

Knowledge and Handling Practices of Pharmacy Students on the Disposal of Used and Expired Reagents at MCNP-ISAP

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ABSTRACT

This study evaluated the knowledge and handling practices of pharmacy students at MCNP-ISAP regarding the disposal of used and expired reagents. A descriptive quantitative research design was employed, involving 150 pharmacy students selected through stratified sampling. Data were collected using a validated self-administered questionnaire and analyzed using descriptive and inferential statistics. Results showed that respondents demonstrated a very high level of knowledge (mean = 3.39) and a high level of handling practices (mean = 3.00) in chemical waste disposal. Students were highly aware of proper labeling, reporting procedures, and the risks associated with improper disposal. However, gaps were

observed in their familiarity with legal frameworks such as Republic Act 6969 and in the consistent application of waste segregation and standard disposal protocols. Inferential analysis revealed that year level significantly influenced both knowledge and handling practices, with higher-year students exhibiting better competence due to increased laboratory exposure. No significant differences were found when grouped according to age and gender. Despite generally positive findings, students reported challenges such as lack of proper disposal facilities, insufficient labeling of containers, unclear guidelines, and inconsistent adherence to laboratory protocols. The study concludes that while pharmacy students possess adequate knowledge and generally practice safe chemical disposal, improvements in institutional support are necessary. It is recommended that schools strengthen laboratory infrastructure, implement clear and standardized disposal guidelines, and provide continuous training and education on chemical waste management. These measures will enhance safety practices and promote environmental responsibility among future pharmacy professionals.

Keywords: *Hazardous chemical waste, waste segregation practices, pharmaceutical education, environmental safety, regulatory compliance*

INTRODUCTION

The disposal of used and expired chemicals and reagents has emerged as a growing concern in academic institutions in the Philippines, especially within college laboratories. Improper chemical waste management can lead to environmental hazards, accidental exposure, and long-term health consequences, marking it as a pressing issue that demands attention. In 2022, the Philippines generated 252,758.67 tons of hazardous waste, of which organic chemicals—such as laboratory reagents—contributed 203.95 tons

(0.1% of the total) (Philippine Statistics Authority, 2022). This underscores that even though chemical wastes may represent a small percentage, they still carry significant risk and regulatory importance within the broader hazardous waste stream. In educational settings, pharmacy students—who routinely handle a variety of chemicals—must be equipped with proper disposal knowledge to mitigate hazards both inside and outside the laboratory. Nonetheless, the lack of clear disposal guidelines within universities has been shown to contribute to student reliance on informal waste practices, which may include mixing reagents with regular laboratory trash or chemical disposal in common bins (Alghamdi et al., 2021). Such practices conflict with Philippine environmental regulations, particularly those under the Toxic Substances and Hazardous and Nuclear Wastes Control Act (RA 6969), which mandates that waste generators oversee the proper storage, treatment, and disposal of chemical wastes (DENR, 1990).

Moreover, chemical waste management in higher education is frequently constrained by limited formal training and low awareness of regulatory standards. In many cases, students rely on peer behavior or informal instructions—rather than official protocols—resulting in unsafe disposal of reagents. This informal approach is problematic, as institutional data reveals only 153 treatment, storage, and disposal (TSD) facilities are registered nationwide as of 2022, which may not suffice for efficient academic chemical waste processing (Philippine Statistics Authority, 2022). These infrastructure limitations highlight the urgent need for continuous monitoring, evaluation, and capacity-building initiatives within academic settings to safeguard laboratory and environmental safety.

The variation in pharmacy students' knowledge and laboratory chemical handling practices may also be influenced by factors such as academic year level, age, and gender. Students with greater exposure to lab work—typically upper-year students—often demonstrate better understanding of safety protocols compared to their lower-year counterparts. Understanding these differences is vital: targeted interventions, when adjusted for learner profiles, are more effective (Mendoza & Castillo, 2021). Addressing these educational disparities ensures that all students—not just those in advanced years—develop the competence necessary for safe chemical and reagent disposal. Despite this, gaps remain evident in our own school setting. Many students, particularly in the lower years, exhibit confusion about the proper segregation of chemical waste, while some even admit to disposing of used reagents with regular trash due to lack of clear instruction. As a teacher, the researcher has also observed instances where expired chemicals remained stored in the laboratory because no standard protocol for their disposal was strictly enforced. These experiences highlight the pressing need to strengthen awareness and improve laboratory practices so that chemical waste is managed both safely and responsibly.

