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ASSESSMENT OF PRACTICES REGARDING THE HANDLING
AND DISPOSAL OF UNUSED AND EXPIRED MEDICATIONS
AMONG STUDENTS AND FACULTY AT PUBLIC HIGHER
EDUCATION INSTITUTIONS IN XALAPA, MEXICO

DIAGNÓSTICO DE LOS HÁBITOS EN EL MANEJO Y LA DISPOSICIÓN
DE RESIDUOS DE MEDICAMENTOS NO USADOS Y CADUCOS EN
ESTUDIANTES Y ACADÉMICOS DE INSTITUCIONES DE EDUCACIÓN
SUPERIOR PÚBLICAS EN LA CIUDAD DE XALAPA, MÉXICO

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ABSTRACT

The aim of this study was to assess the habits regarding the handling and disposal of unused and expired medications among students and faculty at public higher education institutions (HEIs) in the city of Xalapa, Veracruz, Mexico. This study shed light on some of the existing problems regarding the inadequate management of medications that are no longer used or have expired, as well as the importance of their proper disposal; otherwise, they become highly toxic waste. This study sought to answer the following research question: What are the habits regarding the handling and disposal of used and expired medication among students and faculty at public HEIs in the city of Xalapa, Mexico? Among the key findings, it was discovered that 3% of respondents have never taken any medication; 22% suffer from a medical condition and require long-term medication; 54% purchase medication on their own; 78% keep medication they do not consume; 72% mentioned that they throw away expired medication; and 81% were unaware of any collection centers for expired medication.

Keywords: medications, habits, management, disposal

RESUMEN

La presente investigación tuvo como objetivo realizar un diagnóstico de los hábitos en el manejo y la disposición de residuos de medicamentos no usados y caducos en estudiantes y académicos de instituciones de educación superior (IES) públicas de la ciudad de Xalapa, Veracruz, México. El desarrollo de esta investigación permitió conocer algunas de las problemáticas existentes en cuanto a la inadecuada gestión de los medicamentos que ya no se usan o que han caducado, así como la importancia de su disposición final pues, de otro modo, se convierten en desechos altamente tóxicos. Este diagnóstico buscó contestar la siguiente pregunta de investigación: ¿cuáles son los hábitos en el manejo y la disposición de residuos de medicamentos usados y caducos en estudiantes y académicos de IES públicas de la ciudad de Xalapa, México? Dentro de los hallazgos destacados se encontró que el 3% de los encuestados no ha tomado ningún medicamento; el 22% padece alguna enfermedad y requiere tomar medicamentos permanentemente; el 54% adquiere el medicamento por cuenta propia; el 78% guarda el medicamento que no consume; el 72%, mencionó que tira el medicamento caducado; y el 81% desconoció algún centro de acopio de medicamento caduco.

Palabras clave: medicamentos, hábitos, manejo, disposición

1. INTRODUCTION

The use of medications is not limited by age, gender, or social group. Everyone has taken some form of medication, whether prescribed by a doctor or self-administered. It is important to note that unused medications are often saved for later use or, over time, expire.

The disposal of expired medications poses a challenge for society because, at best, they end up in open dumps or in storm drains. In both cases, they pollute the environment. To give us an idea of medication consumption in Mexico, in the public sector, specifically at the Mexican Social Security Institute (IMSS, according to its Spanish acronym), The Institute for Social Security and Services for State Workers (ISSSTE, according to its Spanish acronym) and IMSS-Bienestar distributed 745 million doses of medication for 2024. In addition, it is important to include prescriptions in the private sector and self-medication.

By its very nature, the pharmaceutical industry should be one of the sectors most committed to helping improve social and environmental conditions through its core activity—the research and development of medicines—in order to improve public health. Furthermore, it should improve environmental conditions and care by properly monitoring the management (handling and disposal) of the medicines it produces, distributes, and markets.

In this regard, the Pan American Health Organization ([OPS] 2026) states that expired medications must be incinerated at temperatures exceeding 1,200 °C. However, only industrialized countries have incineration equipment with adequate controls. In Mexico, the National Center for the Prevention of Natural Disasters (CENAPRED) notes that, in emergency situations, the incineration of expired solid pharmaceutical forms may be considered in two-chamber incinerators operating at a temperature of 850 °C with a retention time in the second chamber of at least two seconds.

