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Unused, expired pharmaceuticals and their disposal practices among the general public in Burdur-Türkiye: a cross-sectional study

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Abstract

Background Unused pharmaceuticals are currently a public health problem. This study aimed to identify unused pharmaceuticals, research practices about the disposal methods, classify the medicines according to Anatomical Therapeutic Chemical codes (ATC) and, to determine the number of unused medicines.

Methods The study was designed as a cross-sectional study. Data were collected between April and August 2023 in Burdur-Türkiye by non-probability sampling technique (convenience method). Pharmaceuticals were classified according to ATC. Statistical Package for Social Science SPSS (V.24) package program was used for data analysis.

Results A total of 1120 people, 1005 in the first sample group and 115 in the second sample group, participated in the study. Findings of first sample group: A total of 4097 boxes of unused pharmaceuticals (4.7 ± 4.3 boxes/per capita) were detected. It was found that pharmaceuticals were stored in areas such as kitchens (59.1%) and refrigerators (38.6%), the reason for keeping them was reuse (41%), and the disposal practice was household garbage (81%). *Paracetamol* (648 boxes), *Other cold preparation* (303 boxes), *Dexketoprofen* (239 boxes), *Diclofenac* (218 boxes), *Amoxicillin and beta-lactamase inhibitor (*190 boxes) were found to be the most frequently unused pharmaceuticals. Using the unused medicines at home without consulting a physician was 94.1% (self-medication). Findings of second sample group: Of the 6189 dosage forms in 265 boxes pharmaceutical, 3132(50.6%) dosage forms were used and 3057(49.4%) were found to be unused.

Conclusion There is a significant amount and number of unused medicines in households, and self-medication is common. Medicines are not properly disposed of and some of them expire. Public information is needed. A "drug take-back system" for unused medicines can be useful in solving this problem.

Keywords Pharmaceutical, Public health, Self medication, Türkiye

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Introduction

Drugs are agents used in the treatment of diseases and are prescribed by physicians based on the patient's diagnosis. For home treatment, medications prescribed by physicians are obtained from the pharmacy and used for treatment. However, patients may prematurely discontinue home drug treatment for various reasons. The main reasons for early discontinuation include the early recovery from disease, a change in diagnosis, a decrease in or loss of faith in the treatment, side effects of the medication, and the patient non-compliance with treatment, among others [1]. When the patients discontinue drug treatment for any reason, they may contribute to the accumulation of unused medicines in the household. The unused pharmaceuticals that accumulate in the household can be reused at different times to alleviate the symptoms of various diseases, can be given to another person, or kept on hand until the expiration date [2]. If there is lack of knowledge about the medicines that accumulate in the household, the expiration dates of the medicines may expire, which can lead to health problems when these medicines are used [3].

Several epidemiological studies have been conducted on unused pharmaceuticals. In a study conducted in Saudi Arabia, it was reported that about half of the participants accumulated unused pharmaceuticals in their households, the main reason for accumulation was to cure illness, they disposed of the pharmaceuticals by throwing them in the garbage, and a significant number of participants were uneducated about pharmaceutical disposal practices [4]. In a study conducted by Woldeyohanins et al. (2021), it was reported that more than half of the participants had unused pharmaceuticals in their homes, about 59.2% checked the expiration date, and the household trash can was used as a method of pharmaceutical disposal practices [5]. In a similar study, people were reported to have unused medicines at homes, to store them because they might need them later, and to dispose of them inappropriately [6].

While this is the case in the general public, similar findings have been reported among student in health professions (medicine, nursing, pharmacy, etc.). For example, a previous study reported that 95.7% of pharmacy students had unused medications, some of which were expired and not properly disposed [7, 8]. Improper disposal of pharmaceuticals posed an environmental hazard. The presence of pharmaceutical waste in wastewater treatment plants was indicative of this problem. A study reported that pharmaceutical metabolites and active ingredients were detected in drinking water facilities, even if at low levels [9].

There are numerous studies in the literature on unused medicines. These studies summarize data from different countries, cultures, geographies, and levels of development. In generel, these studies categorize the unused medicines by mechanism of action (antibiotics, analgesics, etc.) rather than by Anatomical Therapeutic Chemical classification (ATC). In addition, it has been observed that the number of studies reporting the amount of used and unused medicines is extremely limited. This gap in the literature needs to be addressed. Therefore, this study aimed to identify unused medications, classify them according to the ATC, research participants' practices about these medications, and determine how much of medications such as tablets, capsules and dragees with a given quantity are used and how much is unused.

Methods

Study design

The study was designed as a cross-sectional study. Data were collected between April 1 and August 31, 2023 in Burdur-Türkiye. This study consists of two sample groups, the first sample group and the second sample group. The data of both groups were collected by a non-probability sampling technique (convenience method). While the online method (Google form) was used to collect the data in the first sample, the face-to-face method was used in the second sample. For first sample size, proportionally based sampling with the double design effect method was used. For second sample size, certain percentage of the calculated number of participants in the first sample group was taken as a basis. The purpose of the second sample was to determine the quantity of unused pharmaceuticals, to strengthen the findings and to enhance the literature. For some reasons, the data collected from the first sample were not collected from the second sample (Private life/privacy, protection of personal data, difficulty of voluntary participation, similar personal characteristics.etc.).

Participant criteria

Participant criteria were determined to participate in the study. These were determined as not having any chronic disease at the time of data collection and not taking medication for any disease, having appropriate equipment for online data (computer, smartphone, tablet), living at home due to the question types, being literate (for face-to-face data collection), not being given partial or incomplete information, being above the age of 18 years and giving consent. Participant exclusion criteria were defined as not having the above-mentioned conditions and not having unused medicines.

First sample size

A formula ($n=Z^2$ x $p(1-p)/d^2$ x *DEFF* (*n: sample size, Z:confidence interval, p:expected proportion, d:margin of error and DEFF: design effect*)) was used to calculate this

sample size [10]. According to this formula (*1.96²×0.5(1–0.5)/0.05²×2n=754×0.1*), it was needed that at least 830 people participate in the study. Sociodemographic data, practices on unused medicines, disposal methods, number of unused medicines and generic names of medicines were collected from these sample group.

Second sample size
For the quantity analysis, 10% (*n*=83) of the first sample size (*n*=830) was taken as a basis [11]. Only the generic name of pharmaceutical and quantity of unused drugs (dosage forms) were collected from this sample.

