

Characteristics of Antibiotic Storage in a Suburban Population in Mexico

Características del almacenamiento de antibióticos en una población suburbana de México

Características do armazenamento de antibióticos em uma população suburbana do México

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Abstract: Objective: To determine the antibiotic storage characteristics of families in a suburban population in Mexico. Methodology: The study approach is quantitative, observational, cross-sectional and descriptive in scope. The unit of study was families living in the area under study in a suburban zone of Mexico. Results: A total of 235 families were surveyed, within which there are different age groups, with 153 families predominantly aged between 36 and 64 years old. It was obtained that more than 70 % presented illnesses and, regarding the possibility that they had stored expired or soon to expire antibiotic drugs, 68.1 % mentioned that it was not likely. Conclusions: The significant number of adult population, the wide presence of comorbidities and various sociodemographic factors impact practices and attitudes regarding the ways in which families obtain, use, store and dispose of medications within their homes. This research seeks to contribute to the awareness and creation of various programs for the adoption of safety measures for the storage of medicines within the home, as well as to serve as a guide in the identification of optimal, efficient and effective procedures to deal with this phenomenon.

Keywords: anti-bacterial agents; drug storage; drug resistance.

Resumen: Objetivo: Determinar las características de almacenamiento de los antibióticos de las familias en una población suburbana en México. Metodología: El enfoque del estudio es cuantitativo, observacional, de corte transversal y alcance descriptivo. La unidad de estudio fueron las familias que vivían en el área de estudio de una zona suburbana en México. Resultados: Se encuestaron un total de 235 familias, dentro de las cuales existen diversos grupos etarios, de los cuales predominaron las edades de entre 36 a 64 años en 153 familias. Se obtuvo que más del 70 % presentaban enfermedades y, respecto a la posibilidad de que tuviesen almacenados medicamentos antibióticos caducados o próximos a caducar, el 68.1 % mencionó que no era probable. Conclusiones: El importante número de población adulta, la

amplia presencia de comorbilidades y diversos factores sociodemográficos impactan en las prácticas y actitudes en relación con las formas en que las familias obtienen, usan, almacenan y desechan los medicamentos dentro de sus hogares. Esta investigación busca contribuir a la concientización y creación de diversos programas para la adopción de medidas de seguridad para el almacenamiento de medicamentos dentro del hogar, así como servir de guía en la identificación de procedimientos óptimos, eficientes y eficaces para tratar este fenómeno.

Palabras clave: antibacterianos; almacenamiento de productos; farmacorresistencia bacteriana.

Resumo: Objetivo: Determinar as características do armazenamento de antibióticos das famílias em uma população suburbana no México. Metodologia: A abordagem do estudo é quantitativa, observacional, transversal e de escopo descritivo. A unidade de estudo foram as famílias que viviam na área de estudo de uma zona suburbana no México. Resultados: Foram pesquisadas 235 famílias, de diversas faixas etárias, das quais predominaram as idades de 36 a 64 anos em 153 famílias. Verificou-se que mais de 70% apresentavam enfermidades, e com relação à possibilidade de terem medicamentos antibióticos vencidos ou prestes a vencer armazenados, 68,1 % mencionaram que não era provável. Conclusões: O significativo número de população adulta, a ampla presença de comorbilidades e vários fatores sociodemográficos impactam nas práticas e atitudes relativas às formas como as famílias obtêm, usam, armazenam e descartam medicamentos em suas residências. Esta pesquisa busca contribuir para a conscientização e a criação de vários programas para adoção de medidas de segurança para o armazenamento de medicamentos em casa, bem como servir de guia na identificação de procedimentos ideais, eficientes e eficazes para lidar com esse fenômeno.

Palavras-chave: antibacterianos; armazenamento de produtos; farmacorresistência bacteriana.

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Introduction

Drugs or medicines are prepared substances which have specific effects on the human pathways, they have been one of the most important benefits of modern medicine, especially by including home treatment schemes to empower people in handling their diseases. ⁽¹⁾

Additionally, the discovery and incorporation of antibiotics into the therapeutic scheme marks one of the major advances in history, being used in the treatment of infections, Therefore, they are indispensable inputs that represent an essential part of therapeutic in-

home use, allowing individuals and families to promote their self-care through the recovery of their health in their context; derived from the above. ⁽²⁾

Consequently, due to the excessive consumption of antibiotics that families have in-home treatment, global and regional health organizations declare that one of the primary objectives is the rational use of antibiotics to maintain the efficacy and safety of these drugs, families must carry out different activities to ensure proper storage, consumption, and disposal. ⁽³⁾