On the other hand, the National System for the Management of Packaging and Medication Waste (SINGREM, according to its Spanish acronym) (2022) states that the collected waste undergoes physical shredding processes and is sent to its final destination for co-processing in a cement kiln. The concept of co-processing involves thermal destruction with energy recovery. In other words, as the material is destroyed, the energy it contains is harnessed for another purpose. SINGREM's Management Plan aims to have the collected waste serve as an *alternative fuel* for various cement kilns authorized for this purpose.

Building on what SINGREM mentions, there are various methods for disposing of expired medications; the challenge lies in collecting them and making them available to the agencies responsible for their handling, disposal, and destruction. In general terms, this research shed light on one of the existing problems regarding the inadequate management of expired medications, as well as the importance of their final disposal.

1.1. Problem statement

Medications enter the environment through various sources. For example, human and animal waste, household trash, and stormwater runoff, among others. Once the metabolites of these medications enter the environment, they seep into aquifers, reaching drinking water sources. During this process, the life cycles of flora and fauna are disrupted. The potential presence of human pharmaceuticals in the aquatic environment showed evidence of active pharmaceutical ingredients in treated water; consequently, it was found that ethinylestradiol (EE2) contributes to the feminization of male fish in rivers (Environmental Protection Agency [EPA], 2013).

The Ministry of Health (2016) noted that Mexico has the highest consumption of pharmaceuticals. This is due to the ease of access, self-medication, high rates of chronic degenerative diseases in the population, and the discontinuation of medical treatment upon early improvement, among other factors. The inadequate management of pharmaceutical waste represents a latent problem and highlights the lack of a culture of proper medication disposal. This poor practice results in the growing presence of hazardous pollutants in water and soil. Consequently, people who have medications at home are unaware of the proper disposal procedures and end up discarding them in vacant lots, drains, trash cans, or selling them improperly.

Before the pandemic, SINGREM (2022) collected between 50 and 60 tons of medications per month; that is, 625 tons per year. This figure represents 30% of all medications discarded annually. Approximately 12 million expired medications are not recovered by health authorities, of which 30% are diverted to the black market. It is estimated that this market sells 6% of the medications sold in the country, and of those, 30% are expired medications (Pazarán, 2014).

From an economic perspective, in 2024, the Ministry of Economy (2025) reported that the total trade in pharmaceutical products in Mexico amounted to \$11.534 billion. In this regard, three out of every four expired medications end up in the trash or on the black market without undergoing recycling or safe collection processes. The lag in managing this waste increases the pharmaceutical industry's carbon footprint and opens the door to the clandestine resale of expired drugs that circulate without control or guarantee (Calderón, 2025).

2. METHOD OF RESEARCH

This study was a quantitative, prospective, cross-sectional study. The objective was to assess the habits regarding the handling and disposal of unused and expired medications among students and faculty at public higher education institutions (HEIs) in the city of Xalapa, Veracruz, Mexico. The study sought to answer the question: What are the habits regarding the handling and disposal of used and expired medications among students and faculty at public HEIs in the city of Xalapa, Veracruz, Mexico?

2.1. Sample

The study included faculty and students enrolled in on-campus programs at public higher education institutions in Xalapa, Veracruz, Mexico (Universidad Veracruzana, Normal Veracruzana, Tecnológico de Xalapa, Universidad Pedagógica Veracruzana, and Colegio de Veracruz). A total of 1,685 data points were collected from five public higher education institutions; participants' ages ranged from 18 to 69 years. Sampling was simple random, and the data collection instrument was a questionnaire..

3. RESULTS

To ensure the study's validity, care was taken to ensure that the participants were nearly evenly split by gender, with 51% being men, 48% women, and 1% non-binary (Figure 1). In this regard, it was found that 48% of participants *never* take medication or do so *rarely*. This results in unused medications being stored at home (Figure 2).