As a result, it was calculated that at least 913 people participated in the study.

Data collection tool
Since the research consisted of two separate sample groups, two separate forms were used. The data collection form collected from the first sample included the sociodemographic characteristics of the participants, their practices about unused drugs, disposal method, generic names of drugs and the number of unused drugs. In the second sample group data collection form, only data on the quantity of unused medicines such as tablets, dragees and capsules were collected.

Description of unused drug: It is called the leftover part of the drug after treatment. This description was sent as a video to the group for online data collection. It was explained verbally to the face-to-face data collection group.

The data collection form of the first sample group
In order to obtain data from the first sample group of the study, a questionnaire was developed based on the questions of previous studies [11–14]. The content of this form includes socio-demographics, practices about on unused medicines, disposal practices, number of unused medicines and generic names of medicines. The data collected through this form were collected online by using a Google form. The Google form was turned into a link. This link and the explanation video of the research (purpose, participant criteria, data filling examples, etc.) were sent to people as text messages via WhatsApp. In particular, groups with a large number of people registered (groups such as school, work, etc.) were targeted.

The data collection form of the second sample group
This was a data collection form in which quantity of unused medicines in the medicines box (tablets, dragees, capsules, etc.) was recorded. The number of dosage forms of these medicines was obtained by simple subtraction (Number of dosage forms of unused medicines=number of dosage forms of medicines - number of dosage forms of medicines used). Data used for quantity analysis were collected face-to-face by using a written data collection form.

Classification of Pharmaceuticals
Pharmaceuticals were classified according to the ATC/DDD Index 2023. This index is a very useful resource published by WHO and WHO Collaborating Centre for Drug Statistics Methodology and includes Anatomical Therapeutic Chemical (ATC) classification, Defined Daily Dose (DDD) values, codes [15].

Data Analysis
SPSS (V.24) package program was used for data analysis. Descriptive parameters were summarized as (n) and percentage (%) where relevant [n(%)]. Mean ($\bar{X}$) and standard deviation (S) were summarized as $\bar{X}\pm S$. The relationship between the number of pharmaceuticals in the households and sociodemographic variables was tested with non-parametric tests (Mann Whitney U, Kruskal Wallis, Tamhanes T2). Statistical significance level was taken as $p<0.05$.

Results
A total of 1172 people participated in the study, 1057 in the first sample group (52 people were excluded) and 115 in the second sample group. The study was completed with 1120 participants.

The findings of the first sample group (*n*=1005)
Some people data were not included in the study due to exclusion criteria (*n*=24, 2.3%). The number of people with unused pharmaceuticals was found to be 28(2.6%) (97.4% of participants have unused medicines). Therefore, study was completed with 1005 participants (Age_mean 36.9±12.3 years). A total of 4097 boxes of unused pharmaceuticals were observed (4.7±4.3 boxes/per capita).

When evaluating the number of unused pharmaceuticals and the sociodemographic characteristics of the participants (*n*=1005), no statistical difference was observed in gender variable (*p*=0.089). However, statistical differences were observed in marital status (lower in singles), place of residence (lower in rural areas), and economic status (Income<Expense) (*p*<0.001, *p*<0.001, *p*<0.001, respectively) as shown in Table 1.

It was found that the options of kitchen (59.1%) as the room where pharmaceuticals were kept at home, refrigerator (38.6%) as the place where pharmaceuticals were stored, family health center (42.2%) as the health facility where most pharmaceuticals were prescribed, reuse (41%) as the reason for keeping pharmaceuticals in household, family physician (48.7%) as the specialty branch where most pharmaceuticals were prescribed, were selected more than other options. The options of

Table 1 The relationship between sociodemographic variables and the number of unused pharmaceuticals ($n = 1005$)

Variable		*n*	%	Med	Mean Rank	Test	*p*
Gender	Female	603	60	3	489.38	U:113,105,500	0.089
	Male	402	40	4	520.94		
Marital Status	Single	328	32.6	3	435.89	U:88,909,500	< 0.001
	Married	677	67.4	4	533.98		
Place	City	772	76.8	3	477.15	U:70,277,000	< 0.001
	Rural	233	23.2	5	584.58		
Economic Status	Income = Expense	511	50.9	4	535.63	K-W:15,217	< 0.001[a, a,b]
	Income > Expense	113	11.3	3	489.30		
	Income < Expense	377	37.5	3	460.16		
Education Status	Primary	246	24.5	3	520.81	K-W:39,919	< 0.001[a, b,c]
	Secondary	222	22	4	596.88		
	Higher	537	53.3	3	454.25		
Employment status	Working	579	57.5	3	488.64	U:115,102,000	0.086
	Not Working	426	42.3	3	520.17		

n: Participants, %: percentage of participants, Med: Median of the number of pharmaceuticals, U: Mann-Whitney U Test, K-W: Kruskal Wallis H Test, Posthoc: Tamhanes T2 (shoved letters and according to the dependent variable, respectively)

checking the expiry date of pharmaceuticals (72.1%), reading the package insert (56.7%) and not buying pharmaceuticals without a prescription (58.7%) were more chosen ones by the participants. Keeping pharmaceuticals in household until the expiry date (44.6%), throwing expired pharmaceuticals in the garbage (81%), thinking that improper disposal of pharmaceuticals pollutes the environment (74.8%), and The Ministry of Health is responsible for raising awareness on medicines (41.7%) were the options that were more frequently marked by the participants. Using the unused medicines at home without consulting a physician was 94.1% (self-medication). (Table 2).

