | 3 | 0.370 |
| Female | 03 | 96 | 0.195-2.901 | 2 | 287 | 1.739<br>0.541-5.592 | 213 | 86 | 1.429<br>0735-2.777 |
| Age | | | | | | | | | |
| 20-44 years | 69 | 34 | 0.396 | 6 | 97 | 0.184 | 144 | 59 | 0.573 |
| 45-64 years | 60 | 95 | 0.632<br>0.272-1.469 | 0 | 45 | 0.442<br>0.157-1.243 | 115 | 40 | 0.849<br>0.530-1.359 |
| Education | | | | | | | | | |
| <12 years | 80 | 92 | 0.258 | 6 | 56 | 0.001* | 140 | 2 | 0.001* |
| >12 years | 49 | 37 | 0.543<br>0.225-1.309 | 0 | 86 | 0.907<br>0.865-0.951 | 119 | 67 | 2.463<br>1.514-4.001 |
| Occupation | | | | | | | | | |
| Working | 63 | 02 | 0.525 | 9 | 86 | 0.564 | 28 | 35 | 0.185 |
| Not working | 66 | 27 | 0.685<br>0.286-1.641 | | 56 | 0.652<br>0.237-1.792 | 30 | 62 | 0.605<br>0.312-1.171 |
| Status in the family | | | | | | | | | |
| Parent | 1 | 98 | 0.764 | 4 | 284 | 0.901 | 210 | 88 | 0.107 |
| Child | 29 | 31 | 0.881<br>0.271-2.8861 | 2 | 58 | 1.430<br>0.316-6.460 | 49 | 1 | 0.536<br>0.266-1.078 |
| Monthly income | | | | | | | | | |
| < Rp. 1.000.000 | 63 | 99 | 1.000 | 2 | 50 | 0.029* | 127 | 5 | 0.409 |
| > Rp. 1.000.000 | 66 | 96 | 1.061<br>0.439-2.563 | 4 | 92 | 3.840<br>1.214-12.146 | 132 | 64 | 0.798<br>0.499-1.276 |
| Medical history | | | | | | | | | |
| None | 68 | 91 | 0.41* | 5 | 94 | 0.081 | 140 | 59 | 0.717 |
| Existing | 61 | 38 | 2.057<br>1.074-5.851 | 1 | 48 | 0.347<br>0.118-1.020 | 119 | 40 | 1.198<br>0.615-2.332 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Frequency of visits to health facilities | | | | | | | | | |
| 1-2 times | 86 | 57 | 0.684 | 8 | 235 | 0.196 | 172 | 71 | 0.403 |
| >3 times | 43 | 72 | 0.762 | 8 | 07 | 0.455 | 87 | 28 | 0.780 |
| | | | 0.326-1.782 | | | 0.166-1.245 | | | 0.469-1.295 |

Analysis using Spearman's correlation (Table 5) revealed a significant positive association between knowledge and attitude ($\rho = 0.147$, $p = 0.005$), knowledge and practice ($\rho = 0.308$, $p = 0.001$) as well as between attitude and practice ($\rho = 0.104$, $p = 0.050$). While the correlation strength was weak, these findings suggest a direct positive association between knowledge/attitudes and disposal practices: better knowledge and attitudes predict improved disposal practices modestly. Because of the small correlation magnitude, other barriers are likely limiting awareness translation towards observable behavior, including such barriers external to the study as lack of disposal infrastructure and minimal pharmacist engagement.

**Table 5.** Relationship between KAP about Unused Drug Management

| Independent variable | Dependent variable | ρ -*value* | Correlation Coefficient *(Rho)* |
|---|---|---|---|
| Knowledge | Attitude | 0.005 | 0.147 |
| Knowledge | Practice | 0.001 | 0.308 |
| Attitude | Practice | 0.050 | 0.104 |

Both knowledge and practice aspects were additionally verified by multivariate logistic regression (shown in Table 5); education level was identified as the most robust predictor with participants who attained higher education level being around 2.5 times more likely to present appropriate behavior. This highlights the important role of educational interventions in drug social management and environmental stewardship.

