

EWELINA MUNDZIK-JANCZARSKA, ANDRZEJ STAŃCZAK

The analysis of unused medications and other products returned by patients to selected public pharmacies in Poland

Abstract

The issue of expired and unused medications is a significant matter worthy of analysis. The study focused on the analysis of pharmaceutical products returned to public pharmacies, with particular emphasis on expired drugs and those returned within their expiration date, along with an economic assessment of the returned products.

The research methodology relied on the analysis of products returned by patients to public pharmacies in the Mazovian voivodeship. The analysis encompassed the content of containers containing expired medications in terms of their expiration date, pharmaceutical form, active ingredient, ATC classification, drug availability category, and monetary value. The analyzed products belonged to various categories, including: medicines, dietary supplements, medical devices, specialized medical foods, cosmetics, biocidal products, and hygiene items.

The study revealed that 75.75% of the returned products were drugs. Among the most frequently returned active ingredients was paracetamol, and prescription medications were the predominant category among the returned products. The most commonly returned therapeutic products belonged to the groups related to the Gastrointestinal and Metabolism, Respiratory System, and Nervous System. The economic evaluation showed that the value of returned products was significantly lower for expired items compared to those within their expiration date. The total value of the returned products amounted to 42 218.07 PLN.

In summary, the issue of medication waste presents a challenge that requires a comprehensive approach, such as public education and the proposal of efficient solutions.

Keywords: unused drugs, drug wastage, expired drugs.

DOI: 10.12923/2083-4829/2023-0009

INTRODUCTION

In the current era of facilitated access to diverse pharmaceutical products, a significant issue arises concerning their wastage. Expired medications and other pharmaceuticals generate substantial economic losses for the entire healthcare system. Consequently, this study focuses on the analysis of products returned by patients to public pharmacies.

The pharmaceutical industry has been one of the most dynamically operating sectors in both the global and European economies for years. Each year witnesses a rise in the number of new medicinal products, accompanied by an increase in the locations where such drugs can be acquired, leading to easier access to preparations and heightened drug consumption. In 2021, the total value of the pharmaceutical market in Europe, at manufacturing prices, amounted to 255 billion euros. Mandatory health insurance systems, including national health funds, allocated nearly 157.5 billion euros for outpatient treatment [1].

Pharmacies and pharmacy points constitute essential elements of the healthcare system, providing residents with medicinal products, medical supplies, and dietary supplements.

According to the Central Statistical Office's report in 2021, there were 11,866 public pharmacies and 1,147 pharmacy points in Poland. Health Ministry data for 2021 indicated that the sales value of all prescription drugs amounted to 19.7 billion PLN, with a reimbursement value of 8.1 billion PLN. The sales value of prescription drugs, per capita in Poland, was 520 PLN, of which 305 PLN constituted the patient's co-payment [2].

The increase in drug consumption and the growing quantity of waste in the form of unused medicinal products present a global problem, particularly observed in countries like India and China [3]. Drugs remain unused for various reasons, with treatment discontinuation due to achieving the intended therapeutic effect being a primary cause (New Zealand: nearly 68% [4], Ethiopia: 42% [5]). Other reasons include excessive prescription, treatment change, lack of treatment continuation, non-compliance with the treatment regimen, adverse effects or patient death, and the purchase of more medication than necessary [3,6]. Storing unused medications poses risks such as taking medication against the doctor's recommendations, usage by other individuals in the household, or taking expired medication.

A review of scientific literature reveals that the primary method of disposing of unused/expired medications, both in highly developed and low- to middle-income countries, is disposing them in household garbage and subsequently flushing them down the sewer through toilets or sinks (England, Lithuania, Serbia, Ireland, Romania, Cyprus, Poland, Pakistan, Bangladesh, India, Malaysia, Thailand, Hong Kong, China, Egypt, Ethiopia, Nigeria, Ghana, Kuwait, Qatar, Saudi Arabia, Brazil, New Zealand, and Australia) [7-13]. Among countries with the highest medication return rates to pharmacies are the Netherlands (58%), Sweden (43%), and Germany (29%), while in Australia and New Zealand, approximately 1/4 of respondents return medications to pharmacies [10]. A pilot study conducted in Poland revealed that nearly 68% of respondents dispose of expired products together with household waste or sewage, while an average of 33% declare returning expired preparations to the pharmacy [14].

AIM

The aim of the study was to assess the products returned by patients to selected public pharmacies, with a focus on the expiration date of the products, the accessibility category of the returned drugs, their classification within the anatomical groups of the ATC Classification, active substance, and pharmaceutical form. Additionally, the study aimed to evaluate the economic aspects of the products returned by patients to pharmacies.

MATERIAL AND METHODS

The research methodology was based on the analysis of products returned by patients to four public pharmacies in the Mazovian Voivodeship (103 days of study). The analysis of the products was conducted based on the contents of containers for expired medications, with two containers sourced from rural areas and two from urban areas. Each pharmacy was visited four times. Quantitative assessment and container contents were determined after obtaining information from the pharmacy staff about the filling status and the approaching disposal date (through incineration) of the returned products.