The most unused drugs by ATC class were *Lansoprozole, Folic Acid, Propranolol, Other Cicatrizants, Levothyroxine Sodium, Amoxicillin and beta lactamase inhibitor, Dexketoprofen, Paracetamol, Metronidazole, Other Cold Medicines*. In terms of number of boxes, it was *"Paracetamol, Other Cold Medicines, Dexketoprofen, Diclofenac, Amoxicillin and beta lactamase inhibitor, Pseudoephedrine combination, Lansoprazole and Acetylsalicylic acid"* (Table 3).

n = number of pharmaceuticals (box), %=percentage of the number of pharmaceuticals. Pharmaceuticals with fewer than 10 were given as "others" in the table. Pharmaceuticals in the Others section was summarized separately as ATC name, ATC code and number of pharmaceuticals (For example: Zinc sulfate(A12CB01):9). A-Others($n = 80$):Benzidamine(A01AD02):9, Lactulose(A06AD11):9, Zinc sulfate(A12CB01):9, Nifuroxazide(A07AX03):8, Tioctic acid(A16AX01):7, Pinaverium(A03AX04):6, Sodium fluoride(A01AA01):6, Famotidine(A02BA03):5, Orlistat(A08AB01):3, Rabeprazole(A02BC04):3, Multivitamins and other minerals, incl. combinations(A11AA03):2, Otilonium bromide(A03AB06):2, Multienzymes(lipase, protease etc.)(A09AA02):2, Dexpanthenol(A11HA30):1, Domperidone(A03FA03):1, Glibenclamide(A10BB01):1, Glibornuride(A10BB04):1, Glycerol(A06AG04):1, Magnesium hydroxide(A02AA04):1, Mebeverine(A03AA04):1, Various(A01AD11):1, Pyridoxine(A11HA02):1. B-Others($n = 24$):Cyanocobalamin(B03BA01):8, Ferrous amino acid complex and folic acid(B03AD01):7, Clopidogrel(B01AC04):3, Ticagrelor(B01AC24):1, Apixaban(B01AF02):1, Tranexamic acid(B02AA02):1, Ferrous glycine sulfate(B03AA01):1, Ferrous fumarate(B03AA02):1, Cyanocobalamin, combinations(B03BB51):1. C-Others($n = 46$):Doxazosin(C02CA04):7, Rosuvastatin(C10AA07):6, Candesartan(C09CA06):4, Nebivolol(C07AB12):3, Amlodipine(C08CA01):2, Captopril(C09AA01):2, Lercanidipine(C08CA13):2, Digoxin(C01AA05):2, Atenolol(C07AB03):1, Benidipin(C08CA15):1, Calcium Dobesilat(C05BX01):1, Organo-heparinoid(C05BA01):1, Hydrocortisone(C05AA01):1, Quinapril and diuretics(C09BA06):1, Lisinopril(C09AA03):1, Losartan and diuretics(C09DA01):1, Olmesartan mdeoxomil and amlodipine(C09DB02):1, Pentoxifylline(C04AD03):1, Pitavastatin(C10AA08):1, Other preparations, combinations(C05AX03):1, Spironolactone(C03DA01):1, Hydrochlorothiazide combinations(C03AX01):1, Torasemide(C03CA04):1, Trimetazidine(C01EB15):1, Valsartan and diuretics(C09DA03):1, Zofenopril(C09AA15):1. D-Others($n = 51$):Silver sulfadiazine(D06BA01):8, Centella asiatica herba(D03AX14):7, Carbamide combinations(D02AE51):5, Clobetasol(D07AD01):3, Oxytetracycline(D06AA03):3, Sertaconazole(D01AC14):3, Terbinafine(D01BA02):3, Diphenhydramine(D04AA32):2, Nadifloxacin(D10AF05):2, Wart and anti-corn preparations (D11AF):2, Acyclovir(D06BB03):1, Other antibiotics

Table 2 Participants' practices on pharmaceuticals (*n* = 1005)

Questions		*n*	%
In which room of your household do you keep your pharmaceuticals? *	Kitchen	727	59
	Living room	148	12
	Salon	151	12.3
	Bedroom	157	12.8
	Bathroom-toilet	48	3.9
In which storage area do you store your pharmaceuticals? *	Refrigerator	520	38.6
	Kitchen cabinet	372	27.6
	Storage and other cabinets	419	31.1
	Wardrobe	37	2.7
In which health facility do you think most pharmaceuticals are prescribed to you? *	City-state hospital	394	27
	Training and research hospital	244	16.7
	Family health center	616	42.2
	Medical faculty hospital	92	6.3
	Private health facilities	113	7.8
Why do you keep unused pharmaceuticals in household? *	I can use the pharmaceutical again after a while	630	41
	I may need pharmaceutical in an emergency	555	36.1
	It can be used by friends or family	273	17.8
	Other causes	80	5.2
Which branch do you think prescribes the most pharmaceuticals to you? *	Family medicine	600	48.7
	Emergency service	147	11.9
	Other specialties in the hospital	486	39.4
Do you check the expiration date of the pharmaceuticals you take?	Yes	725	72.2
	Sometimes	173	17.2
	No	107	10.6
Do you read the package leaflet of the pharmaceutical you take?	Yes	570	56.7
	Sometimes	270	26.9
	No	165	16.4
Do you buy pharmaceuticals without consulting a physician?	Yes	415	41.3
	No	590	58.7
Which pharmaceuticals do you use without consulting a physician? *	Antibiotics	119	4,5
	Analgesics	786	29,7
	The common cold drugs	498	18,8
	Cough syrup	199	7,5
	Antiacids	266	10,1
	Muscle relaxant	289	10,9
	Vitamin	332	12,6
	I do not use without consulting a physician	157	5,9
What do you do with unused pharmaceuticals? *	I throw it in the garbage	358	29.5
	I give to health organizations	94	7.7
	I give it to the pharmacy	63	5.2
	I give it to people who need it	117	9.6
	I keep it in household until it expires	542	44.7
	Other	40	3.3
What do you do with expired pharmaceuticals? *	I throw it in the garbage	854	81
	I give to health organizations	55	5.2
	I give it to the pharmacy	43	4.1
	I give it to people who need it	21	2
	Other	81	7.7
Can improper disposal of unused and expired pharmaceuticals affect the environment and health?	Yes	752	74.8
	No opinion	231	23
	No	22	2.2

Table 2 (continued)

Questions		*n*	%
Who is responsible for raising awareness about proper disposal of unused and expired pharmaceuticals? *	Ministry of Health	745	41.7
	Pharmaceutical companies	361	20.2
	Pharmacy and pharmacist	391	21.9
	Education institutions	248	13.9
	Other	40	2.3

