

Medication disposal: knowledge and practices of primary health care users in the municipality of Araçatuba, State of São Paulo, South-eastern Brazil

Descarte de medicamentos: conhecimentos e práticas de usuários da atenção primária em saúde no município de Araçatuba, estado de São Paulo, Sudeste do Brasil

Aparecida de Fátima Michelin ¹

Camila Pedrozo Rodrigues Furlan ²

Neuza Alves Bonifácio ³

Euclides Teixeira Neto ⁴

Kátia Denise Saraiva Bresciani ⁵

¹ PhD in Agricultural Microbiology, Professor, Instituto de Ciências da Saúde da Universidade Paulista (Unip), Araçatuba, SP, Brasil
E-mail: cidinhamichelin@gmail.com

² Master's in Statistics, Doctoral Student, Faculdade de Medicina Veterinária da Universidade Estadual Paulista (Unesp), Araçatuba, SP, Brasil
E-mail: camila.furlan@unesp.br

³ Master's in Nursing, Professor and Doctoral Student, Instituto de Ciências da Saúde da Universidade Paulista (Unip) and Faculdade de Medicina Veterinária da Universidade Estadual Paulista (Unesp), Araçatuba, SP, Brasil
E-mail: neuza.bonifacio@unesp.br

⁴ Master's in Agribusiness, Professor, Centro Paula Souza, Faculdade de Tecnologia Araçatuba, SP, Brasil
E-mail: euclidestneto@gmail.com

⁵ PhD and Doctor in Veterinary Medicine, Professor, Faculdade de Medicina Veterinária da Universidade Estadual Paulista (Unesp), Araçatuba, SP, Brasil
E-mail: katia.bresciani@unesp.br

doi:10.18472/SustDeb.v16n1.2025.57307

Received: 18/12/2024
Accepted: 07/04/2025

ARTICLE- VARIA

ABSTRACT

Our aim was to obtain information from users regarding the disposal location for unused or expired household medications. A descriptive, cross-sectional and prospective study was conducted with 451 patients from primary health care centres in Araçatuba, SP, Brazil. The respondents answered a pre-validated questionnaire, composed of objective questions. For data analysis, we used the chi-square association test and chi-square with Yates' correction, with a significance level of 5%. Age is associated with the location chosen to dispose of medications, while receiving guidance on the correct place modifies certain disposal habits, with 95% confidence. Most people believe that improper disposal of medications can cause harm to the environment and to human and animal health; however, the most common way to dispose of medications is to throw them in the household waste. Consumer knowledge and practices regarding medication disposal need to be improved.

Keywords: Medications. Disposal. Health. Environment.

RESUMO

O objetivo é obter informações dos usuários acerca do destino dado aos medicamentos domiciliares não utilizados ou vencidos. Um estudo descritivo, transversal e prospectivo foi realizado com 451 pacientes de Unidades Básicas de Saúde em Araçatuba/SP. Os entrevistados responderam um questionário pré-validado, composto por questões objetivas. Para análise dos dados, utilizamos o teste de associação Qui-Quadrado e Qui-Quadrado com correção de Yates, com nível de significância de 5%. A idade tem associação com o destino escolhido para o descarte do medicamento, e receber orientação quanto ao destino correto interfere em alguns hábitos de descarte, com 95% de confiança. A maioria das pessoas acredita que o descarte indevido de medicamentos pode causar danos ao meio ambiente e à saúde humana e animal, porém, a maneira de descarte de medicamentos mais praticada é jogar no lixo doméstico. O conhecimento e as práticas dos consumidores em relação ao descarte de medicamentos precisam ser aprimorados.

Palavras-chave: Medicamentos. Descarte. Saúde. Meio ambiente.

1 INTRODUCTION

Patient safety is a current strategic priority for modern health, such that the elimination or reduction of harm is a major growing global public health challenge. It requires actions that include the involvement of patients, families and civil society organisations, in order to “reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination” (WHO SDG Target 3.9, 2021).

Unsafe storage of medications in home pharmacies increases the risk of toxicity (Kalyango *et al.*, 2012), suicide (Kristinsson *et al.*, 2008), and accidental poisoning in childhood (Alghadeer *et al.*, 2018). Home storage of medications is usually the result of self-medication practices (Huang *et al.*, 2019), non-adherence to treatment (Costa *et al.*, 2015; Faure *et al.*, 2014; Hussain *et al.*, 2019) and storage in cases of need (Hussain *et al.*, 2019). Disposing of these products through non-recommended means is associated with soil and water contamination, and concentrations measured in these locations indicate a high risk to aquatic organisms (Arun *et al.*, 2020).

The way in which medications are disposed of at home has been the subject of numerous discussions in different parts of the world, as shown by research conducted in Kuwait, Malta, Serbia, the United States and the United Kingdom, where people expressed concerns about this issue (Kusturica *et al.*, 2017). However, good knowledge regarding the disposal of medications often contrasts with bad practices (Aluko *et al.*, 2022; Ariffin *et al.*, 2019; JHA *et al.*, 2021).

Given this scenario, it is important and urgent to develop and implement public policies aimed at the use and proper disposal of household medications, considering that the main routes used are still household waste and sewage systems (Amoabeng *et al.*, 2022; Ayele; Mamu, 2018; Constantino *et al.*, 2018; Jafarzadeh *et al.*, 2021; Jankie *et al.*, 2022).

User awareness and practices regarding pharmaceutical waste disposal are the structural basis of future strategies to reduce the release of active pharmaceutical products into ecosystems (Dias-Ferreira *et al.*, 2016). Pharmacists and other health professionals should assume the role of educators for medication users, addressing the health and environmental risks caused by the accumulation of discarded medications in household waste and sewage systems (Barnett-Itzhaki *et al.*, 2016; Bashaar *et al.*, 2017; Huang *et al.*, 2019). Furthermore, those responsible for producing medications should include specific instructions on the disposal of a specific medication on their labels and inserts (Barnett-Itzhaki *et al.*, 2016).