The selection criterion for the study material was the content of the product in the immediate packaging. All products from the container were analyzed, excluding empty packag-

ing, medical materials such as bandages, syringes, needles, and unpackaged pharmaceutical forms like tablets, capsules, or others.

Information about the returned products was collected, including the trade name of the product, dosage, substances (International Nonproprietary Names, INN), pharmaceutical form, expiration date, quantity of the product in the immediate packaging in relation to the quantity in the external packaging, the initial capacity of the product, and its origin. Products described in a foreign language with an active substance were classified as foreign drugs. Kamssoft system: KS-AOW (version 2022.4.0.0), the KS-BLOZ database, as well as the Summaries of Product Characteristics were used. The database was supplemented with the Anatomical Therapeutic Chemical (ATC) classification and drug availability category. Market price, representing the amount the patient must pay for the product in the pharmacy (assuming no reimbursement for the patient, 100% out-of-pocket payment, as the product's price at the time of purchase was unknown, status as of October 2022), was also determined. Data were collected in tabular form using MS Excel 2021. Statistical analysis was performed using statistical tools and software such as Microsoft Excel 2021, STATISTICA 13.1. Statistical methods applied included the Pearson's chi-squared test, Similarity Index of Structures [15], and the Student's t-test. The analysis encompassed data from the direct packaging of the products, as well as information available in the Kamssoft online system, the KS-BLOZ database, and the Summaries of Product Characteristics.

RESULTS

The total number of products subjected to analysis was $n=4776$. The study results are summarized in Tables 1-9. Details regarding products returned by patients to public pharmacies in the examined material are presented in Figure 1.

The analysis of products returned by patients to public pharmacies revealed that the largest category consisted of drugs (75.75%), both for expired and non-expired products. Patients returned a total of $n=3014$ expired drugs and $n=604$ with current expiration dates to pharmacies. In the examined material, in addition to over-the-counter (OTC) medications ($n=1580$) and prescription medications (Rx) ($n=1983$), homeopathic remedies ($n=11$), foreign drugs ($n=24$), and veterinary medications ($n=20$) were also identified. Detailed data are presented in Table 1.

TABLE 1. The assessment of the products returned by patients to public pharmacies based on expiration date in the studied material.

Products	Expired		Non-expired		All	
	Number	Structure index [%]	Number	Structure index [%]	Number	Structure index [%]
Drugs*	3014	75.03	604	79.58	3618	75.75
Cosmetics	57	1.42	9	1.19	66	1.38
Medical products	248	6.17	52	6.85	300	6.28
Dietary supplements	623	15.51	92	12.12	715	14.97
Food for special medical purposes	72	1.79	1	0.13	73	1.53
Biocidal products	3	0.07	0	0.00	3	0.06
Hygiene products	0	0.00	1	0.13	1	0.02
All	4017	100.00	759	100.00	4776	100.00
Statistical analysis	Pearson's Ch-squared test = 7.11			Significance level = 0.0685		

Source: own research

Note: Due to the distribution of the feature, statistical analysis was performed for the first 4 rows, including homeopathic, veterinary, and foreign medicines.

Tablets were the predominant pharmaceutical form in the examined material, representing 49.78% (n=2335) of all analyzed products (i.e., tablets in blister packs were the most common among all analyzed products). Capsules ranked second in terms of frequency, accounting for 12.34% (n=577) of the examined products. Powder was a pharmaceutical form in 10.10% of products (n=472). Aerosols (n=215), solutions (n=149), drops (n=138), and gels (n=124) were also commonly used pharmaceutical forms, though to a lesser extent than tablets, capsules, and powders. Other pharmaceutical forms, such as ointments, liquids, syrups, creams, and suspensions, constituted a smaller

part of the analyzed material. Statistical analysis showed a high similarity index of pharmaceutical form structures between expired and non-expired products (89.20%). This suggests that pharmaceutical forms do not significantly differ depending on the expiration date of the products.

The most frequently returned active substance among medicinal products, constituting 8.86% of products, was paracetamol alone and in combination with other drugs (n=267), followed by bisoprolol (n=128). For medicinal products with a current expiration date, the largest group consisted of substances enoxaparin sodium (n=34) and budesonide (n=21).

TABLE 2. The Assessment of the most commonly contained active substances in medicinal products depending on the expiration date in the examined material.

