BJPS

Brazilian Journal of
Pharmaceutical Sciences

http://dx.doi.org/10.1590/s2175-97902023e21525

Article

Health education can save the environment from medicine residues

Giulia de Souza Castro[1], Estael Luzia Coelho da Cruz-Cazarim[2], Marcelo da Silva Silvério[3], Alessandra Ésther de Mendonça[3], Maurílio de Souza Cazarim[3*]

[1]Faculty of Pharmacy, Federal University of Juiz de Fora, Juiz de Fora, MG, Brazil, [2]Faculty of Pharmaceutical Sciences of Ribeirão Preto, University of São Paulo, Ribeirão Preto, SP, Brazil, [3]Faculty of Pharmacy, Department of Pharmaceutical Sciences, Federal University of Juiz de Fora, Juiz de Fora, MG, Brazil

The incorrect disposal of medicines and their environmental impact has been related to the health medicalization and the improper use of medication by society. In this sense, it is very important to know the profile of drug disposal for foster health policies. The aim was to identify the profile of disposal of medicines by the population, including the cost perspective. This is an inquiry descriptive study that began in September 2019. Medicine disposal health education program was carried out over six months in two University pharmacies. A questionnaire for sociodemographic and discarded medicines data collection was applied. Logistic regression analysis for variables association of correct disposal and the chi-square and t-student analysis for comparison between disposal programs were performed for a level of 5% and test power of 80%. Medicines weighed 23.3 kg and 28.5 kg, with the cost variation from US$ 13.5 to US$ 16.1 until the final treatment. The correct disposal was strongly associated with the disposal reason (p=0.013), source of information (p=0.006), prescription (p=0.03), form of use (p=0.01), acquisition source (p=0.001), cost with medication (p=0.0001), education (p=0.028) and age (p=0.05). The correct medicine disposal was associated with important features of the community related to education health.

Keywords: Pharmaceutical services. Medicalization. Health education. Reverse logistics. Drug utilization. Environmental pollution.

INTRODUCTION

Brazil is one of the largest consumers of medicines around the world, it is in seventh place in the worldwide rank (Alvarenga, Nicoletti, 2010; Ramos *et. al*., 2017). This is part of the process of health's medicalization and medicamentation. This fact represents a perspective from global growth that has incorporated the pressure of the pharmaceutical industry in the drug's commercialization and, consequently, in the use of medicines. Additionally, the Brazilian culture is grounded in prompt care and not preventive care, which has corroborated to inappropriate use of medicines (Brasil, 2018).

In this trivialization' scenario of medicines consumption by Brazilian society, it is highlighted that there are policies that strengthen the access to prescription medicines but confront the medicines logistics as a whole due to several factors, including cultural and professional features (Brasil, 2014). That is summarized in set rules and conceptions constituting the Pharmaceutical Services, which predicts a guaranteed provision to access quality medicines and the promotion of Rational Drug Use (RDU) (Ribeiro *et al.,* 2021). However, the policies have not been strong enough to stop the inappropriate use of medicines and their exaggerated consumerism by society (Magalhães, Mol, 2013).

***Correspondence:** M. S. Cazarim. Faculdade de Farmácia. Universidade Federal de Juiz de Fora. Campus Universitário. Rua José Lourenço Kelmer, s/n. 36036-900, São Pedro, Juiz de Fora, MG. E-mail: maurilio.jf@gmail.com. ORCID: https://orcid.org/0000-0002-2826-5903

Unified Health System (*SUS*) spent around US$ 5 billion on medicines in 2016, but since 2010 the annual investment in these products had increased by about 30% (Vieira, 2018). In a report by the Federal Comptroller General, it was presented that eleven states and the Federal District discarded about US$ 4 million in medicines between 2014 and 2015, the main reason was the expired and incorrect storage of medicines. Brazil occupies sixth place in the ranking of the market for medicines (Carneiro, 2011). However, according to the Association of the Pharmaceutical Research Industry (*Interfarma*) the market should turn over US$ 44 billion in medicines in 3 years, displacing Brazil to the fifth position in the ranking until 2023 (CRSP, 2017). According to National Health Surveillance Agency (*ANVISA-Brazil*), there is an estimate that about 10,000 and 28,000 tons of medicines are thrown away every year by consumers, which had been highlighted as a wide problem for public health policies (ICTQ, 2019; Bellan *et al.,* 2012).

In fact, the background of the consumption of medicines in Brazil, besides culminating medication losses in the logistical management of Pharmaceutical Services, also is accountable for increasing the number of medicines in "home pharmacies", and many medicines expire or become disuse objects, thus propitious to be disposable. In this way, the disposal of these pharmaceutical products occurs, in great part, of the inappropriate way and in an amount capable to generate a wide impact on the environment (Quadra *et al*., 2019).

Efforts are needed to change this reality, becoming by population awareness for reducing the impact caused by the incorrect disposal of medicines. In this sense, the Decree 10338 of 2020 regulates from the structuring to the operationalization of medicines reverse logistics system of expired or in disuse. This applies only to medicines that are exclusive to human use. In this logistics, there are assignments for all actors in the medication chain: manufacturers, importers, distributors, traders, and consumers (Brasil, 2020).

In addition, expired medicines from health services are regulated by the National Health Surveillance Agency (ANVISA), as public as private pharmacies, Resolution of Collegiate Board of Directors nº222/2018. Therefore, the responsibility for such residues remains unchanged and reinforced, now, with the task of managing reverse drug logistics (Brasil, 2018).

Nonetheless, these regulations are still insufficient in view of society's habits, is important stewardship along with society for fighting the waste of public funds and reducing the environmental impact (Ribeiro *et al*., 2021). Furthermore, there are obstacles to be overcome, one of them is the absence of health educational actions in society, the consequences of various health problems as problems that directly and indirectly compromise the quality of life, not only of medicines users but in the whole Brazilian populations because we are vulnerable to accidental intoxications and important impacts as to contamination of water, soil, and damages to biomes (Iob, Camillo, Petry, 2013).

