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https://doi.org/10.22239/2317-269x.01314

Analysis of pharmaceutical waste received in educational practices towards the promotion of conscious disposal of unused or expired medicines in Goiás state, Brazil

Análise dos resíduos farmacêuticos recebidos em práticas educativas para promoção do descarte consciente de medicamentos vencidos ou em desuso no estado de Goiás, Brasil

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Received: May 7, 2019
Approved: Dec 11, 2019

ABSTRACT

Introduction: Annually, 10-28 thousand tons of medicines are inappropriately discarded in the environment by Brazilian consumers, being a great problem in public and environmental health. The lack of knowledge of the population about the impacts generated is one of the factors that promote this scenario. **Objective:** To perform the characterization of expired or unused medicines received in educational practices in Goiânia, Goiás State, Brazil. **Method:** Educational practices and receipt of expired/unused medicines occurred in June, October and December 2018 in different places of Goiânia (educational institution, municipal parks etc). The medicines were characterized regarding the pharmaceutical form, therapeutic classes, compliance with current Brazilian legislation etc, and forwarded to an environmentally correct disposal. **Results:** 866 medicines were received, predominantly products of national origin (98.72%), human use (97.46%), solid pharmaceutical forms (75.64%), unused (10.16%) or expired (86.26%), and industrialized medicines of the generic (26.32%), similar (39.26%) or reference (28.86%) types. In addition, 17.10% were free medicine samples, mainly contraceptives, antihypertensives and antibacterials. Moreover, 7.51% were medicines under special control (Ordinance No. 344/1998), while 9.12% were antimicrobials with a need for retention of the prescription (RDC No. 20/2011). Among the drugs classified in the therapeutic classes covered by the RDC No. 222/2018, 344 (39.72%) were received, among them: antimicrobials (18.93%), hormones (14.20%), immunosuppressants (6.12%) and antiretrovirals (0.47%). **Conclusions:** In view of the large amount of pharmaceutical waste characterized in this study, it is highlighted the need to promote continuing educational practices to provide the population with correct information and public awareness. Moreover, it is important to establish effective legislative instruments to promote the environmentally correct disposal of expired/unused medications found in household environments.

KEYWORDS: Environmental Pollution; Drug Utilization; Medical Waste; Waste Management; Drug Publicity

RESUMO

Introdução: Anualmente, entre 10 e 28 mil toneladas de medicamentos são inadequadamente descartados no ambiente pelos consumidores brasileiros, tratando-se de um grande problema em saúde pública e ambiental. A falta de conhecimento da população sobre os impactos gerados é um dos fatores promotores desse cenário. **Objetivo:** Realizar a caracterização de medicamentos vencidos ou em desuso recebidos em práticas educativas em Goiânia, estado de Goiás, Brasil. **Método:** Práticas educativas e recebimento de medicamentos vencidos/em desuso aconteceram em junho, outubro e dezembro de 2018 em diferentes pontos de Goiânia (instituição de ensino, parques municipais etc.). Os medicamentos foram caracterizados quanto à forma farmacêutica, classes terapêuticas, atendimento a legislações brasileiras vigentes etc. e encaminhados para

descarte ambientalmente correto. **Resultados:** Foram recebidos 866 medicamentos, dos quais havia predominantemente produtos de origem nacional (98,72%), para uso humano (97,46%), formas farmacêuticas sólidas (75,64%), em desuso (10,16%) ou vencidos (86,26%), e medicamentos industrializados do tipo genérico (26,32%), similar (39,26%) ou de referência (28,86%). Além disso, 17,10% eram amostras grátis, principalmente hormônios sexuais, medicamentos para o aparelho cardiovascular e antibacterianos. Ademais, 7,51% eram medicamentos sujeitos a controle especial (Portaria nº 344/1998), enquanto que 9,12% eram antimicrobianos com necessidade de retenção de receita (RDC nº 20/2011). Sobre os medicamentos classificados nas classes terapêuticas de abrangência da RDC nº 222/2018, foram recebidos 344 (39,72%) unidades, entre eles: antimicrobianos (18,93%), hormônios (14,20%), imunossupressores (6,12%) e antirretrovirais (0,47%). **Conclusões:** Em vista da grande quantidade de resíduos farmacêuticos caracterizados nesse estudo, evidencia-se a necessidade de promover práticas educativas continuadas com a finalidade de fornecer à população informações corretas e conscientização pública. Além disso, é necessário estabelecer instrumentos legislativos eficazes que promovam o descarte ambientalmente correto de medicamentos vencidos/em desuso presentes em ambientes domiciliares.