**Table 6.** Multivariate Test Results of Characteristic Associations with Variables

| **Variable** | **B** | **S.E.** | **Wald** | **df** | **Sig.** | **Exp(B)** | **95% CI for Exp(B)** |
|---|---|---|---|---|---|---|---|
| **A. Knowledge** | | | | | | | |
| Education | 0.882 | 0.231 | 14.552 | 1 | 0.000 | 2.416 | 1.535– 3.801 |
| Role | -0.793 | 0.300 | 6.993 | 1 | 0.008 | 0.453 | 0.252– 0.815 |
| Medical history | -0.524 | 0.232 | 5.086 | 1 | 0.024 | 0.592 | 0.376– 0.934 |
| Constant | 0.961 | 0.633 | 2.309 | 1 | 0.129 | 2.614 | - |
| **B. Attitude** | | | | | | | |
| Education | 18.708 | 2925.876 | 0.000 | 1 | 0.995 | 1,677 | 0.000 – |
| Income | 0.736 | 0.600 | 1.504 | 1 | 0.220 | 2.087 | 0.644– 6.763 |
| Constant | - 17.407 | 2925.876 | 0.000 | 1 | 0.995 | 0.000 | - |
| **C. Practice** | | | | | | | |
| Education | 0.901 | 0.248 | 13.167 | 1 | 0.000 | 2.463 | 1.514– 4.008 |
| Constant | -2.377 | 0.421 | 31.950 | 1 | 0.000 | 0.093 | - |

## DISCUSSION

### Key Findings of the Study

Unlike prior Indonesian studies focusing more on prevalence and correlation trends, through multivariate analysis conducted to assess whether socio-demographic predictors found are really correlated with waste disposal pattern this will certainly add another empirical value to the existing literature. This method allows for a more accurate identification of modifiable factors pertinent to targeted health promotion interventions in primary care.

The objective of this study was to evaluate the knowledge, attitudes and practices (KAP) of the public regarding management of unused drugs in three primary health care centers in the Special Region Yogyakarta province, Indonesia. Majority of participants had good knowledge, and positive attitude towards safe drug handling but their practices were sub-optimal. Both things are very slow to change with people, there's this lag between

knowing and doing, right? And I think that has always been one of the enduring fulkies if you look at a community health promotion kind of settings, you know so much but yet you just struggle to do more.

Many said they stored unused medication at home as their health conditions improved or they received too much medication. This trend was in conformity with previous studies in Indonesia (26) and Ethiopia (27), which found that the general population kept leftover medicines for self-medication or future use. This behavior is reflective of cultural tendencies around "saving drugs" and limited access to disposal sites. In addition, more than 60% participants also discarded unused drugs by disposing them into household rubbish, similar finding was reported in previous community-based studies conducted in Malaysia and United Arab Emirates (15,20). These practices represent a significant environmental challenge as pharmaceutical residues may leach into the soil and infiltrate groundwater, increasing global ecological toxicity and promoting antibiotic resistance.

The upwards of 90 percent of the participants that were aware of safe storage methods, such as storing drugs in dry places and consuming them before their expiry dates, date points to an encouraging understanding among members of the public. But there was limited understanding of the things that should be done to dispose of them properly, particularly liquid and topical formulations. Such incomplete knowledge leads to the perpetuation of improper behaviours. From the perspective of behavioral theory, knowledge is the basis in practice, but by itself it does not lead to behavior change without enabling structures, social support and reinforcement (28). As a result, these discrepancies between knowledge and behavior opportunities in the present study are likely due to limited access to return programs and insufficient community-based education.

**Determinants of Knowledge and Practice**

The association between the components of education and KAP results found in our study corroborated those from countries around the world. Those with higher educational attainment had greater odds ratio of showing adequate knowledge and appropriate disposal behaviors. Education improves people's ability to process the health information, evaluate risks, and take appropriate actions(29). Also, the positive attitudes were more frequent among individuals with higher positions, which can be justified by a better access to information means and health promotion. However, participants who did not have any chronic illness had a higher knowledge score than those with existing medical illnesses. This trend may signal cognitive fatigue or complacency among patients accustomed to regularly taking medications, who do not see the potential harms associated with failure to properly dispose of drugs. It also highlights that being exposed to drugs long term does not equate with safer approaches in handling them. Pramestutie et al. reported similar results (30), in East Java in 2021, where socio economic and educational factors, rather than disease status were stronger predictors of safe drug management.