Active substance	All		Expired pharmaceuticals		Non-expired pharmaceuticals	
	Number	Structure index [%]	Number	Structure index [%]	Number	Structure index [%]
bisoprololum	128	8.01	121	8.78	7	3.17
paracetamolom	126	7.88	119	8.64	7	3.17
budesonidum	78	4.88	57	4.14	21	9.50
diosmectitum	75	4.69	75	5.44	0	0.00
diclofenacum	69	4.32	62	4.50	7	3.17
acidum acetylsalicylicum	69	4.32	65	4.72	4	1.81
enoxaparinum natricum	62	3.88	28	2.03	34	15.38
drotaverinum	59	3.69	48	3.48	11	4.98
metformini hydrochloridum	59	3.69	51	3.70	8	3.62
productum compositum	57	3.56	48	3.48	9	4.07
acidum ascorbicum. rutosidum	57	3.56	54	3.92	3	1.36
ibuprofenum	55	3.44	46	3.34	9	4.07
simeticonum	45	2.81	41	2.98	4	1.81
pantoprazolum	43	2.69	35	2.54	8	3.62
mometasonum	42	2.63	29	2.10	13	5.88
acetylcysteinum	40	2.50	30	2.18	10	4.52
argininum	38	2.38	38	2.76	0	0.00
tramadolom. paracetamolom	35	2.19	35	2.54	0	0.00
natrium chloratum	32	2.00	25	1.81	7	3.17
amoxicillinum	30	1.88	26	1.89	4	1.81
loperamidum	30	1.88	29	2.10	1	0.45
inosinum	30	1.88	29	2.10	1	0.45
ramiprilum	29	1.81	9	0.65	20	9.05
ranitidinum	29	1.81	26	1.89	3	1.36
amlodipinum	29	1.81	27	1.96	2	0.90
atorvastatinum	29	1.81	26	1.89	3	1.36
thiaminum. pyridoxinum. cyanocobalaminum	28	1.75	17	1.23	11	4.98
nimesulidum	27	1.69	26	1.89	1	0.45
benzydaminum	26	1.63	24	1.74	2	0.90
captoprilum	26	1.63	19	1.38	7	3.17
paracetamolom, acidum ascorbicum, phenylephrinum	25	1.56	25	1.81	0	0.00
naproxenum	24	1.50	24	1.74	0	0.00
meloxicamum	23	1.44	20	1.45	3	1.36
hydroxyzinum	23	1.44	23	1.67	0	0.00
omeprazolom	22	1.38	21	1.52	1	0.45
All	1599	100.00	1378	100.00	221	100.00
Statistical analysis	Index of similarity of structures [%] = 55.98					

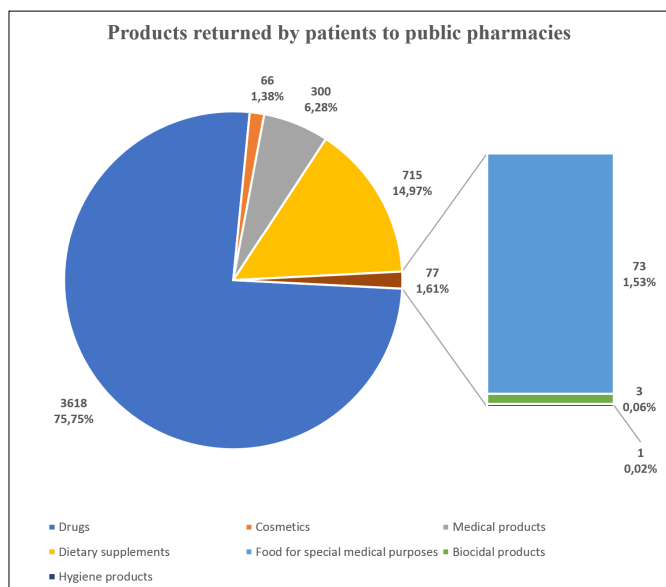
Table 2. presents the active substances most commonly found in medicinal products depending on the expiration date in the examined material. The content of paracetamol in products in the examined material is depicted in Figure 2.

Anatomical Therapeutic Chemical (ATC) classification

The examined material encompassed a wide range of pharmaceutical products belonging to various groups in the ATC classification [16]. The analysis revealed therapeutic diversity among pharmaceutical products in the examined material. The study demonstrated that anatomical groups such as the Gastrointestinal System and Metabolism (21.57%) and the Respiratory System (17.53%), along with the Nervous System (16.89%), were the most numerous in the case of expired prod-