Figure 1
Gender of participants

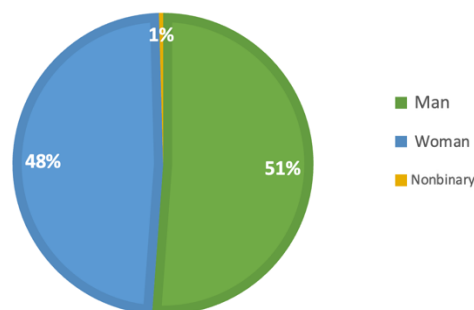
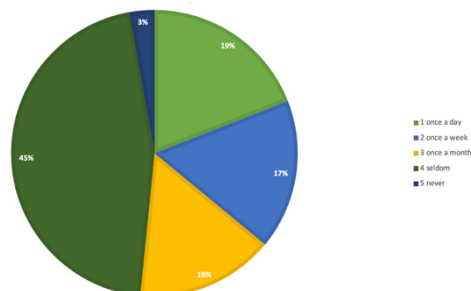


Figure 2

Frequency of medication use



Furthermore, it was found that 78% of participants do not have conditions that require long-term medication use, while 22% do (Figure 3). In this regard, it was found that 54% of participants purchase medications on their own; 22% obtain them from the public sector; 16% from the private sector; 6% receive them as gifts from a family member; and 2% acquire them through other means (Figure 4).

Figure 3

Answers to the question: Do you have a medical condition that requires you to take medication on a long-term basis?

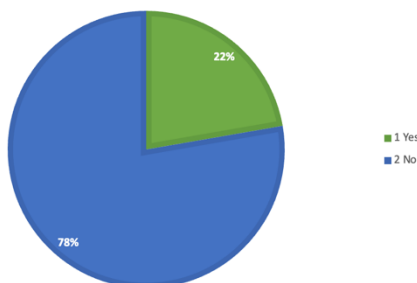
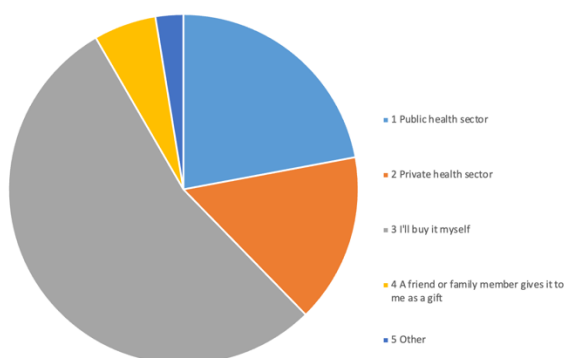


Figure 4

Answer to the question: Where do you usually get the medication you have taken?



It was found that 50% of the participants take some form of medication that has been prescribed by a doctor or purchased on their own (Figure 5). The participants' use of medication varied, but it is noteworthy that a large proportion of the medications they purchase are not taken and are therefore kept at home (Figure 6).

Figure 5

Answer to the question: What percentage of the time do you estimate you take medication that has been prescribed by a doctor or that you have bought yourself?

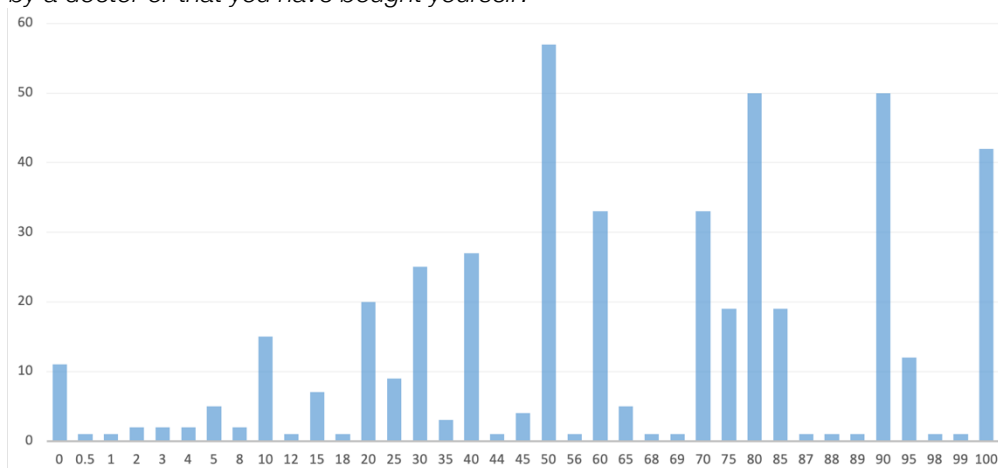
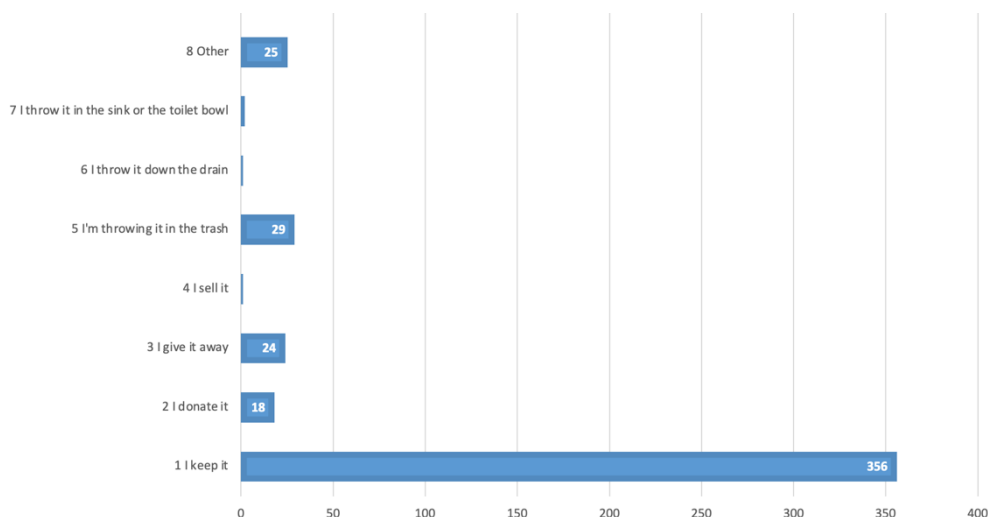


