

Drug resistance in bacteria: An analysis of the knowledge, attitudes and beliefs of primary care patients in areas that are key for better management of the problem

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Abstract

Introduction: The growing issue of bacterial resistance to antibiotics is a global problem and requires urgent action, including at the stage of primary healthcare (PHC). **Objective:** The goal of the study was to assess patients' knowledge of antibiotic-resistant bacteria and patients' attitudes toward antibiotic therapy. **Material and method:** The study, using the survey method by means of a self-developed questionnaire, was conducted among 110 residents of the Wielkopolskie province in 2022. **Results:** As many as 76.4% of the respondents had not come across information about antibiotic resistance at any PHC facility. A high percentage of the respondents believed that antibiotics are effective against influenza (60%) and the common cold (31.8%). In total, 27.3% of the study group reported taking medication that they had left over after previous therapies. Only 50.9% of the respondents properly handled expired antibiotics. At least eight out of ten respondents had not encountered any educational campaigns on the issue. Demographic factors do not differentiate the responses to key questions on antibiotic protection. **Conclusions:** The unsatisfactory knowledge in the patient population that frequently undergoes antibiotic therapy calls for more effective health education. The role of medical personnel and conditions in which educational campaigns are more accessible is crucial.

Keywords: antimicrobial resistance, antibiotic therapy, One Health, primary health care, health education

Introduction

Antimicrobial resistance (AMR) occurs when bacteria, viruses, fungi, and parasites do not respond to drugs as they should (World Health Organization, 2023). Some bacteria may be naturally resistant to antibiotics, while others may be able to acquire such mechanisms (European Centre for Disease Prevention and Control, 2023; European Medicines Agency, n.d.). The emergence and spread of antibiotic resistance has been accelerated by human activity, mainly through the inappropriate use and abuse of antimicrobial drugs in treating, preventing, or controlling infections in people and animals, in livestock, agriculture, and industry, or as a consequence of poor sanitation and hygiene (Narodowy program ochrony antybiotyków, n.d.; Sobierajski et al., 2021; Sobierajski et al., 2023; World Health Organization, 2023). The underlying factors of the problem include inadequate knowledge about the rational use of antibiotics and about the development and spread of antibiotic resistance (Ashiru-Oredope et al., 2021; European Center for Disease Prevention and Control, 2019; Mazińska et al., 2017).

Bacterial resistance to antibiotics is a worsening, multifaceted, and very costly public health problem that requires urgent, organized efforts to preserve drug efficacy for longer (European Centre for Disease Prevention and Control, 2022a, 2023; Polskie Towarzystwo Zdrowia Publicznego, 2022; Tacconelli, 2018; World Health Organization, 2015a, 2020, 2023). We need a multidisciplinary approach to this threat, which affects all regions of the world (European Medicines Agency, n.d.; World Health Organization, 2023). Antibiotic resistance is associated with epidemiological risks, increased patient morbidity and mortality, the danger of losing the efficacy of life-saving medical interventions, a significant burden on healthcare and communities, losses in gross domestic product, and many other ramifications (European Centre for Disease Prevention and Control, 2022a; European Medicines Agency, n.d.; Najwyższa Izba Kontroli. Departament Zdrowia, 2019; Tacconelli, 2018; World Health Organization, 2023). Therefore, a health policy on antibiotic resistance requires a comprehensive approach, by monitoring both the use of these drugs and the growing rates of resistance to them, as well as setting the course for research on new medicinal products so that they can be developed in time (European Centre for Disease Prevention and Control, n.d.a; European Centre for Disease Prevention and Control, 2022b; Narodowy program ochrony antybiotyków, n.d.; Tacconelli, 2018; World Health Organization, n.d.a). The One Health approach of close and integrated collaboration for sustainable and optimized protection of human and animal health and the environment is also being developed, as these areas are closely linked and interdependent (Sobierajski et al., 2023; World Health Organization, n.d.b).

One of the key areas of action is raising the awareness and understanding of antimicrobial resistance through effective communication, education, and training (World Health Organization, n.d.c). Since 2008, a European Antibiotic Awareness Day (EAAD) has been celebrated annually on November 18 in the EU/European Economic Area

(Ashiru-Oredope et al., 2021; European Centre for Disease Prevention and Control, n.d.b.). The World Health Organization (WHO) also runs a global World AMR Awareness Week (WAAW) campaign (World Health Organization, n.d.c). In Poland, these efforts have been organized mainly under the National Program to Protect Antibiotics (NPPA) and are currently funded by the National Health Plan 2021–2025 (Narodowy program ochrony antybiotyków, n.d.).

The data indicates a high rate of antibiotic use in outpatient care, as well as a conspicuous antibiotic resistance problem in Poland compared to other European countries (European Centre for Disease Prevention and Control, 2022b, 2022c; Najwyższa Izba Kontroli. Departament Zdrowia, 2019; Olczak-Pieńkowska & Hryniewicz, 2021; Sobierajski et al., 2021). Primary healthcare (PHC) is responsible for the vast majority of all antibiotic prescriptions, many of which are issued for respiratory tract infections (NFZ, n.d.; Olczak-Pieńkowska et al., 2018). There is reason to believe that we should first analyze the effectiveness of relevant health education at the PHC level and create conditions to increase its availability. Monthly trends in antimicrobial usage, factors that may influence antibiotic consumption, and the awareness and attitudes of medical staff, medical students, and patients have already been assessed (European Centre for Disease Prevention and Control, 2019; European Union, 2022; Mazińska & Hryniewicz, 2017; Olczak-Pieńkowska et al., 2018; Olczak-Pieńkowska & Hryniewicz, 2021; Sobierajski et al., 2021). Our study goes slightly beyond the previous research, as it addresses the One Health approach and looks at the awareness of antibiotic protection initiatives in the PHC patient population.

