RESEARCH ARTICLE

Unused, leftover and expired medicine and disposal practices among health sciences faculty students in Burdur, Turkey

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Abstract

Objective: To evaluate the opinions of university-level Health Sciences students about unused, leftover and expired medicine, as well as their disposal practices, and to classify the medicines.

Methods: The cross-sectional study was conducted from April 1 to May 31, 2023, at the Faculty of Health Sciences, Burdur Mehmet Akif Ersoy University, Turkey, and comprised those studying at the Nursing, Nutrition Dietetics and Physical Therapy and Rehabilitation departments. Data was collected using Google Forms. The Anatomical Therapeutic Chemical classification was used for classifying pharmaceutical active ingredients. Data was analysed using SPSS 24.

Results: Of the 373 participants, 272(73%) were females and 101(27%) were males. The overall mean age was 20.8±2.8 years. There were 348(93.3%) subejcts who reported having a total of 845 boxes of leftover and unused medicines in their homes (2.3±1.9 per capita), while 25(6.7%) participants had none. The medicines were stored in the kitchen 261(61.5%) as the storage area, and in the refrigerator 181(40.2%) as the storage unit. The expired medicine was disposed of in the garbage in 328(86.1%) cases. Self-medication was prevalent in 325(87.1%) cases. Anatomical Therapeutic Chemical classification analysis showed that paracetamol, acetylsalicylic acid, paracetamol+caffeine and metamizole sodium was the most common group of leftover and unused medicines 283(81.3%).

Conclusion: High prevalence of unused and leftover medicine, disposal of medicine in household garbage, and self-medication behaviour indicated a serious public health and environmental problem.

Keywords: Pharmaceutical, Public health, Self-medication, Turkey. (JPMA 74: 1280; 2024)

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Introduction

According to the World Health Organisation (WHO), a significant proportion of medicines given to patients are taken, prescribed, or sold inappropriately, leading to unnecessary storage of medicines in households, and posing an environmental threat.[1] Medicines obtained from health facilities, such as hospitals and pharmacies, can accumulate at home when not used according to the prescribed treatment protocol. Without a proper recycling protocol for these accumulated medicines, the problem can escalate.[2] A recent study on the disposal of medicines nearing or surpassing their expiry dates found that a significant proportion of participants were unaware of proper disposal methods. Generally, the participants disposed of these medicines in household waste disposal sites, such as garbage bins, toilets and sinks. The main reason for lack of proper disposal of medicines was reported to be lack of knowledge.[3]

The presence of medicine residues in water samples from wastewater treatment plants suggests that medicines enter wastewater, and wastewater plants do not adequately treat this water. Additionally, low amounts of active ingredients and metabolites of medicines were found in drinking water facilities. Several circumstances contribute to the generation of medicine waste. For example, medicine waste is generated after treatments in health facilities, leftover and unused medicines are disposed of in garbage, toilets and sinks, and these wastes may mix with wastewater.[4]

Numerous studies have been conducted on leftover, expired medicines and medicine disposal in the general population. In one study, 95% participants reported storing unused medicines in their homes, and approximately 80% of them used household garbage as the disposal method. They had not received any training on disposal, and about half of them reported that improper disposal of medicines could harm health and the environment.[5] Another study found that improper disposal of medicines in inappropriate conditions is harmful to environment and human health, and most participants had not received training on medicine disposal.[6] In a review, it was claimed that giving leftover and unused medicines to other individuals would pose a health risk, storing unused and expired medicines at home would pose risks, such as intentional or unintentional use and ingestion, and disposing of medicines as household waste would have negative impact on life.[7]

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Various studies have been conducted on unused and leftover medicines and their disposal methods among students studying in various fields associated with human health. Departments such as Medicine, Pharmacy, Dentistry, Nursing, Physical Therapy and Rehabilitation, Nutrition and Dietetics, etc., offer pharmacology-based courses that provide basic theoretical knowledge about drugs, dosages and their use in diseases. These courses are expected to promote rational behaviour among Health Sciences students and contribute to positive findings compared to the general public. However, a study conducted on Pharmacy students showed that the majority (95.7%) had unused or leftover prescription and over-the-counter (OTC) medicines in their homes. It was also reported that some of medicines had expired.[8] According to a study conducted on both Nursing and Pharmacy students, approximately one in three Pharmacy students and around half of Nursing students stored unused or leftover medicines until expiration date, and approximately 80% of participants disposed off expired medicines in household garbage, sinks or toilets.[9] Another study reported that around 70% of Nursing and Pharmacy students had unused and leftover medicines in their homes, and >50% disposed of expired medicines in the trash, while very few of them returned the medicines to the pharmacy.[10]

The current study was planned to evaluate the opinions of university-level Health Sciences students about unused, leftover and expired medicine, as well as their disposal practices, and to classify the medicines.