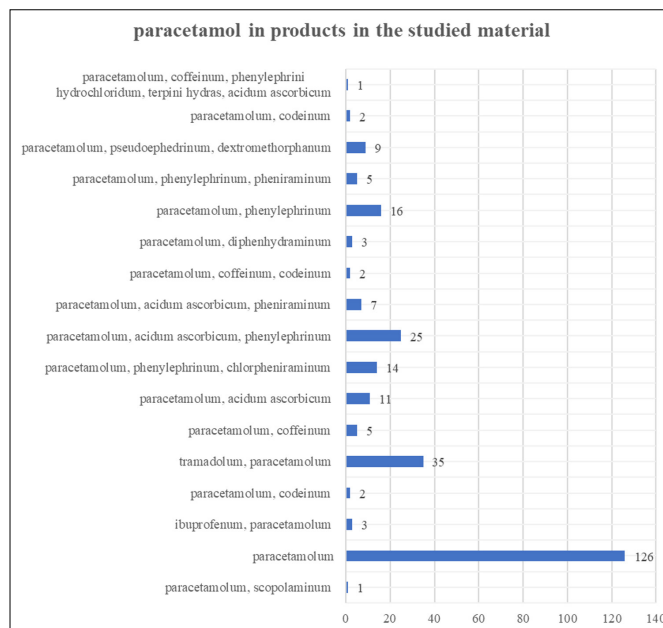
ucts. Conversely, for products with a current expiration date, the dominant groups were the Respiratory System (17.90%), Cardiovascular System (17.57%), Gastrointestinal System and Metabolism (15.76%), and Nervous System (15.60%). Detailed data are presented in Table 3.

Medications used in infections (antibiotics, antifungals, antituberculosis, antiviral, vaccines) constituted 4.77% of the products. A graphical representation of the distribution of the Anatomical Therapeutic Chemical (ATC) Classification of products returned by patients to public pharmacies is depicted in Figure 3.



Source: own research

FIGURE 1. Products returned by patients to public pharmacies in the examined material.



Source: own research

FIGURE 2. The structure of paracetamol in products in the studied material.

TABLE 3. The Anatomical Therapeutic Chemical (ATC) Classification of preparations depending on their expiration date in the studied material.

Anatomical Group	All		Expired		Non-expired	
	Number	Structure index [%]	Number	Structure index [%]	Number	Structure index [%]
Alimentary tract and metabolism	769	20.62	673	21.57	96	15.76
Respiratory system	656	17.59	547	17.53	109	17.90
Nervous system	622	16.68	527	16.89	95	15.60
Cardiovascular system	536	14.37	429	13.75	107	17.57
Musculo-skeletal system	309	8.29	274	8.78	35	5.75
Dermatologicals	209	5.60	186	5.96	23	3.78
Antiinfectives for systemic use	178	4.77	150	4.81	28	4.60
Blood and blood forming organs	134	3.59	85	2.72	49	8.05
Sensory organs	103	2.76	72	2.31	31	5.09
Various	82	2.20	65	2.08	17	2.79
Genito urinary system and sex hormones	71	1.90	64	2.05	7	1.15
Systemic hormonal preparations, excl. sex hormones and insulins	37	0.99	27	0.87	10	1.64
Antiparasitic products, insecticides and repellents	19	0.51	17	0.54	2	0.33
Antineoplastic and immunomodulating agents	4	0.11	4	0.13	0	0.00
All	3729	100.00	3120	100.00	609	100.000
Statistical analysis	Index of similarity of structures [%] = 86.23					

Source: own research

Category of medication availability in the examined material

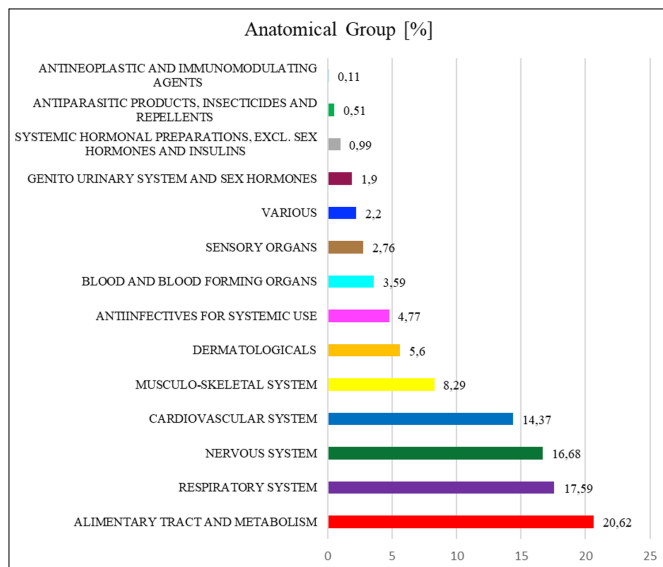
The examined material exclusively included drugs from the OTC category (over-the-counter – without a doctor’s prescription): n=1580 and Rx (prescription medications – requiring a doctor’s prescription) n=1983 [17]. The analysis revealed that in the examined material returned to pharmacies, the majority of medications were prescription drugs (Rx), constituting 55.66%, while OTC drugs accounted for 44.34%. In the case of expired medications, Rx drugs were the dominant group, comprising 52.15%. Among products with a current expiration date, Rx drugs also prevailed, constituting 73.42%.

Over 47% of OTC drugs had exceeded their expiration date. Meanwhile, OTC medications with a current expiration date accounted for 26.58% of OTC medications.

Statistical analysis demonstrated a statistically significant difference (p=0.0001) in the distribution of OTC and Rx medications depending on the expiration date in the examined material (Table 4).