Figure 6

Answer to the question: If your answer to the previous question is not 100%, please state what you do with any unused medication?



The study found that there are several reasons why participants discontinue their medical treatment. One consequence of this is the accumulation of unused medication that may eventually expire (Figure 7). This practice indicates that 88% of participants have medication at home that is no longer being taken (Figure 8).

Figure 7

Answer to the question: Please explain why you sometimes do not finish the entire course of your medication

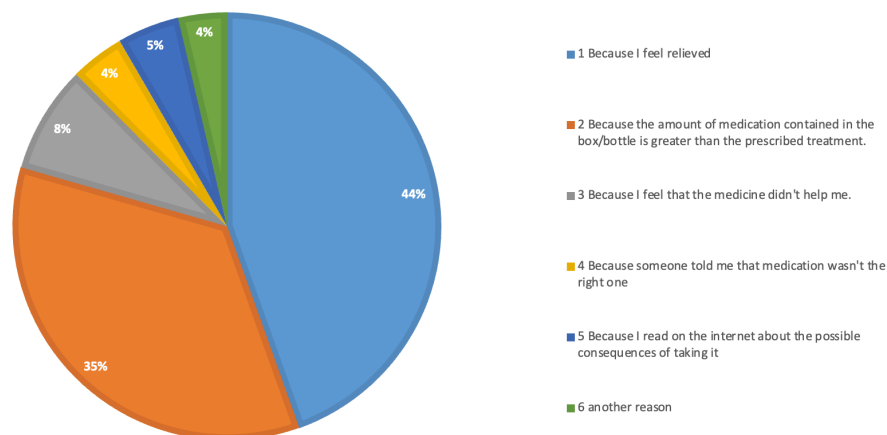
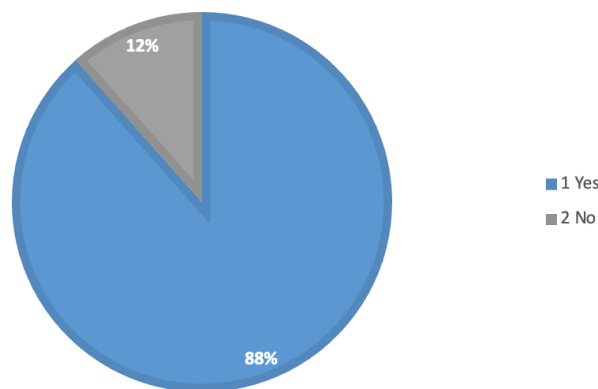


Figure 8

Answer to the question: Please explain why you sometimes do not finish the entire course of your medication?



When medications expire, 72% of participants throw them away. Few people use collection centers. This presents an opportunity to foster a culture of donating medications to established centers for their disposal and final treatment (Figure 9). In contrast, when treatment is completed or interrupted, only 6% throw the medications away, even if they have not expired. On the other hand, 15% donate them, and 77% keep them in case they might need them later (Figure 10).

Figure 9

Answer to the question: Please state what you do with medicines once they have expired?