Purpose of the study

The main objective of this study was to assess the knowledge, attitudes, and beliefs in key areas for rational antibiotic therapy and management of the problem of antibiotic resistance in the PHC patient population. We also analyzed knowledge of educational campaigns and projects, as well as factors that differentiate the respondents' knowledge and behavior. The survey sought to identify educational needs at the health system facilities that are closest to the patients.

Materials and methods

The study was conducted between March 7 and April 15, 2022 using a diagnostic survey method in the population of adult patients of two PHC facilities: one outpatient clinic from Poznań and one from Gostyń (Wielkopolskie province). The research tool was a self-developed questionnaire consisting of 29 single-choice and multiple-choice

questions. The survey was divided into four sections and included questions on socio-demographic characteristics, knowledge of antimicrobial resistance, behavior related to antibiotic use, awareness of drug resistance campaigns, behavior during antibiotic use, and beliefs about who has an impact on reducing the problem of antibiotic resistance. The paper-based survey was anonymous and participation was voluntary. The Bioethics Committee at the Poznań University of Medical Sciences confirmed that the survey did not constitute a medical experiment. Statistical analysis of the data was performed using Statistica 13.1. Pearson's χ^2 test was used to test for interactions between qualitative variables. A significance level of $p \leq 0.05$ was used in all analyses.

Results

Characteristics of the study population

The study involved 110 patients, the majority of whom were women (59.1%). The respondents were between 18 and 75 years old, with a mean age and standard deviation of 39.6 ± 15 . Slightly over 45% of the respondents had a higher education. Most respondents were not taking long-term medication (59.1%), had been hospitalized at least once (70.9%), and had never been infected with a drug-resistant bacterium (55.5%) (Table 1).

Table 1. Characteristics of the study population (N = 110)

Variable		n	%
Gender	F	65	59.1
	M	45	40.9
Age	18–27	35	31.8
	28–37	17	15.5
	38–47	23	20.9
	48–57	19	17.3
	58–75	16	14.5
Education	Elementary	6	5.4
	Vocational	21	19.1
	Secondary	29	26.4
	Post-secondary	4	3.6
	College/university	50	45.5
Medical education or healthcare-related profession	No	96	87.3
	Yes	14	12.7

Variable		n	%
Place of residence	Countryside	27	24.5
	Village in an urban agglomeration	11	10
	Town of up to 50,000 residents	32	29.1
	Town of up to 100,000 residents	10	9.1
	City of up to 250,000 residents	6	5.5
	City of up to 500,000 residents	3	2.7
	City with more than 500,000 residents	21	19.1
On long-term medication	No	65	59.1
	Yes	45	40.9
History of hospitalization	No	32	29.1
	Yes	78	70.9
History of drug-resistant bacterial infection	No	61	55.5
	I don't know	44	40
	Yes	5	4.5

Patients' awareness of antibiotic resistance in bacteria

More than half of the respondents (59.1%) had heard of the phenomenon of antibiotic resistance, but at least a third had not encountered the term. Most patients who were familiar with the issue (n = 65) found out about it from the media, while 29.2% learned about the problem from their doctor. Up to 76.4% of the patients had not come across any information about bacterial antibiotic resistance in their doctor's office and nearly a third were not familiar with any of the terms used to describe the problem. Fifty-five percent of those asked pointed to the correct definition of antibiotic resistance. When asked about the reasons for the rise of antibiotic resistance, the most common answers were overuse and misuse of antibiotics in medicine (69.1%) and the use of antibiotics on one's own/over the counter/without consulting a doctor (54.5%); the least common answer was non-compliance with hygiene rules (3.6%). A quarter of the study group (24.5%) mistakenly believed that antibiotics work against viruses, while 31.8% thought they are effective against the common cold and 60% that they help fight the flu. One in three respondents would expect a prescription for an antibiotic when they have the flu (32.7%) and one in five for the common cold. The mean value of participants' self-assessed awareness of appropriate antibiotic use was 2.87 ± 0.88 , i.e. between "mediocre" and "sufficient" (Table 2).

Table 2. Responses to questions testing respondents' knowledge (N = 110)