*Could be more than one option, n: Participants, %: Percantege of participants

for topical use (D06AX):1, Betamethasone(D07AC01):1, Butenafine(D01AE23):1, Hydroquinone(D11AX11):1, Hydrocortisone(D07AA02):1, Isotretinoin combinations(D10AD54):1, Clobetasone(D07AB01):1, Methylprednisolone aceponate(D07AC14):1, Mometasone(D07AC13):1, Naftifine(D01AE22):1, Terbinafine(D01AE15):1, Oxiconazole(D01AC11):1. G-Others($n=9$):Clotrimazole(G01AF02):2, Progesterone(G03DA04):2, Dydrogesteron(G03DB01):2, Imidazole derivates and corticosteroids(G01BF):1, Estradiol(G03CA03):1, Darifenacin(G04BD10):1. H-Others($n=12$):Dexamethasone(H02AB02):6, Prednisolone(H02AB06):5, Betamethasone(H02AB01):1. J-Others($n=31$):Cefaclor(J01DC04):8, Azithromycin(J01FA10):5, Clarithromycin(J01FA09):4, Cefixime(J01DD08):3, Doxycycline(J01AA02):2, Cefprozil(J01DC10):1, Sulfamethoxazole and trimethoprim (J01EE01):1, Lincomycin(J01FF02):1, Levofloxacin(J01MA12):1, Fusidic acid(J01XC01):1, Fluconazole(J02AC01):1, Rifamycin(J04AB03):1, Aciclovir(J05AB01):1, Valaciclovir(J05AB11):1. L-Others($n=1$):Leflunamide(L04AA13):1 M-Others($n=37$):Acemetacin(M01AB11):7, Thiocolchicoside, combinations(M03BX55):7, Preparations with salicylic acid derivatives(M02AC):5, Colchicine(M04AC01):5, Phenprobamate, combinations excl. psycholeptics(M03BA51):2, Thiocolchicoside(M03BX05):2, Indomethacin(M01AB01):2, Meloxicam(M01AC06):2, Benzidamine(M02AA05):1, Etofenamate(M02AA06):1, Piroxicam(M02AA07):1, Methocarbamol, combinations excl. psycholeptics(M03BA53):1, Tizanidine(M03BX02):1. N-Others($n=34$):Paracetamol, combinations with psycholeptics(N02BE71):8, Sertraline(N06AB06):5, Eletriptan(N02CC06):3, Frovatriptan(N02CC07):2, Paroxetine(N06AB05):2, Methylphenidate(N06BA04):2, Flunarizine(N07CA03):2, Acetylsalicylic acid, combinations excl. psycholeptics(N02BA51):1, Ergotamine(N02CA02):1, Topiramate(N03AX11):1, Gabapentin(N0BF01):1, Lacosamide(N03AX18):1, Diazepam(N05BA01):1, Escitalopram(N06AB10):1, Trazodone(N06AX05):1, Duloxetine(N06AX21):1, Lamotrigine(N03AX09):1. R-Others($n=52$):Oxymetazoline(R01AA05):10, Salbutamol and sodium cromoglicate (R03AK04):7, Cyproheptadine(R06AX02):4, Oxolamine(R05DB07):3, Rupatadine(R06AX28):3, Diphenhydramine(R06AA2):2, Beclomethasone(R01AD01):2, Mometasone(R01AD09):2, Fluticasone(R03BA05):2, Theophylline(R03DA04):2, Montelukast(R03DC03):2, Ebastine(R06AX22):2, Fexofenadine(R06AX26):2, Levodropizine(R05DB27):2, Xylometazoline(R01AA07):1, Azelastine(R01AC03):1, Pseudoephedrine(R01BA02):1, Formoterol and budesonide(R03AK07):1, Formoterol and beclometasone(R03AK08):1, Doxylamine(R06AA09):1, Bilastine(R06AX29):1. S-Others($n=13$):Fusidic acid(S01AA13):3, Ketotifen(S01GX08):3, Tobramycin(S01AA12):2, Artificial tears and other indifferent preparations(S01XA20):2, Gentamicin(S03AA06):2, Corticosteroids and antiinfectives in combination(S01CA01):1 (Table 3)

The findings of the second sample group ($n=115$)

It was found that there were 265 boxes (6189 dosage forms in the boxes) of unused pharmaceuticals (3.8 ± 5 boxes/per capita) in in households of these participants. Of the 265 boxes medicines, 74(27.9%) were found to be expired. The most *Pseudoephedrine combination* (23 boxes) and *Other cold preparation* (23 boxes) and *Dexketoprofen* (20 boxes) drugs were found to be unused drugs. The percentage of unused drugs was highest in class D(79%), P(55.4%) and N(54.6%), while used drugs were in class G(76.9%), C(69.6%) and A(53.9%) (Table 4).

Among the prescribed pharmaceuticals, pharmaceuticals in "Class G" were the most commonly used (76.9%), while pharmaceuticals in "Class D" were the least used (21%). The highest number of unused pharmaceuticals was found to be in "Class R" (929 dosage forms), followed by "Class M" drugs (682 dosage forms). Of the pharmaceuticals prescribed to the participants (6189 dosage forms), 3132(50.6%) were used and 3057(49.4%) were unused (Table 4).

Discussion

Many studies have been conducted on unused medicines and their disposal practices. According to the findings of these studies, there is a serious public health problem and lack of policy. This study presents the current situation in Türkiye. In our study, there was a statistical difference

Table 3 ATC classification of unused pharmaceuticals (Number of participants:1005)

ATC Code		ATC Name	Box	%Box
A-Digestive System and Metabolism	A02BC03	Lansoprazole	140	21.5
	A02AD01	Ordinary salt combinations	97	14.9
	A02BC02	Pantoprazole	83	12.8
	A11CC05	Colecalciferol	52	8
	A03FA01	Metoclopramide	51	7.8
	A02BC05	Esomeprazole	34	5.2
	A03BB01	Butylscopolamine	32	4.9
	A11AA01	Multivitamins and trace elements	29	4.5
	A11DB	Vitamin B1 in combination with B6 and/or B12	18	2.7
	A06AB06	Senna glycosides	13	2
	A12CC30	Magnesium	12	1.8
	A03AXX1	Silicones	10	1.5
	Others		80	12.4
	Class Total		**651**	**100**
B-Blood and Blood Forming Organs	B03BB01	Folic Acid	13	35.1
	Others		24	64.9
	Class Total		**37**	**100**
C-Cardiovascular System	C07AA05	Propranolol	26	17.2
	C08DB01	Diltiazem	17	11.3
	C03BA11	Indapamide	15	9.9
	C10AA05	Atorvastatin	13	8.6
	C07AB02	Metoprolol	12	7.9
	C03CA01	Furosemide	11	7.3
	C01EB18	Ranolazine	11	7.3
	Others		46	30.5
	Class Total		**151**	**100**
D-Dermatological	D03AX	Other cicatrizants	43	27.2
	D11AX	Other dermatologicals	25	15.8
	D06AX01	Fusidik Acid	14	8.9
	D01AC20	Imidazoles/triazoles in combinations with corticosteroids	13	8.2
	D06AX09	Mupirocin	12	7.6
	Others		51	32.3
	Class Total		**158**	**100**
G- Genito Urinary System	Others		9	100
	Class Total		**9**	**100**
H-Systemic Hormonal Preparations	H03AA01	Levothyroxine sodium	31	72.1
	Others		12	27.9
	Class Total		**43**	**100**
J-Anti-infective (Systemic)	J01CR02	Amoxicillin and beta-lactamase inhibitor	190	65.3
	J01DC02	Cefuroxime	44	15.1
	J01MA02	Ciprofloxacin	26	8.9
	Others		31	10.7
	Class Total		**291**	**100**
L-Antineoplastic and Immunomodulating	Others		1	100
	Class Total		**1**	**100**