Thus, our aim was to obtain information from users of primary health care centres in a Brazilian city concerning their knowledge and practices on the disposal of unused and/or expired medications at home.

2 METHODOLOGICAL PROCEDURES

This research was approved by the Research Ethics Committee of the School of Dentistry, Araçatuba campus, of São Paulo State University, in report no. 4,854,162.

This cross-sectional, descriptive, quantitative, prospective study was conducted with 451 adult patients (18 or over) attended at primary health care centres (PHCCs) – 17 urban and three rural centres – in the municipality of Araçatuba, State of São Paulo, Brazil. The city has 200,124 inhabitants, according to the last demographic census conducted in 2022 (IBGE, 2022).

The data collection instrument was adapted and modified from studies previously published by Bashaar *et al.* (2017) and Wang *et al.* (2021). This instrument consisted of objective questions containing independent variables such as: demographic, employment and academic information of patients, and dependent variables such as: guidelines on the disposal of home pharmacy medications and knowledge of reverse logistics. The following disposal options were listed: the household waste, the sewage system, surface water, soil and return to the pharmacy. Some questions allowed only one of the proposed alternatives to be selected, while others accepted more than one answer. The questionnaire was reviewed by experts and pre-tested with 12 respondents. No changes were necessary, and the pilot questionnaire was added to the sample.

We used convenience sampling, in which all patients present at the PHCCs on the days visited by the researcher were invited to answer the questionnaire. Those under 18 years of age and those who refused to sign a term of free informed consent were excluded. The interviews were conducted on random days, from Monday to Friday, during the day, from July to November 2022.

For statistical analysis of the data, the association tests chi-square and chi-square with Yates' correction were applied, at a significance level of 5%, using Microsoft Excel version 2010 and Jamovi version 1.6.23 software.

3 RESULTS

The sample consisted of 74.3% women and 25.7% men, aged between 18 and 81 years, with an approximate mean of 47 years and an approximate standard deviation of 14 years. With regard to the respondents' education, 68.3% had completed primary education, secondary education or technical

school, followed by those who had not completed primary education (19.51%), those who attended higher education (8.7%), and illiterate adults (3.6%).

Regarding the use of medications, we found that most of the respondents used them frequently (58.8%) and usually purchased them both at PHCCs and at pharmacies or commercial drugstores (50.6%). With 95% confidence, we are able to affirm that age is related to the frequency of medication use; older adults tend to consume medications more frequently than younger adults and sex and education do not significantly alter the frequency of use. The place where the medications are purchased is significantly associated with age, sex and education ($p < 0.05$). A higher percentage of 18 and 19-year-olds (50.0%) and respondents who studied higher education (41.0%) only purchase their medications at commercial pharmacies/drugstores. In contrast, women purchase medications at both PHCCs and commercial pharmacies/drugstores with greater frequency (54.6%).

The majority of respondents (91.6%) do not use expired medicines and, considering a significance level of 5%, this behaviour is similar for the different age groups, sexes and levels of education (Table 1).

Table 1 – Respondents’ profile versus habits related to medication use

<i>Frequency of medication use</i>				
<i>Age</i>	<i>Rarely</i>	<i>Sometimes</i>	<i>Always</i>	<i>P-Value¹</i>
18 or 19 years old	12.5%	87.5%	0.0%	<0.001*
20 or 59 years old	14.0%	34.8%	52.2%	
60 years old	5.3%	10.4%	84.3%	
<i>Sex</i>	<i>Rarely</i>	<i>Sometimes</i>	<i>Always</i>	<i>P-Value¹</i>
Female	11.3%	28.7%	60.0%	0.659
Male	12.9%	31.9%	55.2%	
<i>Education</i>	<i>Rarely</i>	<i>Sometimes</i>	<i>Always</i>	<i>P-Value¹</i>
Illiterate	18.8%	12.4%	68.8%	0.290
Primary not completed	12.5%	22.7%	64.8%	
Primary completed	8.0%	30.9%	61.1%	
Secondary / Technical school	12.6%	32.7%	54.7%	
Higher education	17.9%	33.3%	48.8%	
Total	11.8 %	29.5 %	58.8 %	
<i>Place of purchase of medications</i>				
<i>Age</i>	<i>PHCC only</i>	<i>Pharmacy only</i>	<i>PHCC & pharmacy</i>	<i>P Value²</i>
18 or 19 years old	25.0%	50.0%	25.0%	0.040*
20 to 59 years old	17.4%	33.2%	49.4%	
60 years old or over	24.3%	20.0%	55.7%	
<i>Sex</i>	<i>PHCC only</i>	<i>Pharmacy only</i>	<i>PHCC & pharmacy</i>	<i>P Value²</i>
Female	17.9%	27.5%	54.6%	0.013*
Male	23.3%	37.9%	38.8%	

Education	PHCC only	Pharmacy only	PHCC & pharmacy	P Value²
Illiterate	37.5%	6.3%	56.3%	
Primary not completed	21.6%	13.6%	64.8%	
Primary completed	23.5%	29.5%	47.0%	<0.001*
Secondary / Technical school	12.6%	39.6%	47.8%	
Higher education	18.0%	41.0%	41.0%	
Total	19.3 %	30.2 %	50.6%	

Use of expired medication			
Age	No	Yes	PValue¹
18 or 19 years old	75.0%	25.0%	0.085
20 to 59 years old	93.0%	7.0%	
60 years old or over	88.7%	11.3%	

Sex	No	Yes	P Value²
Female	91.6%	8.4%	0.930
Male	91.4%	8.6%	

Education	No	Yes	P Value¹
Illiterate	100.0%	0.0%	0.715
Primary not completed	90.9%	9.1%	
Primary completed	92.6%	7.4%	
Secondary / Technical school	90.6%	9.4%	
Higher education	89.7%	10.3%	
Total	91.6%	8.4%	

PHCC, primary health care centre.