On the other hand, gender, occupation and age could not contribute significantly to the differences in KAP levels which indicates that regardless of demographics, people do not know what to do with unused drugs or they simply throw it away. This universal finding suggests that interventions need to be applied at the population level rather than for specific subpopulations. But the underrepresentation of male respondents highlights that when it comes to drug management within households, women and housewives in particular also play a role. Hence, advocating for women in the community through better education can help provide health promotion at the community level. Moreover, despite the positive correlations between KAP components being weak statistically, they do indicate a directional relationship, namely that better understanding and a more favourable attitude modestly increase behaviour. Structural barriers such as limited pharmacist engagement, take-back schemes absence and limited outreach to the community could generate weak correlations. This will promote sustainable behaviour change; addressing these systemic barriers requires multi level approaches.

**Strengths and Limitations of the Study**

Such information further contributes to new evidence on community practices regarding the disposal of unused drugs in Indonesia a theme still neglected throughout Southeast Asia. The involvement of a number of accredited primary health care centers allows the study to include a wide diversity in its population, therefore providing an appropriate framework for developing localized health promotion programs. Using a legitimate and reliable tool enhances the validity of findings and different statistical analyses give out detailed information about KAP WASH influencing factors. But there are significant caveats that should be acknowledged. Due to its cross-

sectional nature, no causal inference of the variables explored can be made, and self-reported data may also suffer from social desirability bias as participants may tend to over-report the "good practices." Moreover, this study was only conducted in 3 health care centers located in the Special Region of Yogyakarta and may not fully represent different areas with difference cultural or economic background. Despite these limitations, the study provides useful baseline data that can guide targeted interventions and tailor national policies for the management of pharmaceutical waste.

**Implications for Health Promotion**

The study's findings are significant for health development policy and practice. Community gateways the first level of primary healthcare centers can be as community gateways and these strategic platforms to provide educational interventions on the issue of safe drug management for consumers. Pharmacy based counseling has the potential to bridge the knowledge practice gap by bringing knowledge into practice, from a general understanding of what behavior must change (eg, quit smoking or lose weight) to a contextualized understanding of how that behavior changes in any given patient scenario. Pharmacists must also play an active role as health educators not only when it comes to how to store, separate and safely discard unused or expired drugs. More broadly, the findings back up WHO's features on community-based health intervention, focused around empowerment, participation and environmental continuity. Educational programs need participatory components, starting from merely relaying information (in person and through technology) to demonstrations, workshops within communities, and a social campaign engaging the public. Academic research from similar interventions in other countries has shown that hands-on educational programmes, alongside policy enforcement, significantly decrease sloppy disposal practices (31).

At the policy level, there is currently no national program in Indonesia that addresses drug take-back or household pharmaceutical waste collection in an integrated manner. Building this infrastructure, perhaps in partnership with the Ministry of Health, local governments and pharmacies, would furnish that environmental and behavioural nudge. Health promotion must therefore be positioned not as an individual responsibility, but also as a structural and policy driven endeavor. These results may help with wider public health and environmental sustainability agendas (which are also reflected in some of the Sustainable Development Goals), despite the current study only indirectly sought action on individual indicators at SDG level. In addition, the incorporation of environmental education into pharmacy and community health curricula would entrench responsible medicine disposal as a professional and civic responsibility. Digital media and mobile apps might also be part of future campaigns to expand awareness, especially because younger segments are more dependent than ever on Web-based health information.