To illustrate, several authors have studied the relationship between people and medicines in their homes to increase rational consumption. Rodríguez and Roig propose a model for managing medicines in the house, which starts from assessing the need for drugs, their acquisition, the guarantee of the quality of storage, and the proper disposal. As for the storage of antibiotic medications at home, it is understood as the protection of such medicines to ensure their conservation, to be used in the presence of some acute disease. ^(4, 5)

As a result, these and other drugs are usually stored in a home medicine cabinet, defined as the device or container where medical supplies are stored for minor ailments that do not require medical consultation and mostly, from over-the-counter sales medication, residues of past treatments to mitigate signs and symptoms while they for healthcare services, with the objective to maintain their effectiveness and safety, This first aid kit must follow a set of guidelines issued by the Pan-American Health Organization (PAHO), and other institutions. ⁽⁶⁻⁸⁾

Furthermore, the temperature, air, humidity and light control can expose the drugs to changes in the active ingredient of the drug, reducing their effectiveness and making them unfit for consumption because they are harmful to health. ^(8, 9)

Another aspect to consider is the room where they are kept, which must have the above-mentioned environmental secure conditions, and in turn, should not expose family members to events such as poisoning from accidental consumption. Secondly, the characteristics of the person managing them are an important factor in determining the quality of storage, since age, gender, and educational level are directly associated with health literacy; and thirdly, access to social security, the type and size of family, the co-morbidities among members influence their family health care habits, of how they handle, store and dispose of their medicines. ⁽¹⁰⁾

Admittedly, incorrect storage may lead to loss of stability of the active ingredient, deterioration of the product, and consequently effectiveness loss. On the other hand, due to population increase, globalization and the rise of infectious diseases cause an increase in the use and storage of antibiotics triggering negative phenomena to health such as antimicrobial resistance (AMR), as well as poisoning, accidental intoxication, and drug dependence. ^(3, 11)

In Mexico, excessive or improper antibiotic home storage is explained due to various factors such as lack of adherence to treatment due to an anticipated sense of well-being, inadequate sale or dispensing in the drug store, self-medication, access to private sector pharmacies, and lack of public health care services. When these elements are accompanied by errors in the storage and conservation of such drugs, represent a severe healthcare problem. ⁽⁹⁾

Moreover, AMR is recognized as a global health hazard and a menace in development, according to the World Health Organization (WHO). The Mexican Ministry of Health also identifies it as a leading factor to more expensive diagnostic methods and treatments; adverse drug reactions and poisoning, and finally the prolonged time of sickness due to microorganisms such as bacteria, viruses, fungi, and parasites can generate the ability to survive exposure any type of antibiotic that can kill others of the same species. ⁽¹²⁻¹⁴⁾

Currently, there is very little information on the status or quantity of medicines that people have in their homes and the particular storage characteristics in medicine cabinets. The need to prevent health problems related to the above is not known; since there is no regular national or state monitoring of this phenomenon.

Community nurses are responsible for encouraging healthy behaviors in families in their homes with programs aimed at raising awareness about the AMR problem and improving the storage and rational consumption of antibiotics in households. Moreover, the diagnosis of this phenomenon provides useful information to improve the behavior in storing antibiotics medicines at home, through educational programs, allowing a practice based on real evidence-based nursing, community needs, and contextualized interventions tailored to the population, which will make it possible to effectively contribute to solving the various problems that emerge during the storage of antibiotics at home. ⁽¹⁵⁾

Last but not least, this research is carried out in a suburban community, which is considered vulnerable to various factors, such as limited access to public health services and private pharmacies, high environmental pollution, high unemployment, low income, and educational level, and with low health literacy. ⁽¹⁶⁾

Because of this, this study aims to determine the characteristics of antibiotic home-storage in families of a suburban population in Mexico.

Materials and Methods

This is a quantitative approach study, with cross-sectional temporality, and descriptive range. This study unit of observation was the families (defined as all members living in the same residence) who lived in the AGEB (Area of Basic Geostatistics). The inclusion criteria were the willingness to participate in the study, and an adult person who was able to answer the survey at the time of the interview. For exclusion, the population who lived in the study area for less than six months (defined as a 'floating population' according to the National Population Council in Mexico), where there is no one of age at the time of the survey, and who does not wish to participate, were the criteria. Finally, the incomplete surveys were eliminated.