¹ Chi-square test with Yates' correction.

² Chi-square test.

* Significant at a level of 5%.

Source: The authors (2023).

Regarding the reasons for storing medications not being used, the main one was to take them when necessary (97.3%). In addition to this reason, some users have medications in stock because they stopped taking them on doctor's orders (11.5%), stopped taking them because they chose to (8.7%), or stockpiled expired medications (4.4%).

Most people (70.7%) dispose of medications in the household waste, a few bury them in the ground or burn them, while none of the respondents said they throw them in streams, rivers or lakes (Table 2).

Table 2 – Disposal location of unused medications

<i>Disposal location</i>	<i>Frequency</i>	<i>Percentage</i>
Throw them in the household waste	319	70.73%
Return them to the health centre	76	16.85%
Throw them down the toilet	57	12.64%
Give them to neighbours/friends/relatives	44	9.76%
Throw them in the bathroom/kitchen sink	41	9.09%
Throw them in the recyclable waste	13	2.88%
Return them to the pharmacy/drugstore	12	2.66%
Bury them in the ground	6	1.33%
Burn them	2	0.04%
Throw them in streams, rivers or lakes	0	0.00%

Source: The authors (2023).

With 95% confidence, we are able to affirm that the percentage of respondents who discard expired or unused medicine in the household waste is higher among 18 and 19-year-olds (87.5%). In contrast, the percentage of respondents who return expired or unused medications to a PHCC is higher among older adults (28.7%). Only 16.9% of the respondents had returned medications to a PHCC; among these, 6.6% stated that the PHCC refused to accept the medications. We observed that 12.6% of respondents have the habit of discarding expired or unused medicine down the toilet, and, with 95% confidence, this practice is more common among women (14.9%) than among men (6.0%). There are also those who have the habit of giving unused medications to neighbours, friends or relatives (9.8%) or disposing of them in the bathroom or kitchen sink (9.1%). Respondents’ profile (age, sex and education) is not associated with these practices, considering a significance level of 5% (Table 3).

Table 3 – Respondents’ profile versus the disposal habit of expired or unused medications

<i>Disposal in household waste</i>			
<i>Age</i>	<i>No</i>	<i>Yes</i>	<i>P Value¹</i>
18 or 19 years old	12.5%	87.5%	0.002
20 to 59 years old	25.3%	74.7%	
60 years old or over	41.7%	58.3%	
<i>Sex</i>	<i>No</i>	<i>Yes</i>	<i>P Value²</i>
Female	30.7%	69.3%	0.241
Male	25.0%	75.0%	
<i>Education</i>	<i>No</i>	<i>Yes</i>	<i>P Value¹</i>
Illiterate	18.7%	81.3%	0.223
Primary not completed	38.6%	61.4%	
Primary completed	28.8%	71.2%	
Secondary / Technical school	27.0%	73.0%	
Higher education	23.1%	76.9%	
Total	29.3%	70.7%	

<i>Return them to primary health care centre</i>			
<i>Age</i>	<i>No</i>	<i>Yes</i>	<i>P Value¹</i>
18 or 19 years old	100.0%	0.0%	
20 to 59 years old	86.9%	13.1%	<0.001*
60 years old or over	71.3%	28.7%	
<i>Sex</i>	<i>No</i>	<i>Yes</i>	<i>P Value²</i>
Female	84.8%	15.2%	0.117
Male	78.4%	21.6%	
<i>Education</i>	<i>No</i>	<i>Yes</i>	<i>P Value¹</i>
Illiterate	87.5%	12.5%	0.659
Primary not completed	80.7%	19.3%	
Primary completed	80.5%	19.5%	
Secondary / Technical school	85.5%	14.5%	
Higher education	87.2%	12.8%	
Total	83.1%	16.9%	
<i>Throw them down the toilet</i>			
<i>Age</i>	<i>No</i>	<i>Yes</i>	<i>P Value¹</i>
18 or 19 years old	100.0%	0.0%	
20 to 59 years old	86.6%	13.4%	0.467
60 years old or over	88.7%	11.3%	
<i>Sex</i>	<i>No</i>	<i>Yes</i>	<i>P Value²</i>
Female	85.1%	14.9%	0.013*
Male	94.0%	6.0%	
<i>Education</i>	<i>No</i>	<i>Yes</i>	<i>P Value¹</i>
Illiterate	93.8%	6.2%	0.708
Primary not completed	88.6%	11.4%	
Primary completed	86.6%	13.4%	
Secondary / Technical school	85.5%	14.5%	
Higher education	92.3%	7.7%	
Total	87.4%	12.6%	
<i>Give them to neighbours, friends or relatives</i>			
<i>Age</i>	<i>No</i>	<i>Yes</i>	<i>P Value²</i>
18 or 19 years old	100.0%	0.0%	
20 to 59 years old	94.8%	5.2%	0.091
60 years old or over	88.4%	11.6%	

Sex	No	Yes	P Value²
Female	89.0%	11.0%	0.117
Male	94.0%	6.0%	
Education	No	Yes	P VALUE¹
Illiterate	81.3%	18.7%	0.704
Primary not completed	90.9%	9.1%	
Primary completed	91.9%	8.1%	
Secondary / Technical school	89.3%	10.7%	
Higher education	89.7%	10.3%	
Total	90.2%	9.8%	
Throw them in the bathroom or kitchen sink			
Age	No	Yes	P Value¹
18 or 19 years old	75.0%	25.0%	0.287
20 to 59 years old	91.2%	8.8%	
60 years old or over	91.3%	8.7%	
Sex	No	Yes	P Value²
Female	89.6%	10.4%	0.089
Male	94.8%	5.2%	
Education	No	Yes	P Value¹
Illiterate	93.8%	6.2%	0.159
Primary not completed	86.4%	13.6%	
Primary completed	89.9%	10.1%	
Secondary / Technical school	91.8%	8.2%	
Higher education	100.0%	0.0%	
Total	90.9%	9.1%	

¹ Chi-square test with Yates' correction.