Subjects and Methods

The cross-sectional study was conducted from April 1 to May 31, 2023, at the Faculty of Health Sciences, Burdur Mehmet Akif Ersoy University, Turkey, and comprised undergraduate students associated with Nursing, Nutrition Dietetics and Physical Therapy and Rehabilitation departments. Those included had no chronic disease, were resideing at home and had a device suitable for online data collection. Those having chronic diseases, living in communal living spaces, such as student dormitories, and not living in the earthquake zone in Turkey were excluded. The data was collected online using Google Forms because all universities in Turkey had switched from face-to-face to online education due to the two earthquakes that hit the country on February 6, 2023.

After approval form the institutional ethics review committee, the sample size was calculated using formula with known population (n=(N.t2.p.q)/[d2.(N-1)+(t2.p.q)]). The relevant values were N(population size of students in the relevant departments) = 1082, p(proportion)=0.5, q=(1-p), d(margin of error)=0.05, t(critical value with %95 confidence interval [CI])=1.96. The sample size calculated was 284 people. The sample was inflated by 10% to account for missing or incorrect answers,. The scale response rate was determined as 60%.8 Thus, it was calculated that the data collection form should reach at least 474 people. The sample was raised using simple random sampling method.

The data-collection tool was developed based on literature.[3,4,9-12] In addition to an informed consent form and sociodemographic data, questions about leftover, unused medicines, and their disposal methods were added. The last question of the form related to the generic name and dose of the unused, leftover and expired medicines. The reponses to this question were analysed in the light of the Anatomical Therapeutic Chemical (ATC) classification.[13]

Data was analysed using SPSS 24. Data was expressed as frequencies and percentages, or as mean±standard deviation, as appropriate.

Results

The data collection form was delivered to 648 individuals, and 380(58.6%) of them responded. However, 7(1.8%) responses had to be excluded, and the study was completed with 373(98.2%) subujects; 272(73%) females and 101(27%) males with overall mean age 20.8±2.8 years. There were 348(93.3%) subejcts who reported having a total of 845 boxes of leftover and unused medicines in their homes (2.3±1.9 per capita), while 25(6.7%) participants had none. Expired medicines were not reported at all. The average household size was 4.8±1.4 persons (Table 1).

The most common storage area for medicines was the kitchen 261(61.5%), and the most common storage unit was refrigerator 181(40.2%). The expired medicine was disposed of in the garbage in 328(86.1%) cases. Self-medication was prevalent in 325(87.1%) cases (Table 2).

According to the main groups of ATC classification, pantoprazole, vitamin B12, amoxicillin+clavulanic acid, dexketoprofen, paracetamol, and pseudoephedrine combinations were the most commonly leftover and unused medicines (Table 3).

Discussion

In the current study, the prevalence of unused and leftover medicines was 93.3%. It was observed that the participants stored their medicines in the kitchen and in refrigerators. One of the most important reasons for storing medicines at home was related to reusing them in emergencies. Participants stored leftover medicines at home until expiry

date, and the expired medicines were discarded mostly in household garbage. In addition, it was found that medicines were commonly used without consulting a physician. A 2022 study involving participants from the United States, Italy and Japan showed that the most

Table-1: Characteristics and attitudes towards medication of the participants (n=373).

Sociodemographic Variable	n (%)
Gender	
Male	101 (27.1)
Female	272 (72.9)
Marital Status	
Single	367 (98.4)
Married	6 (1.6)
Working status	
Employee	24 (6.4)
Unemployed	349 (93.6)
Department	
Nursing	242 (64.9)
Physical Therapy and Rehabilitation	69 (18.5)
Nutrition and Dietetics	62 (16.6)
Class	
1	154 (41.3)
2	85 (22.8)
3	105 (28.1)
4	29 (7.8)
Place of residence	
City Centre	226 (60.6)
District-Village-Town	147 (39.4)
Economic status	
Balanced Income-Expenditure	257 (68.9)
Less Income-Expenditure	89 (23.9)
More Income-Expenditure	27 (7.2)
Family members' behaviour of using medications without consulting a physician	
Yes	53 (14.2)
Sometimes	203 (54.4)
No	117 (31.4)
Checking the expiry date of unused and leftover medications	
Yes	312 (83.6)
Sometimes	14 (3.8)
No	47 (12.6)
Reading the package inserts of medications	
Yes	327 (87.7)
No	46 (12.3)
Non-prescription medicine purchasing behaviour	
Yes	191 (51.2)
No	182 (48.8)
Receiving a training/seminar/course etc. On the disposal of medicines	
Yes	17 (4.6)
No	356 (95.4)
Improper disposal of unused, leftover and expired medicines impacts the environment and health	
Yes	310 (83.1)
No	9 (2.4)
No idea	54 (14.5)

n=Number of participants; %=Percentage of participants *Percentages were calculated by dividing by the number of participants (n=373).