Question	Answer	n	%
Have you heard about bacterial resistance to antibiotics?	Yes	65	59.1
	No	36	32.7
	I don't know	9	8.2
Where/from whom did you learn about bacterial resistance to antibiotics? (n = 65; multiple answers possible)	Doctor	19	29.2
	Nurse	4	6.2
	Pharmacist	0	0
	Family member/friend	17	26.2
	Press, radio, television	24	36.9
	Internet (e.g., websites, social networks, or blogs)	29	44.6
School/university		17	26.2
Have you ever come across any information about bacterial resistance to antibiotics in your GP clinic? (multiple answers possible)	Yes, I have discussed it with my doctor	11	10
	Yes, I have discussed it with a nurse	3	2.7
	Yes, in a leaflet/poster/video in the waiting room	16	14.5
	No, I have not	84	76.4
Which of the following terms are you familiar with? (multiple answers possible)	Antibiotic resistance	63	57.3
	Drug resistance	46	41.8
	Antibiotic-resistant bacteria	41	37.3
	Superbugs	16	14.5
	Antimicrobial resistance	12	10.9
	AMR	5	4.5
I am not familiar with any of the above terms	35	31.8	
Which of the following phrases do you think best describes what antibiotic resistance is?	The human body becomes resistant to antibiotic treatment	38	34.5
	Resistance of bacteria to an antibiotic / Ability of bacteria to stop the antibiotic's effect and survive in its presence	61	55.5
	Inappropriate use of antibiotics	3	2.7
	Genetic characteristics of the human body that make an antibiotic ineffective	8	7.3
What do you think may be contributing to the growing problem of antibiotic resistance in bacteria? (multiple answers possible)	Overuse and misuse of antibiotics in medicine	76	69.1
	Failure to follow doctor's instructions during antibiotic therapy	52	47.3
	Using antibiotics on your own / without a prescription / without consulting your doctor	60	54.5
	Poor knowledge of the proper use of antibiotics and of the consequences of careless antibiotic use	51	46.4
	Limited use of microbiological diagnostics	8	7.3
	Failure to comply with rules of hygiene	4	3.6
	Widespread use of antibiotics in animal farming and the economy	25	22.7
Antibiotics work against viruses	True	27	24.5
	False	83	75.5
Antibiotics work against bacteria	True	94	85.5
	False	16	14.5

Question	Answer	n	%
Antibiotics are effective in treating the common cold	True	35	31.8
	False	75	68.2
Antibiotics are effective in treating influenza	True	66	60
	False	44	40
Which health problems do you think would require a prescription for an antibiotic? (multiple answers possible)	Bacterial infection	75	68.2
	Viral infection	32	29.1
	Runny nose	7	6.4
	Fever	13	11.8
	Headache	0	0
	Influenza	36	32.7
	Sore throat	16	14.5
	Cold	22	20
	Cough	8	7.3
	COVID-19	15	13.6
How would you rate your knowledge of the proper use of antibiotics?	1 – insufficient	5	4.5
	2 – mediocre	31	28.2
	3 – sufficient	51	46.4
	4 – good	19	17.3
	5 – very good	4	3.6

Patient behavior toward antibiotics

A total of 40.9% of the respondents had used a systemic antibiotic during the year preceding the survey, most often for the common cold (26.4%) and the flu (18.2%) and purchased the medication from a brick-and-mortar pharmacy (95.5%). The vast majority of the group (70.9%) said their doctor had never ordered a microbiological test before starting antibiotic therapy for them. The respondents most often disposed of expired antibiotics and leftovers from previous therapies by handing them over to a pharmacy or drug collection point (50.9%) or throwing them away (42.7%) (Table 3).

Table 3. Responses to questions on respondents' behavior toward antibiotics (N = 110)

Question	Answer	n	%
When was the last time you took a systemic antibiotic (which works on the whole body)?	In the past month	1	0.9
	In the last 6 months	29	26.4
	In the last 12 months	15	13.6
	More than a year ago	27	24.6
	I don't remember	38	34.5

Question	Answer	n	%
What was the reason why you last took a systemic antibiotic?	Cold	29	26.4
	Sore throat	7	6.3
	Influenza	20	18.2
	Cough	1	0.9
	Fever	12	10.9
	COVID-19	5	4.5
	Other	18	16.4
	I don't remember	18	16.4
Where/from whom did you learn how long you should use the antibiotic? (multiple answers possible)	Doctor	101	91.8
	Pharmacist	22	20
	Family/friends	5	4.5
	Drug leaflet	23	20.9
	Internet	2	1.8
	I did not find that out / I was not told	1	0.9
Where did you get the systemic antibiotic you last took?	Brick-and-mortar pharmacy	105	95.5
	Online pharmacy	0	0
	From a friend/family member	0	0
	From previous treatments	0	0
	I don't remember	4	3.6
	Other	1	0.9
Which of the following statements best describes your attitude during antibiotic treatment? (multiple answers possible)	I have always taken the doses regularly	80	72.7
	I would forget to take some doses	8	7.3
	I would take too long between doses	4	3.6
	I ended the treatment after the period recommended by the doctor	34	30.9
	I ended the treatment earlier, once I felt better	16	14.5
Have you ever ...?	taken an antibiotic without consulting a doctor, without a prescription	20	18.2
	taken an antibiotic that was left over from previous therapy	30	27.3
	taken an antibiotic that you got from a family member/friend	20	18.2
	given your antibiotics to others	14	12.7
	put pressure on your doctor or persuade them to prescribe an antibiotic	10	9.1
Has there been a time when the antibiotic you took was not effective?	Yes, once	16	14.5
	Yes, several times	22	20
	No	72	65.5
Has your doctor ever recommended a microbiological test to decide which treatment to use?	Yes, a family doctor	5	4.5
	Yes, a specialist doctor	1	0.9
	Yes, a doctor at the hospital	6	5.5
	No	78	70.9
	I don't know / I can't remember	20	18.2

Question	Answer	n	%
What do you do with expired antibiotics that are left over from previous therapies? (multiple answers possible)	I donate them to a pharmacy or drug collection point	56	50.9
	I throw them away	47	42.7
	I flush them down the toilet	4	3.6
	I keep them in my medicine cabinet at home	25	22.7
	I give them to other family members/acquaintances	3	2.7
	I resell them, for example, on the internet	0	0
	Other	2	1.8

Awareness of educational campaigns and patient beliefs

In the study group, 80% of the subjects had never encountered an educational campaign and 83.6% were not familiar with any of the leading programs or campaigns on the appropriate use of antibiotics. According to those surveyed, it is medical personnel (64.5%) and national and international health organizations (41.8%) that can make a difference in reducing bacterial resistance to antibiotics. Only 30% of the respondents felt that anyone who uses antibiotics can make such a difference (Table 4).