² Chi-square test.

* Significant at a level of 5%.

Source: The authors (2023).

Only 77 respondents (17.3%) had received guidance on how to dispose of expired or unused medications. Among these, guidance came mainly from the media (55.8%), followed by pharmacists (11.7%), community health agents (10.4%), family members or friends (10.4%), nurses (9.1%) or doctors (2.6%). Older adults received the most guidance.

With 95% confidence, we found that among respondents who dispose of medications in the household waste, the majority did not receive guidance on correct disposal. Among those who take medications to a PHCC or pharmacy/drugstore, the majority received guidance (Table 4).

Table 4 – Respondents’ habits concerning medication disposal versus having received guidance on correct disposal

<i>Disposal in household waste</i>	<i>Did not receive guidance</i>	<i>Received guidance</i>	<i>P Value²</i>
Yes	89.7%	10.3%	<0.001*
No	65.9%	34.1%	
<i>Throw them down the toilet</i>	<i>Did not receive guidance</i>	<i>Received guidance</i>	<i>P Value²</i>
Yes	87.7%	12.3%	0.284
No	82.0%	18.0%	
<i>Give them to neighbours, friends or relatives</i>	<i>Did not receive guidance</i>	<i>Received guidance</i>	<i>P Value²</i>
Yes	88.6%	11.4%	0.273
No	82.1%	17.9%	
<i>Throw them in the bathroom / kitchen sink</i>	<i>Did not receive guidance</i>	<i>Received guidance</i>	<i>P Value¹</i>
Yes	92.7%	7.3%	0.076
No	81.7%	18.3%	
<i>Throw them in the recyclable waste</i>	<i>Did not receive guidance</i>	<i>Received guidance</i>	<i>P Value¹</i>
Yes	100.0%	0.0%	0.094
No	82.2%	17.8%	
<i>Return them to a primary health care centre</i>	<i>Did not receive guidance</i>	<i>Received guidance</i>	<i>P Value²</i>
Yes	30.3%	69.7%	<0.001*
No	93.3%	6.7%	
<i>Return them to a pharmacy / drugstore</i>	<i>Did not receive guidance</i>	<i>Received guidance</i>	<i>P Value²</i>
Yes	25.0%	75.0%	<0.001*
No	84.3%	15.7%	
tOTAL	82.7%	17.3%	

¹ Chi-square test with Yates’ correction.

² Chi-square test.

* Significant at a level of 5%.

Source: The authors (2023).

Only 2.7% of respondents have the habit of checking information concerning the disposal of medicines on their packaging. This practice has no significant association with an interviewee’s profile, considering a significance level of 5%.

The majority of respondents (83.6%) believe that the improper disposal of medications can cause harm to the environment and to human and animal health; however, 6.3% said there was no relationship, and 11.8% were unable to form an opinion on this matter.

4 DISCUSSION

In recent years, we have observed a technical and scientific focus on the disposal of medications in home pharmacies due to the impacts that improper disposal can have on the environment and on the health of people and animals. Thus, this study was conducted with users of primary health care centres to verify their practices and knowledge regarding the disposal of these medications.

Different locations for expired and/or unused household medications were mentioned by the respondents, mainly throwing them in the household waste, down the toilet, in the bathroom or kitchen sink, or returning them to a health centre. Direct disposal of medications in household waste is considered inappropriate and can have a negative impact on the lives of people, animals and the environment, because they can be intentionally or accidentally reused by people or animals. Moreover, if they remain as waste, they can be absorbed by the soil and dissolved in waterways, constituting environmental contaminants. Improper disposal of pharmaceutical waste was the option indicated by more than half of those interviewed in studies conducted in recent years in several countries: Saudi Arabia (Al-Shareef *et al.*, 2016), Ethiopia (Ayele; Mamu, 2018), Malaysia (Ariffin; Zakili, 2019) and Pakistan (Shoib *et al.*, 2022). The option of disposing of medicines by flushing them down toilets or kitchen and bathroom sinks contaminates watercourses and harms the development of aquatic beings (Silva *et al.*, 2023). Such harm can include hormonal interference in fish, genotoxicity, carcinogenicity in laboratory animals, endocrine disruption and immunological toxicity. All these can be caused in humans and aquatic organisms, even at concentrations as low as nanograms per litre (ng/L) (Mortensen *et al.*, 2014; Voloshenko-Rossin *et al.*, 2015). Antibiotic pollution represents a major global threat, since their metabolites in the aquatic environment are exerting a negative impact on all organisms. The easy migration of antibiotics in drinking water causes serious microbial resistance to these drugs, which poses an environmental risk in view of their residual release into the ecosystem (Kumar *et al.*, 2019; Szymańska *et al.*, 2019).