PALAVRAS-CHAVE: Poluição Ambiental; Uso de Medicamentos; Resíduos de Serviços de Saúde; Gerenciamento de Resíduos; Publicidade de Medicamentos

INTRODUCTION

According to the Institute for Human Data Science[1], Brazil is one of the largest consumer markets for medicines in the world. Despite the political and economic obstacles faced in recent years, the expectation is that Brazil will rank fourth on this list as from 2018, behind the United States, China and Japan. In view of this high consumption of medicines, we may question, for example, whether the population is getting sick more often or there is overconsumption of medicines. The second option seems plausible when we learn that about 10 to 28,000 tons of medicines, which corresponds to approximately 20% of the country's pharmaceutical production, are discarded by Brazilian consumers in the sewer or in common waste every year[2,3].

Because of the potential for bioaccumulation and low biodegradability, it is known that part of this chemical waste, like antibiotics, painkillers and contraceptives, are not totally removed by the conventional process of sewage treatment in force in Brazil and in several parts of the world[4,5,6]. Nevertheless, their levels in the environment are not routinely monitored in different parts of Brazilian states, and they are therefore considered as emerging contaminants[7]. Thus, society and the environment may be exposed to different potential hazards, many of them hitherto unknown, due to our limited knowledge of the toxicological impact of the various types of drugs disposed of in the environment. In addition to the active ingredients responsible for the pharmacological action, a medication is made of a mixture of other substances, called fillers (for example: on average, a tablet or capsule contains approximately nine fillers). Although they are declared as inactive ingredients, these substances are not necessarily free from toxicity to the human body[8].

The irrational use of medicines has prevailed, among other factors, because of a healthcare model focused on the disease to the detriment of the promotion of preventive measures[3,9,10]. It is also driven by the distribution of free samples by pharmaceutical companies[5] and the easy acquisition associated with the practice of self-medication, which result in the accumulation and expiration of these products in people's homes[5,10]. Several other reasons can lead to the accumulation and waste of drugs in home environments, such as: excess medication per package, improvement of the patient's clinical condition and failure to complete the treatment, low therapeutic adherence or change of prescription due to adverse reactions[6,11]. Prescribing medications for long-term treatments at once (for example: use for three months) can also increase the amount of unused products[12]. It is worth noting that the veterinary market is also responsible for this large consumption of pharmaceutical products, which can cause the same problems as medicines for human use: accumulation in homes and inadequate disposal in the environment[13].

Some damages generated by the incorrect disposal of expired or out-of-use medicines are the contamination of water, soil, food, and animal and human poisoning[5,11,12]. Even though every drug can cause some harm, the disposal of some pharmacological classes has attracted a lot of attention from the scientific community. For example: antibiotics are involved in the process of bacterial resistance; estrogens affect the reproductive system of aquatic organisms promoting the feminization of male fish; and antineoplastic and immunosuppressive drugs have the potential to cause genetic mutations in living organisms, including humans[14].

This issue has been increasingly debated among health and environmental agencies, governmental and non-governmental institutions, researchers, and others, in order to design legal instruments that regulate the management of this hazardous waste. Based on the Brazilian Laws and Guidelines, one of the regulatory milestones in the area of Biosafety was the publication, by the National Health Surveillance Agency (Anvisa), of a legal framework that regulates the Good Practices in the Management of Waste from Health Services, Resolution of the Collegiate Board (RDC) n. 222, of March 28, 2018[15], which revoked RDC n. 306, of December 7, 2004. Likewise, Law n. 12.305, of August 2, 2010[16], establishes the National Solid Waste Policy, which includes medicines. In 2018, the Ministry of the Environment launched a public inquiry to regulate Law n. 12.305/2010 and also to determine the reverse logistics of medicines discarded by consumers (http://consultaspublicas.mma.gov.br/medicamentos/). In fact, the disposal of medicines

for human use, expired or unused, has already been standardized by the Brazilian Association of Technical Standards (ABNT NBR 16457:2016)[17], but not effectively enforced in Brazil. The state of Goiás, which has Brazil's second largest pharmochemical industrial complex, has established the State Policy on Solid Waste and the definition of pollution prevention guidelines and standards through Law n. 14.248, of July 29, 2002[18].