Table 4. Responses to questions testing respondents' knowledge of campaigns and respondent's beliefs (N = 110)

Question	Answer	n	%
Have you ever encountered an educational campaign on the proper use of antibiotics? (multiple answers possible)	Yes, from leaflets	11	10
	Yes, from posters	5	4.5
	Yes, from a TV commercial	5	4.5
	Yes, from a radio program	3	2.7
	I have not encountered such a campaign	88	80
Mark only those campaigns that you have heard of. (multiple answers possible)	National Program to Protect Antibiotics	6	5.5
	European Antibiotic Awareness Day	7	6.4
	World AMR Awareness Week	7	6.4
	Global action plan on antibiotic resistance	0	0
	The "One Health" approach	2	1.8
	None of the above	92	83.6

Question	Answer	n	%
Who do you think can have an impact on reducing the problem of antibiotic resistance in bacteria? (multiple answers possible)	Medical personnel	71	64.5
	Decision-makers and leaders in healthcare	36	32.7
	National and international organizations working in the field of health	46	41.8
	Anyone who uses antibiotics	33	30
	Food producers, including breeders of food-producing animals	32	29.1

Factors influencing the knowledge and behavior of the study population

The study found that women were more likely than men (70.8% vs. 42.2%) to declare that they were familiar with the concept of antibiotic resistance ($p = 0.00060$), but the correct understanding of this phenomenon did not depend on gender. Women were significantly more likely than men (50.8% vs. 24.4%) to know that antibiotics do not cure influenza ($p = 0.02149$) and to assess their knowledge of proper antibiotic use better (0.01440).

Age influenced whether the participants had come across the term *antibiotic resistance*. People under the age of 37 were more likely to have heard of antibiotic resistance in bacteria ($p = 0.00140$). With increasing age, the percentage of subjects who chose the correct definition of this problem declined ($p = 0.00704$). While 68.6% of the youngest age group (18–24) knew what the term meant, only 6.3% of the oldest (58–75) selected the correct answer. Respondents under the age of 37 were more likely to be aware that antibiotics are not effective against influenza ($p = 0.00234$).

The higher the respondents' level of education, the more often they reported having heard about antibiotic resistance (from 33.3% among those with an elementary-school education to 76% among those with a university degree; $p = 0.0004$), but we did not find that education was associated with choosing a more accurate definition of the problem. Subjects with a higher education judged their knowledge in the area better ($p = 0.00586$), but only responded more accurately when it came to the ineffectiveness of antibiotics against viruses ($p = 0.04447$).

The respondents' place of residence had an effect on their familiarity with the concept of antibiotic resistance. Residents of urban areas were more likely to have heard of this phenomenon than rural residents ($p = 0.02453$). This knowledge was most common among subjects who lived in a city with more than 500,000 residents (81%) and in villages that are part of urban agglomerations (72.7%); it was least common among residents of villages located far from cities (29.6%). However, the mere fact that a person declared being familiar with the problem did not significantly translate into defining it better or into higher scores on questions about the ineffectiveness of antibiotics against viral diseases, such as in influenza and the common cold.

The statistical analysis showed that there was an association between the participants' education and/or medical profession and their knowledge of antibiotic resistance in bacteria ($p = 0.00388$). Respondents with a medical degree and/or profession had heard of the phenomenon before, rated their knowledge better ($p = 0.03446$), and were more likely to give the correct answer on whether antibiotics are ineffective against viruses ($p = 0.02235$) and influenza ($p = 0.00092$).

We did not collect sufficient data to show that any of the demographic factors (gender, age, education, or place of residence) significantly differentiated risk behaviors, such as taking antibiotics without a prescription or without consulting a doctor, taking pills left over from previous therapies or obtained from family members/acquaintances, giving medications to others, or pressuring a doctor. The use of long-term medications was not shown to be significantly linked to the subjects' knowledge, attitudes, and views.

Discussion

In the Polish scholarly literature, the subject of patients' knowledge, views, and attitudes on issues relevant to the better management of antibiotic resistance is not addressed extensively enough, given the scale of the problem. We hope that our results will contribute to the discussion about the need to improve health education in PHC when it comes to judicious antibiotic therapy and antibiotic resistance.