In this context, there is a need to delineate the characteristics of the main actors and scenarios in reverse logistics facing the use of medicines and a home pharmacy. Thus, becomes evident to necessary understanding of the scope of the educational activities for planning them so that the process of medicines reverse logistics works well established (Ribeiro *et al*., 2021). This study aimed to promote health education for the correct disposal of medicines and to assess the disposal profile of medicines by the population including the costs generated.

MATERIAL AND METHODS

Study design

This is an inquiry descriptive study, started in September 2019. The sampling was carried out for convenience given the normal flow of services offered by the teaching pharmacies. In this way, it included customer patients at pharmacies, students, and employees. The inclusion criteria for the analysis of the data were defined as: population linked to the pharmacy, as well as its users and members of the Campus University; and exclusion criteria: individuals with incomplete data on the registration form; the disposal represented by a legal entity.

Study Location

The University Pharmacy (FU-UFJF) of UFJF is a practice scenario for undergraduate and graduate students, research and extension projects also, professional training, and provision of services such as dispensing, care pharmaceutical, and homeopathic and allopathic manipulation. The FU-UFJF serves users of the SUS in the western district of Juiz de Fora. The pharmacy provides service to an average of 90 daily prescriptions and attends an average of three to six patients in pharmaceutical consultations per day. The University Pharmacy of (FUUSP-RP) offers the same services as FU-UFJF, except for homeopathic manipulation. In addition, it has industrialized products for sale and not for SUS service. The FUUSP-RP has an average of 40 service orders per day, with 60 prescriptions fulfilled, and an average attendance of 2 daily patients in the clinic.

Disposal service: pilot project

The medicines disposal program started in October 2017 at FUUSP-RP and in September 2019 at FU-UFJF. The program had a Health Education service, which aimed to sensitize the community to awareness of medicines disposal. Concurrently, the user was presented with the medicine disposal device, and furniture. Sequentially, information on logistics service for the correct disposal of medicines was given and, personal and medicines data were collected and recorded. Furthermore, personalized segregation and disposal furniture has been available to users divided between the categories: solids, semi-solids and liquids, packaging / instructions and spray. Each category was classified on a Universal code as it is requested by the United Nations (UN) for each transported category of product, UN number (each class, solid, liquid and flammable, with its UN code 3249, 1851 and 3248, respectively), segregated in specific disposal bags for each material and, therefore, proceeded to the outsourced collection for correct disposal in the municipality. The entire process was established in the Health Services Waste Management Plan (PGRSS) in both pharmacies, counting the due documentation required by current legislation.

Initially, pharmacy users were exclusively approached with the delivery of material and guidance on the correct disposal of medication at the time they were looking for a pharmacy to use their services. There is also an information folder, posted at the pharmacy, about the importance of the correct disposal of medicines.

Data collection and variables searched

At the moment that the user arrived with the medicines to be discarded, he was welcomed and oriented about the health risks involved, sequentially, the collection of information related to the discard. For this, a questionnaire with closed questions was applied to each user who sought the service in order to contemplate the following variables to be analyzed: age, sex, education, source of information, place of purchase, prescription, continuity of use, and reason for disposal. It is noteworthy, that the data referring to costs were obtained by consulting the Medicines Price Ceiling Table (CMED) of ANVISA, version April 2020.

Data collection was performed over six months, from September 2019 to February 2020. A pre-structured spreadsheet was applied to collect sociodemographic information (gender, education, and age), and information related to discarded drugs such as quantity, dosage, pharmaceutical form, and cost. Medicines discarded were classified by the Anatomical Therapeutic Chemical (ATC) systematization to identify the anatomical group (**http://www.whocc.no/atc_ddd_index/**) (WHO, 2020).

Data analysis

The obtained data were tabulated in the Microsoft Excel 2016 program and analyzed using the statistical software MINITAB® v17, considering the significance level of 5% and test power above 80%. Descriptive statistics performed for continuous variables measured the summary and dispersion measures: mean, standard deviation, median, minimum, maximum, mode, and modal number. For the categorical variables, the absolute number and frequency were measured.

Simple binary logistic regression analysis was used using a dependent variable “disposal site” with the

options: correct and incorrect. The answer "Correct" was fixed in the regression, and it was understood as the disposal in pharmacies that comply with legislation for medicines reverse logistics or pioneers in disposal systems with a correct destination for pharmacological waste. The "incorrect" answer was used to classify the other disposal sites, such as: toilets, common garbage, and environment, among others.

The independent variables were adjusted for the answer with the highest association value. A Pearson analysis was also performed to assess a correlation between variables. In addition, analyzing Odds Ratio (OR) was made by using logistic regression and 95% confidence interval (IC 95%).

The t- student test for independent samples was run to compare the means of the continuous variable of age and drug costs between two groups of analyzes, FU-UFJF and FUUSP-RP. The null hypothesis referred to as averages for both groups were equal. For categorical variables, the chi-square test was run to verify the difference between the proportions of the categories for the Institutional variables of the scenarios FU-UFJF and FUUSP-RP.

As the monetary values for the cost evaluation, it was used Index for conversion of Central Bank of Brazil, where US$ 1 corresponded to R$ 5.41 on 30th April 2021 (available at the site: **https://www.bcb.gov.br/en**).

Ethics

This study obtained the approbation from the Research Ethics Committee for both scenarios, release nº 032/2017 of the Research Ethics Committee of the Faculty of Pharmaceutical Sciences of Ribeirão Preto - USP.

RESULTS

Of the total eligible population in this study, 191 users were served in the discard medicines program and, consequently, they had guidance on health education for the correct disposal of medicines. However, only 183 were eligible for data analysis, corresponding to 89 for FU-UFJF and 94 for USP-RP (Figure 1).