However, several factors contribute to inappropriate drug disposal in Brazil. One of them is the population's lack of awareness of the impacts generated by these pharmaceutical products when disposed of in household waste or sewer system[5,19]. For example, a field survey carried out in Rio de Janeiro has shown that 61% (n = 25) of the respondents were unaware of the consequences of the incorrect disposal of medicines[19]. Another survey, carried out in the same location and with 1,055 university students from different courses (human, exact or biomedical areas), has shown that 96% (n = 1,012) of the respondents had never received any guidance on how to correctly dispose of pharmaceutical waste. In São Paulo, a study has shown that 92% (n = 564) of the university students interviewed made inadequate disposal due to lack of information on medication collection sites. This highlights the need for public campaigns to advertise collection points located in municipal health clinics, for example[5]. This lack of adequate information and clear instructions on how to responsibly manage household pharmaceutical waste has also been reported in other countries, such as the United States, New Zealand, Bangladesh, Malta and Ireland[20].

In this context, in 2018 the Academic League of Toxicology (LATox), from the College of Pharmacy of the Federal University of Goiás (FF/UFG), started social initiatives in strategic points of the city of Goiânia, state of Goiás (GO), Brazil, with the objective of raising the society's awareness of the topic. In addition to promoting awareness in the media and social networks, expired or unused medicines from the community were collected for correct final disposal. This study identified the material received during the initiatives to analyze the types of drugs that could have been discarded inappropriately in the environment.

METHOD

All educational activities and/or receipt of expired or unused medicines occurred in 2018, in the city of Goiânia, Brazil. The first part of the activities was an educational initiative on the correct disposal of pharmaceutical waste and the receipt of medicines from the population. It took place on June 30, 2018 (month of the Environment Day – June 5) in a midsized municipal park. After this experience, continued actions were conducted throughout October and on December 1st, 2018 in the following locations: at UFG (Goiânia campus), in a compounding pharmacy, two medium to large parks and a charity event held in a church. In addition, awareness-raising activities were carried out through lectures at the University and scientific events in October 2018. The initiatives were also promoted on social networks with posts like "Did you know?", for example (https://www.instagram.com/p/BofY-38lJ0k/). Information about the awareness-raising initiatives and collection sites was shared on the UFG website (https://www.ufg.br/n/110117-acao-evita-descarte-incorreto-de-medicamentos), social media, the Integrated System for the Management of Academic Activities at UFG (http://sigaa.sistemas.ufg.br/) and in television and radio shows.

The collection of medicines was also made in seven customized boxes in strategic places at UFG (Goiânia campus), from October 1 to 31, 2018. These locations were chosen because of the high circulation of students, civil servants and the community from outside the University: FF, School of Civil and Environmental Engineering (EECA), College of Nursing (FEN), College of Nutrition (FANUT), University Pharmacy (FU), UFG University Radio, and School of Veterinary and Animal Science (EVZ). The seven cardboard boxes were lined with a plastic layer and duly identified. The opening of each box was sealed and a hole was made for the disposal of medicines (Figure 1).

The material received was sorted according to human or veterinary use. After sorting, the material was grouped based on the anatomical therapeutic chemical classification (ATC), pharmaceutical form (solid, semi-solid, liquid etc.), empty primary packaging, primary packaging containing medicine (blisters with tablets, syrup bottles, etc.) and secondary packaging and package inserts. The type of medication received was also considered: free samples; medicines for which there is the need to withhold the prescription at the health establishment that dispenses them, according to Ordinance n. 344, of May 12, 1998[21], or RDC n. 20, of May 5, 2011[22]; drugs belonging to one of the eight therapeutic classes (hormones, antimicrobials, cytostatics, antineoplastics, immunosuppressants, digitalis, immunomodulators and antiretrovirals) listed in article 59 of RDC n. 222/2018[15]; and expired drugs (expired shelf life), out of use (not expired, but discarded by the individual) or undetermined expiration date (a discarded product without valid information on the drug label, for example: packaging without legible expiration date). Furthermore, recyclable materials that did not have direct contact with the medicines were prepared and sent for recycling, whereas the rest were weighed and sent to an environmentally correct final destination by a specialized company. All data were included in a spreadsheet using the Excel® software for Windows.

Source: Collected by the authors, 2019.

Figure 1. Representative images of boxes made to collect expired or unused medicines.

The characterization of the collected material was done at the Laboratory of Pharmaceutical Practices of FF/UFG.