## CONCLUSION

As a delivery of public knowledge, attitudes and practices towards unused drug management which would be the basis for health promotion development in the context of Indonesian primary healthcare. The findings of this study indicated that Attitudes were positive and knowledge was moderate, but the disposal practices were inadequate. Ormiston et al. also identified education and income as key factors influencing responsible behavior and emphasized the role of health literacy in improving practices in communities. The results suggest that continual education from pharmacists, availability at medicine return desks and better cooperation between sectors are needed. Future research should test the applicability of such targeted health promotion interventions to achieve sustainable pharmaceutical stewardship and environmental safety practices in different population groups.

## AUTHOR CONTRIBUTION STATEMENT

Conceptualization, methodology, project administration, supervision, and writing – original draft were performed by Woro Supadmi (WS). Devi Indri Alvian (DI) contributed to the investigation, validation, and writing – review and editing. Larasati Aprita Nanda Setyawan (LA) was responsible for data curation, formal analysis, and visualization. Della Friska Andani (DF) carried out the investigation, data collection, and field coordination. Githa Fungie Galistiani (GFG) provided resources and contributed to writing – review and editing. Muhammad Muhlis (MM) contributed to the literature review, data entry, and technical support. Finally, Muhammad Thesa Ghozali (MT) contributed to supervision, methodological guidance, and final review and editing.

## CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest related to this research project.

## DECLARATION OF GENERATIVE AI AND AI-ASSISTED TECHNOLOGIES IN THE WRITING PROCESS

During the preparation of this manuscript, the authors did not use any generative artificial intelligence (AI) tools (e.g., ChatGPT or other large language models) for content generation, drafting, or editing. However, AI-assisted technologies were employed solely to support the technical quality of the writing. Specifically, Grammarly was used for grammar and style correction, and DeepL was used for language refinement and translation support where necessary.

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## BIBLIOGRAPHY

1. Chattu VK, Singh B, Pattanshetty S, Reddy S. Access to medicines through global health diplomacy. Health Promot Perspect [Internet]. 2023 [cited 2025 Nov 5];13:40. https://doi.org/10.34172/HPP.2023.05.
2. Ling JY, Ng PY, Shamsuddin AS, Zulkifli A, Lee KE. Medication Disposal Patterns and Practices with Awareness of Environmental Contamination Caused by Pharmaceuticals among the General Public in Malaysia. Asian Pac J Cancer Prev [Internet]. 2024 [cited 2025 Nov 5];25:2723. https://doi.org/10.31557/APJCP.2024.25.8.2723
3. Freitas L de AA, Radis-Baptista G. Pharmaceutical pollution and disposal of expired, unused, and unwanted medicines in the Brazilian context. J Xenobiot [Internet]. 2021 [cited 2025 Nov 5];11:61–76. https://doi.org/10.3390/JOX11020005/S1.
4. Rogowska J, Zimmermann A. Household Pharmaceutical Waste Disposal as a Global Problem—A Review. Int J Environ Res Public Health [Internet]. 2022 [cited 2025 Nov 5];19:15798. https://doi.org/10.3390/IJERPH192315798.
5. Ghozali MT, Murni IW. Knowledge and Attitude among Community Pharmacists regarding Pharmacovigilance – A Cross Sectional Survey. Indonesian Journal of Pharmacy. 2023;34:686–694. https://doi.org/10.22146/IJP.5814.
6. Sinaga CR, Elvinda E, Annafiatuzakiah. Relationship Between Knowledge Level And Behavior Of Disposing Damaged And Expired Medicine In The Community Of Marga Mulia Village, Kutai Timur Regency. PHARMACON [Internet]. 2025 [cited 2025 Nov 5];14:937–953. https://doi.org/10.35799/PHA.14.2025.61319.
7. Alfian SD, Insani WN, Halimah E, Qonita NA, Jannah SS, Nuraliyah NM, Supadmi W, Gatera VA, Abdulah R. Lack of Awareness of the Impact of Improperly Disposed Of Medications and Associated Factors: A Cross-Sectional Survey in Indonesian Households. Front Pharmacol [Internet]. 2021 [cited 2025 Nov 5];12:630434. https://doi.org/10.3389/FPHAR.2021.630434/FULL.
8. Pramestutie HR, Hariadini AL, Ebtavanny TG, Illahi RK, Ilmi SN. Managing unused, damaged, and expired medications: Knowledge and attitudes among people of Malang, Indonesia. J Appl Pharm Sci [Internet]. 2021 [cited 2025 Nov 5];11,:102–109. https://doi.org/10.7324/JAPS.2021.110912.