Recognizing all these gaps, this study aims to assess the awareness and practices of pharmacy students in relation to the disposal of used and expired chemicals and reagents in a Philippine college laboratory setting. Specifically, it will evaluate students' levels of awareness, assess the safety of their current disposal practices, and determine the challenges they face in managing laboratory chemical waste. The study will also examine whether significant differences exist across demographic and academic variables. Ultimately, the findings are intended to inform the development of a targeted action plan to enhance students' chemical disposal knowledge and practices—contributing to safer academic laboratories and fostering environmental responsibility in their growing professional careers.

LITERATURE REVIEW

According to Creswell (2014), the Review of Related Literature and Studies provide a comprehensive summary of existing theories and research relevant to the study. It helps identify gaps in knowledge, supports the research framework, and guides the direction of the current investigation. The safe disposal of chemicals and reagents has emerged as an increasingly important issue in both academic and professional contexts. While chemical waste is an inevitable byproduct of laboratory work, improper handling and disposal practices create risks for human health, environmental safety, and institutional

compliance. A review of global and local studies reveals recurring gaps in awareness, practices, and infrastructure, underscoring the urgent need for structured guidelines, institutional support, and targeted interventions.

Chemical Waste Management in Academic Institutions

Alhomoud et al. (2021) revealed that even though students in Saudi Arabia were aware of the importance of safe chemical storage, improper disposal methods such as discarding chemicals in sinks or trash bins remained common. Similarly, Bashatah and Wajid (2020) emphasized that the absence of formalized waste management systems forced students to dispose of reagents inappropriately, increasing risks of contamination. In the Philippines, Gatmaitan et al. (2022) reported that students continued to discard chemical waste in ordinary garbage bins due to limited access to proper disposal facilities. In addition, Shuleta-Qehaja and Kelmendi (2022) found that in Kosovo, a lack of infrastructure pushed students toward unsafe disposal practices despite their awareness of risks. Likewise, Kampamba et al. (2024) highlighted a similar challenge in Zambia, where 92.7% of participants reported having no access to chemical take-back programs, making unsafe disposal methods widespread. Both studies stressed the need for institutional investment in chemical waste infrastructure to ensure sustainability and safety in academic laboratories. Furthermore, Almeida et al. (2023) examined the implementation of a Chemical Waste Management Program (CWMP) at the Federal University of Lavras, Brazil. They found that after establishing a dedicated chemical waste management laboratory and conducting training courses, the number of reagents recovered and properly treated increased by 400% over ten years. This case demonstrated that institutional commitment and structured programs could substantially improve waste handling in university settings.

Similarly, Omer et al. (2024) assessed laboratory safety practices, chemical inventory management, and waste disposal procedures in university laboratories and revealed significant gaps in recordkeeping and compliance with standardized waste protocols. Their findings emphasized that even institutions with robust infrastructure still struggled with consistent practice enforcement and internal audit systems, underscoring the importance of administrative oversight. In the same vein, Twumasi Kwarteng et al. (2023) investigated chemistry students' knowledge and practices of chemical waste management in Ghana and reported that, while students generally held good theoretical knowledge, their actual practices were poor. Statistical tests showed a weak positive correlation between knowledge and practice ($r = 0.415$), highlighting the persistent "knowledge–practice gap" observed in many academic laboratories. Moreover, Goh et al. (2019) focused on reducing chemical waste generation in teaching laboratories by applying strategies such as micro-scale experiments, reagent reuse, and waste minimization protocols. Their intervention-based approach resulted in a measurable decline in waste production, pointing to preventive measures as an effective complement to disposal systems.