RESULTS

Different events were held involving awareness-raising activities and/or collection of medicines from the community. One of them was the participation in "Science Day C" during the 15th UFG Teaching, Research and Extension Congress (October 15-17, 2018). At the University, four educational lectures talked about the importance of not disposing of medicines in household waste and sewer systems, for example, and the impacts on the environment, human and animal health. The audience involved professionals, graduate and undergraduate students from different courses (Pharmacy, Medicine, Dentistry, Food Engineering, Electrical Engineering, Biomedicine, Nutrition, Veterinary Medicine, Law, etc.) and the community. In addition, four social actions were conducted on June 30, October 6 and 20, and December 1st, 2018, in the city of Goiânia. With that, face-to-face educational activities reached an audience of 1,430 people. It is worth noting that the educational initiatives were also promoted on other platforms (for example: social media and television and radio shows), thus providing even more people with information.

Figure 2 shows an overview of the amount of material received in the face-to-face activities and at the collection points. In all, 939 products were received: 73 (7.78%) non-pharmaceutical waste (sunscreens, shampoos, food supplements, etc.); and 866 (92.22%) medicines (whole packages or partially consumed), of which there were products of national origin (n = 863, 98.72%) or imported (n = 3, 1.28%), for human use (n = 844, 97.46%) or exclusively veterinary (n = 22, 2.54%), unused (n = 88, 10.16%), expired (n = 747, 86.26%) or with undetermined expiration date (n = 31, 3.58%). Medicines of synthetic origin (n = 818, 94.45%) and the most prevalent active ingredients are shown in Table 1. There is a predominance of agents indicated for painkilling, infections and hormonal treatments.

Moreover, we found that, of 866 medications, 148 (17.10%) were free samples, mostly sex hormones (n = 98), medications for the cardiovascular system (n = 11) and anti-infectives for systemic use, especially antibacterials (n = 9) (Table 2).

The pharmaceutical materials were then divided into two categories: common recyclable waste (12.7 kg), including package inserts and empty boxes that had no direct contact with medicines; and chemical waste (34.5 kg), such as medicines in their primary packaging (32.1 kg) or materials that had direct contact with the product, like empty primary packaging (2.4 kg) (Figure 3A).

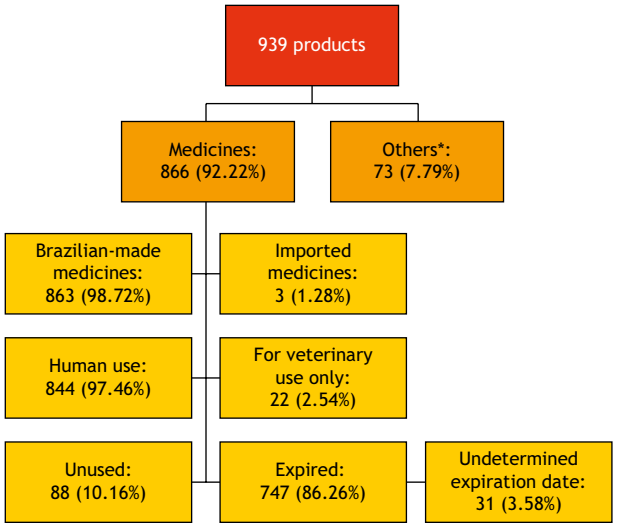
Regarding the pharmaceutical forms, predominantly solid forms (n = 655, 75.64%) were received, with 6,214 tablets, pills or capsules, rather than semi-solid forms (n = 138, 15.94%), liquid (n = 61, 7.04%), gaseous (n = 2, 0.23%), or special (n = 10, 1.15%), which in this case were only in spray (Figure 3B). There were more manufactured drugs of the generic (n = 228, 26.32%), similar (n = 340, 39.26%) and reference types (n = 250, 28.86%) than compounded drugs (n = 22, 2.54%), homeopathic drugs (n = 2, 0.23%) or plant-based therapy (n = 24, 2.77%) (Figure 3C).

With regard to the need for prescription retention in the health establishment, we found that 722 (83.37%) medications were free from prescription retention, while the rest were not (n = 144, 16.62%) (Figure 3D). Of these, 65 (7.51%) were drugs subject to special control, as established by Ordinance n. 344/1998, while 79 (9.12%) were antimicrobials with the need to withhold the prescription in accordance with RDC n. 20/2011 (Figure 3D).