Water and soil contamination influences the structure of the ecosystem in a vital way, and waste management is crucial for its control. Different solid waste management strategies are used around the world: landfills are the cheapest and the most method practiced; open dumping is also a common practice, in which solid waste is dumped in swamps and low-lying areas (Al-Salem; Lettieri, 2009); together with burning and incineration methods (Josep *et al.*, 2018). The worst effect of waste disposal on the environment can be expected in countries where landfills and open-air garbage dumps are predominant and are not properly regulated. In both cases, the entry of pharmaceuticals into the aqueous medium, both in surface and groundwater, is inevitable (Tong; Peake; Braund, 2011). Unfortunately, incorrect disposal remains a reality, promotes the contamination of environmental matrices and is often not removed by wastewater treatment plants, which leads to interference in the balance of ecosystems (Silva *et al.*, 2023).

There is statistical evidence that the age of the respondents impacted these decisions, with younger adults tending to use household waste for disposal more frequently than older adults, while a higher proportion of older adults normally dispose of these products at PHCCs. Among those who received guidance on the correct disposal of expired and/or unused household medications, there is a significantly higher percentage of those who do not dispose of these products in household waste, preferring to return them to PHCCs or pharmacies. Returning expired and/or unused medicines to health centres was one of the main options indicated by studies conducted in Poland (Rogowska *et al.*, 2019) and Portugal (Dias-Ferreira; Valente; Vaz, 2016).

However, the number of people who use inappropriate methods to dispose of these pharmaceutical products remains significant. It can be assumed that a lack of guidance contributes to such practices, since 82.7% of respondents have never received guidance, and 97.3% have never looked for information on the medication packaging. Among those who have received guidance, a few indicated health professionals (doctors, nurses, pharmacists and community health agents) as a source of information.

A Brazilian study showed that only a small portion of pharmacists have the habit of always advising customers on the proper disposal of unused and expired household medications. Moreover, consumers rarely or never request information on this subject (Michelin *et al.*, 2024). It can be assumed that these professionals are not prepared to guide users. Thus, it is clear how important professional training and continuing education programmes are to promote knowledge on the subject (Bashaar *et al.*, 2017; Fernandes *et al.*, 2020). In addition to acquiring knowledge, the health team must adopt innovative ways to provide guidance to users of health services (Alhomoud *et al.*, 2021; Mahlaba *et al.*, 2022). In Turkey, a study showed that although medications are still disposed of inappropriately, respondents reported having improved their behaviour compared with previous times following educational programmes (Akici *et al.*, 2018), indicating that, among other actions, interventions in people's education can yield positive results.

Household medications and their packaging, whether expired or unused, manufactured or compounded, should be returned to their source through a reverse logistics process currently being implemented, with collection points in commercial pharmacies (Brasil, 2020). Pharmacies in the public health network receive medications independently, at no cost to the user. User education must be in line with government programmes established for the collection of this waste and its respective collection points, at no cost to the population, preferably based on return to the source (Sapkota *et al.*, 2021).

In Brazil, Law no.12.305/10, regulated by Decree no. 10.936/22, established the National Solid Waste Policy, which provides for the objectives, instruments and guidelines related to the integrated management and administration of solid waste, including hazardous waste, the responsibilities of generators and the government and the applicable economic instruments. Chapter I highlights that "in the management and administration of solid waste, the following order of priority must be observed: non-generation, reduction, reuse, recycling, treatment of solid waste and environmentally appropriate final disposal of waste". Furthermore, article 33 of the law requires the organisation and implementation of reverse logistics systems, through the return of products after use by the consumer. This law was regulated by Decree no. 10.388/20, which establishes the reverse logistics system for expired and unused household medications for human use, both manufactured and compounded, and their respective packaging following disposal by consumers.

Some pharmaceutical companies and pharmacy chains have implemented medication collection programmes, allowing consumers to return unused products, preventing them from being disposed of inappropriately, and avoiding the harm caused to public health and the environment. According to the Monitoring and Performance Group (*Grupo de Acompanhamento e Performance*), in 2023, 448,000 kg of medications were collected at 6,294 points distributed across 648 municipalities (Brasil, 2024).

5 CONCLUSIONS

The knowledge of users of primary health care centres in Araçatuba, SP, concerning the correct ways to dispose of expired and/or unused household medications needs to be improved, since only 17.3% of respondents have ever received guidance, and the majority (97.3%) have never looked for information on this subject on medication packaging. The guidance received came mainly from the media (55.8%) rather than health professionals (33.8%) or family and friends (10.4%).

Unfortunately, the lack of knowledge is reflected in the disposal practices of these pharmaceutical products, since a significant number of people use inappropriate methods, such as throwing them in the household waste (70.73%), throwing them down the toilet (12.63%), or in the bathroom or kitchen sink (9.09%), even though the majority (83.6%) believe that such practices can have negative effects on the environment and human and animal health.

Given this scenario, it is important that actions are taken, including educating the population on rational consumption and the proper disposal of expired and/or unused medications, promoting environmental education actions to create socio-environmental empathy, increasing the number of collection points for these products and conducting health surveillance actions.

DECLARATIONS

Conflict of interests: The authors declare that there are no conflicts of interest.

REFERENCES

AKICI, A.; AYDIN, V.; KIROGLU, A. Assessment of the association between drug disposal practices and drug use and storage behaviors. **Saudi Pharmaceutical Journal**, v. 26, n. 1, p. 7-13, 2018. DOI: 10.1016/j.jsps.2017.11.006.

ALGHADEER, S.; ALROHAIMI, M.; ALTHIBAN, A.; KALAGI, N. A.; BALKHI, B.; KHAN, A. A. The patterns of children poisoning cases in community teaching hospital in Riyadh, Saudi Arabia. **Saudi Pharmaceutical Journal**, v. 26, n. 1, p. 93-97, 2018. DOI: 10.1016/j.jsps.2017.10.007.