Finally, Giurea et al. (2024) conducted a systematic review of sustainable waste management systems in universities and advocated for integrating circular economy principles—including reuse, recycling, and resource recovery—into campus chemical waste frameworks. Their analysis suggested that combining infrastructure development, policy enforcement, and educational interventions produced more sustainable and long-term outcomes than isolated efforts. Shuleta-Qehaja and Kelmendi (2022) found that in Kosovo, a lack of infrastructure pushed students toward unsafe disposal practices despite their awareness of risks. Kampamba et al. (2024) highlighted a similar challenge in Zambia, where 92.7% of participants reported having no access to chemical take-back programs, making unsafe disposal methods widespread. Both studies stress the need for institutional investment in chemical waste infrastructure to ensure sustainability and safety in academic laboratories

Students' Knowledge on Chemical Safety and Waste Disposal

Shakib et al. (2022) compared disposal practices between science and non-science students in Bangladesh, showing that while science students displayed slightly better awareness, both groups frequently used unsafe methods. Chinnakandukuru et al. (2024) echoed these findings in India, reporting that students often discarded chemicals in household bins or flushed them due to insufficient guidance. Salime et al. (2024) further revealed that many students in Malaysia and Brunei lacked formal knowledge of disposal protocols, often keeping expired chemicals at home. These findings consistently show that awareness without structured training does not translate to safe laboratory practices.

Handling Practices in Laboratory Settings

Jankie et al. (2022) demonstrated that even licensed pharmacists in Trinidad failed to consistently follow disposal procedures, often discarding chemicals with regular workplace trash. This highlights the persistence of unsafe practices beyond student populations, pointing to gaps in professional accountability. International studies emphasize that institutions must enforce best practices such as providing designated disposal bins, clearly labeled containers, and trained staff for chemical collection. Shuleta-Qehaja and Kelmendi (2022) and Kampamba et al. (2024) both recommended structured curriculum enhancement combined with institution-wide systems for waste segregation and storage. These measures align with global recommendations for sustainable laboratory waste management, ensuring that students and professionals alike are better equipped to handle hazardous reagents safely.

The reviewed studies consistently reveal that while students across different countries—such as Saudi Arabia (Alhomoud et al., 2021), Bangladesh (Shakib et al., 2022), and the Philippines (Gatmaitan et al., 2022)—possess some level of awareness regarding chemical safety, their actual disposal practices often remain unsafe due to inadequate institutional systems and facilities. Similar patterns were observed in India (Chinnakandukuru et al., 2024) and Malaysia and Brunei (Salime et al., 2024), where misconceptions and the absence of disposal infrastructure hindered the translation of knowledge into practice. In contrast, studies involving professionals, such as in Trinidad (Jankie et al., 2022), showed that unsafe disposal persists even among licensed practitioners, underscoring that the problem extends beyond the academic setting. Although the specific contexts vary, a common theme emerges: without structured guidelines, proper facilities, and continuous education, both students and professionals are prone to unsafe chemical waste management.

Conceptual Framework

A conceptual framework serves as the foundation that links the study's variables, theories, and concepts, showing how they interact to address the research problem. It visually and descriptively illustrates the logical relationship between independent and dependent variables based on existing literature, theories, and empirical evidence. Essentially, it guides the direction of the study by providing a structured understanding of what is being investigated and how the key elements are expected to relate. Proper chemical waste management in academic laboratories followed national regulations that promoted safety, environmental protection, and legal compliance. Under Republic Act No. 6969, or the Toxic Substances and Hazardous and Nuclear Wastes Control Act of 1990, and its Implementing Rules and Regulations under DENR Administrative Order No. 29, Series of 1992, institutions were required to handle, store, transport, and dispose of hazardous wastes properly. These provisions mandated waste segregation at the source, clear labeling of chemical containers, and coordination with accredited treatment or disposal facilities to prevent contamination and ensure accountability of waste generators. To operationalize these standards, many laboratories implemented internal safety protocols—such as color-coded waste segregation systems (e.g., assigning distinct containers for acids, bases, and other hazardous compounds)—which, although not explicitly mandated by law, aligned with the intent of the IRR to prevent cross-contamination, reduce exposure risks, and promote safer disposal practices.

In academic laboratories, the proper disposal of used and expired reagents is shaped not only by student knowledge and handling practices but also by institutional and legal frameworks that regulate hazardous waste. This study is grounded on the idea that pharmacy students' demographic profile—such as age, gender, and academic year level—may influence both their awareness of chemical safety and their actual disposal behavior. Students with greater exposure to laboratory activities are expected to comply more consistently with safety standards compared to those with limited experience.