Value of products in the examined material [in PLN]

The total value of the returned products in the examined material was estimated at 42,218.07 PLN. The value of products with a current expiration date was 9,598.42 PLN. The highest value (in PLN) among all products was attributed to medications with a total value of 30,968.06 PLN, of which expired medications accounted for 22,722.57 PLN, and medications with a current expiration date amounted to 8,245.49 PLN. The value (in PLN) of products returned by patients to public pharmacies in the examined material, along with the classification of products into anatomical groups (ATC Classification),

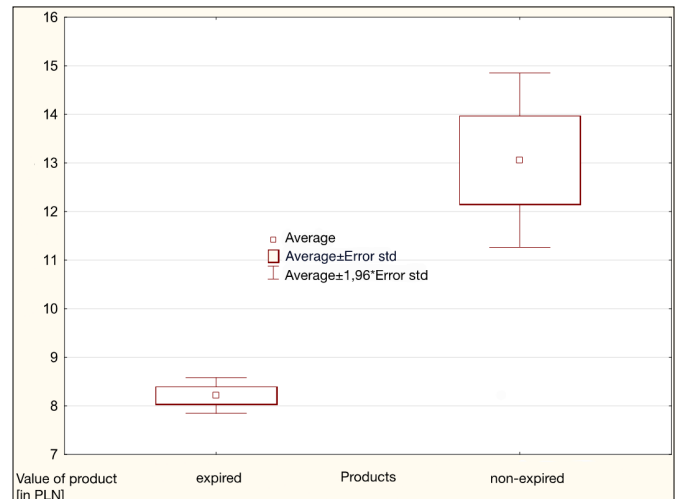


Source: own research

FIGURE 3. Graphic representation of the Anatomical Therapeutic Chemical (ATC) Classification System of medications returned by patients to public pharmacies.

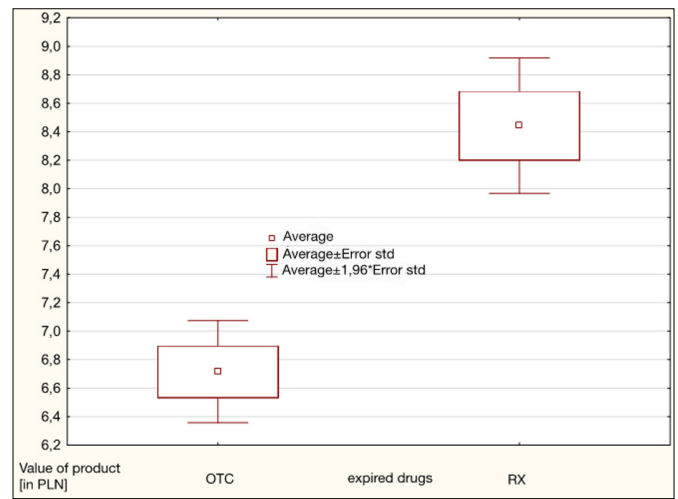
based on the value of products (in PLN), is presented in Tables 5. and 6. Statistical analysis revealed that the value of expired medications returned to the pharmacy is significantly statistically smaller than the value of products with a current expiration date (p<0.0001). Detailed data are presented in Table 7. and Figure 4.

The value (in PLN) of OTC and Rx medications in the examined material is presented in Table 8. The average value of expired medications returned to the pharmacy was 7.61 PLN. Statistical analysis indicated a statistically significant difference (p<0.0001) in the average value of expired OTC and Rx medications. Detailed data regarding the statistical analysis



Source: own research

FIGURE 4. Graphic representation of the values of medications (in PLN) returned to the pharmacy depending on the expiration date in the examined material.



Source: own research

FIGURE 5. Graphic representation of the value of expired OTC and prescription (RX) medications (in PLN) returned to the pharmacy in the examined material.

TABLE 4. The division between over-the-counter (OTC) and prescription drugs depending on the expiration date in the studied material.

Drugs	Expired		Non-expired		All	
	Number	Structure index [%]	Number	Structure index [%]	Number	Structure index [%]
OTC	1424	47.85	156	26.58	1580	44.34
RX	1552	52.15	431	73.42	1983	55.66
All	2976	100.00	587	100.00	3563	100.00
Statistical analysis	Pearson’s Ch-squared test = 89.91			Significance level = 0.0001		

Source: own research

Note: Drugs excluding veterinary, homeopathic, foreign medicines

for the value of expired medications (OTC and Rx) are included in Table 9. and Figure 5.

Waste Index

$$Waste\ Index = \left(\frac{\sum\ prices\ of\ products\ returned\ to\ the\ pharmacy}{\sum\ market\ prices\ of\ products} \right) \times 100\%$$

The waste index for the examined material, defined as the percentage of the quotient of the sum of the values of products returned to the pharmacies and the sum of the market values

TABLE 5. The medications returned by patients to public pharmacies depending on the value (in PLN) in the examined material.