Table-2: Practices regarding storage, disposal and reuse of medicines.

Variable (multiple-response questions)	n (%)
Medicines storage unit	
Refrigerator	181 (40.2)
Kitchen cabinet	101 (22.4)
Wardrobe	3 (0.7)
Storage cabinets and other areas	165 (36.7)
Total	450 (100)
Medicines storage room	
Kitchen	261 (61.5)
Bathroom	17 (4)
Salon	41 (9.7)
Bedroom	64 (15.1)
Living Room	41 (9.7)
Total	424 (100)
Facility with the most medicines prescribed to participants	
Family Health Centre	157 (35.3)
City-State Hospital	205 (46.2)
Faculty of Medicine	24 (5.4)
Education-Research Hospital	42 (9.5)
Private Health Centre	16 (3.6)
Total	444 (100)
Branches that prescribe medication to the participant	
Hospital emergency services	98 (22.6)
Family medicine	187 (43.1)
Other specialties in the hospital	149 (34.3)
Total	434 (100)
Reason for storing unused and leftover medicines at home	
I can use the medicine again after a while.	172 (35.1)
I may need medicine in an emergency.	213 (43.5)
It can be used by friends or family.	71 (14.5)
Other	34 (6.9)
Total	490 (100)
Status of unused and leftover medicines	
I throw it in the garbage	147 (33.9)
I give it to the pharmacy	23 (5.3)
I give it to people who need it	21 (4.9)
I'll store it at home until it expires	208 (48)
I give to health organizations	22 (5.1)
Other	12 (2.8)
Total	433 (100)
Disposal method for expired medicines	
I throw it in the garbage	328 (86.1)
I give it to the pharmacy	15 (3.9)
I give it to people who need it	5 (1.3)
I give to health organizations	10 (2.6)
Other	23 (6.1)
Total	381 (100)
Medicines used without consulting a physician*	
Antibiotics	57 (5)
Analgesic	323 (28.1)
Vitamin	325 (28.3)
Common cold	203 (17.7)
Antacid	70 (6.1)
Muscle relaxant	81 (7)
Cough syrup	83 (7.2)
Other	7 (0.6)
Total	1149 (100)

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Table-2: *Continued from previous page.....*

Variable (multiple-response questions)	n (%)
Who is responsible for the proper disposal of unused, leftover and expired medicines?	
Ministry of Health	293 (45.8)
Pharmaceutical Companies	119 (18.6)
Pharmacy and Pharmacist	138 (21.5)
Education Institutions	71 (11.1)
Other	19 (3)
Total	640 (100)

* The question was answered by 325 respondents.

important reason for storing unused medicines at home in the US was "use in case of need". Findings of the same study in Italy and Japan were found to be "illness-recovery". When the reason for storing medicines at home was evaluated for all participants, the option of "recovery from illness" was found to be higher than the other options. The method of drug disposal was flushing down the toilet in the US, taking it back to pharmacy in Italy, and garbage disposal in Japan.[2]

A study reported that participants were unaware of how to dispose of leftover, unused or expired medications, and resorted to discarding them in the garbage or toilet. It was also observed that a significant number of participants had unused or leftover medicines at home, with the most common motive for storing these medicines being "reuse". Furthermore, medicines were frequently stored in refrigerators.[3]

One study reported that participants had unused and leftover medicines at home, stored the medicines until expiration date, disposed of unused medicines in garbage, lacked knowledge about drug disposal, and were unaware of medicines' negative effects on human and environmental health.[5]

According to a study done on university students, 61% participants had leftover medicines at home, 94% purchased medicines, of which 77% were prescription medicines. Disposal method for medicines was reported as throwing in garbage, a very small percentage disposed of them by flushing down toilet, and 24% had knowledge about medicine recycling programmes.[14]

A 2018 study comprising Health sciences students and healthcare professionals showed that 55.4% participants had unused medicines at home. The main reason for not using medicines was reported as "recovery from illness". It was also found that the main reason for storing medicines was "future need", and the primary method of medicine disposal was throwing them in garbage.[15]

A study assessed the opinions of Nursing and Pharmacy students regarding unused and leftover medicines, and reported that the prevalence of storing unused medicines was 52.5% among Nursing students and 37.6% among Pharmacy students. Majority of participants reported

Table-3: ATC Classification.