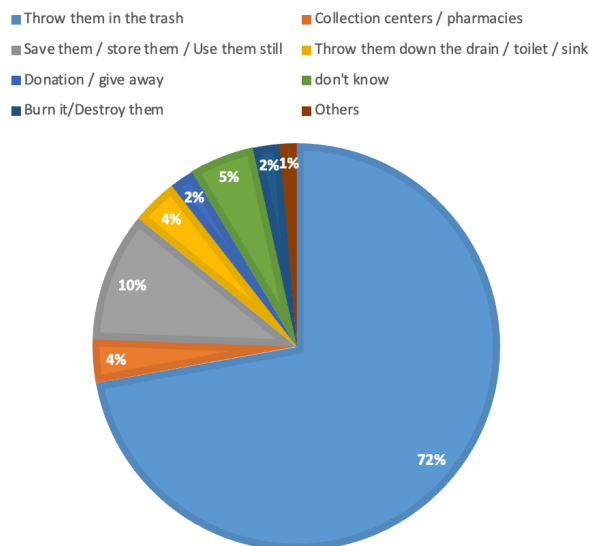
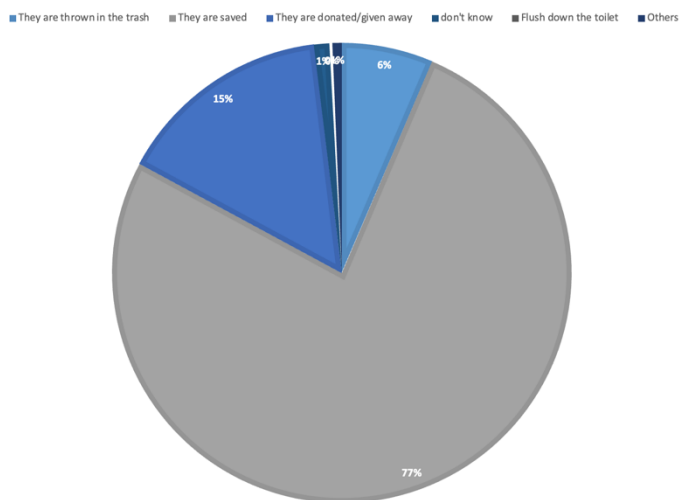


Figure 10

Answer to the question: Please indicate what happens to medications when they are no longer used but have not expired?



It was found that 81% of participants are unaware of collection centers for unused or expired medications (Figure 11). Furthermore, it was found that only 8% of respondents take unused or expired medications to collection centers. Therefore, it is possible that people are not interested in learning about and using these centers (Figure 12).

Figure 11

Answer to the question: *Are you aware of any collection centers for unused or expired medication?*

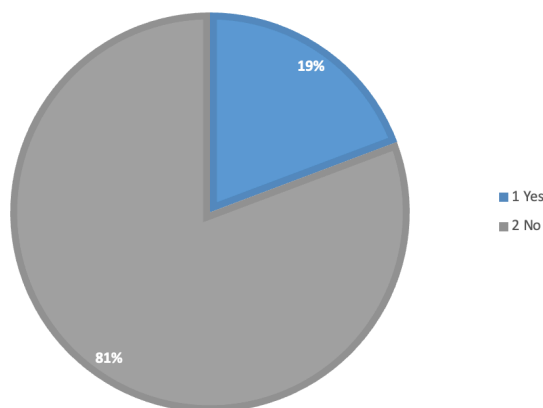
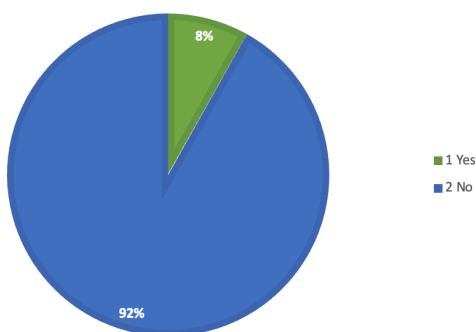


Figure 12

Answer to the question: *Do you take unused or expired medication to a collection center?*



Given the above, it was important to determine some of the reasons why people do not donate or give away medications. It was found that 36% believed they might need the medication later, 25% did not think to do so, and 4% considered the cost too high to give away or donate the medications (Figure 13). Additionally, it was found that 80% of participants do not clean medication containers before throwing them away (Figure 14).