9. Samal K, Mahapatra S, Hibzur Ali M. Pharmaceutical wastewater as Emerging Contaminants (EC): Treatment technologies, impact on environment and human health. Energy Nexus. 2022;6:100076. https://doi.org/10.1016/J.NEXUS.2022.100076.
10. Rahmadani MA, Kristina SA. A Scoping Review of Disposal of Unused Medicines in Take-Back Programs. Jurnal Manajemen dan Pelayanan Farmasi (Journal of Management and Pharmacy Practice) [Internet]. 2021 [cited 2025 Nov 5];11:73–90. https://doi.org/10.22146/JMPF.61343.
11. Insani WN, Qonita NA, Jannah SS, Nuraliyah NM, Supadmi W, Gatera VA, Alfian SD, Abdulah R. Improper disposal practice of unused and expired pharmaceutical products in Indonesian households. Heliyon [Internet]. 2020 [cited 2025 Nov 5];6. https://doi.org/10.1016/J.HELIYON.2020.E04551.
12. Rahayu AP, Rindarwati AY. Pengelolaan Obat yang Tidak Terpakai Dalam Skala Rumah Tangga di Kota Bandung. Majalah Farmaseutik [Internet]. 2021 [cited 2025 Nov 5];17:238–244. https://doi.org/10.22146/FARMASEUTIK.V17I2.64389.
13. Gidey MT, Birhanu AH, Tsadik AG, Welie AG, Assefa BT. Knowledge, Attitude, and Practice of Unused and Expired Medication Disposal among Patients Visiting Ayder Comprehensive Specialized Hospital. Biomed Res Int [Internet]. 2020 [cited 2025 Nov 5];2020:9538127. https://doi.org/10.1155/2020/9538127.
15. Al Dweik R, Ajaj R, Hafez W. Public awareness of medication disposal and its impact on environmental and public health: A cross-sectional study in the United Arab Emirates. Inform Med Unlocked. 2024;50:101580. https://doi.org/10.1016/J.IMU.2024.101580.
16. Rokayah, Puspitasari HP, Nita Y. Evaluation of rational drug use in primary healthcare centres of Probolinggo District, Indonesia. Pharmacy Education [Internet]. 2024 [cited 2025 Nov 5];24:401–405. https://doi.org/10.46542/PE.2024.243.401405.
17. Sari O, Anwar K, Putri I. Tingkat Pengetahuan Dalam Penyimpanan dan Pembuangan Obat di Rumah pada Masyarakat Kota Banjarbaru Kalimantan Selatan. Cendekia Journal of Pharmacy. 2021;5.
18. Friedemann ML, Buckwalter KC. Family Caregiver Role and Burden Related to Gender and Family Relationships. J Fam Nurs [Internet]. 2014 [cited 2025 Nov 5];20:313. https://doi.org/10.1177/1074840714532715.
19. Aisyah DN, Setiawan AH, Mayadewi CA, Lokopessy AF, Kozlakidis Z, Manikam L. Understanding Health Information Systems Utilization Across Public Health Centers in Indonesia: Cross-Sectional Study. JMIR Med Inform [Internet]. 2025 [cited 2025 Nov 5];13:e68613. https://doi.org/10.2196/68613.
20. Ong SC, Ooi GS, Shafie AA, Hassali MA. Knowledge, attitude and disposing practice of unused and expired medicines among the general public in Malaysia. Journal of Pharmaceutical Health Services Research [Internet]. 2020 [cited 2025 Nov 5];11:141–148. https://doi.org/10.1111/JPHS.12333.
21. Yohannes L, Tegegne AA, Genet G, Workie Limenh L, Mohammed Seid A, Alemayehu TT, Ayenew W, Simegn W. Disposal practice and determinants of unused medicines among the general public in Gondar City, Northwest Ethiopia. Front Public Health. 2025;13:1516809. https://doi.org/10.3389/FPUBH.2025.1516809/BIBTEX.
22. Ambianti N, Hardani R, Tandah MR, Putro H. Gambaran Pembuangan Obat yang Tidak Digunakan di Kalangan Masyarakat Kota Palu. PREPOTIF : Jurnal Kesehatan Masyarakat [Internet]. 2022 [cited 2025 Nov 6];6:925–932. https://doi.org/10.31004/PREPOTIF.V6I1.3700.
23. Rahimah, Melviani, Hateriah St. Pengelolaan Obat yang Tidak Terpakai Dalam Skala Rumah Tangga di Kecamatan Banjarmasin Timur. Health Research Journal of Indonesia [Internet]. 2022 [cited 2025 Nov 6];1:84–90. https://doi.org/10.63004/HRJI.V1I2.86.
24. Bashaar M, Thawani V, Hassali MA, Saleem F. Disposal practices of unused and expired pharmaceuticals among general public in Kabul. BMC Public Health [Internet]. 2017 [cited 2025 Nov 6];17:1–8. https://doi.org/10.1186/S12889-016-3975-Z/TABLES/4.
25. Jones CL, Jensen JD, Scherr CL, Brown NR, Christy K, Weaver J. The Health Belief Model as an Explanatory Framework in Communication Research: Exploring Parallel, Serial, and Moderated Mediation. Health Commun [Internet]. 2014 [cited 2025 Nov 7];30:566. https://doi.org/10.1080/10410236.2013.873363.