Products	Value of products according to market price (in PLN)	Value of returned products to the pharmacy (in PLN)		
		Expired	Non-expired	All
Drugs*	83 427.79	22 722.57	8 245.49	30 968.06
Cosmetics	1 339.91	682.13	151.56	833.68
Medical products	10 469.85	4 148.52	873.18	5 021.70
Dietary supplements	16 488.88	4 788.59	304.24	5 092.83
Food for special medical purposes	1 949.98	221.55	11.96	233.51
Biocidal products	64.79	56.30	0.00	56.30
Hygiene products	11.99	0.00	11.99	11.99
All	113 753.19	32 619.66	9 598.42	42 218.07

Source: own research

*excluding foreign and veterinary drugs

TABLE 6. Classification of medicinal products by anatomical therapeutic chemical (ATC) classification, based on the value of the products (in PLN) in the examined material.

Anatomical Group	Value of products according to market price (in PLN)	Value of returned products to the pharmacy (in PLN)		
		Expired	Non-expired	All
Respiratory system	17 450.16	4 971.97	1 134.56	6 106.53
Dermatologicals	4 615.53	2 242.24	350.84	2 593.08
Alimentary tract and metabolism	15 987.56	4 913.49	1 328.01	6 241.49
Various	2 605.65	1 742.89	178.73	1 921.61
Nervous system	13 089.91	2 599.17	604.4	3 203.57
Genito urinary system and sex hormones	2 281.37	792.31	129.28	921.59
Sensory organs	3 178.91	1 088.74	528.17	1 616.92
Cardiovascular system	7 823.41	2 366.39	515.72	2 882.11
Musculo-skeletal system	6 290.55	1 729.01	182.02	1 911.03
Antiinfectives for systemic use	4 625.09	1 437.69	281.23	1 718.92
Blood and blood forming organs	9 093.79	890.11	3 198.34	4 088.45
Antiparasitic products, insecticides and repellents	614.01	247.48	14.53	262.02
Antineoplastic and immunomodulating agents	139.83	82.37	0	82.37
Systemic hormonal preparations, excl. sex hormones and insulins	452.39	178.83	51.11	229.94
All	88 248.16	25 282.71	8 496.93	33 779.64

Source: own research

of the same products, was equal to 37.11%. Medications exhibited a waste index of 37.12%. The highest waste index was observed in the following groups: Miscellaneous (73.75%), Antineoplastic and Immunomodulating Agents (58.91%) and Dermatology (56.18%). The lowest Waste Index, on the other hand, was found in the groups: Nervous System (24.47%), Musculoskeletal System (30.38%), and Respiratory System (34.99%).

TABLE 7. Statistical analysis of the values of medications (in PLN) returned to pharmacies depending on the expiration date in the examined material.

Value of products (in PLN)	Products		
	Expired	Non-expired	All
Number	3971	735	4706
Minimum	0.10	0.16	0.10
Maximum	238.40	206.17	238.40
Quartile I	2.39	2.00	2.35
Quartile II (Median)	4.95	4.98	4.95
Quartile III	9.26	11.99	9.59
Average	8.21	13.06	8.97
Standard deviation	11.81	14.73	14.73
Asymmetry factor	7.90	4.05	6.74
Statistical analysis	Pearson's Ch-squared test = 8.25		Significance level = 0.0001

Source: own research

TABLE 8. The value (in PLN) of OTC and Rx drugs in the examined material.

Drugs	Value of products according to market price (in PLN)	Value of returned products to the pharmacy (in PLN)		
		Expired	Non-expired	All
OTC	30 730.16	9 542.30	1 064.76	10 607.06
RX	52 402.08	13 001.75	7 180.72	20 182.47
All	83 132.24	22 544.05	8 245.48	30 789.53

Source: own research

TABLE 9. Statistical analysis of the value of expired OTC and prescription (RX) medications (in PLN) returned to pharmacies in the examined material.

Value of products (in PLN)	Expired		
	OTC	RX	All
Number	1421	1540	2961
Minimum	0.14	0.27	0.14
Maximum	61.66	115.46	115.46
Quartile I	2.20	2.95	2.60
Quartile II (Median)	4.32	4.99	4.95
Quartile III	8.65	9.30	8.98
Average	6.72	8.44	7.61
Standard deviation	6.89	8.41	8.41
Asymmetry factor	2.37	3.42	3.30
Statistical analysis	Pearson's Ch-squared test = 5.62		Significance level = 0.0001

Source: own research

DISCUSSION

The study revealed that the largest group of returned products consisted of drugs, accounting for 75.75%. Dietary supplements constituted over 1/7 of the analyzed products. In the studied material, solid oral forms were the predominant type of products returned by patients to pharmacies, both with current and expired expiration dates. Tablets, representing nearly 50% of all analyzed products, and capsules, constituting over 13%, are commonly used and available on the market. They are popular due to their convenience and the ease of administering active substances. A significant diversity in pharmaceutical forms was noted. Importantly, pharmaceutical forms did not significantly differ depending on the expiration date of the products. The studied material also included a wide range of pharmaceutical products belonging to various groups in the Anatomical Therapeutic Chemical (ATC) Classification.