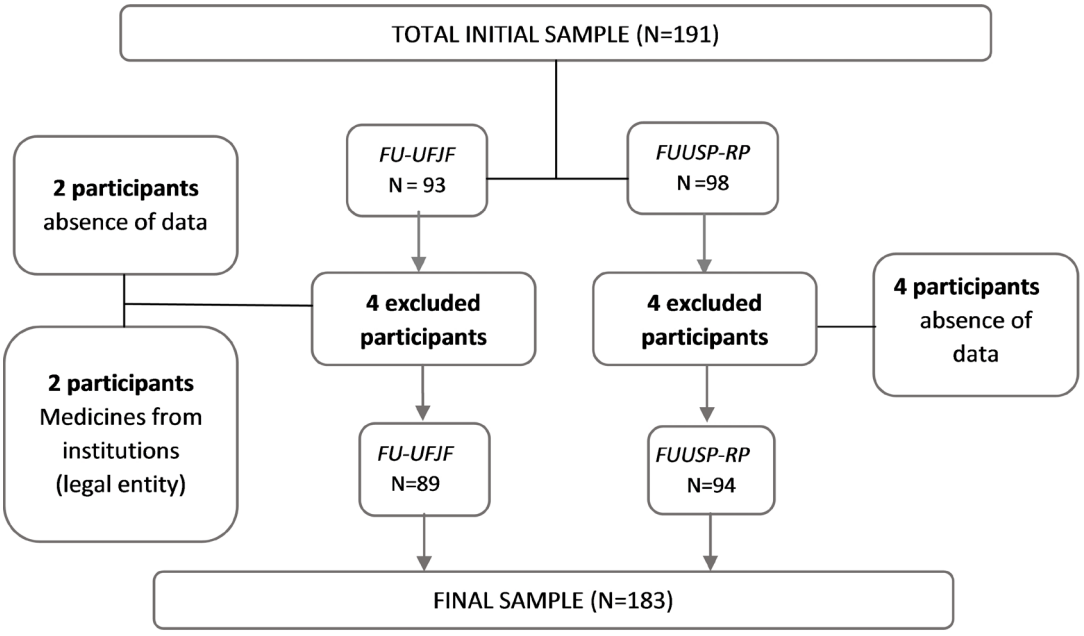

FIGURE 1 - Study participants according to the inclusion and exclusion criteria.

Caption: FU-UFJF = University Pharmacy at the Federal University of Juiz de Fora; FUUSP-RP = University Pharmacy of the University of São Paulo, Ribeirão Preto.

The total number of medicines discarded in the period weighed 28.5 kg and 23.3 kg and the cost was US$ 13.5 and US$ 16.1 (R$ 72.90 and R$ 86.92) for the treatment and final destination to the Public Service, respectively for FU-UFJF and FUUSP-RP. The correct disposal at the FU-UFJF was strongly associated with the disposal reason (p = 0.013), Information source for disposal (p = 0.006), prescription (p = 0.03), form of use (p = 0.01), acquisition source (p = 0.001) and also with the cost of medication (p = 0.0001). In the USP-RP scenario, the correct disposal was strongly associated with the variables: education (p = 0.028) and age (p = 0.05) (Table I and Table II).

TABLE I - Result of logistic regression regarding the correct disposal profile by the population of FU-UFJF (n = 89)

Variable	Category	Number (%)	Gross Odds Ratio (IC 95%)	Adjusted Odds Ratio (IC 95%))	Gross P-value	Adjusted p-value
DEPENDENT CATEGORIC VARIABLE						
Disposal site						
	Correct disposal *	23 (25.84)	-	-	-	-
	Incorrect disposal **	66 (74.16)				
INDEPENDENT CATEGORIC VARIABLES						
Sex						
	Female †	63 (70.79)		-	0.72	-
	Male	26 (29.21)	1.2874 (0.3242; 5.1130)			
Education						
	High School †	34 (38.20)		-	0.858	-
	Basic and Fundamental	25 (28.09)	1.5338 (0.2284; 10.2994)			
	Higher	30 (33.71)	0.8363 (0.1814; 3.8552)			
Acquisition source						
	Private †	46 (51.69)			0.002	0.001
	SUS	20 (22.47)	0.0297 (0.0029; 0.3014)	0.0353 (0.0045; 0.2745)		
	Mixed	23 (25.84)	0.1967 (0.0360; 1.0746)	0.2253 (0.0467; 1.0874)		
Information source for disposal						
	University Pharmacy †	67 (75.28)			0.005	0.006
	Social media	4 (4.49)	3.6527 (0.1488; 89.6346)	3.8742 (0.1562; 96.0902)		
	Third parties***	7 (7.87)	2.4779 (0.2895; 21.2067)	2.8266 (0.3645; 21.9178)		
	Others	11 (12.36)	0.0188 (0.0011; 0.3324)	0.0244 (0.0015; 0.3899)		
Form of use (Continuous use)						
	No †	43 (48.31)			0.005	0.01
	Yes	35 (39.33)	0.1112 (0.0193; 0.6418)	0.1332 (0.0267; 0.6641)		

(continues on the next page...)

TABLE I - Result of logistic regression regarding the correct disposal profile by the population of FU-UFJF (n = 89)

Variable	Category	Number (%)	Gross Odds Ratio (IC 95%)	Adjusted Odds Ratio (IC 95%))	Gross P-value	Adjusted p-value
	Mixed	11 (12.36)	0.0483 (0.0033; 0.7057)	0.0853 (0.0077; 0.9447)		
Disposal reason						
	Quality / validity †	53 (59.55)			0.016	0.013
	Disuse	36 (40.45)	6.6099 (1.2465; 35.0504)	5.99814 (1.3438; 26.6234)		
Prescription						
	Yes †	80 (89.89)			0.041	0.03
	No	9 (10.11)	0.0953 (0.0071; 1.2779)	0.094 (0.0080; 1.1017)		
CONTINUOUS VARIABLES						
Age						
	-	-	0.9893 (0.9478; 1.0325)	-	> 0.05	-
Number of medicines						
	-	-	1.0826 (0.8700; 1.3472)	-	> 0.05	-
Amount of medication (u)						
	-	-	1,0009 (0.9930; 1.0089)	-	> 0.05	-
Cost with medication						
			0.9927 (0.9865; 0.9990)	0.9943 (0.9902; 0.9983)	0.0001	0.0001

SUS = Unified Health System; IC 95% = confidence interval with an accuracy of 95%. The categories that were fixed in the regression analysis to assess correlation with the correct disposal in the analysis were: Female; High school; Private; University Pharmacy; non-continuous use; validity / quality; Prescribed.