Table 3 (continued)

ATC Code		ATC Name	Box	%Box
M-Musculoskeletal System	M01AE17	Dexketoprofen	239	24
	M01AB05	Diclofenac	218	21.8
	M01AE09	Flurbiprofen	101	10.1
	M02AA10	Ketoprofen	90	9
	M01AE02	Naproxen	64	6.4
	M01AE01	Ibuprofen	62	6.2
	M01AB08	Etodolac	35	3.5
	M02AA13	Ibuprofen-Topical	34	3.4
	M03BB53	Chlorzoxazone, combinations excl psycholeptics	30	3
	M03BX30	Feniramidol	26	2.6
	M02AA26	Nimesulide -Topical	19	1.9
	M02AA15	Diclofenac-Topical	16	1.6
	M03BX05	Thiocolchicoside	16	1.6
	M05BB03	Alendronic acid and colecalciferol	11	1.1
	Others		37	3.8
	Class Total		**998**	**100**
N-Nervous System	N02BE01	Paracetamol	648	71.2
	N02BA01	Acetylsalicylic acid	139	15.3
	N02BB02	Metamizole sodium	53	5.8
	N02BE51	Paracetamol, combination excl psycholeptics	36	4
	Others		34	3.7
	Class Total		**910**	**100**
P-Antiparasitic, Insecticides and Repellents	P01AB01	Metronidazole	37	100
	Class Total		**37**	**100**
R-Respiratory System	R05X	Other cold preparation	303	38
	R01BA52	Pseudoephedrine combinations	158	19.8
	R06AE07	Cetirizine	51	6.4
	R05DB13	Butamirate	40	5
	R03DC03	Montelukast combination	37	4.6
	R06AX17	Ketotifen	26	3.3
	R03AC02	Salbutamol	23	2.9
	R05CB10	Combination (Acetylcysteine, Vitamin C)	23	2.9
	R06AB05	Pheniramine	23	2.9
	R06AX27	Desloratadine	19	2.4
	R05CB01	Acetylcysteine	17	2.1
	R03BA02	Budesonide	15	1.9
	R03CC53	Terbutaline combinations	11	1.4
	Others		52	6.4
	Class Total		**798**	**100**
S- Sensory Organs	Others		13	100
	Class Total		**13**	**100**
	Total		**4097**	**100**

between the number of unused drugs and some sociodemographic characteristics such as marriage, education, economic status etc. In the literature search, studies researching socio-demographic characteristics and the number of pharmaceuticals are very limited. A previous study found that medication disposal practice was found to be associated with some sociodemographic variables such as gender, age, marital status, and residence [16]. In another study, it was reported that parameters such as gender, education level, and place of residence were associated with drug keeping at home [17]. Therefore, it is possible to say that some sociodemographic characteristics are effective on the dependent variables.

According to the findings obtained from the participants' practices on unused pharmaceuticals, it was found that pharmaceuticals were generally stored in the kitchen and refrigerator, and most of the pharmaceuticals were prescribed by primary health care facilities and family physicians. Addition, it was found that the most important reason for having unused pharmaceuticals in their

households was reuse (for treatment), 44.6% kept them in household until the expiration date, 72.1% checked the expiration date, 56.7% read the package insert, and 41.3% purchased pharmaceuticals without a prescription. The findings that expired pharmaceuticals were thrown away, that improper disposal of pharmaceuticals polluted the environment and that the awareness on pharmaceuticals should be raised by the Ministry of Health came to the forefront. In a study reported by Manocha et al. (2020), it was reported that a significant proportion of participants had unused pharmaceuticals in their households and threw away expired pharmaceuticals [18]. In a study conducted by Althagafi et al. (2022), it was shown that about half of the participants were found pharmaceuticals in their households and that these pharmaceuticals were mainly stored in the refrigerator [4]. In another study researching the storage conditions of pharmaceuticals, it was shown that pharmaceuticals were stored in many different places, but especially in the kitchen [19]. In a study conducted by Gidey et al. (2020), it was reported that improper disposal of pharmaceuticals might be harmful to the environment and 77.4% disposed of pharmaceuticals by throwing them in household garbage [20]. In another study on medication disposal, it was reported that participants mostly disposed of medicines by throwing them in household garbage [21]. The dominant view was that unused pharmaceuticals were generally accumulated in households, expired pharmaceuticals were thrown in household garbage, pharmaceuticals were stored in the kitchen, and improper disposal harmed the environment in literature. When we compare the findings in the literature with our study findings, it is possible to say that the findings are similar. We think that the variation in the findings of behaviors towards unused medicines (storage, disposal, etc.) may be related to the type of study, number of participants, participant characteristics, culture, region and development level of the country.