The most frequently returned active substance was paracetamol. Preparations containing paracetamol accounted for just under 9% of all returned medicines, and the scale of returns indicates its potential misuse by patients in the surveyed pharmacies. Similar results were obtained in the USA [6]. Differences between the group of expired drugs and those with a current expiration date suggest that certain active substances may be more prone to expiration than others. Interestingly, one of the reasons for the high number of returned products with enoxaparin sodium and a current expiration date may be the fact that, since September 1, 2020, in appropriate indications or conditions, drugs containing this substance have been free of charge for pregnant women.

The statistical analysis of the anatomical groups of the ATC Classification indicates that they differ depending on the expiration date of the products. Nevertheless, there is a relatively high similarity between anatomical groups among expired and current products. In terms of the availability category of medicines, prescription drugs dominate among returned products, both expired and with a current expiration date.

Economic analysis showed that the value of returned products was significantly lower for expired products compared to products with a current expiration date. This may suggest that patients are more inclined to take care of storing and using still-valid products to avoid financial losses associated with waste. However, it is essential to note that the reasons for this phenomenon may be diverse and require additional analysis and further research. Extrapolating the value of returned products over 12 months shows that the value of returned products would be 149,607.724 PLN. For all 11,866 registered pharmacies in Poland (in 2021), the annual value of returned products would be nearly PLN 500 million (of which nearly PLN 318 million would be medicines).

For comparison, a study conducted in Vienna in 2009, analyzing drugs disposed in household waste, showed that the most numerous group consisted of cardiovascular drugs (23.7%), musculoskeletal drugs (11.2%), and nervous system drugs (10.5%). As many as 95% of the drugs had a current expiration date. When it comes to 18% of disposed drugs, they were in full packaging, and 74% of drugs were prescription drugs [18]. Another Viennese study showed that 36% of drugs were disposed with a current expiration date, and the most frequently disposed drugs were in the groups of the gastrointestinal tract, nervous system, and respiratory system. In this study, the value of wasted medicinal products reached 4207 euros. It

was estimated that for Vienna, at least 37.65 million euros of public funds were wasted, equivalent to 21 euros per inhabitant [19]. In Italy, a study conducted for a similar sample size (n=3219) and at a similar time in 2020 and 2021 showed that 72.4% of medicinal products were expired. Cardiovascular drugs and drugs used in infections were the main therapeutic classes (17.2% and 15.2%, respectively), and the total cost was 27,681 euros [20]. In a study conducted in the USA during so-called take-back days, aimed at assessing drug disposal practices and quantitatively determining discarded products, a total of 786,882 dosage units were collected, with a total estimated value of 1,118,020 USD. The most frequently returned drugs were antihypertensive drugs, drugs used for gastrointestinal disorders, and analgesics. The study showed that organizing drug return events is an effective method of collecting unused drugs [21]. A 9-month study conducted in Malta showed that the value of products collected during the study was 2613.28 euros. Most of the products belonged to the groups of the gastrointestinal tract (24.6%, 619.39 euros), respiratory system (23.8%, 309.93 euros), and musculoskeletal system (10.5%, 397.82 euros). Dietary supplements and herbal products accounted for 1.9% of the total (73.75 euros) [22].

Study Limitations

The study had several limitations that should be considered when interpreting the results. One limitation was the lack of information regarding the cost of the drugs returned by patients. Therefore, the analysis assumed a 100% cost for all drugs. Additionally, the cost analysis did not account for losses associated with returning aerosol products (due to the inability to determine the amount of product remaining in the primary packaging). A subjective assessment of residues was made for liquid or semi-solid products. Foreign and veterinary products were excluded from the analysis for which the market price could not be determined. Products with removed expiration dates (e.g., cut blister packs) were also excluded from the analysis. Due to the COVID-19 pandemic, access to research material was limited. It would have been interesting to understand the reasons for not using and returning drugs, however, conducting such surveys using questionnaires would exceed the scope of this work.

CONCLUSIONS

The conducted analysis revealed a significant quantity of unused drugs and other products returned by patients. A substantial portion of these drugs expires without being utilized. Moreover, over 15% of the returned drugs had not yet reached their expiration date and could potentially be reused if they are in intact packaging and stored under appropriate conditions or subjected to recycling. The analysis highlighted a significant issue related to the wastage of pharmaceuticals, including medicinal products that could be effectively recycled. Of particular concern is the fact that antibiotics accounted for 3.6% of the returned medicinal products. It is essential to investigate the reasons for non-compliance with prescribed medications, as adhering to medical recommendations is crucial for minimizing the risk of antibiotic resistance. The returned products encompassed a variety of preparations, emphasizing the need to monitor not only the expiration dates of medications but also those of other products and cosmetics. Collaboration among pharmacies, physicians, manufacturers, and patients

can contribute to reducing the number of unused products by increasing awareness and education on proper handling of pharmaceutical products.