This framework was also guided by national policies and regulations. Republic Act 6969, or the Toxic Substances and Hazardous and Nuclear Wastes Control Act of 1990, and its Implementing Rules and Regulations (DAO 29, s. 1992) established the responsibility of chemical waste generators, including schools, to ensure the safe handling, storage, and disposal of hazardous substances. The Department of Health (DOH) Health Care Waste Management Manual, Fourth Edition (2020), further outlined protocols for segregation, collection, storage, treatment, and disposal of chemical and hazardous waste in laboratories and health facilities. Additionally, the Code on Sanitation of the Philippines (PD 856, Chapter XVIII on Refuse Disposal) emphasized that chemical and hazardous wastes had to be managed according to prescribed safety and environmental standards. These guidelines provided a regulatory backdrop that highlighted both the duty of institutions to establish proper systems and the need for students to follow safe practices.

By integrating student-related factors with institutional and legal frameworks, the conceptual model assumed that knowledge and practice were interdependent: awareness without application resulted in unsafe behavior, while practices unsupported by proper guidance led to inconsistent compliance. Assessing these dimensions made it possible to identify critical gaps that hindered safe chemical disposal. The framework therefore illustrated the relationship between students' demographic profiles, their knowledge, and their handling practices within the context of regulatory expectations. Ultimately, this study aimed to use these insights to propose an action plan that promoted safer academic laboratories and strengthened environmental responsibility among future pharmacy professionals.

Paradigm of the Study

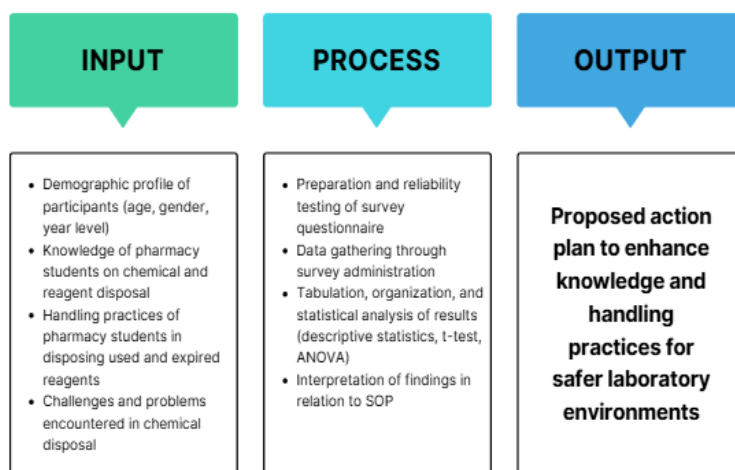


Figure 1. *Paradigm of the Study*

A research paradigm is a fundamental structure or worldview that guides how the study was designed, conducted, and interpreted. It reflected the researchers' assumptions about reality, knowledge, and methods of inquiry, providing a coherent framework that connected the study's objectives, variables, and analytical processes. By defining the overall direction of the investigation, the research paradigm

ensured that each stage—from data collection to interpretation—remained aligned with the study’s theoretical and methodological foundations.

The research paradigm served as the blueprint for how the study was conceptualized, organized, and carried out. It followed the Input–Process–Output (IPO) model, which demonstrated the logical flow of variables and procedures used in the investigation. This paradigm illustrated how the demographic and academic characteristics of pharmacy students, together with their knowledge and practices on chemical disposal, were examined through systematic processes to produce meaningful outcomes.

As shown in Figure 1, the Input included the demographic profile of participants (age, gender, and year level), their knowledge of chemical and reagent disposal, their actual handling practices, and the challenges they encountered in chemical waste management. The Process covered the major steps of the research, including the preparation and validation of the survey questionnaire, the administration of data gathering, and the subsequent organization and statistical analysis of results using descriptive and inferential tests (t-test and ANOVA). Interpretation of these findings was then aligned with existing standards of practice for laboratory safety. The Output was the development of a proposed action plan designed to enhance students’ knowledge and handling practices for safer laboratory environments. In summary, the IPO model reflected the study’s structured approach: it identified the students’ profiles and practices as inputs, subjected them to systematic research procedures, and translated the results into a practical and actionable output that aimed to improve both laboratory safety and environmental responsibility.

This study assessed students’ knowledge and handling practices regarding the disposal of used and expired chemicals. It described the participants’ profile and determined their level of knowledge and handling practices. The study also examined differences based on profile variables, identified challenges encountered, and proposed an action plan to enhance students’ knowledge and proper chemical disposal practices.