Secondly, for sample calculation, through the System for the Consultation of Census Information (SCINCE), it was determined that 856 families lived in this AGEB distributed in different blocks, so the formula to estimate proportions was applied, with the following criteria: confidence level of 95%, precision and proportion of 0.5 % (to maximize sample size) and adding an expected participant loss ratio of 10 %, giving a total of at least 234 families to be interviewed for being representative of the total population. To select these families, interviewers conducted a door-to-door search in the different homes of the AGEB until they reached the sample size without repetition of houses.

For the information collection in December 2022, a survey was designed based on previous studies and items presented in the research carried out by Fernández et al. ⁽¹⁷⁾ This research describes the characteristics of the person in charge of managing medicines in households with 5 multiple-choice questions (age, education, people in the household, present diseases and social security) Characteristics of home medicine cabinets for household storage with 3 multiple-choice questions (place of house, container type and use of auxiliary devices) and methods of drug disposal with 2 multiple-choice questions (expiry and method of disposal). A psychometric validation process was not needed, because the theoretical-practical construct was not evaluated with the combination or summation of items. ⁽¹⁷⁾

The procedure for data collection was divided into four phases: 1) a survey was placed in the Google Forms tool along with the descriptive sheet with the information of the definition of an antibiotic, and the most common examples were printed; 2) we went to the study area and made a graphical mapping of the number of houses per block, eliminating uninhabited, abandoned houses and businesses with uninhabited or floating population; 3) we collected data, house to house, providing informed consent to participating families and feedback on reported behaviors, as well as going into homes to take pictures of home medicine kits in households that allow it; 4) the database was downloaded and frequencies and percentages were obtained.

Once the data were collected, the information on the items was analyzed in the Microsoft Excel program. The data was then interpreted using absolute frequencies and percentages for each of the answers to the survey questions and then presented in tables and graphs. On the other hand, a qualitative cartographic description of the obtained photos was made.

Lastly, it is worth noticing that according to Title IV of the regulations of the General Health Law for Health Research in Mexico, ⁽¹⁸⁾ this investigation was considered a minimal risk level since there was no manipulation of the subjects' behavior; Privacy and anonymity criteria were also respected by not requesting names in the data collection survey. In addition, the participating families were given an informed consent form, clarifying and explaining their participation, and were presented with the option to withdraw their participation at any time if they did not want to participate. Also, all the ethical criteria set out in the Declaration of Helsinki, ⁽¹⁹⁾ were respected and this study was approved by the Ethics and Research Committee of the Universidad Autónoma de Yucatán (registration number 14/22).

Results

Family Characteristics

A total of 235 families were surveyed, exceeding the required sample size, within which there are various age groups. The presence of members between 36 and 64 years were in 153 families of the 235 (65.1 %), followed by elderly people in 92 families (39.14 %); young people aged 26 to 35 in 70 families (29.78 %), young adults aged 18 to 25 in 64 families (27.23 %), children aged 6 to 12 in 51 families (21.7 %), adolescents aged 13 to 17 in 49 families (20.8 %) and finally the under-5s with 35 families (14.89 %). The families were not asked about the number of members living in the household, only the age groups that coexist in the household.

As for the type of diseases that predominate within the families (Figure 1), 68.1 % of the families were found to have diseases, while the remaining 31.9% did not. Within the type of illnesses reported in these families, chronic degenerative diseases predominated in 64.7 % of the families (152), compared to mental health illnesses, which were reported in only 3.4 % of the families (8).