Regarding medicines under the therapeutic classes covered by RDC n. 222/2018, 344 units (39.72%) were received, including: antimicrobials (n = 164, 18.93%), hormones (n = 123, 14, 20%), immunosuppressants (n = 53, 6.12%) and antiretrovirals (n = 4, 0.47%) (Table 3).

DISCUSSION

Stocking up medicines at home can have different impacts on public health and environmental issues, including self-medication, accidental consumption by children, build-up of pharmaceutical ingredients in water sources and risk of bacterial resistance[12,23]. In order to raise the population's awareness of the importance of correctly disposing of expired or unused medicines, this study proposed educational activities and shared knowledge through other approaches, like the use of social media and television and radio shows. In addition, the activities contributed to the recognition of the need to design effective legal standards that promote the collection and reverse disposal of expired or unused medicines in health establishments, such as drugstores and pharmacies (https://www.ufg.br/n/112091-liga-de-toxicologia-contribui-para-projeto-de-lei). This illustrates



* Non-pharmaceutical products, such as sunscreens, shampoos, food supplements etc.
Source: Prepared by the authors, 2019.

Figure 2. Overview of medicines and other products received during on-site community orientation activities and at collection points set up in different areas of the city of Goiânia, Brazil.

Table 1. List of the categories of collected medicine, of synthetic origin for human use or exclusively for veterinary use.

Therapeutic Group (according to ATC code)	Quantity
For veterinary use only	22
A: GI tract and metabolism	1
D: Dermatological medicines	3
G: Genitourinary system and sex hormones	1
H: Systemic hormonal preparations, excluding sex hormones and insulins	4
J: Antiinfectives for systemic use	6
P: Antiparasitics, insecticides and repellents	6
V: Miscellaneous	1
Human use	**796**
A: GI tract and metabolism	97
Bromopride	23
Omeprazole	21
Dimenhydrinate + pyridoxine hydrochloride	6
Others	47
B: Blood and hematopoietic organs	27
Aspirin	20
Tranexamic acid	5
Others	2
C: Cardiovascular system	61
Hydrochlorothiazide	15
Metoprolol succinate	10
Atenolol	6
Amlodipine besylate	5
Others	25
D: Dermatological medicines	105
Lidocaine hydrochloride	18
Triamcinolone acetonide	12
Neomycin sulfate + zinc bacitracin	12
Tretinoin	8
Ketoconazole + betamethasone dipropionate	7
Ketoconazole	6
Others	42
G: Genitourinary system and sex hormones	144
Desogestrel + ethinylestradiol	46
Levonorgestrel + ethinylestradiol	23
Dienogeste	13
Gestodene + ethinylestradiol	9
Chlormadinone acetate + ethinyl estradiol	5
Tamsulosin hydrochloride	5
Others	43
H: Systemic hormonal preparations, excluding sex hormones and insulins	23
Prednisone	8
Prednisolone	6
Others	9
J: Anti-infectives for systemic use	91
Amoxicillin	27
Azithromycin	25
Amoxicillin + potassium clavulanate	10
Others	29
M: Musculoskeletal system	61
Nimesulide	12
Ibuprofen	8
Trometamol Ketorolac	7
Cyclobenzaprine	7
Ketoprofen	5
Others	22
N: Nervous system	109
Paracetamol	27
Dipyrone	18
Paracetamol + caffeine + carisoprodol + diclofenac sodium	12
Paracetamol + codeine	8
Dipyrone + isometheptene mucate + caffeine	6
Clonazepam	5
Betahistine dihydrochloride	5
Dipyrone + orphenadrine citrate + caffeine	5
Others	23
P: Antiparasitics, insecticides and repellents	4
Albendazole	4
R: Respiratory system	51
Desloratadine	14
Codeine Phosphate	6
Others	31
S: Sensory organs	5