ALHOMOUD, F. K.; ALSADIQ, Y.; ALGHALAWIN, L.; ALHIFANY, A.; ALHOMOUD, F. Pharmacy students' knowledge and practices concerning the storing and disposal of household medication in Saudi Arabia. **Currents in Pharmacy Teaching and Learning**, v. 13, n. 1, p. 5-13, 2021. DOI: 10.1016/j.cptl.2020.08.004.

AL-SALEM, S. M.; LETTIERI, P. Life cycle assessment (LCA) of municipal solid waste management in the state of Kuwait. **European Journal of Scientific Research**, v. 34, n. 3, p. 395–405, 2009.

AL-SHAREEF, F.; EL-ASRAR, S. A.; AL-BAKR, L.; AL-AMRO, M.; ALQAHTANI, F.; ALEANIZY, F. Investigating the disposal of expired and unused medication in Riyadh, Saudi Arabia: a cross-sectional study. **International Journal of Clinical Pharmacy**, v. 38, n. 4, p. 822-828, 2016. DOI: 10.1007/s11096-016-0287-4.

ALUKO, O. O.; IMBIANZOR, G. T.; JIDEAMA, C. O.; OGUNDELE, O. V.; FAPETU, T. E.; AFOLABI, O. T.; ODEWADE, O. L. The perception and disposal practices of unused and expired medicines by households in an urban municipality, southwest Nigeria: a comparative cross-sectional study. **Waste Management**, v. 1, n. 140, p. 121-132, 2022. DOI: 10.1016/j.wasman.2022.01.022.

AMOABENG, I. A.; OTOO, B. A.; DARKO, G.; BORQUAYE, L. S. Disposal of Unused and Expired Medicines within the Sunyani Municipality of Ghana: a cross-sectional survey. **Journal of Environmental and Public Health**, v. 26, n. 61, p. 1-7, 2022. DOI: 10.1155/2022/6113346.

ARIFFIN, M.; ZAKILI, T. S. T. Household Pharmaceutical Waste Disposal in Selangor, Malaysia-Policy, Public Perception, and Current Practices. **Environmental Management**, v. 64, n. 4, p. 509-519, 2019. DOI: 10.1007/s00267-019-01199-y.

ARUN, S.; KUMAR, R. M.; RUPPA, J.; MUKHOPADHYAY, M.; ILANGO, K.; CHAKRABORTY, P. Occurrence, sources and risk assessment of fluoroquinolones in dumpsite soil and sewage sludge from Chennai, India. **Environmental Toxicology and Pharmacology**, v. 79, p. 1-9, 2020. DOI: 10.1016/j.etap.2020.103410.

AYELE, Y.; MAMU, M. Assessment of knowledge, attitude and practice towards disposal of unused and expired pharmaceuticals among community in Harar city, Eastern Ethiopia. **Journal of Pharmaceutical Policy and Practice**, v. 11, n. 27, p. 1-7, 2018. DOI: 10.1186/s40545-018-0155-9.

BARNETT-ITZHAKI, Z.; BERMAN, T.; GROTO, I.; SCHWARTZBERG, E. Household medical waste disposal policy in Israel. **Israel Journal of Health Policy Research**, v. 5, n. 48, p. 1-8, 2016. DOI: 10.1186/s13584-016-0108-1.

BASHAAR, M.; THAWANI, V.; HASSALI, M. A.; SALEEM, F. Disposal practices of unused and expired pharmaceuticals among general public in Kabul. **BMC Public Health**, v. 17, n. 45, p. 1-8, 2017. DOI: 10.1186/s12889-016-3975-z.

BASHATAH, A.; WAJID, S. Knowledge and Disposal Practice of Leftover and Expired Medicine: a cross-sectional study from nursing and pharmacy students' perspectives. **International Journal of Environmental Research and Public Health**, v. 17, n. 2068, p. 1-8, 2020. DOI: 10.3390/ijerph17062068.

BRASIL. Law no. 12.305, of August 2, 2010. Establishes the National Solid Waste Policy; amends Law no. 9,605 of February 12, 1998; and provides other measures. **Diário Oficial da União**: Brasília, DF, August 2010.

BRASIL. Decree no. 10.388, of June 5, 2020. Regulates § 1 of chpt. of art. 33 of Law no. 12,305, of August 2, 2010, and establishes the reverse logistics system for expired or unused household medicines, for human use, industrialized and manipulated, and their packaging after disposal by consumers. **Diário Oficial da União**: Brasília, DF, June 2020.

BRASIL. Decree no. 10.936, of January 12, 2022. Regulates Law no. 12,305, of August 2, 2010, which establishes the National Solid Waste Policy. **Diário Oficial da União**: Brasília, DF, January 2022.

BRASIL. Brazilian Institute of Geography and Statistics. **Cities and States**. 2022.

BRASIL. National Information System on Solid Waste Management. **Medicines, their Waste and Packaging**. 2024.

CONSTANTINO, V. M.; FREGONESI, B. M.; TONANI, K. A. A.; ZAGUI, G. S.; TONINATO, A. P. C.; NONOSE, E. R. D. S. et al. Storage and disposal of pharmaceuticals at home: a systematic review. **Ciência & Saúde Coletiva**, v. 25, n. 2, p. 585-594, 2020. DOI: 10.1590/1413-81232020252.10882018.

COSTA, F. A. da; PEDRO, A. R.; TEIXEIRA, I.; BRAGANÇA, F.; SILVA, J. A. da; CABRITA, J. Primary non-adherence in Portugal: findings and implications. **International Journal of Clinical Pharmacy**, v. 37, n. 4, p. 626-635, 2015. DOI: 10.1007/s11096-015-0108-1.

DIAS-FERREIRA, C.; VALENTE, S.; VAZ, J. Practices of pharmaceutical waste generation and discarding in households across Portugal. **Waste Management & Research**, v. 34, n. 10, p. 1006-1013, 2016. DOI: 10.1177/0734242X16639388.