METHODS

Research Design

This study employed a descriptive quantitative research design to examine pharmacy students’ knowledge and handling practices in disposing of used and expired chemicals. Data were collected using a structured survey questionnaire and analyzed statistically to assess awareness levels, evaluate safety practices, and determine differences based on profile variables such as age, gender, and year level. This design enabled a systematic and objective assessment of existing practices under natural conditions.

Participants of the Study

The participants of the study were pharmacy students enrolled in the Bachelor of Science in Pharmacy program for Academic Year 2024–2025. A stratified sampling method was used to ensure proportional representation across year levels, with inclusion limited to students who had completed at least one laboratory course involving chemicals. Students without laboratory experience or on leave were excluded. The sample size was determined using Slovin’s formula with a 5% margin of error. Participation was voluntary, and informed consent was obtained prior to data collection.

Instrumentation

A researcher-developed, self-administered survey questionnaire was used as the primary data collection instrument. It was validated by experts in pharmacy, chemistry, and research methodology and pilot-tested among 20 non-participants, yielding acceptable reliability (Cronbach’s $\alpha \geq 0.70$). The instrument consisted of four parts: demographic profile; level of knowledge on chemical disposal; level of handling practices; and challenges encountered through open-ended responses. Likert scales were used to

measure knowledge and practices, while qualitative responses provided additional insights, enabling a comprehensive assessment of students' competencies and challenges in chemical waste management.

Data Gathering Procedure

Data collection followed a systematic and ethical process, including securing ethics clearance and administrative approval, identifying eligible participants, and obtaining informed consent. Questionnaires were administered in printed form during scheduled sessions, with uniform instructions provided to ensure consistency. Completed surveys were collected immediately, checked for completeness, and stored securely. Data were then encoded, verified, and organized for statistical analysis, ensuring accuracy, confidentiality, and reliability of the results.

Data Analysis Tools

Data were analyzed using both descriptive and inferential statistics. Frequency, percentage, mean, and standard deviation were used to summarize respondents' profiles and levels of knowledge and practices. Inferential tests, including independent samples t-test and one-way ANOVA, were applied to determine significant differences among groups at a 0.05 level of significance. All analyses were conducted using SPSS or equivalent software.

RESULTS AND DISCUSSION

Part I. Demographic Profile of Respondents

Table 1. *Demographic Profile of Respondents in terms of Age*

Age	Frequency	Percentage
17	7	4.67%
18	30	20.00%
19	25	16.67%
20	41	27.33%
21	26	17.33%
22	7	4.67%
23	13	8.67%
35	1	0.67%
Total	150	100.00%

The data in Table 1 show that most respondents were between 18 and 21 years old, indicating that the participants were typical college-aged students who were actively engaged in their academic coursework. The largest group was 20-year-olds (27.33%), followed by those aged 18 (20.00%), 21 (17.33%), and 19 (16.67%), suggesting that the sample was composed primarily of students in the mid-years of their pharmacy program. Smaller proportions of respondents were 17 years old (4.67%), 22 years old (4.67%), 23 years old (8.67%), and a single respondent aged 35 (0.67%), reflecting minimal representation from older or nontraditional learners. Overall, the age distribution confirms that the study population largely represented young adult pharmacy students in the usual college age bracket, making them an appropriate group for assessing knowledge and practices on chemical waste management.

Table 2. *Demographic Profile of Respondents in terms of Gender*

Gender	Frequency	Percentage
Male	18	12.00%
Female	132	88.00%
Total	150	100.00%

Table 2 reveals that the majority of the respondents were female (88.00%), while only 12.00% were male. This indicates a significant gender imbalance among the participants, reflecting the general trend of higher female enrollment in pharmacy programs in the Philippines. The predominance of female respondents suggests that women constituted the larger proportion of students actively engaged in laboratory activities where chemical waste management practices are applied. Despite the smaller male representation, both genders contributed valuable insights to the study, helping to capture a comprehensive understanding of students' knowledge and handling practices regarding chemical waste disposal.