† are the categories set for regression analysis

* correct disposal refers to pharmacies and UBS

** incorrect disposal refers to common waste and other

*** Third parties include: friends, radio and email

TABLE II - Result of logistic regression regarding the profile of correct disposal by the population of FUUSP-RP (n = 94)

Variable	Category	Number (%)	Gross Odds Ratio (IC 95%)	Adjusted Odds Ratio (IC 95%)	Gross P-value	Adjusted p-value
DEPENDENT CATEGORIC VARIABLE						
Disposal site						
	Correct disposal *	29 (30.85)	-	-	-	-
	Incorrect disposal **	65 (69.15)				

(continues on the next page...)

TABLE II - Result of logistic regression regarding the profile of correct disposal by the population of FUUSP-RP (n = 94)

Variable	Category	Number (%)	Gross Odds Ratio (IC 95%)	Adjusted Odds Ratio (IC 95%)	Gross P-value	Adjusted p-value
INDEPENDENT CATEGORIC VARIABLES						
Sex						
	Female †	69 (73.40)		-	0.401	-
	Male	25 (26.60)	0.5827 (0.1608; 2.1112)			
Education						
	Higher†	64 (68.09)			0.042	0.028
	High school	29 (30.85)	0.1874 (0.0405; 0.8676)	0.1743 (0.0411; 0.7386)		
	Basic and Fundamental	1 (1.06)	5.9997 (0.1895; 189.9265)	3.698 (0.1849; 73.9560)		
Acquisition source						
	Private †	76 (80.85)		-	0.914	-
	SUS	6 (6.38)	0.6279 (0.0532; 7.4173)			
	Mixed	12 (12.77)	0.8152 (0.1701; 3.9076)			
Information source for disposal						
	University Pharmacy †	51 (54.26)		-	0.471	-
	Social media	12 (12.77)	0.9665 (0.1967; 4.7493)			
	Third parties***	8 (8.51)	0.2271 (0.0208; 2.4733)			
	Others	23 (24.47)	1.4734 (0.4341; 5.0010)			
Form of use (Continuous use)						
	No †	49 (52.13)			0.116	0.151
	Yes	8 (8.51)	7.3358 (0.9224; 58.3428)	4.8137 (0.8532; 27.1599)		
	Mixed	37 (39.36)	2.1874 (0.6705; 7.1362)	1.9468 (0.8532; 27.1599)		
Disposal reason						
	Disuse †	52 (55.32)			0.274	0.193
	Quality / validity	42 (44.68)	0.5413 (0.1769; 1.6558)	0.5125 (0.1840; 1.4279)		
Prescription						
	Yes †	79 (84.04)		-	0.616	-
	No	15 (15.96)	1.4453 (0.3449; 6.0554)			
CONTINUOUS VARIABLES						
Age						
	-	-	0.9451 (0.8945; 0.9985)	0.9561 (0.9118; 1.0026)	0.04	0.05

(continues on the next page...)

TABLE II - Result of logistic regression regarding the profile of correct disposal by the population of FUUSP-RP (n = 94)

Variable	Category	Number (%)	Gross Odds Ratio (IC 95%)	Adjusted Odds Ratio (IC 95%)	Gross P-value	Adjusted p-value
Number of medicines						
	-	-	0.9878 (0.9072; 1.0755)	-	0.78	-
Number of medications						
	-	-	0.999 (0.9946; 1.0034)	-	0.64	-
Cost with medication						
	-	-	1,0007 (0.9999; 1.0015)	1,0004 (0.9998; 1.0010)	0.08	0.17

SUS= Unified Health System; IC 95% = confidence interval with an accuracy of 95%. The categories that were fixed in the regression analysis to assess correlation with the correct disposal in the analysis were: Female; University education; Private; Pharmacy School; non-continuous use; disused and prescribed.

† are the categories set for regression analysis

* correct disposal refers to pharmacies and UBS

** incorrect disposal refers to common waste and other

*** Third parties include: friends, radio and email

The category with the highest frequency of disposal was A (alimentary tract and metabolism) and the one that was related to the highest individual cost per discarded medication was N (nervous system) in both FUUSP-RP and FU-UFJF: 18.65% and 19.53%; US$ 1,431.21 and US$ 875.24 (R$ 7,742.87 and R$ 4,735.06), respectively (Table III).

TABLE III - Number of drugs discarded and their costs according to the ATC / WHO classification

ATC	No. of medication (%)	Mean number of drugs per patient (SD)	Total cost	Mean cost per patient (SD)	No. of drug with cost not found
FU-UFJF					
A	109 (19,53)	1,239 (1,77)	US$ 687,242	US$ 7,809 (18,77)	14
B	9 (1,61)	0,10 (0,37)	US$ 47,402	US$ 0,537 (2,35)	1
C	54 (9,68)	0,61 (1,31)	US$ 648,937	US$ 7,373 (27,68)	-
D	30 (5,38)	0,34 (0,87)	US$ 196,205	US$ 2,229 (6,87)	3
G	12 (2,15)	0,14 (0,41)	US$ 145,101	US$ 1,64 (7,39)	4
H	25 (4,48)	0,28 (0,62)	US$ 91,297	US$ 1,03 (4,67)	-
J	71 (12,72)	0,81 (1,05)	US$ 514,499	US$ 5,84 (12,23)	-

(continues on the next page...)