Corresponding author

Ewelina Mundzik-Janczarska
Department of Applied Pharmacy, Faculty of Pharmacy, Medical University of Lodz
1 Muszyńskiego St., 90–151 Łódź
e-mail: ewelina.mundzik@stud.umed.lodz.pl

REFERENCES

1. The pharmaceutical industry in figures: European Federation of Pharmaceutical Industries Associations (EFPIA); 2022. [<https://www.efpia.eu/media/637143/the-pharmaceutical-industry-in-figures-2022.pdf>] (access: 18.05.2023)
2. Zdrowie i Ochrona Zdrowia w 2021. [https://stat.gov.pl/files/gfx/portalinformacyjny/en/defaultaktualnosci/3325/1/14/1/health_and_health_care_in_2021.pdf] (access: 18.05.2023)
3. Zalpuri A, Kamra V, Zalpuri R, Garg A. Awareness and practices of disposal of unwanted medicines among patients visiting the OPD and healthcare professionals. *IJAMM*. 2022;7(1):30–4.
4. Braund R, Peake BM, Shieffebien L, Shieffebien L. Disposal practices for unused medications in New Zealand. *Environ Int*. 2009;35(6):952–5.
5. Addis GT. Assessment of disposal practices for unused medication: a multi-center cross-sectional study of patients visiting public health facilities in northwest Ethiopia. *J Publ Health*. 2023.
6. Yang CHJ, Doshi M, Mason NA. Analysis of medications returned during a medication take-back event. *Pharmacy*. 2015;3(3):79–88.
7. Rogowska J, Zimmermann A. Household pharmaceutical waste disposal as a global problem—a review. *Int J Environ Res Public Health*. 2022;19(23):15798.
8. Rogowska J, Zimmermann A, Muszyńska A, et al. Pharmaceutical household waste practices: Preliminary findings from a case study in Poland. *Environ Manag*. 2019;64(3):97–106.
9. Paut Kusturica M, Tomas A, Sabo A. Disposal of unused drugs: Knowledge and behavior among people around the world. *Rev Environ Contam Toxicol*. 2017;204:71–104.
10. Zimmermann A, Rogowska J, Wolska L. Odpady farmaceutyczne z gospodarstw domowych—rola aptek ogólnodostępnych. *Farm Pol*. 2018;74(1):40–4.
11. Alnahas F, Yeboah P, Fliedel L, et al. Expired medication: Societal, regulatory and ethical aspects of a wasted opportunity. *Int J Environ Res Public Health*. 2020;17(3):787.
12. Rodrigues Fernandes M, Carvalho de Figueiredo R, Resende da Silva LG, et al. Storage and disposal of expired medicines in home pharmacies: emerging public health problems. *Einstein*. 2020;18:1–6.
13. 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):1–13.
14. Luo Y, Reimers K, Yang L, et al. Household drug management practices of residents in a second-tier city in China: Opportunities for reducing drug waste and environmental pollution. *Int J Environ Res Public Health*. 2021;18(16):8544.
15. Pojęcia stosowane w statystyce publicznej; 2023. [<https://stat.gov.pl/metainformacje/slownik-pojec/pojecia-stosowane-w-statystyce-publicznej/2952,pojcie.html>] (access: 02.06.2023)
16. ATC/DDD Index 2023: WHO; 2023. [https://www.whocc.no/atc_ddd_index/] (access: 02.06.2023)
17. Ustawa z dnia 6 września 2001 r. Prawo Farmaceutyczne; 2023. [<https://isap.sejm.gov.pl/isap.nsf/download.xsp/WDU20011261381/U/D20011381Lj.pdf>] (access: 17.04.2021)
18. Vogler S, Leopold C, Zuidberg C, et al. Medicines discarded in household garbage: Analysis of a pharmaceutical waste sample in Vienna. *J Pharm Policy Pract*. 2014;7(6).
19. Vogler S, de Rooij RHPF. Medication wasted – Contents and costs of medicines ending up in household garbage. *Res Soc Admin Pharm*. 2018;14(12):1140–6.
20. Romanelli L, Lucente F. Analysis of medicines returned to pharmacies for disposal and estimation of the cost due to medicine wasting. *ERCSP*. 2022;5:100133.
21. Perry LA, Shinn BW, Stanovich J. Quantification of an ongoing community-based medication take-back program. *J Am Pharm Assoc*. 2014;54(3):275–9.
22. Vella V, West L. Analysis of disposed unused medications at a village community pharmacy. *Pharmacy*. 2019;7(2):45.