According to the findings of our study, there were unused drugs in almost all ATC classes. In addition, the most prominent drugs in the quantity of leftover drugs were analgesics (paracetamol, etc.), cold medicines, NSAIDs (dexketoprofen, etc.), antibiotics (amoxicillin, etc.) and proton pump inhibitors (lansoprazole, etc.). According to various studies conducted based on the classification of the mechanism of action, drugs such as analgesics and pain relievers [22], antipyretics, analgesics, antispasmodics, antibiotics, antacids, and vitamins [23], antibiotics and pain-spasm relievers [24], antibiotics and non-steroidal anti-inflammatory drugs (NSAIDs) [12], antibiotics and analgesics [2], NSAIDs, antibiotics, and vitamins [13], were reported. In studies conducted in Mexico and Saudi Arabia, which are located in two different geographies, NSAIDs came to the forefront [25, 26]. It is seen that the findings of studies based on the

mechanism of action of unused pharmaceuticals in the literature are similar to each other. In our study, ATC classification was performed and it can be said that the Turkish context also supports the existing literature.

According to the findings of our study, 50.6% of the total number of dosage forms of pharmaceuticals were used but 49.4% were unused. Patients should follow the treatment procedure prescribed by the physician. However, in some cases, medication may be stopped early by the patient. Some studies have reported that the most important reason for having unused or expired pharmaceuticals in household is recovery [1, 27]. Other reported reasons were a change in treatment by the doctor and feeling well [28]. In our study, we showed that approximately half of the medicines were not used. The presence of unused medicines in households might be related to self-medication. In our study the prevalence of self-medication was 94.1%. Analgesics, common cold and muscle relaxants of the pharmaceuticals were found to be the most commonly used pharmaceuticals without consulting a physician. This finding was reported by Kumar et al. (2013) as 78.6% [29], by Niromand et al. (2020) as 72% [30], by Abdi et al. (2018) as 89.6% [31], and by Bahzadifar et al. (2020) as 70.1%. In the same study, it was reported as 97.2% in medical students and 44.7% in nonmedical students [32]. According to the findings of a local study, the prevalence of self-medication was 64.3%, and it was found that analgesics, antibiotics and cold pharmaceuticals were mostly used in this way [33]. In another study, analgesics, antibiotics and antacid pharmaceuticals came to the forefront [34]. When we compare the findings of previous studies with our finding, it is possible to say that a finding similar to the literature has emerged when the number and quantity of unused pharmaceuticals at home are taken into consideration and that the prevalence related to self-medication is one of the highest findings in the literature.

Conclusion

According to findings, there is a significant quantity and number of unused pharmaceuticals with various active ingredients in households. It was observed that the unused pharmaceuticals were used without consulting a physician, were not disposed of properly, and some of them had expired. Considering the conditions associated with pharmaceuticals, this situation points to a significant public health problem for both people and environment. The public urgently needs to be informed about the use of pharmaceuticals. The accumulation resulting from any discontinuation of pharmaceutical therapy needs to be monitored and updated public health policies and legislation are required. In addition, a "drug take-back system" for unused pharmaceuticals may be useful in solving this problem.

Table 4 An analysis of unused pharmaceuticals (Number of participants = 115)

ATC Code-ATC Name	Number of pharmaceuticals	Number of Dosage Forms	Used	Unused
A12CB01 Zinc Sulfate	6	220	82(37)	138(63)
A11DB Vitamin B1 in combinations with B6 and/or B12	6	210	112(53)	98(47)
A02BC05 Esomeprazole	5	140	93(66)	47(34)
A09AA02 Multienzymes (lipase, protease etc.)	1	100	70(70)	30(30)
A02BC02 Pantoprazole	3	84	44(52)	40(48)
A02AD04 Hydrotalcite	2	80	61(76)	19(24)
A03BB01 Butylscopolamine	3	60	20(33)	40(67)
A03FA01 Metoclopramide	2	60	5(8)	55(92)
A03AX13 Silicones	1	50	38(76)	12(24)
A02AB04 Dihydroxialumini sodium carbonate	1	48	36(75)	12(25)
A03AX58 Alverine, Combinations	1	40	20(50)	20(50)
A03AB06 Otilonium Bromide	1	31	26(84)	5(16)
A16AX01 Thioctic Acid	1	30	15(50)	15(50)
A12CC30 Magnesium	1	30	22(73)	8(27)
A02BC03 Lansoprazole	1	28	10(36)	18(64)
A02BC04 Rabeprazole	1	20	1(5)	19(95)
A04AD Other antiemetics	2	32	29(91)	3(9)
A07FA02 Saccharomyces Boulardii	1	10	2(20)	8(80)
Class Total	**39**	**1273(100)**	**686(53.9)**	**587(46.1)**
B02AA02 Tranexamic Acid	1	50	17(34)	33(66)
B03AA02 Ferrous Fumarate	1	30	22(73)	8(27)
Class Total	**2**	**80(100)**	**39(48.8)**	**41(51.2)**
C09CA06 Candesartan	3	84	66(79)	18(21)
C05CA53 Diosmin, combination	1	60	50(83)	10(17)
C04AD03 Pentoxifylline	1	20	10(50)	10(50)
C05AX03 Other preparations, combinations	2	20	7(35)	13(65)
C07AB02 Metoprolol	1	20	9(45)	11(55)
Class Total	**8**	**204(100)**	**142(69.6)**	**62(30.4)**
D01BA02 Terbinafine	1	28	6(21)	22(79)
Class Total	**1**	**28(100)**	**6(21)**	**22(79)**
G04CA02 Tamsulosin	1	30	29(97)	1(3)
G04BD10 Darifenacin	1	28	23(82)	5(18)
G03DB01 Dydrogesterone	1	20	8(40)	12(60)
Class Total	**3**	**78(100)**	**60(76.9)**	**18(23.1)**
J01CR02 Amoxicillin and beta-lactamase inhibitor	16	224	136(61)	88(39)
J01XE01 Nitrofurantoin	3	90	27(30)	63(70)
J05AH02 Oseltamivir	6	60	31(52)	29(48)
J01FA09 Clarithromycin	3	42	22(52)	20(48)
J01DC04 Cefaclor	1	20	12(60)	8(40)
J01DC10 Cefprozil	1	20	14(70)	6(30)
J01FA10 Azithromycin	1	3	2(67)	1(33)
Class Total	**31**	**459**	**244(53.2)**	**215(46.8)**
M01AE17 Dexketoprofen	20	460	200(43)	260(57)
M01AB05 Diclofenac	19	320	150(47)	170(53)
M03BB53 Chlorzoxazone, combinations excl psycholeptics	9	180	87(48)	93(52)
M01AE09 Flurbiprofen	4	105	80(76)	25(24)
M01AB08 Etodolac	3	52	18(35)	34(65)
M01AE01 Ibuprofen	3	42	24(57)	18(43)
M01AG01 Mefenamic Acid	2	40	18(45)	22(55)
M01BX Other antiinflammatory/antirheumatic	2	40	20(50)	20(50)
M03BX30 Pheniramidol	1	24	4(17)	20(83)
M01AE02 Naproxen	2	20	10(50)	10(50)