TABLE III - Number of drugs discarded and their costs according to the ATC / WHO classification

ATC	No. of medication (%)	Mean number of drugs per patient (SD)	Total cost	Mean cost per patient (SD)	No. of drug with cost not found
L	-	-	-	-	-
M	48 (8,60)	0,55 (0,95)	US$ 125,471	US$ 1,42 (2,74)	3
N	99 (17,74)	1,13 (1,69)	US$ 875,242	US$ 9,95 (22,29)	-
P	6 (1,08)	0,07 (0,25)	US$ 15,20	US$ 0,17 (0,70)	-
Q	-	-	-	-	6
R	78 (13,98)	0,89 (1,72)	US$ 395,71	US$ 4,35 (12,54)	1
S	17 (3,05)	0,19 (0,52)	US$102,42	US$1,16 (3,47)	1
V	-	-	-	-	-
TOTAL	**558**	-	**US$3.844,72**	-	33
FUUSP-RP					
A	133 (18,65)	1,41 (1,62)	US$1.372,01	US$14,60 (64,70)	23
B	7 (0,98)	0,074 (0,30)	US$34,39	US$0,37 (1,40)	2
C	45 (6,31)	0,48 (0,92)	US$703,28	US$7,48 (24,58)	3
D	96 (13,46)	1,02 (1,80)	US$803,92	US$8,55 (19,44)	13
G	16 (2,24)	0,17 (0,46)	US$163,03	US$1,73 (6,44)	1
H	28 (3,93)	0,30 (0,72)	US$96,69	US$1,03 (3,77)	-
J	47 (6,59)	0,50 (0,92)	US$1.268,97	US$13,50 (82,28)	-
L	6 (0,84)	0,06 (0,35)	US$522,47	US$5,56 (49,62)	-
M	53 (7,43)	0,56 (0,87)	US$155,81	US$1,66 (3,61)	3
N	108 (15,15)	1,15 (1,72)	US$1.431,21	US$15,23 (77,79)	2
P	12 (1,68)	0,13 (0,34)	US$76,65	US$0,82 (3,12)	-
Q	-	-	-	-	21
R	124 (17,39)	1,32 (1,92)	US$686,66	R$7,30 (16,62)	5
S	38 (5,33)	1,52 (1,00)	US$274,69	R$2,92 (6,36)	1
V	-	-	-	-	-
TOTAL	**713**	-	**US$7.589,79**	-	-

Legend: All drugs whose prices were not found in the *CMED* 2020 table were discarded for the absolute numbers and percentages.

\In addition to the drugs used in the previous analyzes, herbal medicines, homeopathic and cosmetics were discarded. The herbal medicines were the most discarded among three, being discarded about 335 (94.90%) and 197 (98.50%) drug units and 25 and 30 types of active ingredient, respectively, to FU-UFJF and FUUSP-RP (Table IV).

TABLE IV - Quantification of herbal medicines, homeopathic and cosmetics from FU-UFJF and FUUSP-RP

Class	Quantity of medicine s (%)	Mean of medication per patient (SD)	Total Medicine number (%)	Mean of the units of drugs per patient (SD)
FU-UFJF				
Phytotherapic	335 (94.90)	3.81 (14.16)	25 (64.10)	0.28 (0.74)
Homeopathic	9 (2.55)	0.10 (0.59)	5 (12.82)	0.06 (0.28)
Cosmetic	9 (2.55)	0.10 (0.76)	9 (23.08)	0.10 (0.76)
FUUSP-RP				
Phytotherapic	197 (98.5)	2.20 (8.45)	30 (90.90)	0.33 (0.87)
Homeopathic	3 (1.5)	0.02 (0.15)	3 (9.10)	0.02 (0.15)
Cosmetic	-	-	-	-

Legend: Cosmetics were considered gel, creams, moisturizers for hands and body and softener for cuticles; SD = Standard Deviation; Units' drugs = pills, vials and etc

Continuous variables were shown to be different for the mean age of patients and the cost of medications discarded, 45 ± 18.4 and 38 ± 14.1 years (p = 0,04); US$ 43,06 ± US$ 57.96 (p<0,0001) and US$ 76.63 ± US$ 143.38 for FU-UFJF and FUUSP-RP, respectively (Table V). As for categorical variables, all variables presented a difference between Institutions, except the prescription (Table VI).

TABLE V - Analysis of continuous variables regarding the correct disposal of drugs from the FU-UFJF and FUUSP-RP

Variable	Mean (SD)	Median (Q1-Q3)	Minimum – Maximum	Mode (Modal N)	p-value (gross)
FU-UFJF **(n = 89)**					
Age	44,88 (18,38)	49 (23.5-60.5)	16-81	21 (7)	> 0.05
Number of medications *	6,281 (7,187)	4 (2.0-8.0)	1-44	1 (21)	> 0.05
Qtd. of medication (u) **	99,5 (177.6)	43 (8-100.5)	1-1022	3 (6)	> 0.05
Cost with medication (US$)	43,06 (57,96)	20,64 (6.9-46,87)	0,075-303,99	-	0.0001
FUUSP-RP (n = 94)					
Age	37,53 (14,05)	35 (24-51.25)	18-73	32 (7)	0.04

(continues on the next page...)

TABLE V - Analysis of continuous variables regarding the correct disposal of drugs from the FU-UFJF and FUUSP-RP

Variable	Mean (SD)	Median (Q1-Q3)	Minimum – Maximum	Mode (Modal N)	p-value (gross)
Number of medicines	6,862 (7,486)	4 (2-8)	140	2 (19)	0.78
Qtd. of medication (u)	91,2 (165,5)	44 (11.8-91)	1-1066	1,4,9 (4)	0.64
Cost with medication(US$)	76,63 (143,38)	36,93 (11,12-72,31)	0,18-786,24	-	0.08

SD = standard deviation; Q1 = First Quartile; Q2 = Second Quartile ; *FU-UFJF* = University Pharmacy of the Federal University of Juiz de Fora; *FUUSP-RP* = University Pharmacy of the University of São Paulo, Ribeirão Preto .