DING, G.; CHEN, G.; LIU, Y.; LI, M.; LIU, X. Occurrence and risk assessment of fluoroquinolone antibiotics in reclaimed water and receiving groundwater with different replenishment pathways. **Science of the Total Environment**, v. 738, p. 1-9, 2020. DOI: 10.1016/j.scitotenv.2020.139802.

FAURE, H.; LEGUELINEL-BLACHE, G.; SALOMON, L.; POUJOL, H.; KINOWSKI, J. M.; SOTTO, A. Assessment of patient adherence to anti-infective treatment after returning home. **Médecine et Maladies Infectieuses**, v. 44, n. 9, p. 417-422, 2014. DOI: 10.1016/j.medmal.2014.08.001.

FERNANDES, M. R.; FIGUEIREDO, R. C.; SILVA, L. G. R. D.; ROCHA, R. S.; BALDONI, A. O. Storage and disposal of expired medicines in home pharmacies: emerging public health problems. **Einstein (São Paulo)**, v. 18, p. 1-6, 2020. DOI: 10.31744/einstein_journal/2020AO5066.

HUANG, Y.; WANG, L.; ZHONG, C.; HUANG, S. Factors influencing the attention to home storage of medicines in China. **BMC Public Health**, v. 19, n. 833, p. 1-10, 2019. DOI: 10.1186/s12889-019-7167-5.

HUSSAIN, R.; RASHIDIAN, A.; HAFEEZ, A. A Survey on Household Storage of Medicines in Punjab, Pakistan. **Journal of Ayub Medical College Abbottabad**, v. 31, n.1, p. 90-97, 2019.

INSANI, W. N.; QONITA, N. A.; JANNAH, S. S.; NURALIYAH, N. M.; SUPADMI, W.; GATERA V. A. Improper disposal practice of unused and expired pharmaceutical products in Indonesian households. **Heliyon**, v. 6, p. 1-5, 2020. DOI: 10.1016/j.heliyon.2020.e04551.

JAFARZADEH, A.; MAHBOUB-AHARI, A.; NAJAFI, M.; YOUSEFI, M.; DALAL, K. Medicine storage, wastage, and associated determinants among urban households: a systematic review and meta-analysis of household surveys. **BMC Public Health**, v. 21, n.1127, p. 1-15, 2021. DOI: 10.1186/s12889-021-11100-4.

JANKIE, S.; BARSATEE, N.; DOOKHAN, V.; SOOKDEO, K.; HERNANDEZ, S.; VILLARROEL STUART, A. Patients' knowledge, attitudes and concerns regarding the disposal of expired/unused medication. **International Journal of Pharmacy Practice**, v. 30, n. 3, p. 247-252, 2022. DOI: 10.1093/ijpp/riac006.

JHA, N.; SHANKAR, P. R.; PALAIAN, S. Knowledge and Practice on Ecopharmacovigilance and Medicine Storage Amongst Medical and Dental Students in Lalitpur, Nepal. **Risk Management and Healthcare Policy**, v. 14, p. 793-802, 2021. DOI: 10.2147/RMHP.S291025.

JOSEP, A. M.; SNELLINGS, R.; VAN DEN HEEDE, P.; MATTHYS, S.; DE BELIE, N. The Use of Municipal Solid Waste Incineration Ash in Various Building Materials: a Belgian point of view. **Materials (Basel)**, v. 11, n. 1, p. 141. 2018. DOI: 10.3390/ma11010141

KALYANGO, J. N.; HALL, M.; KARAMAGI, C. Home medication management practices and associated factors among patients with selected chronic diseases in a community pharmacy in Uganda. **BMC Health Services Research**, v. 18, n. 323, p.1-9, 2012. DOI: 10.1186/1472-6963-12-323.

KRISTINSSON, J.; PALSSON, R.; GUDJONSDOTTIR, G. A.; BLONDAL, M.; GUDMUNDSSON, S.; SNOOK, C. P. Acute poisonings in Iceland: a prospective nationwide study. **Clinical Toxicology (Phila)**, v. 46, n. 2, p. 126-132, 2008. DOI: 10.1080/15563650701438268.

KUMAR, M.; JAISWAL, S.; SODHI, K. K.; SHREE, P.; SINGH, D. K.; AGRAWAL, P. K.; SHUKLA, P. Antibiotics bioremediation: perspectives on its ecotoxicity and resistance. **Environment International**, v. 124, p. 448-461. 2019. DOI: 10.1016/j.envint.2018.12.065.

KUSTURICA, M. P.; TOMIĆ, Z.; BUKUMIRIĆ, Z.; HORVAT, O.; PAVLOVIĆ, N.; MIKOV, M.; SABO, A. Antibiotics in Serbian Households: a source of potential health and environmental threats? **Central European Journal of Public Health**, v. 23, n. 2, p. 114-118, 2015. DOI: 10.21101/cejph.a4093.

KUSTURICA, M. P.; TOMAS, A.; SABO, A. Disposal of Unused Drugs: knowledge and behavior among people around the world. **Reviews of Environmental Contamination and Toxicology**, v. 240, p. 71-104, 2017. DOI: 10.1007/398_2016_3.

KUSTURICA, M. P.; GOLOCORBIN-KON, S.; OSTOJIC, T.; KRESOJA, M.; MILOVIC, M.; HORVAT, O. Consumer willingness to pay for a pharmaceutical disposal program in Serbia: a double hurdle modeling approach. **Waste Management**, v. 104, p. 246-253, 2020. DOI: 10.1016/j.wasman.2020.01.029.