Table 3. *Demographic Profile of Respondents in terms of Year Level*

Year Level	Frequency	Percentage
1st	44	29.33%
2nd	69	46.00%
3rd	30	20.00%
4th	7	4.67%
Total	150	100.00%

Table 3 shows that the largest group of respondents were second-year students (46.00%), followed by first-year students (29.33%), third-year students (20.00%), and a small portion of fourth-year students (4.67%). This distribution suggests that the majority of participants were in the early to mid-stages of their pharmacy education, where laboratory subjects are commonly taken and foundational knowledge of chemical handling and safety is developed. The relatively lower participation of fourth-year students may be due to their focus on internships or thesis requirements, which limit their exposure to routine laboratory work. Overall, the data indicate that most respondents had sufficient academic and practical experience to provide relevant insights into proper chemical waste disposal practices within academic laboratories.

Part II. Level of Knowledge on Disposal of Used and Expired Reagents

Statements	Weighted Mean	Verbal Interpretation
I am aware that expired reagents should not be disposed of in regular trash bins.	3.42	High
I know that mixing chemical waste with common garbage is harmful to the environment.	3.44	High
I am familiar with Republic Act 6969 (Toxic Substances and Hazardous and Nuclear Wastes Control Act).	2.40	Moderately Low
I know that reagents should be labeled properly before disposal.	3.75	Very High

I understand that expired reagents must be segregated according to chemical type (e.g., acids, bases, organics).	2.99	High
I know where the designated disposal or storage area for chemical waste is located in our laboratory.	3.12	High
I am aware that improper disposal of reagents can cause accidents and long-term health effects.	3.45	High
I know that expired or unused reagents must be reported to the laboratory instructor or safety officer.	3.62	Very High
I have been taught the standard operating procedures for disposing of laboratory chemical waste.	3.15	High
I know that chemical waste management is both a student and institutional responsibility.	3.55	Very High
Overall Weighted Mean	3.39	Very High

The results in Table 4 reveal that the respondents possessed a very high overall level of knowledge regarding the disposal of used and expired reagents, with an overall weighted mean of 3.39. This indicates that pharmacy students were generally aware of proper waste management principles and recognized the importance of safety and environmental protection in laboratory settings. The highest-rated indicators were related to labeling reagents before disposal (3.75), reporting expired chemicals to instructors (3.62), and recognizing shared responsibility between students and institutions (3.55)—all interpreted as Very High. Meanwhile, familiarity with Republic Act 6969 obtained the lowest mean (2.40), suggesting a gap in students' awareness of the specific legal frameworks governing hazardous waste management.

This finding aligns with the study of Gatmaitan et al. (2022), which found that students in Philippine universities demonstrated good awareness of proper laboratory waste disposal practices but limited familiarity with environmental laws. Similarly, Kampamba et al. (2024) reported that while students understood the general risks of improper disposal, their knowledge of regulatory compliance and technical guidelines remained incomplete. The current results thus reflect a broader trend in developing countries, where institutional training effectively promotes safe laboratory habits but often lacks emphasis on the legal and policy aspects of waste management.

The results imply that pharmacy students have a solid foundation in the practical aspects of chemical waste handling, but there is a need to strengthen their understanding of the regulatory and procedural dimensions of hazardous waste management. Integrating topics related to Republic Act 6969 and its implementing rules into laboratory orientation or environmental health courses could help bridge this knowledge gap. By reinforcing both theoretical and regulatory awareness, academic institutions can ensure that students not only perform safe disposal practices but also appreciate their legal and ethical responsibilities in promoting sustainable and compliant laboratory operations.

Part III. Level of Handling Practices on Disposal of Used and Expired Reagents

Statements	Weighted Mean	Verbal Interpretation
Chemical waste is categorized based on type (e.g., organic, inorganic, acidic, basic).	2.59	Moderately Low
Chemical containers are labeled clearly before disposal.	3.04	High
Used and expired reagents are placed in designated waste containers.	2.73	High
Expired or leftover chemicals are reported to the instructor in charge.	3.46	High
Personal Protective Equipment (PPE) is worn when	3.09	High

handling used or expired reagents.		
Laboratory guidelines or protocols for chemical disposal are followed.	2.63	Moderately Low
Chemicals are not poured down the sink or placed in regular trash bins.	2.73	High
Guidance is sought from the Instructor or Laboratory Technician when unsure about disposal methods.	3.50	Very High
Participation in discussions or training on laboratory waste management is encouraged.	3.24	High
Reagent disposal is managed responsibly, even without supervision.	3.01	High
Overall Weighted Mean	3.00	High