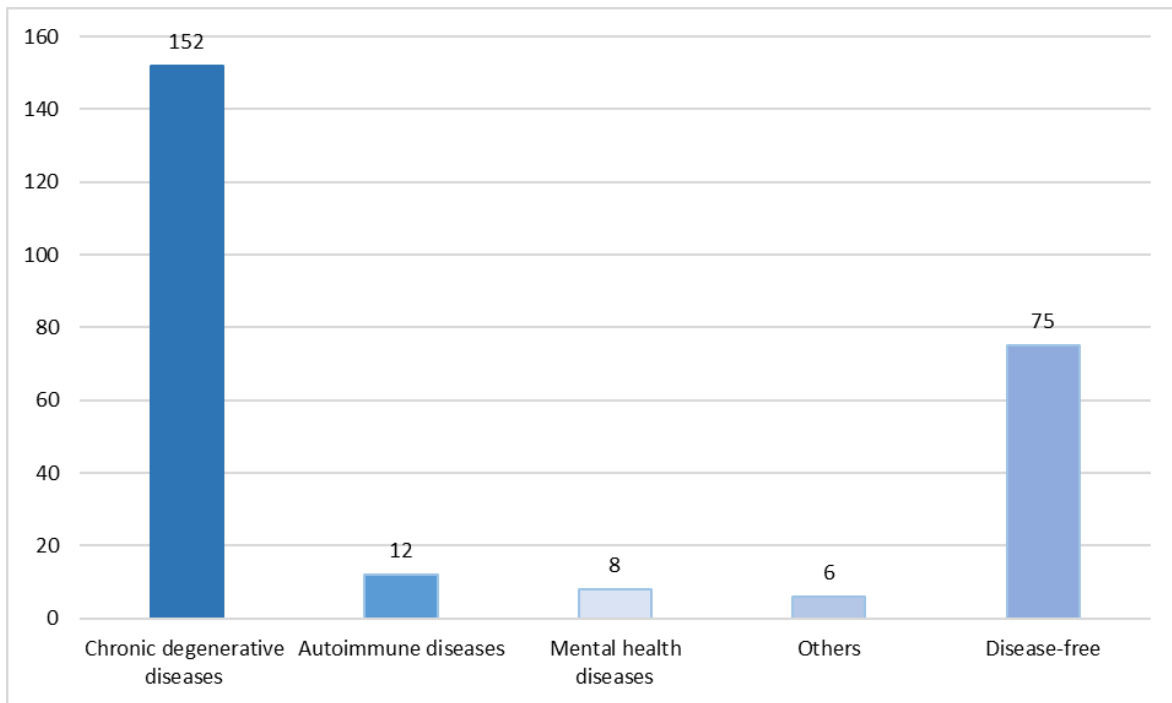


Figure 1. Frequency of types of diseases within families.

Attributes of the Medical Kit and House Room

As shown in Figure 2, regarding the type of container usually used by families to store their antibiotics and other medicines, 87 families (37 %) use a plastic box with a lid, while 34 families (14.5 %) do not have a specific container, so they use containers such as cosmetics and pills, among others.

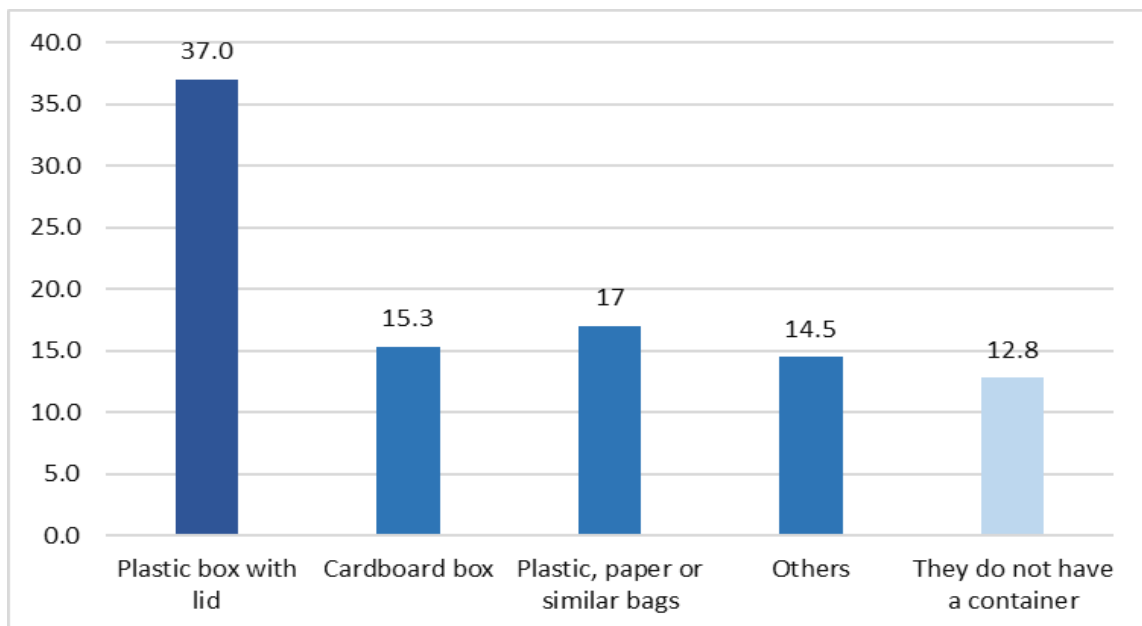


Figure 2. Type of container used to store antibiotics and other medicines.