Table 4 (continued)

ATC Code-ATC Name	Number of pharmaceuticals	Number of Dosage Forms	Used	Unused
M01AE03 Ketoprofen	2	20	12(60)	8(40)
M03BX05 Thiocholchicoside	1	14	12(86)	2(14)
Class Total	**68**	**1317(100)**	**635(48.2)**	**682(50.8)**
N02BE01 Paracetamol	18	360	153(43)	207(58)
N02BE51 Paracetamol, combinations excl psycholeptics	4	120	52(43)	68(57)
N07CA01 Betahistine	2	120	86(72)	34(28)
N02BA01 Acetylsalicylic Acid	4	110	37(34)	73(66)
N02BB02 Metamizole Sodium	4	70	24(34)	46(66)
N02CC07 Frovatriptan	1	6	5(83)	1(17)
Class Total	**33**	**786(100)**	**357(45.4)**	**429(54.6)**
P01AB01 Metronidazole	6	120	53(44)	67(56)
P01AB03 Ornidazole	1	10	5(50)	5(50)
Class Total	**7**	**130(100)**	**58(44.6)**	**72(55,4)**
R01BA52 Pseudoephedrine, combinations	23	636	292(46)	344(54)
R05X Other cold preparations	23	558	298(53)	260(47)
R05CB10 Combinations (Acetylcysteine, Vit C)	7	210	88(42)	122(58)
R05CB01 Acetylcysteine	6	140	89(64)	51(36)
R06AE07 Cetirizine	4	80	42(53)	38(48)
R06AX27 Desloratadine	3	60	9(15)	51(85)
R06AX29 Bilastine	3	60	16(27)	44(73)
R03DC53 Montelukast, combinations	1	30	27(90)	3(10)
R05DB13 Butamirate	1	20	17(85)	3(15)
R06AB05 Pheniramine	1	20	17(85)	3(15)
R06AX28 Rupatadine	1	20	10(50)	10(50)
Class Total	**73**	**1834**	**905(49.3)**	**929(50.7)**
Total	**265**	**6189**	**3132(50.6)**	**3057(49.4)**

Number of pharmaceuticals: Number of boxes of prescribed pharmaceuticals leftover after treatment, Number of Dosage Forms: Number of dosage forms in a box of pharmaceuticals, Used n(%): Used for treatment, Unused n(%): Leftover after treatment

Limits of the study

This study has some limitations. The limitations of this study included the fact that a significant portion of the study data was collected by online method, that it was based on the statements and practices of the participants, and that some pharmaceuticals might not be reported by the participants considering that they were related to privacy and research data were collected from a single center.

Author contributions

SK Carried out the study design and execution of the research work and writing of the initial draft of the manuscript. SK Writing and expert review of the manuscript. SK Reviewed the statistical analysis for appropriate writing of the manuscript and expert review of the manuscript. All authors read and approved the final version of the manuscript.

Data availability

The datasets used and/or analysed during the current study available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

Ethical approval for this study was taken from Burdur Mehmet Akif Ersoy University Non-Invasive Clinical Trials Ethics Committee (2023 – 210). Informed consents were obtained according to the conditions accepted by the ethics committee. For data collected online, it was obtained in the form of a checkbox on the first opening screen of the link and before proceeding to the study questions (First sample group). In face-to-face data collection, it was read directly to the participant and their written informed consent was obtained (Second sample group). The Declaration of Helsinki was followed at every stage of the study.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

References

1. Shah S, Abbas G, Hanif M, et al. Disposal practices of Expired and unused medications among households in Punjab, Pakistan. Curr Drug Saf. 2023;18(2):196–201. https://doi.org/10.2174/1574886317666220513102654.
2. Ayele Y, Mamu M. Assessment of knowledge, attitude and practice towards disposal of unused and expired pharmaceuticals among community in Harar city, Eastern Ethiopia. J Pharm Policy Pract. 2018;11:27. https://doi.org/10.1186/s40545-018-0155-9.

3.   Nepal S, Giri A, Bhandari R, et al. Poor and unsatisfactory disposal of expired and unused pharmaceuticals: A Global Issue. Curr Drug Saf. 2020;15(3):167–72. https://doi.org/10.2174/1574886315666200626164001.

4.   Althagafi A, Alshibani M, Alshehri S, et al. Assessment of knowledge and awareness of safe disposal of unused or expired medication in Saudi Arabia: a cross-sectional study. Saudi Pharm J. 2022;30(11):1672–8. https://doi.org/10.1016/j.jsps.2022.09.012.

5.   Woldeyohanins AE, Adugna M, Mihret T, et al. Knowledge, attitude, and Practices of Unused Medications Disposal among Patients Visiting Public Health Centers in Gondar Town, Ethiopia: a cross-sectional study. J Environ Public Health. 2021;2021:5074380. https://doi.org/10.1155/2021/5074380.

6.   Vellinga A, Cormican S, Driscoll J, et al. Public practice regarding disposal of unused medicines in Ireland. Sci Total Environ. 2014;478:98–102. https://doi.org/10.1016/j.scitotenv.2014.01.085.

7.   Bashatah A, Wajid S. Knowledge and disposal practice of Leftover and Expired Medicine: a cross-sectional study from nursing and pharmacy students' perspectives. Int J Environ Res Public Health. 2020;17(6):2068. https://doi.org/10.3390/ijerph17062068.

8.   Alhomoud FK, Alsadiq Y, Alghalawin L, et al. Pharmacy students' knowledge and practices concerning the storing and disposal of household medication in Saudi Arabia. Curr Pharm Teach Learn. 2021;13(1):5–13. https://doi.org/10.1016/j.cptl.2020.08.004.

9.   Begum MM, Rivu SF, Hasan MMA, et al. Disposal practices of unused and Leftover Medicines in the households of Dhaka Metropolis. Pharm (Basel). 2021;9(2):103. https://doi.org/10.3390/pharmacy9020103.