Continue

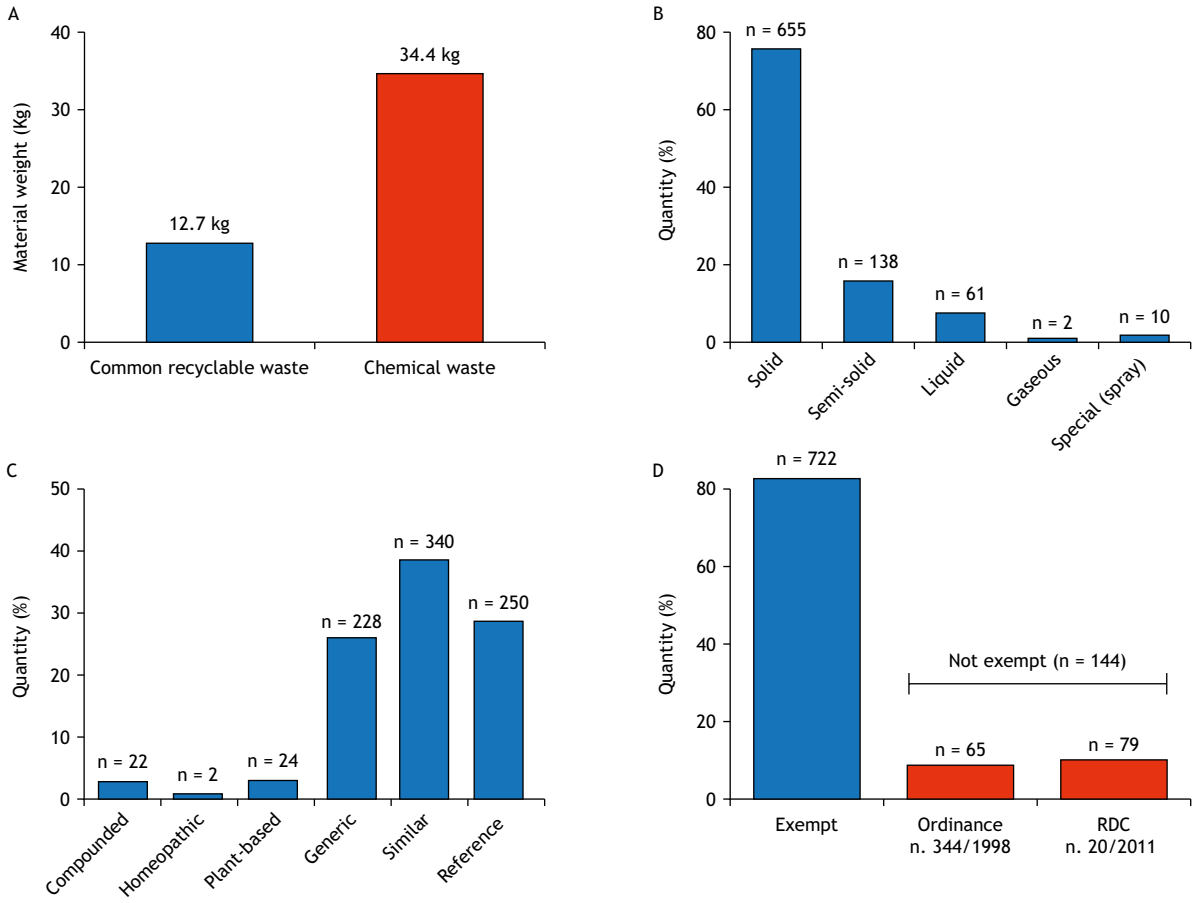
Continuation

Source: Prepared by the authors, 2019.

Table 2. List of free samples of medicines received during on-site community orientation activities and at collection points set up in different areas of the city of Goiânia, Brazil.

Free samples	Human use	Veterinary use only	Total
Sex hormones	98	-	98
Cardiovascular system	11	-	11
Antibacterials	9	-	9
Glucocorticoids	4	-	4
Antifungals	3	-	3
Antihistamines	3	-	3
Local anesthetics	3	-	3
NSAIDs	2	-	2
Antacids/Antiulcer	2	-	2
Erectile dysfunction	2	-	2
Bisphosphonates	2	-	2
Muscle relaxants	2	-	2
Antivertigo	2	-	2
Antitussives	1	1	2
Antiemetics	1	-	1
Ophthalmic lubricants	1	-	1
Rash creams	1	-	1
Total	147	1	148

NSAIDs: non-steroidal anti-inflammatory drugs.
Source: Prepared by the authors, 2019.



Source: Prepared by the authors, 2019.

Figure 3. Characterization of medicines received during on-site community orientation activities and at collection points set up in different areas of the city of Goiânia, Brazil. The materials were divided into common recyclable or chemical waste (A). They were also analyzed as to their pharmaceutical form (B), type of medication (C) and in relation to the need to withhold the prescription at the health establishment (D), according to Ordinance n. 344/1998[21] or RDC n. 20/2011[22].

the need for the commitment of different spheres to avoiding or minimizing the problem of environmentally incorrect disposal of medicines, since the responsibility must be shared among managers, the population, prescribers, distributors of pharmaceutical products and producers of this type of waste[3,9].