ATC classification	ATC Code	ATC Name	n (%)
A-Digestive System and Metabolism			
	A02BC02	Pantoprazole	16 (20)
	A02BC03	Lansoprazole	10 (12.5)
	A01AD02	Benzidamine combinations-oral	7 (8.8)
	A02AD1	Antacid combinations	7 (8.8)
	A03AX58	Alverinecitrate+simethicone	6 (7.4)
	A02BC04	Rabeprazole	4 (5)
	A03BB01	Hyoscyamine butylbromide	4 (5)
	A03FA01	Metoclopramide	4 (5)
	A11AA01	Multivitamin mineral combinations	4 (5)
		Others	18 (22.5)
	Total	80 (100)	
B-Blood and Blood Forming Organs			
	D03AXX2	Vitamin B12	6 (31.6)
	B03AA02	Ferrous fumarate	4 (21.1)
	B03AD01	Iron III hydroxide+Folic acid	4 (21.1)
		Others	5 (26.2)
	Total	19 (100)	
J-Anti-infective (Systemic)			
	J01CR02	Amoxicillin+Clavulanic acid	43 (65.2)
	J01DC02	Cefuroxime	13 (19.7)
		Others	10 (15.1)
	Total		66 (100)
M-Musculoskeletal System			
	M01AE17	Dexketoprofen	65 (33)
	M01AB05	Diclofenac	48 (24.4)
	M01AE09	Flurbiprofen	29 (14.7)
	M02AA13	Ibuprofen-topical	8 (4.1)
	M01AE02	Naproxen sodium	7 (3.6)
	M02AA10	Ketoprofen-topical	7 (3.6)
	M01AE01	Ibuprofen	6 (3)
	M01AC02	Tenoxicam	4 (2)
	M03BB53	Chlorzoxazone+Paracetamol	4 (2)
	M03BX05	Thiocolchicoside	4 (2)
		Others	15 (7.6)
	Total		197 (100)
N-Nervous System			
	N02BE01	Paracetamol	259 (91.5)
	N02BA01	Acetylsalicylic acid	11 (3.9)
	N02BE51d	Paracetamol+Caffeine	8 (2.8)
	N02BB02	Metamizole sodium	5 (1.8)
	Total		283 (100)
R-Respiratory System			
	R01BA52	Pseudoephedrine combination	66 (37.7)
	R05X	Paracetamol combination	65 (37.1)
	R03DC03a	Levocetirizine+Montelukast	5 (2.9)
	R03DC03b	Desloratadine+Montelukast	4 (2.3)
	R05CB01	Acetylcysteine	4 (2.3)
	R05DB13	Butamirate citrate	4 (2.3)
	R06AE07	Cetirizine	4 (2.3)
		Others	23 (13.1)
	Total		175 (100)

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Table-3: *Contiued from previous page.....*

ATC classification	ATC Code	ATC Name	n (%)
C-D-G-H-S-V Class.	Total		25 (100)
Total number of pharmaceutics			845 (100)

A-others(n=18): Otilonium bromide, Esomeprazole, Hyoscyamine butylbromide+medazepam HCl, Famotidine, Trimebutine maleate, Trimetobenzamide, Sennosides, Lactulose, Pancreatin combinations, Vitamin D3, Vitamin B1 and B2 or B6 or B12, Zinc sulfate, Magnesium, Zinc+Magnesium. **B-others(n=5)**: Vitamin B9-Folic acid velron+Zinc. **J-others(n=10)**: Penicillin G benzathine, Cefaclor+Clavunate, Cefprozil, Sefdinir, Clarithromycin, Ciprofloxacin. **M-others(n=15)**: Etodolac, Dexketoprofen+Thiocolchicoside, Diclofenac-topical, Nimesulide-topical, Salicylate, Indomethacin, Etodolac+Thiocolchicoside, Aceclofenac, Mefenamic acid, Nimesulide+Lidocaine-topical. **R-others(n=23)**: Oxymetazoline HCl, Xylometazoline hydrochloride, Beclomethasone dipropionate-nasal, Salbutamol-inhalant, Budesonide-inhalant, Acetylcysteine, Vitamin C combination, Erdosteine, Triamcinolone acetonide-nasal, Umeclidinium+Vilanterol, Terbutaline combination, Pheniramine, Levocetirizine, Ketotifen, Desloratadine, Bilastine. **C,D,G,H,S,V(n=25)** were added to Table 3 due to the low number of drugs in these classes, but not detailed.

disposing of medicines by throwing them in garbage or flushing down the sink/toilet. It was highlighted that the responsibility for creating awareness about medicine disposal was of the Ministry of Health, and it was reported that improper medicine disposal can harm human and environmental health.[9]

According to a study conducted on Pharmacy students, prevalence of home medication storage was 95.7%, with majority being stored in kitchen and bedroom. The preferred method of medication disposal was throwing them in garbage.[8] It can be concluded that the issue exists in almost all countries, and percentage variations in findings may be attributed to factors, such as development level of the countries, and the design of the studies.