Concerning the storage of antibiotics, it was identified that 45 % (106) of the families stored such medicines inside the room where they sleep, 30 % (71) in the living room, dining room or other, 22 % (51) in the kitchen and 3% (7) in the bathroom.



Figure 3. Descriptions of the container for antibiotics and other medicines.

As can be seen in Figure 3, most families use unique containers for the storage and storage of their drugs (including antibiotics), to avoid exposure to environmental factors, which may cause alterations in the active ingredients of these drugs. These containers are plastic, and usually transparent, allowing light to enter and a quick observation of the contents. It is important to note that these containers do not seal hermetically and are mostly closed with pressure locks, so it is easy to open for people of any age. Most of the containers observed are clean, however, some contain remaining powder on the bottom from tablets that have come out of the blister and some stains resulting from small spills of syrups.



Figure 4. Contents of the home medicine kit for antibiotics and other medicines.

Concerning Figure 4, the most notable feature observed is the lack of organization in the medicines due to the type of container such as plastic bags, cardboard boxes, or bins often making it difficult to see the name of the drug clearly with the naked eye. On the other hand, stored medicines display different problems such as spillage of drugs in liquid form, stains on the name and expiration date, indications for use or consumption and warnings, and even showing expired medicines. Finally, it can be observed that households with excessive storage, usually store non-pharmaceutical products such as concentrated electrolytes, food supplements, Naturist products, and even some materials such as syringes, gauze, and cotton, among others.



Figure 5. Home storage for antibiotics.

Following, describing the space in the house intended by families for storing their antibiotics and other drugs, it is apparent that is not usually protected from light, humidity, and heat; adding to this the fact that in many cases there is no container for storing these drugs, which exposes them to changes in their composition due to exposure to the factors already mentioned, as well as other materials such as food, cleaning and construction materials as seen in Figure 5; alike, they are available to all family members increasing the likelihood of poisoning and/or intoxication, due to accidental or impaired consumption.

Characteristics of the expiry and final disposal

Regarding the claim that families have stored expired or near-expired antibiotic medicines (Table 1), 68.1 % mentioned that it was not likely because they had reviewed their medicines a month ago or less; compared to those who mentioned that it was very likely, as they did not check their medicines as often or did not check them with a 7.7 %

On the other hand, 74.5 % of families tend to use their final disposal methods as throwing in the garbage, while only 17 % take them to a specialized center or pharmacy.

Table 1 – Distribution of final disposal methods and the possibility of having expired or near-expired antibiotics stored

Final disposal of antibiotics drugs by households	Possibility of storing expired or soon-to-expire antibiotics				Total
	No, I checked it a month or less ago.	Unlikely, I checked a few months ago.	It's likely, it's been more than 6 months since I've checked it.	Most likely, I don't check it often or I don't check it at all.	
I take them to a specialized center / pharmacy / collection center.	29	8	2	1	40
I give them as gifts or share them with my acquaintances.	4	2	0	3	9
I throw them the drain (either down the toilet or sink).	6	5	0	0	11
I throw them in the trash.	121	23	17	14	175
Total	160	38	19	18	235

Discussion

The study of medicine storage, particularly antibiotics, is an emerging area within social pharmacology and community nursing. Its impact on self-medication is becoming increasingly recognized, as is its role in contributing to antimicrobial resistance

Regarding the predominant diseases among the surveyed families, 64.7 % were found to have chronic degenerative conditions. This aligns with the 2021 study by Seng, Aziz, and Chik, where a similar percentage (65.5 %) of participants had chronic diseases. This suggests that they had access to various medications over extended periods, and, when combined with poor adherence to treatment, it may lead to increased storage of medicines in their homes. ⁽²⁰⁾

About the storage of medicines, the most common location was the bedroom, followed by the living room and kitchen. When compared with the 2019 study by Maričić et al., 31.5 % of participants stored their medications in the living room, 25.8 % in the kitchen, and 28.6 % in their bedrooms. In contrast, Fernandes et al.'s 2020 study showed that 58.6 % stored medicines in the kitchen, while only 14.4 % kept them in the bedroom. These differences may reflect variations in medication intake practices, as the latter studies suggest a stronger association between medication and food intake, making kitchen storage more common. ^(21, 22)