26. Savira M, Ramadhani FA, Nadhirah U, Lailis SR, Ramadhan EG, Febriani K, Patamani MY, Savitri DR, Awang MR, Hapsari MW, et al. Praktik Penyimpanan dan Pembuangan Obat dalam Keluarga. Jurnal Farmasi Komunitas [Internet]. 2020 [cited 2025 Nov 7];7:38–47. https://doi.org/10.20473/JFK.V7I2.21804.
27. Woldeyohanins AE, Adugna M, Mihret T, Kifle ZD. Knowledge, Attitude, and Practices of Unused Medications Disposal among Patients Visiting Public Health Centers in Gondar Town, Ethiopia: A Cross-Sectional Study. J Environ Public Health [Internet]. 2021 [cited 2025 Nov 7];2021:5074380. https://doi.org/10.1155/2021/5074380.
28. Matthews JA, Matthews S, Faries MD, Wolever RQ. Supporting Sustainable Health Behavior Change: The Whole is Greater Than the Sum of Its Parts. Mayo Clin Proc Innov Qual Outcomes [Internet]. 2024 [cited 2025 Nov 7];8:263. https://doi.org/10.1016/J.MAYOCPIQO.2023.10.002.
29. Alfian SD, Insani WN, Halimah E, Qonita NA, Jannah SS, Nuraliyah NM, Supadmi W, Gatera VA, Abdulah R. Lack of Awareness of the Impact of Improperly Disposed Of Medications and Associated Factors: A Cross-Sectional Survey in Indonesian Households. Front Pharmacol [Internet]. 2021 [cited 2025 Nov 7];12:630434. https://doi.org/10.3389/FPHAR.2021.630434/BIBTEX.
30. Pramestutie HR, lllahi RK, Hariadini AL, Ebtavanny TG, Aprilia TE. Faktor yang Berhubungan dengan Tingkat Pengetahuan Masyarakat dalam Mengelola Obat Sisa, Obat Rusak dan Obat Kedaluarsa. Jurnal Manajemen dan Pelayanan Farmasi (Journal of Management and Pharmacy Practice) [Internet]. 2021 [cited 2025 Nov 7];11:25–38. https://doi.org/10.22146/JMPF.58708.
31. Hiew SY, Low BY. The knowledge, attitude, and practice of the public regarding household pharmaceutical waste disposal: a systematic review (2013–2023). International Journal of Pharmacy Practice [Internet]. 2024 [cited 2025 Nov 7];32:120–132. https://doi.org/10.1093/IJPP/RIAE001.