In Turkey, prescription medications are only written by physicians, and can only be obtained from pharmacies using electronic prescriptions. According to the current findings, the participants reported receiving prescriptions for medications most frequently from city-state hospitals and primary healthcare centres. Patients in Turkey have easy access to both types of healthcare facilities. Ease of access to physicians and treatments may result in a higher prescription rate for medications.

Other important findings of the current study were that frequency of self-medication without consulting a physician was 87.1%, a significant proportion of participants checked expiration date of unused medicines, most of them read the package insert, more than half of them purchased medicines without a prescription, and the frequency of self-medication was 14.2%. It was also found that vitamins, analgesics and cold medicines were the most commonly used medicines without consulting a physician. A 2021 study on Nursing students found that the frequency of using non-prescription drugs was high, and a significant proportion stored unused and leftover drugs. It was reported that the most commonly used drug group was non-prescription analgesics.[16] A study reported that frequency of self-use of antibiotics was 52.7%, knowledge about drug was one of the most important reasons for self-use, and betalactam antibiotics were used the most.[17] According to a study on medical students, the frequency of self-medication was 78.6%, and students predominantly used antipyretics without consulting a physician.[18] A study found that 77% participants made their own drug selection, 72% engaged in self-medication, and 59.9% trusted their self-diagnoses.[19] A study done in 2018 found that the frequency of self-medication was 89.6%. The main reasons for this high rate were previous experiences with disease, severity of the condition, and easy availability of medications. The most commonly used drugs were cold medicines, analgesics and antibiotics.[20] Another study involving students revealed that overall frequency of self-medication was 70.1%, with rates of 97.2% among medical students, and 44.7% among non-medical students.[21] Despite the fact that the studies quoted above were conducted in different countries, the findings seem to be consistent.

In the current study, pantoprazole, vitamin B12, amoxicillin+clavulanic acid, dexketoprofen, paracetamol, and pseudofedrine combinations were the most commonly leftover and unused drugs (Table 3). A 2023 study reported that antipyretics and analgesics, antispasmodics, antibiotics, antacids and multivitamins and dietary supplements were the most commonly found drug categories in the homes of participants.[22] Another study reported that paracetamol and ibuprofen were used without prescriptions.[2] A study on Health Sciences students reported that analgesics and antipyretics were the most frequently used drug types, followed by antibiotics.[23] Another study reported that the participants mostly used cold medicines, analgesics and antibiotics.[24] yet another study reported that the usage of analgesics, antibiotics and antacids were common.[25] A 2020 study reported that participants mostly used antipyretic, paracetamol and non-steroidal anti-inflammatory drugs (NSAIDs).[26] In Turkey, self-medication was reported to be common, and the most commonly used non-prescription drugs were analgesics, antibiotics and cold medicines.[27]

It is possible to say that the classification of drugs according to their active ingredients noted in the current study supported literature, and that the situation in Turkey was found to be similar to other developed and developing countries.

The current study has limitations as it was a single-centre study, and data was collected online from a limited population that was predominantly women.[14] Also, it relied on self-reported data which exposed the findings to the risk of bias.

Despite the limitations, the findings highlighted the misuse of health education received, and emphasised the need for training programmes on rational drug use and disposal. It is crucial to implement effective policies addressing issues, like recycling and proper disposal of unused or leftover medicines. Additionally, close monitoring of health problems that may arise from non-use or retention of prescribed medications for any reason is essential. It is also important to develop new and easily applicable methods for studying the number and types of medicines to obtain accurate findings, considering that participants may have refrained from disclosing some unused or leftover medications.

Conclusion

High frequency of unused and leftover medication, improper disposal methods, such as household garbage, self-medication practices, and usage of medication without consulting a physician indicated a significant public health and environmental concern, considering sociodemographic characteristics of the participants and the education they were receiving.

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Author Contribution:

SK: Concept, data curation, investigation, methodology, data collection, statistical analysis, writing, drafting, final approval.

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