The findings in Table 5 indicate that the respondents exhibited a high overall level of handling practices on the disposal of used and expired reagents, with an overall weighted mean of 3.00. This suggests that pharmacy students generally practiced appropriate procedures when dealing with laboratory chemicals. The highest-rated indicators included seeking guidance from instructors when unsure about disposal methods (3.50), reporting expired or leftover chemicals to the instructor in charge (3.46), and participating in discussions or training on waste management (3.24), all of which were rated High to Very High. However, the relatively lower means for categorizing chemical waste by type (2.59) and following formal disposal protocols (2.63) suggest that consistency in adherence to standard procedures still needs improvement.

These results support the findings of Alhomoud et al. (2021), who reported that students often demonstrate good intentions and awareness in handling chemicals but fail to consistently implement waste segregation and disposal protocols. Similarly, Twumasi Kwarteng et al. (2023) found that while chemistry students in Ghana showed satisfactory knowledge of chemical waste management, actual practices—particularly in segregation and compliance with laboratory guidelines—remained uneven. The present study aligns with these observations, highlighting the persistent gap between knowledge and practice, especially in the procedural aspects of chemical waste handling.

The implication of these findings is that while pharmacy students possess responsible attitudes toward laboratory safety, there is a need for continuous training and reinforcement of standardized disposal procedures. Institutions should ensure that students are not only aware of proper practices but are also provided with adequate infrastructure, labeled containers, and supervision to apply them correctly. Incorporating regular laboratory safety drills, visual reminders, and mandatory waste management orientations can help translate theoretical understanding into consistent, compliant behavior—ultimately fostering a safer and more environmentally responsible academic laboratory culture.

Table 6. *Significant Difference in Participants' Level of Knowledge on the Disposal of Used and Expired Chemicals When Grouped According to Profile Variables*

Profile Variable	F-value	p-value	Interpretation	Decision on Ho
Age	1.782	0.116	Not Significant	Fail to Reject
Gender	0.924	0.338	Not Significant	Fail to Reject
Year Level	4.327	0.006	Significant	Reject Ho

The results show that only the year level of participants yielded a statistically significant difference ($F = 4.327$, $p = 0.006$) in their level of knowledge on chemical waste disposal. This finding indicates that as students advance through the pharmacy program, their awareness and understanding of chemical waste

management improve substantially. Senior students, particularly those in higher year levels, are exposed to more laboratory courses, research projects, and safety orientations that emphasize proper chemical handling and disposal. In contrast, the variables age ($F = 1.782$, $p = 0.116$) and gender ($F = 0.924$, $p = 0.338$) did not exhibit significant effects on knowledge levels, suggesting that these demographic factors do not strongly influence familiarity with chemical disposal protocols. This outcome supports the study of Twumasi Kwarteng et al. (2023), who found that students' comprehension of waste management procedures depended more on their academic exposure than on demographic attributes. Similarly, Almeida et al. (2023) emphasized that continuous laboratory engagement enhances students' technical knowledge of waste categorization, segregation, and labeling procedures.

Table 7. *Significant Difference in Participants' Level of Handling Practices on the Disposal of Used and Expired Chemicals When Grouped According to Profile Variables*

Profile Variable	F-value	p-value	Interpretation	Decision on H_0
Age	1.245	0.294	Not Significant	Fail to Reject
Gender	0.576	0.449	Not Significant	Fail to Reject
Year Level	3.918	0.010	Significant	Reject H_0

Table 7 reveals that there was a significant difference in handling practices when respondents were grouped according to year level ($F = 3.918$, $p = 0.010$), while age ($F = 1.245$, $p = 0.294$) and gender ($F = 0.576$, $p = 0.449$) did not show significant variations. This means that higher-year students demonstrated more consistent and responsible laboratory practices, such as proper segregation, labeling, and reporting of chemical waste. This finding may be attributed to the progressive acquisition of laboratory experience and greater accountability expected from students in advanced coursework. These results align with the research of Alhomoud et al. (2021) and Kampamba et al. (2024), both of which reported that exposure to structured laboratory safety programs significantly improves students' compliance with disposal protocols. The observed improvement in handling practices among upper-year students also reflects the positive impact of repeated laboratory training and instructor supervision, which help translate theoretical knowledge into practical behavior.