MAHLABA, K. J.; HELBERG, E. A.; GODMAN, B.; KURDI, A.; MEYER, J. C. Health-Care Professionals' Knowledge and Practice Regarding Disposal of Medicines in Primary Health-Care Facilities in South Africa: impact and implications. **Journal of Research in Pharmacy Practice**, v. 10, n. 4, p. 185-190, 2022. DOI: 10.4103/jrpp.jrpp_84_21.

MARWA, K. J.; MCHARO, G.; MWITA, S.; KATABALO, D.; RUGANUZA, D.; KAPESA, A. Disposal practices of expired and unused medications among households in Mwanza, Tanzania. **PLoS One**, v. 16, n. 2, p. 1-9, 2021. DOI: 10.1371/journal.pone.0246418.

MICHELIN, A. F.; BONIFÁCIO, N. A.; NAGATA, W. B.; SILVA, V. M. S. da; GOBBO, L. E. M.; BRESCIANI, K. D. S. Guidance provided by pharmacists to customers regarding to destination of unused household medications: disposal of household medications. **BMC Health Services Research**, v. 23, n. 1350, p. 1-7, 2023. DOI: 10.1186/s12913-023-10319-8.

MORTENSEN, A.; GRANBY, K.; ERIKSEN, F. D.; CEDERBERG, T. L.; FRIIS-WANDALL, S.; SIMONSEN, Y.; BROESBØL-JENSEN, B.; BONNICHSEN, R. Levels and risk assessment of chemical contaminants in by products for animal feed in Denmark. **Journal of Environmental Science and Health - Part B**, v. 49, n. 11, p. 797-810, 2014. DOI: 10.1080/03601234.2014.938546.

ROGOWSKA, J.; ZIMMERMANN, A.; MUSZYŃSKA, A.; RATAJCZYK, W.; WOLSKA, L. Pharmaceutical Household Waste Practices: preliminary findings from a case study in Poland. **Journal of Environmental Management**, v. 64, n. 1, p. 97-106, 2019. DOI: 10.1007/s00267-019-01174-7.

SAPKOTA, B.; GIRI, A.; BHATTA, B.; AWASTHI, K.; BHURTYAL, K.; JOSHI, B. Implementation of medicine take-back concept at community level in Nepal: a pilot study. **Journal of Public Health**, v. 44, n. 3, p. 575-585, 2021. DOI: 10.1093/pubmed/fdab134.

SHOAIB, M.; RAZIQ, A.; IQBAL, Q.; SALEEM, F.; HAIDER, S.; ISHAQ, R.; IQBAL, Z.; BASHAAR, M. Disposal practices of unused and expired pharmaceuticals among the general public in Quetta city, Pakistan. **PLoS One**, v. 17, n. 5, p. 1-13, 2022. DOI: 10.1371/journal.pone.0268200.

SILVA, V. W. P. da; FIGUEIRA, K. L.; SILVA, F. G. da; ZAGUI, G. S.; MESCHEDE, M. S. C. Disposal of drugs and the ensuing environmental impacts: an integrative review of the literature. **Ciência & Saúde Coletiva**, v. 28, n. 4, p. 1113-1123, 2023. DOI: 10.1590/1413-81232023284.05752022.

SZYMAŃSKA, U.; MAREK, W.; IRENEUSZ, S.; JAROSŁAW, K.; GABRIELA, W.; MATEUSZ, K. W. Presence of antibiotics in the aquatic environment in Europe and their analytical monitoring: recent trends and perspectives. **Microchemical Journal**, v. 147, p. 729-740, 2019. DOI: 10.1016/j.microc.2019.04.003

TAI, B. W.; HATA, M.; WU, S.; FRAUSTO, S.; LAW, A. V. Prediction of pharmacist intention to provide medication disposal education using the theory of planned behaviour. **Journal of Evaluation in Clinical Practice**, v. 22, n. 5, p. 653-661, 2016. DOI: 10.1111/jep.12511.

TOMOKAWA, S.; ASAKURA, T.; KEOSADA, N.; BOUASANGTHONG, V.; SOUVANHXAY, V.; NAVAMAL, P. Introducing Ecohealth education in a Teacher Training Institute in Lao PDR: a case study. **Health Promotion International**, v. 36, n. 3, p. 895-904, 2021. DOI: 10.1093/heapro/daaa100.

TONG, A. Y. C.; PEAKE, B. M.; BRAUND, R. Disposal practices for unused medications around the world. **Environment International**, v. 37, n. 1, p. 292-298, 2011. DOI: 10.1016/j.envint.2010.10.002.

VOLOSHENKO-ROSSIN, A.; BAY, S. M.; MARUYA, K.; SNYDER, S. A.; TRENHOLM, R. A. Emerging pollutants in the Esmeraldas watershed in Ecuador: discharge and attenuation of emerging organic pollutants along the San Pedro–Guayllabamba–Esmeraldas rivers. **Environmental Science: processes & impacts**, v. 17, n. 1, p. 41–53, 2014. DOI: 10.1039/C4EM00394B.

WANG, L. S.; AZIZ, Z.; CHIK, Z. Disposal practice and factors associated with unused medicines in Malaysia: a cross-sectional study. **BMC Public Health**, v. 21, n. 1695, p. 1-10, 2021. DOI: 10.1186/s12889-021-11676-x.

WHO. SDG Target 3.9 **Mortality from environmental pollution**. 2021. Available at: https://www.who.int/data/gho/data/themes/topics/sdg-target-3_9-mortality-from-environmental-pollution. Accessed on: jan. 2022.

ZORPAS, A. A.; DIMITRIOU, M.; VOUKKALI, I. Disposal of household pharmaceuticals in insular communities: social attitude, behaviour evaluation and prevention activities. **Environmental Science and Pollution Research**, v. 25, n. 27, p. 26725-26735, 2018. DOI: 10.1007/s11356-017-9551-y.