Figure 13

Answer to the question: *If you answered "no" to the previous question, what is the reason you do not donate or give away the medication?*

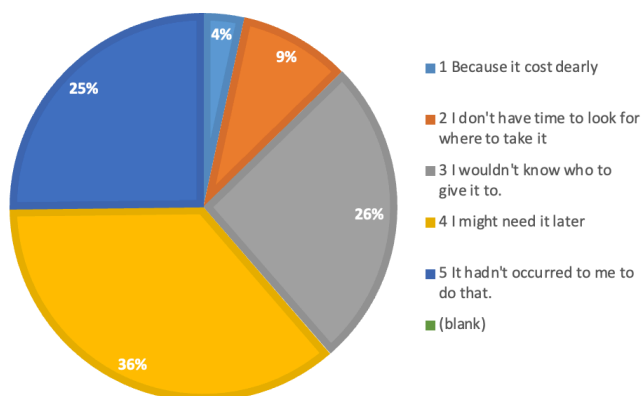
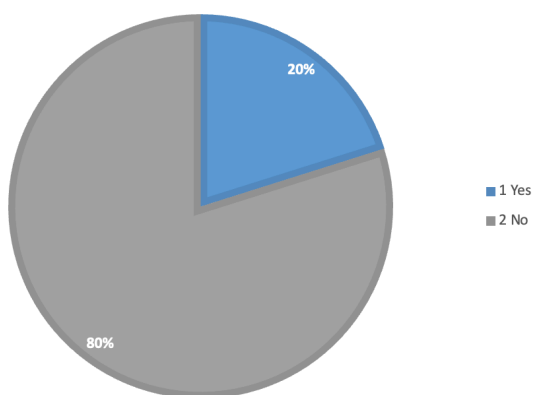


Figure 14

Answer to the question: *When you finish a medication that came in a plastic or glass container, do you clean it before throwing it away?*



It was interesting to note that 51% of participants believed that discarded medications do not pollute the environment, while the remaining 49% stated that they do (Figure 15). In addition, the survey found that 60% of participants believe that medications disposed of in water break down easily and do not pose a health risk (Figure 16).

Figure 15

Answer to the question: *Have you considered that discarded medications cause water and environmental pollution?*

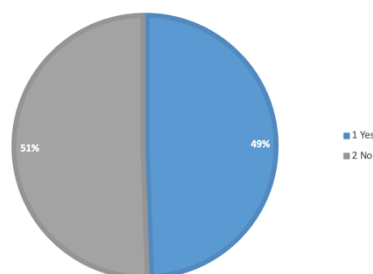
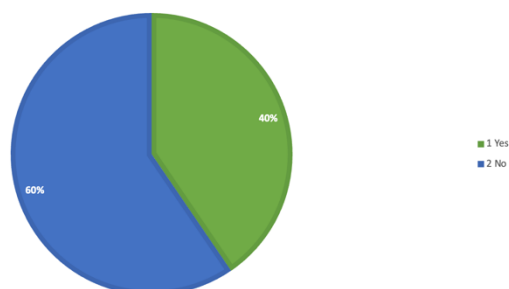


Figure 16

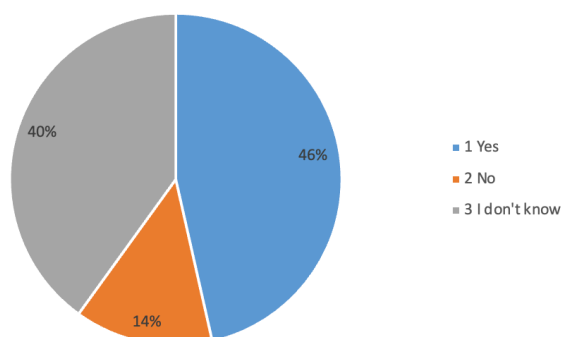
Answer to the question: *Do you believe that medication disposed of in water breaks down easily and poses no health risk?*



Finally, the survey found that 46% of participants believed that disposing of medications does pose a risk to the region's flora and fauna; 40% believed it does not; and 14% were unsure. Therefore, it is important to create a program to raise awareness about the environmental damage caused by the disposal of medications (Figure 17).

Figure 17

Answer to the question: *Do medications disposed of in wastewater or in the trash pose a risk to the region's flora and fauna?*



4. DISCUSSION

The results indicated that 22% of respondents suffer from some type of illness that requires them to take medication. In this regard, the National Institute of Public Health (INSP, according to its Spanish acronym) reported that, in Mexico, 10% of the population has diabetes; 14% has kidney disease; and 32% has high cholesterol. Additionally, more than 50% of older adults have at least one noncommunicable disease. This means that some people must take medication on a permanent basis (INSP, 2025).