Patients' knowledge of antibiotic resistance in bacteria

Only about 6 in 10 patients had heard of antibiotic resistance and were able to accurately define it. Most respondents (76.4%) had not come across information on the subject at their doctor's office and medical staff were all too rarely a source of such knowledge. It seems that because doctors, pharmacists, and nurses are perceived by patients to be the most trustworthy when it comes to information about antibiotics, according to Mazińska et al. (2017), they have the potential to educate people about the risk of developing bacterial resistance to antibiotics and about behaviors that mitigate this risk. Meanwhile, only 15% of respondents from Poland, compared to an average of 23% for EU countries, recall hearing any warnings in the past 12 months not to take antibiotics unnecessarily (European Union, 2022). It turns out that not all professionals who prescribe, administer, or dispense these drugs inform their patients about prudent use through, for example, leaflets, brochures, or advice. When they fail to provide such education, they justify this by a lack of appropriate materials, time, and interest on the part of the patient (European Centre for Disease Prevention and Control, 2019). In Poland, 76% of medical personnel said their knowledge of proper antibiotic use in current practice was sufficient, but only about 68% declared they had easy access to useful recommendations for managing

infections; nearly 70% had good opportunities to provide advice on judicious antibiotic use (European Centre for Disease Prevention and Control, 2019). In our survey, the participants identified the internet and the press, radio, and television as the most common sources of knowledge about antibiotic therapy. In the study by Mazińska et al. (2017), these were health websites, health magazines, health encyclopedias, and information from doctors, family, and friends. On the other hand, in a similar WHO study, a doctor or nurse was ranked first, followed by the media (World Health Organization, 2015b).

When asked about the reasons for the growing problem of resistance to treatment, the respondents in our survey most frequently identified the overuse and misuse of antibiotics in medicine (69.1%) and patients' use of antibiotics on their own/over the counter/without consulting a doctor (54.5%), while the least frequent answer was non-compliance with the rules of hygiene (3.6%). A small percentage of patients were able to identify all correlations. Generally, medical students recognized that the over-prescribing of antibiotics by physicians, the limited awareness of the risks, abuse of antibiotics in medicine, the use of antibiotics in livestock farming, limited access to microbiological diagnostics, under-dosing of antibiotics, and poor hand hygiene have the greatest impact (Sobierajski et al., 2021).

In our study group, 24.5% of the respondents erroneously believed that antibiotics work against viruses, 31.8% thought they are effective against the common cold, and as many as 60% considered them effective in treating the flu. One in three of those surveyed would expect a prescription for an antibiotic for the flu and one in five would expect one for a cold. It was previously reported that up to 60% of Poles believe that antibiotics kill viruses and that 36%–49% believe they are effective against the flu and colds, with about 41% of respondents expecting an antibiotic prescription for the flu (Mazińska et al., 2017). According to the latest special Eurobarometer 522 survey (2022), an average of 50% of Europeans and 47% of Poles thought antibiotics kill viruses, while 62% of Europeans and 45% of Polish respondents thought they were effective in treating the common cold (European Union, 2022). This survey confirms that there is still a high degree of ignorance about the ineffectiveness of antibiotic therapy in viral infections and about the difference between bacteria and viruses (Mazińska et al., 2017). However, 82% of Europeans and 86% of Poles are aware that unnecessary use of antibiotics makes them ineffective, while 67% of Europeans and 81% of Poles understand that taking them frequently causes side effects (European Union, 2022).

Patient behavior toward antibiotics

A total of 40.9% of respondents had used a systemic antibiotic in the 12 months prior to the survey, most often for the common cold (26.4%) or the flu (18.2%). This confirms previous reports that about 40% of Polish adults use antibiotics on a yearly basis, mainly for the common cold, a sore throat, cough, and the flu (Mazińska et al., 2017). This is

also consistent with other Polish studies (Mazińska et al., 2017). Doctors who provide outpatient care admit that Poles overuse antibiotics and that antimicrobial resistance is a serious problem (Mazińska & Hryniewicz, 2017). The results described above are lower than the average for all WHO regions, where 35% of people reported taking antibiotics in the past month, 30% in the past 6 months, and 12% in the past year (World Health Organization, 2015b). In the latest edition of Eurobarometer 522, only 16% of Poles and 23% of Europeans were taking antibiotics orally (European Union, 2022). Poles cited bronchitis, the common cold, and influenza as the three predominant reasons for antibiotic therapy, while other EU nationals cited urinary tract infections, sore throats, and bronchitis as the top three reasons (European Union, 2022). Across all WHO regions, 64% of people consider influenza and the common cold to require antibiotic therapy (World Health Organization, 2015b). It was previously reported that the observed seasonal trends in antibiotic use in Poland were similar to trends in influenza incidence (Olczak-Pieńkowska et al., 2018). Meanwhile, medical professionals in EU countries are well aware of the ineffectiveness of antibiotics in treating the common cold and influenza, but slightly underperform in terms of the One Health approach (European Centre for Disease Prevention and Control, 2019). A study by Mazińska and Hryniewicz (2017) found that 84% of physicians claimed to be familiar with the NPPA recommendations for the management of out-of-hospital respiratory tract infections, but 62% were unfamiliar with the Centor/McIsaac scale used to differentiate between bacterial and viral infections in sore throat patients. Rapid microbiological detection methods for Group A beta-hemolytic streptococcal pharyngitis are used only by 20% of physicians (Mazińska & Hryniewicz, 2017). It is hoped that e-prescribing, introduced in 2020, will provide a better opportunity to tabulate data on antibiotic use together with data on the diagnoses that prescriptions are based on (Olczak-Pieńkowska & Hryniewicz, 2021). Our findings reveal a paucity of knowledge in distinguishing between diseases with bacterial and viral etiologies. Some respondents, despite indicating that antibiotics do not work against viruses, also claim that they are effective for the flu and the common cold.