* Number of drugs discarded (active ingredients)

** Quantity of discarded drugs (tablets, bottles, tubes , etc.)

TABLE VI - Comparison of the profile of medication disposal by the population between the scenarios of the disposal for FU-UFJF and FUUSP-RP

Variable	FU- UFJF	FU USP –RP	Odds Ratio (IC 95%)	p-value	GL	Chi-Square
CONTINUOUS VARIABLES						
Absolute number						
	89	94	-	-	-	-
Mean age (SD)						
	44,8 (18.4)	37.5 (14.1)	7.12 (2.32; 11.93)	0.004	-	-
Average cost (SD)						
	US$ 43,06 (57,96)	US$ 76,63 (143,38)	-	0.041	-	-
CATEGORIC VARIABLES - N (%)						
Education						
Higher	30 (33.71)	64 (68.09)	-	0.000	2	63.4875
High school	34 (38.20)	29 (30.85)	-			
Basic and Fundamental	25 (28.09)	1 (1.06)	-			
Acquisition source						
Private	46 (51.69)	76 (80.85)	-	0.000	2	
SUS	20 (22.47)	6 (6.38)	-			34.5825
Mixed	23 (25.84)	12 (12.77)	-			
Information source for disposal						
University Pharmacy	67 (75.28)	51 (54.26)	-	0.000	3	33.0522
Social media	4 (4.49)	12 (12.77)	-			
Third parties*	7 (7.87)	8 (8.51)	-			
Others	11 (12.36)	23 (24.47)	-			

(continues on the next page...)

TABLE VI - Comparison of the profile of medication disposal by the population between the scenarios of the disposal for FU-UFJF and FUUSP-RP

Variable	FU- UFJF	FU USP –RP	Odds Ratio (IC 95%)	p-value	GL	Chi-Square
Form of use (Continuous use)						
No	43 (48.31)	49 (52.13)	-	0.000	2	83,434
Yes	35 (39.33)	8 (8.51)	-			
Mixed	11 (12.36)	37 (39.36)	-			
Disposal reason						
Disuse	36 (40.45)	52 (55.32)	-	0.002	1	9.1795
Quality / validity	53 (59.55)	42 (44.68)	-			
Prescription						
Yes	80 (89.89)	79 (84.04)	-	0.0052	1	3.7657
No	9 (10.11)	15 (15.96)	-			

SD = standard deviation; IC 95% = 95% confidence interval; GL = Degree of Freedom; ; SUS= Unified Health System.

FU-UFJF = University Pharmacy of the Federal University of Juiz de Fora; *FUUSP-RP* = University Pharmacy of the University of São Paulo, Ribeirão Preto.

* Third parties include: friends, radio and email.

DISCUSSION

In the present study, there was a higher prevalence of females both at FU-UFJF (70.79%) and at FUUSP-RP (73.40%), which can be justified by the fact of greater acceptance by women to answer the script interviews of the disposal program. The age group was as described between 16 and 81 years at FU-UFJF and 18 and 73 years at FUUSP-RP, with the most frequent ages being 21 and 32 years old, respectively. Additionally, our study showed the age variable is associated with the correct disposal of medicines by the population, according to the data analyzed by the FUUSP-RP.

The literature reinforces the prevalence of females for the disposal of medicines and shows that age among individuals who discard can vary between 18 and 89 years, with a frequency of 36.1% in the age group between 18 to 39 years (Ramos *et al*., 2017). In this sense, the results of an important Brazilian study "Use and Promotion of the Rational Use of Medicines (PNAUM)" support the findings of our study. That study was carried out over the years 2013 to 2014 in a population base of data extracted based on the residences of municipalities and evaluated 38,400 interviews regarding the use of medicines for chronic diseases. Our study showed a prevalence of 50.7% (IC 95% 49.3–52.2) of the use of medicines by the population, with 39.3% (IC 95% 37.5–41.1) being male and the majority 61.0% (IC 95% 59.3–62.6) by the female gender. Additionally, the highest prevalence was in the 10-19 age groups between 20 and 29 years old, with women between 20 and 29 years old using twice as manyh medicines as men (Bertoldi *et al*., 2014).

The source where the discarded drugs were purchased was more prevalent in the private sector, approximately 52% at FU-UFJF and 81% at FUUSP-RP. It is noteworthy that the study by Ribeiro and Heineck (2010) acquired about 31.7% of the medicines in use by the population in ***SUS*** and 68.3% in the private health system. Our results showed that this variable was associated with correct disposal, individuals who purchase drugs through ***SUS*** showed a 25 times less chance of correctly disposing OR = 0.035

(IC 95%, 0.0045-0.2745) when compared to the private sector. In addition, education and level of education can corroborate the magnitude of this result, considering that the education variable was associated with the correct disposal of medicines and that, generally, students of public schools may be more vulnerable to social determinants such as education and have a lower degree of schooling considering that the education variable was associated with the correct disposal of medicines (Vaz, Freitas, Cirqueira, 2011). All of this reinforces the need for public policies aimed at reverse medicines logistics.

It was observed that the way of using the drug is associated with correct disposal, there is a greater chance of performing the correct disposal if the user does not use continuous treatment OR = 0.13 (IC 95%, 0.0267-0.6641). This result may indicate that medicines used for a predetermined time may generate less left over in-home pharmacies compared to continuous use that becomes more vulnerable to storege, increasing its volume, and consequently, increasing the portion of incorrect disposal that is more prevalent than the correct disposal for that population (Ramos *et al.*, 2017; Vaz, Freitas, Cirqueira, 2011; Gasparini, Gasparini, Frigieri, 2011; Maia, Giordano, 2012; Pinto *et al.*, 2014). In this context, it is noteworthy that there was a predominance of incorrect disposal of drugs in our study, at FU-UFJF (74.16%), being the main reason for loss of validity and quality (59.55%) and in FUUSP-RP (69.15%), and the main reason being disuse (55.32%).

It was also possible to observe that the disposal reason was associated with the correct disposal of medicines in the FU-UFJF scenario. In addition, among the users of the FU-UFJF, when compared to the disuse category with the category of quality and validity (fixed) it was indicated that people who dispose of medicines for reasons of quality or validity have been approximately six times less chance to discard correctly compared to people who discard for reasons of disuse OR = 5.99 (IC 95%, 1.34-26.62). Attention to checking expiration dates and managing medications can corroborate a profile of an individual with greater awareness and also having the attention to correctly dispose of the medication. As shown in the profile of the FU-UFJF, 59.55% of the population discart by expiration of validity or quality. The literature has shown that the main reason for disposal was also the expiration of the validity period (62.9%) (Ramos *et al*., 2017).