Among the total of 939 materials received within 32 days of activities, 866 (92.22%) were medicines, which could have been incorrectly disposed of in the sewage network or common garbage, which is usual in Brazil and other countries (for example: United Kingdom, Lithuania, Serbia, Saudi Arabia, Kuwait)[20,23,24].

Table 3. List of drugs whose therapeutic class is included in RDC n. 222/18 (article 59)[15], and which were received during the on-site activities of community orientation and at the collection points set up in different areas of the city of Goiânia, Brazil.

Therapeutic class included in RDC n. 222/2018 (article 59)	Human use	Veterinary use only	Total
No	**506**	**8**	**514**
Yes	**330**	**14**	**344**
Antimicrobials	155	9	164
Hormones	122	1	123
Immunosuppressants	49	4	53
Antiretrovirals	4	-	4
Digitalis	-	-	-
Cytostatics	-	-	-
Antineoplastics	-	-	-
Immunomodulators	-	-	-

Source: Prepared by the authors, 2019.

A survey conducted in Australia found the presence of 1,424 medicines for human use in 166 households. Of these drugs, 29% (n = 413) were expired[12]. Another 2009 study has shown a 19% rate of expired drugs when analyzing a sample of pharmaceutical waste from the Municipal Waste Department of Vienna, Austria; however, it is worth mentioning that, of the 152 materials, only 22 contained pharmaceutical waste[6]. In another survey conducted in the same city between 2015 and 2016, a higher rate of expired drugs (64%) was found when analyzing 637 pharmaceutical materials from household waste[25]. However, these rates are lower than the high rate of expired drugs found in the present study, which draws our attention and also alerts us to the possibility that the Brazilian population is buying and/or consuming excess medication.

Among the therapeutic agents, most collected products were indicated for pain (paracetamol and combinations, aspirin, dipyrone and nimesulide), infections (amoxicillin and azithromycin) and sex hormones (association of stinyl estradiol with desogestrel or levonorgestrel). In a survey with 613 university students in the state of São Paulo, it was found that 91% of the respondents incorrectly disposed of drugs, of which antibiotics (39%), painkillers (33%) and anti-inflammatory drugs (16%) were the most common[5]. Furthermore, results of analyses of water samples collected between 2006 and 2015 in São Paulo had a similar profile with regard to the presence of drugs: among the 58 chemicals detected in the water, there were painkillers (paracetamol, aspirin, ibuprofen and diclofenac), antibiotics (amoxicillin, ampicillin, cephalexin, ciprofloxacin, norfloxacin, sulfamethoxazole and trimethoprim) and hormones (17α-ethinylestradiol, 17β-estradiol, estriol, estrone, levonorgestrel, progesterone and testosterone)[7]. Of these, a preliminary analysis has shown potential risks to aquatic life due to the presence of paracetamol, diclofenac, 17α-ethinylestradiol, 17β-estradiol, estriol, estrone and testosterone[7]. This shows that, even at low concentrations (that is, concentrations in ng/L), there are potential risks that are mostly unknown, mainly with regard to chronic exposure[23].

Since little is known about the harm to human and animal health caused by the inadequate disposal of pharmaceutical waste in the environment, some therapeutic classes have gained prominence in the Brazilian legislation, as in RDC n. 222/2018[15], for example. Although there is no specific legislation in Brazil for the disposal of medicines, article 59 of RDC n. 222/2018 highlights eight therapeutic classes (hormones, antimicrobials, cytostatics, antineoplastics, immunosuppressants, digitalis, immunomodulators and antiretrovirals) whose waste must be sent for treatment or disposed of in a hazardous waste landfill (class I). Among the drugs collected in the present study, 344 (39.72%) units were under RDC n. 222/2018, with a predominance of antimicrobials (n = 164, 18.93%), hormones (n = 123, 14.20%) and immunosuppressants (n = 53, 6.12%).