For our respondents, the doctor was the main source of knowledge about how long to take an antibiotic (91.8%). Most often, patients took the doses of the drug regularly (72.7%), but 14.5% ended therapy prematurely once they felt better. It has already been reported that the vast majority of patients (79%) take the full regimen of prescription antibiotics, but there is still a group who does not follow the recommendations and who mostly abandon treatment when their symptoms subside (Mazińska et al., 2017). Similar results to ours were seen in the Eurobarometer report (2022), where 15% of Polish patients said they should stop taking antibiotics when they feel better versus the EU average of 13%.

In Poland, as in other EU countries, antibiotics can only be obtained by prescription, but we have seen high antibiotic use, which can be attributed to several factors (Mazińska et al., 2017; Olczak-Pieńkowska & Hryniewicz, 2021). In our survey, 27.3% of respondents

reported that they had taken an antibiotic that was left over from previous therapy, 18.2% had used an antibiotic without consultation and without a prescription, and 9.1% had pressured a doctor to prescribe an antibiotic. In the 2022 Eurobarometer survey, 3% of respondents from Poland and an average of 8% from EU countries admitted to using an antibiotic that was “not prescribed by a doctor” in their most recent treatment (European Union, 2022). The most common reason for doctors prescribing antibiotics is the fear that the patient’s condition will worsen or that there will be complications. Time constraints and a feeling that they need to maintain a relationship with the patient are also important factors (European Centre for Disease Prevention and Control, 2019). In our study, the vast majority of the group (70.9%) said their doctor had never ordered a microbiological test before starting antibiotic therapy for their condition. Although this is not required for some medical conditions, there have been previous reports that microbiological diagnosis is underutilized (Najwyższa Izba Kontroli. Departament Zdrowia, 2019). A Eurobarometer survey (2022) found that 29% of Polish respondents had a blood, urine, or throat swab before or during antibiotic use to check what caused their illness. Meanwhile, the average for EU countries was 46% (European Union, 2022).

Awareness of educational campaigns and patient beliefs

Our survey shows that from the patients’ perspective, it is healthcare personnel (64.5%) who can make a difference in curbing antibiotic resistance in bacteria. This is in line with previous reports that healthcare workers play a key role, from educating patients to minimizing the spread of infections in healthcare facilities, especially when they are directly involved in treating infections, that is, prescribing, dispensing, and administering antibiotics (Ashiru-Oredope et al., 2021; Sobierajski et al., 2021). However, only 62% of medical care providers believe they play a crucial role in managing the problem of antibiotic resistance (Ashiru-Oredope et al., 2021).

It seems that educational campaigns and health websites can be instrumental in raising public awareness of the issue. Several years ago, measurements of the effects of EAAD campaigns in Poland allowed for slight optimism, as positive changes in behavior toward antibiotics were observed (Mazińska et al., 2017). However, our findings showed that 80% of PHC patients had never encountered an educational campaign on the proper use of antibiotics and 83.6% were not familiar with any of the leading programs. According to a survey of medical personnel in EU countries, more than 40% of health professionals from Poland had heard of EAAD and more than 30% had heard of WAAW (Ashiru-Oredope et al., 2021). In addition, medical staff from Poland rarely agreed with the statement that there was adequate promotion of prudent antibiotic use and information about antibiotic resistance in their country (Ashiru-Oredope et al., 2021). Meanwhile, educational materials targeting PHC physicians and other groups were being created as part of the EAAD (European Centre for Disease Prevention and Control., n.d.b). It is

noteworthy that only half of medical students have heard of the NPPA and one quarter have heard of the EAAD campaign. There is a need to increase the number of class hours for medical students devoted to antibiotic therapy and bacterial resistance, as well as hand hygiene (Sobierajski et al., 2021). It seems, therefore, that the aforementioned campaigns are still underpublicized, although they have been targeting both the public and healthcare professionals for a long time (Ashiru-Oredope et al., 2021). Also, the Polish Public Health Association, in an appeal to the Minister of Health, pointed out the need for promoting rational antibiotic therapy to the medical, pharmaceutical, and patient communities, while also emphasizing the seriousness of the situation (PTZP, 2022).

We must point out that the average self-assessment of our participants' knowledge in the area of proper antibiotic use was less than sufficient. Moreover, according to the 2022 Eurobarometer survey, as many as 40% of Polish patients would be interested in receiving more information about the conditions for which antibiotics are used, the use of antibiotics, resistance to antibiotics, and the links between human, animal, and environmental health (European Union, 2022). Some studies have shown that up to 70% of antibiotics are prescribed unnecessarily. The most effective way to improve this situation is through direct education, encompassing communication training, access to therapeutic recommendations, antibiotic management programs, access to rapid diagnostic tests, and more patient time at the doctor's office (Sobierajski et al., 2021).

Factors influencing the knowledge and behavior of the study population

A variety of studies suggest that age, education level, and gender are the main factors that influence attitudes toward antibiotics (Mazińska et al., 2017). Our analysis did not show that demographic factors were significantly associated with risky behavior during antibiotic therapy. However, we can confirm that women were more likely than men to have heard about antibiotic resistance and had higher self-rated knowledge and awareness that antibiotics do not treat influenza. The younger respondents scored similarly and were better at defining the concept of antibiotic resistance. It has already been reported that women are more likely than men to be aware that antibiotics kill bacteria but are not effective against viruses (Mazińska et al., 2017). This may be due to the fact that more women than men have come across information on the proper use of these drugs (Mazińska et al., 2017).