Private-sector spending on medications increased by 7.9% in real terms, reaching an average of \$6,421 pesos per household per year (Méndez Méndez, 2025). Consequently, in 2024, six out of every 10 people who received care did so at private facilities and pharmacies, which confirms the high percentage of this finding. Furthermore, only 26% of people consume more than 80% of their prescribed medication. In this regard, nearly one-third of people have stopped taking a prescribed medication at some point without consulting their healthcare provider.

Eighty-eight percent of respondents reported that they keep unused medications at home, a finding that is directly linked to the results described above. Additionally, 72% indicated that they dispose of expired medications, while only 22% reported donating or giving away unused medications that have not yet reached their expiration date. This practice is reflected nationwide, as SINGREM collects between 50 and 60 tons of medications per month, which amounts to approximately 625 tons annually—a figure representing just 30% of the total medications discarded each year. Consequently, it is estimated that the remaining 70% is disposed of improperly, either through household trash or wastewater. Additionally, around 12 million expired medications are not recovered by health authorities, of which approximately 30% are diverted to the illegal market. It is estimated that this market accounts for 6% of the medications sold in the country, and nearly 30% of those are expired medications (Pazarán, 2014).

Eighty-one percent of respondents stated that they were unaware of the existence of collection centers for expired medications, with this response being most common among participants aged 18 to 25. This finding may be attributed both to this age group's lack of awareness regarding such centers and to the limited dissemination of proper practices for the safe disposal of expired medications. Consistent with the above, only 8% of participants reported using these collection centers.

Similarly, only 20% reported that they clean medicine containers before disposing of them, which highlights the lack of a culture of responsible waste management—not only for pharmaceutical waste but also for food packaging and hygiene and personal care products. On the other hand, 60% of respondents believed that medications flushed down the drain degrade easily and do not pose a health risk. However, when asked whether medications disposed of in wastewater or in the trash put the region's flora and fauna at risk, only 46% answered in the affirmative, with this perception being more common among participants aged 18 to 25.

In their study, Saturno-Hernández and Quiroz-Razo (2024) noted that most public institutions that responded to requests through the National Transparency System claimed that the management and destruction of expired medications is carried out in strict compliance with regulations, but without providing factual information to support this assertion. Regarding disposal, the method of direct incineration is mentioned, but neither decontamination nor any form of sorting is mentioned, which are other possibilities outlined in official Mexican and international documents. Nor was it possible to obtain detailed information on the process from collection to incineration, or whether the emission limits established by NOM-098-SEMARNAT-2002 are met during the process. In light of the above, one may reflect: it is possible that the very entities responsible for and committed to preventing environmental impact are not complying with official regulations. To this, one may add that, due to the dissolution of the National Institute for Access to Information, it could become more difficult to obtain information such as that requested by the aforementioned researchers.

5. CONCLUSIONS

The findings of this study showed that there is a lack of awareness regarding the environmental impact of medications when they are disposed of. Furthermore, participants were unaware of the existence of collection centers for expired medications. Therefore, there is a need to foster a culture of donating unused medications within society. Today, with the use of social media, it could be easy to donate medicines, learn about collection centers for expired medicines, or understand the environmental impact of throwing expired medicines in the trash.

In this regard, government campaigns are needed to raise awareness about key aspects of the management and disposal of expired medications. Similarly, through corporate social responsibility and university social responsibility, serious pollution problems can be prevented through the proper and responsible management of medications, medical supplies, and equipment. On the other hand, the disposal of pharmaceutical waste offers a potential benefit for social development, supporting actions through various efforts to preserve public health, clean water and sanitation, marine life, and terrestrial ecosystems. This ensures compliance with the sustainable development goals of the United Nations' 2030 Agenda.

The results suggest the need for public policies that yield significant outcomes in the management and disposal of expired medications. Similarly, these policies should raise public awareness to discourage the hoarding of unused medications, thereby promoting donation and ensuring more efficient use. This study provided empirical evidence regarding the need to reflect on the management and disposal of unused medications among students and academic staff in Xalapa, Veracruz, Mexico. This can be replicated in other national settings and countries. However, as this research was limited to a specific physical location, the relevance of conducting future studies that delve deeper into the analysis of the aforementioned issue is acknowledged.

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