Presenting the prescription is mandatory for some classes of drugs, as well as withholding the prescription in the health establishment where the drug is dispensed, in Brazil and in different countries[21,22,25,26]. This is because of the previously known damage, as already listed here, of situations like opioid abuse and resistance to antibiotic therapy in pathogenic bacterial populations[14,27]. In this sense, it was found that 16.62% (n = 144) of the collected drugs were subject to special control, of which 7.51% (n = 65) were narcotic, psychotropic, immunosuppressive or precursor drugs (Ordinance n. 344/1998), while 9.12% (n = 79) were antimicrobials (RDC n. 20/2011). In Vienna, a percentage of 63% (n = 402) of prescription-only drugs was found in samples of pharmaceutical household waste collected between 2015 and 2016[25]. Of this total, 8% (n = 50) were antibiotics[25]. In that city, there are also restrictions for certain therapeutic classes (for example, opioids, benzodiazepines, antibiotics), in a manner that is similar to the Brazilian legislation.

In addition, there was a percentage of 17.10% (n = 148) of free samples in relation to the total of drugs received. In these materials, there was a predominance of medications for the genitourinary system and sex hormones (n = 98), mostly in unused/open packages, followed, to a lesser extent, by medications for the cardiovascular system (n = 11) and antibacterials (n = 9). The distribution of free drug samples to prescribing professionals is a product advertising strategy used by pharmaceutical companies[28]. Although it is a long-standing practice, only in 2009 did a specific Brazilian legislation come into force – RDC n. 60, of November 26, 2009[29] – to regulate the production, dispensation and control of free samples of medicines. It established, for example: the ban on the distribution of samples of compounded drugs and biological products and the requirement that the permitted samples contain at least 50% of the total quantity of the presentation authorized by Anvisa and marketed by the company. In the latter case, there are exceptions for sex hormones, which must present 100% of the amount of the corresponding product; and antibiotics, of which the healthcare professional must dispense the quantity of samples necessary for the full treatment of the patient[29]. Although it also establishes that "the dispensation of free samples by the prescribing professional to the patient must be done in a way that ensures the rational use of the medication" (article 10), our data have shown that this does not seem to be done effectively, especially when we consider the large amount of sex hormones received and not consumed. Therefore, there is a clear need to establish greater control over the amount of free samples distributed by healthcare professionals and the definition of a distribution period after the product marketing authorization, which are conflicting items in the Brazilian legislation, but which occur in European countries[28]. This would be an important measure to promote the rational use of medicines by reducing, for example, unnecessary stocking in households and the waste of medicines. Furthermore, the continuing education of healthcare professionals on this topic is necessary, since the communication with the population must be active to ensure correct guidance. Ideally, this should be done by a multidisciplinary team (physicians, dentists, nurses, pharmacists)[30]. It is also possible to create a strategy to eliminate or reduce sales representatives' influence on the choice of a particular drug by the prescribing professional. This type of choice must be made according to ethical, technical and scientific criteria (that is, data on efficacy, safety, convenience and accessibility to the patient, etc.)[31].

Despite the important findings and observations made here, some limitations of the study can be listed. It was a pilot study, which took place in a short time. In view of this, we could not, for example, identify the change in the behavior of the target covered by the educational initiatives, their perception of the topic in question and the socioeconomic factors involved (gender, age, level of education etc.).

CONCLUSIONS

Based on the characterization of the drugs received in our educational activities, our findings highlight the importance of the rational use of drugs, as well as the need for joint work to promote the conscious disposal of pharmaceutical waste, following environmentally correct standards. One of the options is to offer education to provide the population with correct information and public awareness of the magnitude of the problem of inappropriate disposal of medicines. With that, we could expect a change in the behavior toward this important topic in public and environmental health. In addition, our data are intended to support the enforcement of effective legislative instruments that establish the standardized setup of collection points in Brazilian health establishments (for example: health clinics, pharmacies and drugstores) for consumers to return expired or unused medicines, and also the reverse disposal of these pharmaceutical products.

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Acknowledgments

The authors are grateful for the support received during this study: Social Incubator of the Federal University of Goiás, in particular Fernando Bartholo; Goiânia Municipal Health Department; Farmácia Artesanal; Therapeutica Pharmacia de Manipulação; Sabor Goiano (TS Indústria e Comércio de Alimentos Eireli - Inhumas/GO); and Taynan Alexandre Camilo, Gustavo Cruvinel and team.

Authors' Contributions

All authors participated in the conception, planning (study design), acquisition, analysis, interpretation of data and writing of the work. All authors approved the final version of the paper.

Conflict of Interest

Authors have no potential conflict of interest to declare, related to this study's political or financial peers and institutions.