Those with a higher education were more likely to have heard about the phenomenon and had a higher self-assessment of knowledge on the subject, but gave more accurate responses only about the ineffectiveness of antibiotics against viruses. It was previously reported that respondents with a higher education tended to give correct answers on this issue more often than those with an elementary-school education. The best-educated groups also encountered messages on this topic more often than other groups (Mazińska et al., 2017).

Place of residence was a determinant of familiarity with the term *antibiotic resistance*. Residents of urban areas were more likely to have heard about the phenomenon than rural residents. Aside from several issues that may be at play here, it is worth noting that in populations that live in higher densities, human contact intensifies and this may account for more frequent antibiotic use (Olczak-Pieńkowska & Hryniewicz, 2021).

Our study has many limitations, such as a small sample size and a convenient sampling of volunteers from only two clinics. We only surveyed patients, without considering the opinions of medical staff. We also did not verify medical records. Because the study is not representative, our findings will need to be tested in larger studies in the future. On the other hand, many of our insights are largely mirrored in the literature on the subject. Therefore, we hope that these results, despite some shortcomings in the way they were acquired, will serve to strengthen and guide health education activities in the PHC, in keeping with the recommendations of prudent antibiotic therapy and the One Health approach promoted by the authors and implementers of global, European, and national initiatives.

Conclusions

- PHC patients often report taking antibiotics for viral infections; their self-assessed knowledge of how to properly use these drugs is less than satisfactory. The topic of antibiotic resistance is rarely addressed by medical personnel. The fact that the patient has heard about this problem does not always mean that they have sound knowledge on the subject; thus, counseling should not be neglected.
- In PHC health education, it is worth informing the patient more fully about the etiological agent that caused the infection and to stress that antibiotics are not effective in viral diseases. Explaining what prudent antibiotic therapy means and pointing out that anyone who uses antibiotics has a significant impact is crucial. It is worth reinforcing the message that observing hygiene rules and properly handling expired medications are important for controlling the problem.
- Patients are not sufficiently familiar with campaigns and educational initiatives for rational antibiotic therapy and the fight against antibiotic resistance. Given the high consumption of antibiotics, it would be worth implementing solutions focused on PHC facilities, since these clinics are particularly predisposed to popularizing this knowledge.

References

- Ashiru-Oredope, D., Hopkins, S., Vasandani, S., Umoh, E., Oloyede, O., Nilsson, A., Kinsman, J., Elsert, L., Monnet, D. L., & #ECDCAntibioticSurvey Project Advisory Group. (2021). Healthcare workers' knowledge, attitudes and behaviours with respect to antibiotics, antibiotic use and antibiotic resistance across 30 EU/EEA countries in 2019. *Euro surveillance: Europe's journal on infectious disease surveillance, epidemiology, prevention and control*, 26(12), 1900633. <https://doi.org/10.2807/1560-7917.ES.2021.26.12.1900633>
- European Centre for Disease Prevention and Control. (n.d.a). *European surveillance of antimicrobial consumption network (ESAC-Net)*. Retrieved November 9, 2023 from <https://www.ecdc.europa.eu/en/about-us/partnerships-and-networks/disease-and-laboratory-networks/esac-net>
- European Centre for Disease Prevention and Control. (n.d.b). *European antibiotic awareness day*. Retrieved November 10, 2023 from <https://antibiotic.ecdc.europa.eu/en/about>
- European Centre for Disease Prevention and Control. (2019). *Survey of healthcare workers' knowledge, attitudes and behaviours on antibiotics, antibiotic use and antibiotic resistance in the EU/EEA*. Stockholm: ECDC. Retrieved November 8, 2023 from <https://www.ecdc.europa.eu/sites/default/files/documents/survey-of-healthcare-workers-knowledge-attitudes-behaviours-on-antibiotics.pdf>
- European Centre for Disease Prevention and Control. (2022a). *Antimicrobial resistance in the EU/EEA: A One Health response*. OECD. Retrieved November 8, 2023 from <https://www.ecdc.europa.eu/sites/default/files/documents/antimicrobial-resistance-policy-brief-2022.pdf>
- European Centre for Disease Prevention and Control. (2022b). *Surveillance atlas of infectious diseases*. Retrieved November 10, 2023 from <https://atlas.ecdc.europa.eu/public/index.aspx?Dataset=27&HealthT>
- European Centre for Disease Prevention and Control. (2022c). *Antimicrobial consumption in the EU/EEA (ESAC-Net): Annual epidemiological report 2022*. Stockholm: ECDC. Retrieved November 13, 2023 from <https://www.ecdc.europa.eu/sites/default/files/documents/AER-antimicrobial-consumption.pdf>
- European Centre for Disease Prevention and Control. (2023). *Antimicrobial resistance (AMR)*. Retrieved October 30, 2023 from <https://www.ecdc.europa.eu/en/antimicrobial-resistance>
- European Medicines Agency. (n.d.). *Antimicrobial resistance*. Retrieved November 6, 2023 from <https://www.ema.europa.eu/en/human-regulatory/overview/public-health-threats/antimicrobial-resistance>
- European Union. (2022). *Eurobarometer: Antimicrobial resistance*. Retrieved November 13, 2023 from <https://europa.eu/eurobarometer/surveys/detail/2632>
- Mazińska, B., & Hryniewicz, W. (2017). Polish physicians' attitudes towards antibiotic prescription and antimicrobial resistance. *Polish Journal of Microbiology*, 66(3), 309–319. <https://doi.org/10.5604/01.3001.0010.4856>
- Mazińska, B., Strużycka, I., & Hryniewicz, W. (2017). Surveys of public knowledge and attitudes with regard to antibiotics in Poland: Did the European Antibiotic Awareness Day campaigns change attitudes? *PloS one*, 12(2), e0172146. <https://doi.org/10.1371/journal.pone.0172146>
- Narodowy Fundusz Zdrowia [National Health Fund]. (n.d.). *Antybiotyki – stosuj z rozwagą! Dla lekarzy [Antibiotics – use with caution! For doctors]*. Retrieved November 13, 2023 from <https://www.nfz.gov.pl/antybiotyki-stosuj-z-rozwaga/dla-lekarzy/>