On the other hand, attention to managing medications and checking those that are no longer used can reveal a population profile that cares about a homemade pharmacy in the sense of leftover and greater risks of poisoning. According to data released by the National pharmacological Toxic Information System (SINITOX), 115 of the 32,311 cases resulted in death by drug intoxication in 2016 (SINITOX, 2020). In addition, many of those who seek the pharmacy with disused medicines, usually before dispose, asked if there is a possibility of reuse of these medicines by others, but when there is not, they ended up discarding the medicines. This context was fitted to the profile of the population of FUUSP-RP, in which 55.3% of the persons discarded due to disuse.

The analysis of this independent study shows the importance of health education programs for the correct disposal of medicines. When analyzing the origin of the information on the correct disposal "the place that you learned about the disposal ", our results showed that users who obtained information through other ways had 40 times less chance to discard correctly in relation to those who had information from the University Pharmacy, by the health education, OR = 0.0244 (IC 95%,0.0015-0.3899). Although FUUSP-RP had no presented information source like a significant result associated with correct disposal of medicines, it had a minor perceptual of University Pharmacy information compared to FU-UFJF. This result highlights the important role of health professionals and health education programs.

Evaluating the discarded medicines more directly, it was possible to observe that, on average, each patient at FU-UFJF discarded about six different types of medications with approximately 100 units and wasted about US$ 43.07 (R$ 233.00) on medicines. In the FUUSP-RP scenario, each patient discarded about seven different medicines approximately, 91 units and wasted an average of US$ 76.63 (R$ 414.60). According to the Federal Pharmacy Council (2013) the estimate is that about 10.3 and 19.8 thousand tons of medicines are discarded annually and approximately 6.7 thousand tons by municipalities with more than 100 thousand inhabitants.

In the present study, it was possible to observe that in the scenario of the FU-UFJF the variable "medicines cost" was associated with the correct disposal of the medication. Due to these facts, the need for guidance on the use and care of medications must be reinforced, and this way to avoid abandoning treatments, incorrect storage, and waste of public and individual funds.

Although the study points out important associations of the profile users for the correct disposal of medicines, it is of paramount importance that convenience sampling can be a limiting factor in study results. It is noteworthy that both pharmacies promote services to society and this research had developed so as not to harm those services. Even though the medicines reverse logistic program has been preponderant for the sensitization of users, work on health education the society, and promoting data collection for analysis of a profile, the program did not let training of users to participate in the study and neither randomization in groups. That can have occasioned bias in the memory of the interviewees due to the need to recall some late information and can have contributed to the increasing number of refusals.

CONCLUSIONS

Correct disposal by the population was strongly associated with information sources for disposal, a variable related to health education. Certainly, some pharmacies are fitting themselves to develop the medicines reverse logistics, but our study has shown that as important as offering this service is investing in health education. Our results have indicated that the population is not prepared to contribute to its role in this subject.

In addition, other variables such as the disposal reason, acquisition source, presence of prescription or not, continuous or non-use of the medication, and the cost of the medication in the scenario of the FU-UFJF and, education level, as well as age in the FUUSP-RP scenario, were strongly associated with correct disposal by population. Additionally, those who do not make continuous use of drugs can have a greater chance of disposing of their medicines correctly.

In short, the disposal of medicines has been carried out incorrectly by the majority of people, which proves the need for information and awareness of society for this cause. In this sense, it is reinforced that the projects developed for health education regarding the correct disposal of medicines and to stimulate the collection of medicines in disuse or expiration by the community are important to provide benefits to human health and the environment.

ACKNOWLEDGMENT

National Council for Scientific and Technological Development (CNPq) funding agency has provided scholarship by the Federal University of Juiz de Fora [Institutional scientific initiation scholarship (BIC) from August 2019 to August 2020] and, Minas Gerais Research Funding Foundation (FAPEMIG) funding agency has provided scholarships [grant number CDS APQ 02745/21 - 59597 and 60776 from January 2022 to December 2022]. Thus, it has contributed to the development of the paper "10-year economic impact of a preventive care program for reducing cardiovascular morbidity and mortality". The funder had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript. Opinions, assumptions and conclusions, or recommendations expressed in this article are responsibility of the authors and do not necessarily reflect the viewpoint of FAPEMIG. It is noted that the funders had no role in study design, data collection and analysis, the decision to publish, or the preparation of the manuscript.

REFERENCES

Agência Nacional de Vigilância Sanitária (Brasil). ANVISA. Resolução n°222, de 28 de março de 2018. Regulamenta as boas práticas de gerenciamento dos resíduos de serviços de saúde e dá outras providências. Diário Oficial da União 29 mar 2018; Seção 1.

Alvarenga LSV, Nicoletti MA. Descarte doméstico de medicamentos e algumas considerações sobre o impacto ambiental. Revista Saúde-UNG-Ser. 2010;4(3):34-39.

Bellan N, Pinto TDJA, Kaneko TM, Moretto LD, Santos Junior ND. Critical analysis of the regulations regarding the disposal of medication waste. Braz J Pharm Sci. 2012;48(3):507-518.

Bertoldi AD, Pizzol TSD, Ramos LR, Mengue SS, Luiza VL, Tavares NUL, et al. Perfil sociodemográfico dos usuários de medicamentos no Brasil: resultados da PNAUM 2014. Rev. Saúde Pública. [Internet]. 2016 [cited on 2021 Jan 23];50(Suppl 2):5s. Available: https://doi.org/10.1590/s1518-8787.2016050006119

Brasil. Ministério da Saúde. Secretaria de ciência, tecnologia e insumos estratégicos, departamento de assistência farmacêutica e insumos estratégicos. Assistência Farmacêutica na Atenção Básica: Caderno 1. [Internet]. Brasília (DF): Ministério da Saúde, 2014 [cited on 2021 Ago. 3]. Available: https://bvsms.saude.gov.br/bvs/publicacoes/servicos_farmaceuticos_atencao_basica_saude.pdf