Part III. Problems and Challenges Encountered by the Participants in Handling Used and Expired Chemicals

The results revealed several problems and challenges encountered by the participants in handling used and expired chemicals within their academic laboratories. The most frequently cited issues involved the lack of proper waste disposal facilities, such as limited or non-labeled chemical jars and trash bins, and the absence of systematic segregation for acids, bases, and other reagents. Many students expressed confusion about where to properly dispose of used chemicals due to inadequate labeling, unclear instructions, and insufficient guidance from laboratory personnel. Others noted that some peers failed to follow established safety protocols, often disposing of chemicals in regular trash bins or sinks. Additionally, the mixing of expired reagents with usable ones and improper segregation of chemical waste were identified as common laboratory problems that could compromise both safety and environmental compliance. These findings are consistent with the study of Alhomoud et al. (2021), which reported that poor waste segregation and labeling in university laboratories led to frequent safety risks and contamination incidents. Similarly, Gatmaitan et al. (2022) emphasized that students in Philippine institutions often lacked sufficient training and access to disposal facilities, resulting in inconsistent adherence to waste management guidelines. Shuleta-Qehaja and Kelmendi (2022) further explained that the absence of infrastructure and institutional supervision contributes to unsafe disposal behaviors, even among students who understand the hazards.

Collectively, these studies affirm that both material deficiencies and procedural gaps significantly influence students' ability to dispose of laboratory chemicals properly. The implications of these findings highlight the urgent need for institutional intervention and capacity building in chemical waste management within academic settings. Schools should establish standardized and clearly labeled waste disposal systems, ensure the availability of sufficient containers and designated disposal areas, and strengthen student orientation and laboratory supervision. Regular training on waste segregation, chemical labeling, and environmental safety should be incorporated into the curriculum to enhance compliance and minimize risks. Addressing these challenges not only ensures safer laboratory environments but also instills in future pharmacy professionals a sense of responsibility toward sustainable and environmentally sound chemical management practices.

Summary of Findings

The findings of the study revealed that pharmacy students demonstrated a very high level of knowledge ($\bar{x} = 3.39$) and a high level of handling practices ($\bar{x} = 3.00$) in the disposal of used and expired chemicals, indicating strong awareness and generally responsible laboratory behavior. However, significant differences were observed when grouped according to year level, suggesting that students in higher years exhibited greater understanding and compliance with chemical waste management protocols due to increased laboratory exposure and experience. Despite these positive results, participants identified persistent challenges, including the lack of proper waste disposal areas, insufficient labeling of containers, limited chemical jars, and inconsistent adherence to established safety procedures. These results emphasize the importance of strengthening laboratory infrastructure, supervision, and continuous training to ensure consistent and compliant chemical waste disposal practices among all year levels.

CONCLUSION

At the end of this study, it was found that pharmacy students possessed a generally high level of knowledge and demonstrated responsible handling practices in the disposal of used and expired chemicals. The results showed that awareness and compliance tended to increase with higher year levels, suggesting that laboratory experience played a vital role in shaping students' understanding and behavior toward chemical waste management. Despite these positive outcomes, the study also revealed existing issues such as insufficient disposal facilities, lack of proper labeling, and inconsistent adherence to established protocols. These findings highlight that while students are aware of proper waste management principles, challenges in practice and implementation within the laboratory setting remain evident.

Recommendations

Based on the findings and conclusions made, the researcher draws the following recommendations:

1. Provide adequate and properly labeled waste containers or chemical jars in every laboratory to ensure correct segregation and disposal of used and expired reagents.
2. Establish clear and standardized guidelines for chemical waste management, including visible signage and disposal instructions for different types of chemicals.
3. Conduct regular orientations and safety trainings to reinforce students' knowledge and proper handling practices in laboratory waste management.
4. Strengthen the supervision of laboratory activities by ensuring that instructors and laboratory technicians closely monitor students' compliance with safety protocols.
5. Integrate discussions on Republic Act No. 6969 and related environmental regulations into laboratory courses to promote legal and environmental awareness among students.
6. Foster a culture of accountability and discipline among students by encouraging adherence to safety protocols and discouraging improper disposal practices.

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