- Narodowy program ochrony antybiotyków [National Program to Protect Antibiotics]. (n.d.). *Podstawy utworzenia programu* [Basis for establishing the program]. Retrieved November 6, 2023 from <https://antybiotyki.edu.pl/program/podstawy-utworzenia-programu/>
- Najwyższa Izba Kontroli. Departament Zdrowia [Supreme Audit Institution, Department of Health]. (2019). *Informacja o wynikach kontroli* [Results of the audit]. Warsaw: NIK. Retrieved November 9, 2023 from <https://www.nik.gov.pl/plik/id,20833,vp,23465.pdf>
- Olczak-Pieńkowska, A., & Hryniewicz, W. (2021). Impact of social, economic, and healthcare factors on the regional structure of antibiotic consumption in primary care in Poland (2013–2017). *Frontiers in Public Health*, 9, 680975. <https://doi.org/10.3389/fpubh.2021.680975>
- Olczak-Pieńkowska, A., Skoczyńska, A., & Hryniewicz, W. (2018). Monthly trends in antimicrobial consumption and influenza incidence at the community level in 2014 in Poland. *Polish Archives of Internal Medicine*, 128(12), 731–738. <https://doi.org/10.20452/pamw.4368>
- Polskie Towarzystwo Zdrowia Publicznego [Polish Public Health Association]. (2022, August 31). *Apel o racjonalną antybiotykoterapię* [A plea for rational antibiotic therapy]. Retrieved November 9, 2023 from <https://www.ptzp.org/pl/stanowisko-w-sprawie-racjonalnej-antybiotykoterapii>
- Sobierajski, T., Mazińska, B., Wanke-Rytt, M., & Hryniewicz, W. (2021). Knowledge-based attitudes of medical students in antibiotic therapy and antibiotic resistance: A cross-sectional study. *International Journal of Environmental Research and Public Health*, 18(8), 3930. <https://doi.org/10.3390/ijerph18083930>
- Sobierajski, T., Wanke-Rytt, M., Chajęcka-Wierchowska, W., Śmiątek, M., & Hryniewicz, W. (2023). One Health in the consciousness of veterinary students from the perspective of knowledge of antibiotic therapy and antimicrobial resistance: A multi-centre study. *Frontiers in Public Health*, 11, 1165035. <https://doi.org/10.3389/fpubh.2023.1165035>
- Tacconelli, E., Carrara, E., Savoldi, A., Harbarth, S., Mendelson, M., Monnet, D. L., Pulcini, C., Kahlmeter, G., Kluytmans, J., Carmeli, Y., Ouellette, M., Outterson, K., Patel, J., Cavaleri, M., Cox, E. M., Houchens, C. R., Grayson, M. L., Hansen, P., Singh, N., Theuretzbacher, U., Magrini, N., WHO Pathogens Priority List Working Group. (2018). Discovery, research, and development of new antibiotics: The WHO priority list of antibiotic-resistant bacteria and tuberculosis. *The Lancet Infectious diseases*, 18(3), 318–327. [https://doi.org/10.1016/S1473-3099\(17\)30753-3](https://doi.org/10.1016/S1473-3099(17)30753-3)
- World Health Organization. (n.d.a.). *Global antimicrobial resistance and use surveillance system (GLASS)*. Retrieved November 10, 2023 from <https://www.who.int/initiatives/glass>
- World Health Organization. (n.d.b.). *One health*. Retrieved November 13, 2023 from https://www.who.int/health-topics/one-health#tab=tab_1
- World Health Organization. (n.d.c.). *World AMR awareness week*. Retrieved November 13, 2023 from <https://www.who.int/campaigns/world-antimicrobial-awareness-week>
- World Health Organization. (2015a.). *Global action plan on antimicrobial resistance*. Geneva: WHO Press. Retrieved November 27, 2023 from <https://www.who.int/publications/i/item/9789241509763>
- World Health Organization. (2015b.). *Antibiotic resistance: Multi-country public awareness survey*. Retrieved November 15, 2023 from <https://iris.who.int/handle/10665/194460>
- World Health Organization. (2020, 24 December). *10 global health issues to track in 2021*. Retrieved October 30, 2023 from <https://www.who.int/news-room/spotlight/10-global-health-issues-to-track-in-2021>
- World Health Organization. (2023, 21 November). *Antimicrobial resistance*. Retrieved October 30, 2023 from <https://www.who.int/news-room/fact-sheets/detail/antimicrobial-resistance>