Brasil. Ministério da Saúde. Secretaria de ciência, tecnologia e insumos estratégicos, departamento de assistência farmacêutica e insumos estratégicos. Uso de medicamentos e medicalização da vida: recomendações e estratégias. [Internet]. Brasília (DF): Ministério da Saúde, 2018 [cited on 2021 Ago. 3]. Available: https://portalarquivos2.saude.gov.br/images/pdf/2019/fevereiro/14/errata-livro-uso-de-medicamentos-e-medicalizacao-da-vida.pdf

Brasil. Decreto Nº 10.388, 5 de junho 2020. Regulamenta o § 1º do caput do art. 33 da Lei nº 12.305, de 2 de agosto de 2010, e institui o sistema de logística reversa de medicamentos domiciliares vencidos ou em desuso, de uso humano, industrializados e manipulados, e de suas embalagens após o descarte pelos consumidores. [Internet]. 2020 [cited on 2021 jan 23]. Available: https://www.planalto.gov.br/ccivil_03/_Ato2019-2022/2020/Decreto/D10388.htm

Carneiro F. Descartar medicamentos vencidos ainda é problema. Jornal Rudge Ramos [Internet]. 2011 [cited on 2021 Mar 23]. Available: http://www.metodista.br/rronline/rrjornal/2011/ed.970/descartar-medicamentos-vencidos-ainda-e-problema.

Conselho Federal de Farmácia (CFF). Logística Reversa: Brasil busca solução para descarte inadequado de medicamentos. Pharm. Bras. [Internet]. 2013 [cited on 2020 Apr 20];87:1-66. Available: http://www.cff.org.br/sistemas/geral/revista/pdf/139/revista_web_(1).pdf

Conselho Regional de Farmácia de São Paulo (CRSP). Validade vencida e armazenagem incorreta de medicamentos geram prejuízos de R$ 16 milhões ao SUS. [Internet]. São Paulo: CRFSP. 2017 [cited on 2020 Mar 20]. Available: http://www.crfsp.org.br/noticias/9008-desperdicio-em-medicamentos.html

Gasparini JC, Gasparini AR, Frigieri, MC. Estudo do descarte de medicamentos e consciência ambiental no município de Catanduva-SP. RCT. 2011;2(1):38-51. ISSN 2178-9436.

Instituto de Ciência Tecnologia e Qualidade (ICTQ). Brasil é o 6° mercado farmacêutico do mundo [Internet]. 2019 [cited on 2020 Mar 20]. Available: https://www.ictq.com.br/industria-farmaceutica/1060-brasil-e-o-6-mercado-farmaceutico-do-mundo.

Iob GA, Camillo EGS, Petry RD. Análise da forma de descarte de medicamentos por usuários de uma Unidade de Saúde no município de Porto Alegre/RS. Infarma. 2013;25(3):118-25.

Magalhães SMS, Mol MPG. Medicamentos como problema ambiental. Acurcio, FA, organizador. Medicamentos: Políticas, Assistência Farmacêutica, Farmacoepidemiologia e Farmacoeconomia. Belo Horizonte: Coopmed. 2013.

Maia M, Giordano F. Estudo da situação atual de conscientização da população de Santos a respeito do descarte de medicamentos. Revista Ceciliana [Internet]. 2012 [cited on 2020 Mar 17];4(1):24-28. Available: https://sites.unisanta.br/revistaceciliana/edicao_07/1-2012-24-28.pdf

Pinto GMF, Silva KR, Pereira RFAB, Sampaio SI. Estudo do descarte residencial de medicamentos vencidos na região de Paulínia (SP), Brasil Eng Sanit Ambient. [Internet]. 2014 [cited on 2020 Apr 17];19(3):219-24. Available: https://www.scielo.br/scielo.php?script=sci_arttext&pid=S1413-41522014000300219&lang=pt https://doi.org/10.1590/S1413-41522014019000000472

Quadra GR, Silva PSA, Paranaíba JR, Josué IIP, Souza H, Costa R, et al. Investigation of medicines consumption and disposal in Brazil: A study case in a developing country. Sci Total Environ. 2019;671:505-9.

Ramos HMP, Cruvinel VRN, Meiners MMMA, Queiroz CA, Galato D. Medication disposal: a reflection about possible sanitary and environmental risks. Ambient. soc. [Internet]. 2017 [cited on 2021 Ago 3];20(4):145-168. Available: https://www.scielo.br/j/asoc/a/648TQV9twSrPLBNdRhXpYWR/?format=pdf&lang=pt

Ribeiro DP, Oliveira UR, Silva AC, Aprigliano VF. Evaluation of medicine reverse logistics practices in hospitals. Sustainability. 2021;13(6):3496.

Ribeiro MA, Heineck I. Estoque domiciliar de medicamentos na comunidade ibiaense acompanhada pelo Programa Saúde da Família, em Ibiá-MG, Brasil. Saúde soc. [Internet]. 2010 [cited on 2020 Mar 14];19(3):653-63. Available: https://doi.org/10.1590/S0104-12902010000300016

Sistema Nacional de Informações Tóxico-Farmacológicas. SINITOX. Brasil. [Internet]. 2020 [cited on 2020 Apr 10]. Available: https://sinitox.icict.fiocruz.br/dados-de-agentes-toxicos/

Vaz KV, Freitas MM, Cirqueira JZ. Investigação sobre a forma de descarte de medicamentos vencidos. Revista Cenarium Pharmacêutico [Internet]. 2011 [cited on 2020 Mar 16];4(4):1-25.Available: http://www.unieuro.edu.br/

sitenovo/revistas/downloads/farmacia/cenarium_04_14.pdf

Vieira FS. Evolução do gasto com medicamentos do Sistema Único de Saúde no período de 2010 a 2016. Nº 2356. [Internet]. Brasília: Rio de janeiro: Ipea, 2018. [cited on 2021 Ago 3] Available: https://www.ipea.gov.br/portal/images/stories/PDFs/TDs/180117_td_2356.pdf

World Health Organization. WHO. Collaborating centre for drugs statistics methodology. Anatomical therapeutic chemical classification - ATC Code [Internet]. Noruega: WHO; 2020. [cited on 2020 Mar 18]. Available: https://www.whocc.no/atc_ddd_index/.

Received for publication on 11th August 2021
Accepted for publication on 24th March 2022