Nearly two-thirds of the population store their medicines in locations considered suitable, such as bedrooms and living rooms, as these areas are less prone to temperature and humidity fluctuations. However, living rooms can pose risks, especially for children, due to easy access and potential poisoning hazards. While the kitchen is not typically recommended for proper medicine storage, many families choose to store medications there for convenience, as it provides easy access to beverages for taking the medicine and utensils, such as spoons, for dosing. ⁽²²⁾

Subsequently, significant differences were observed regarding the type of containers used for storing antibiotics and other medications when compared to the study by Hassan, Al Taisan, and Abualhommos in 2021, where 7.8 % of participants stored their medicines in a closed box and 6 % in a plastic bag. Storing medicines in a plastic bag or similar receptacle poses potential health risks, as it may compromise the effectiveness of the antibiotics due to exposure to environmental factors like light, moisture, and temperature variations. Additionally, storing medications in easily accessible containers increases the risk of accidental ingestion, particularly by children, leading to dangerous consequences like poisoning. In contrast, using proper containers like sealed boxes offers a safer storage method, as they protect the medications from environmental damage, ensuring their potency and reducing the risk of unintentional access by others in the household. ^(23, 24)

Additionally, the analysis of photos of antibiotic and other medicine containers revealed a significant lack of organization, largely due to the use of inappropriate containers. This disorganization makes it difficult to identify medications and monitor their expiration dates. These findings are consistent with those of Chandrasekhar, Joseph, Abdul, and Mary, whose study highlighted the risks associated with storing different medications in a single container. Such practices lead to confusion, making it hard to distinguish between drugs, increasing the likelihood of overdoses, or causing accidental intake of expired medicines. This not only jeopardizes patients' health by heightening the risk of adverse events, such as poisoning or ineffective treatments, but also leads to a rise in hospitalization rates and increased healthcare costs. The lack of proper organization and storage practices compounds the financial strain on both patients and healthcare systems, emphasizing the need for better awareness and strategies to manage medication safely at home. ⁽²⁵⁾

More than half of the families reported that it was unlikely they had stored expired medicines. These findings contrast with the 2020 study by Naser, Amara, Daghash, and Naddaf, where 58.1 % of participants had expired medicines stored, and 30.4 % reported not having any. This disparity may be attributed to socio-economic factors, including the lack of regulation in medicine sales, poor adherence to treatment, and improper dispensing practices. These factors can lead to harmful health effects, such as intoxication, poisoning, and the development of AMR. ⁽²⁶⁾

Referring to the latter, compared to the study published in 2018 by Sivasankaran, Mohammed, Ganesan, and Durai, who conducted a descriptive cross-sectional survey among the Indian rural population, the results show notable disparity. More than half of the participants (58.3 %) reported storing expired medicines, while the remaining 41.7 % did not. This discrepancy may be attributed to socio-demographic and cultural differences among participants, which could influence the prevalence of expired medicine storage, especially in rural areas. ⁽²⁷⁾

The results of this study regarding the final disposal of antibiotic drugs revealed that 74.5 % of families dispose of their medicines in the common garbage, while only 3.8 % discard them in the sink or toilet. These findings are consistent with the 2021 study by Hassan, Al Taisan, and Abualhommos, ⁽²⁴⁾ where 97.3 % of respondents discarded antibiotics, and just 6.5 % used the toilet for disposal. In contrast, our results differ from those in the 2021 study by Rawas, AlAhmadi, and Mufti, where 35.3 % of respondents disposed of antibiotics in the toilet or washbasin, and 55.2 % used the trash. ⁽²⁸⁾

Despite the similarities and differences found in the studies, it was determined that incorrect drug disposal practices were due to the fact that the participants did not have sufficient information on the final disposal of drugs and the environmental consequences of improper drug disposal. The same happens with respect to the storage of medicines, since it

is concluded that the correct storage of antibiotic medicines can be attributed to various characteristics of individuals, such as demographic group, gender, pathologies present, lifestyle, educational level and relationship with health systems. ^(24, 29)

Finally, it is important to state that since this is a descriptive study, no causality can be inferred or any kind of statistical correlation between the variables was analyzed.

Conclusions

This study underscores the important role of nursing in addressing how adults, particularly those with co-morbidities, manage their medicines at home. Factors such as low literacy levels and limited access to public social security may impact on how families obtain, use, store, and dispose of medications. Improper practices could lead to health risks like poisoning and antimicrobial resistance. However, this research aims to foster awareness and support the development of educational programs that promote safe medicine storage practices. By enhancing knowledge and practices, nursing professionals can play a pivotal role in improving health outcomes for individuals and communities.

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