10. Shoaib M, Raziq A, Iqbal Q, et al. Disposal practices of unused and expired pharmaceuticals among the general public in Quetta city, Pakistan. PLoS ONE. 2022;17(5):e0268200. https://doi.org/10.1371/journal.pone.0268200.

11. Aluko OO, Imbianozor GT, Jideama CO, et al. The perception and disposal practices of unused and expired medicines by households in an urban municipality, southwest Nigeria: a comparative cross-sectional study. Waste Manag. 2022;140:121–32. https://doi.org/10.1016/j.wasman.2022.01.022.

12. Bashaar M, Thawani V, Hassali MA, et al. Disposal practices of unused and expired pharmaceuticals among general public in Kabul. BMC Public Health. 2017;17(1):45. https://doi.org/10.1186/s12889-016-3975-z.

13. Insani WN, Qonita NA, Jannah SS, et al. Improper disposal practice of unused and expired pharmaceutical products in Indonesian households. Heliyon. 2020;6(7):e04551. https://doi.org/10.1016/j.heliyon.2020.e04551.

14. Kamal KM, Chiumente M, Nakagawa S, et al. Disposal practices for unused and expired medications: pilot data from three cities in three countries. GMS Health Innov Technol. 2022;16:Doc01. https://doi.org/10.3205/hta000133.

15. World Health Organization (WHO). ATC/DDD index 2023, https://www.whocc.no/atc_ddd_index/, Accesed Date: 15.10.2023.

16. Sitotaw B, Philipos W. Knowledge, attitude, and practices (KAP) on antibiotic Use and Disposal ways in Sidama Region, Ethiopia: A Community-based cross-sectional survey. Sci World J. 2023;2023:8774634. https://doi.org/10.1155/2023/8774634.

17. Wang X, Lin L, Xuan Z, et al. Keeping antibiotics at Home promotes self-medication with antibiotics among Chinese University students. Int J Environ Res Public Health. 2018;15(4):687. https://doi.org/10.3390/ijerph15040687.

18. Manocha S, Suranagi UD, Sah RK, et al. Current Disposal practices of unused and expired Medicines among General Public in Delhi and National Capital Region, India. Curr Drug Saf. 2020;15(1):13–9. https://doi.org/10.2174/1574886314666191008095344.

19. Kelly F, McMillan S, Spinks J, et al. You don't throw these things out:' an exploration of medicines retention and disposal practices in Australian homes. BMC Public Health. 2018;18(1):1026. https://doi.org/10.1186/s12889-018-5753-6.

20. Gidey MT, Birhanu AH, Tsadik AG, et al. Knowledge, attitude, and practice of unused and expired medication disposal among patients visiting Ayder Comprehensive Specialized Hospital. Biomed Res Int. 2020;2020:9538127. https://doi.org/10.1155/2020/9538127.

21. Jankie S, Barsatee N, Dookhan V, et al. Patients' knowledge, attitudes and concerns regarding the disposal of expired/unused medication. Int J Pharm Pract. 2022;30(3):247–52. https://doi.org/10.1093/ijpp/riac006.

22. Kahsay H, Ahmedin M, Kebede B, et al. Assessment of Knowledge, attitude, and Disposal Practice of unused and expired pharmaceuticals in community of Adigrat City, Northern Ethiopia. J Environ Public Health. 2020;2020:6725423. https://doi.org/10.1155/2020/6725423.

23. Loni SB, Eid Alzahrani R, Alzahrani M, et al. Prevalence of self-medication and associated factors among female students of health science colleges at Majmaah University: a cross-sectional study. Front Public Health. 2023;11:1090021. https://doi.org/10.3389/fpubh.2023.1090021.

24. Ebrahim AJ, Teni FS, Yimenu DK. Unused and expired medications: are they a threat? A facility-based cross-sectional study. J Prim Care Community Health. 2019;10:2150132719847857. https://doi.org/10.1177/2150132719847857.

25. Gracia-Vásquez SL, Ramírez-Lara E, Camacho-Mora IA, et al. An analysis of unused and expired medications in Mexican households. Int J Clin Pharm. 2015;37(1):121–6. https://doi.org/10.1007/s11096-014-0048-1.

26. Wajid S, Siddiqui NA, Mothana RA, et al. Prevalence and practice of unused and expired Medicine-A Community-based study among Saudi adults in Riyadh, Saudi Arabia. Biomed Res Int. 2020;2020:6539251. https://doi.org/10.1155/2020/6539251.

27. Marwa KJ, Mcharo G, Mwita S, et al. Disposal practices of expired and unused medications among households in Mwanza, Tanzania. PLoS ONE. 2021;16(2):e0246418. https://doi.org/10.1371/journal.pone.0246418.

28. Azmi Hassali M, Shakeel S. Unused and Expired Medications Disposal Practices among the General Public in Selangor, Malaysia. Pharm (Basel). 2020;8(4):196. https://doi.org/10.3390/pharmacy8040196.

29. Kumar N, Kanchan T, Unnikrishnan B, et al. Perceptions and practices of self-medication among medical students in coastal South India. PLoS ONE. 2013;8(8):e72247. https://doi.org/10.1371/journal.pone.

30. Niroomand N, Bayati M, Seif M, et al. Self-medication pattern and prevalence among Iranian Medical sciences Students. Curr Drug Saf. 2020;15(1):45–52. https://doi.org/10.2174/1574886314666191022095058.

31. Abdi A, Faraji A, Dehghan F, et al. Prevalence of self-medication practice among health sciences students in Kermanshah, Iran. BMC Pharmacol Toxicol. 2018;19(1):36. https://doi.org/10.1186/s40360-018-0231-4.

32. Behzadifar M, Behzadifar M, Aryankhesal A, et al. Prevalence of self-medication in university students: systematic review and meta-analysis. East Mediterr Health J. 2020;26(7):846–57. https://doi.org/10.26719/emhj.20.052.

33. Okyay RA, Erdoğan A. Self-medication practices and rational drug use habits among university students: a cross-sectional study from Kahramanmaraş. Turk PeerJ. 2017;5:e3990. https://doi.org/10.7717/peerj.3990.

34. Opare-Addo MNA, Marfo AFA, Owusu-Daaku FT. Disposal of leftover and expired medicines by community pharmacies and their clients in Ghana. Waste Manag Res. 2022;40(10):1539–45. https://doi.org/10.1177/0734242X221084060.

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