Perception of antibiotics in Polish Internet during the infection season 2023/2024

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Abstract

Aim. Public health researchers have used the Internet for disease surveillance, the assessment of risk perception and behaviour changes during epidemics in the past. Currently, investigations of antibiotics (ABx) mentions and the closely related concept of antimicrobial resistance (AMR) on the Internet are mostly limited to information retrieval as well as simple analysis of Google Trends and media narratives.

Methods. To address these shortcomings, we perform media listening and analysis for monitoring of ABx perception in the Polish segment of the Internet during November

and December 2023 with Brand24 – a comprehensive Internet analysis tool – based on 2668 mentions.

Results. Although the scientific community is aware of the importance of AMR, it was not reflected by the general public perception. Real life examples of public engagement related to practical solutions – such as natural and alternative medicine, and ABx acquisition with special focus on children among others – dominated the Internet discourse.

Conclusion. Our findings demonstrate that while the interest in health topics in the general Polish population is high, it is often not matched by a sound biomedical literacy. A long-term patient engagement could be difficult, as they tend to think from an individual perspective (how to help myself/my family/my companion animal) rather than in the context of public health and One health.

Keywords: antibiotics perception, ABx, infodemiology, social media listening, media monitoring

Introduction

Online social media data have been widely used by researchers to investigate the behavioural and affective dynamics of the public during COVID-19 pandemics in the recent years (Jarynowski, Semenov, Kamiński, & Belik, 2021; Olszowski et al., 2022; Valentin et al., 2021). However, non-English European languages and other pathogens besides SARS-CoV-2 (i.e. bacteria) and their treatment with antibiotics (ABx) are rarely covered. The Internet has seemingly revolutionised the availability of medical knowledge and information and the use of medical services. We are increasingly observing the progressive influence of the media on the democratisation of medicine and strengthening the self- care of the population (Nichols et al., 2015). People concerned about the health of their own or their loved ones are increasingly using the Internet to look up online health information (OHI) related to their health (Wójta-Kempa & Jarynowski, 2023) such as in the case of ABx. Seeking explanations for health conditions and assigning importance to symptoms often precedes an in- person visit to a medical professional's office.

Antimicrobial resistance

The perception of ABx and their usage among the general population reveals a complex landscape influenced by knowledge, attitudes, and practices related to antimicrobial usage (AMU) and antimicrobial resistance (AMR). Here, we use antimicrobial resistance and antibiotic resistance interchangeably (even if it is not the case from a biological point of view) because this is how the topic is perceived by the general public (Krockow et al 2023). Little is known about how ABx are perceived on the Internet and what the implications for AMR prevention are (Lyall et al., 2023). It should be noted that the current consumption of antibiotics facilitates their (and the corresponding resistance genes) emission into the environment. Those patients who misuse ABx by using them as self-

medication or unjustifiably changing, stopping therapy on their own may help spread antibiotic resistances (Rzymski et al., 2023). The overuse of antibiotics influences AMR via selection of multidrug-resistant organisms (European Centre for Disease Prevention and Control, European Food Safety Authority, & European Medicines Agency, 2021). As AMR is an emergent threat that undermines modern medicine, the goal of institutions such as WHO (globally), EDCD (on the European level) or PIS/PZH/NIL (on the Polish national level) is to strengthen awareness of the importance of microbiological and infectious diseases literacy in the society. AMR represents a multifaceted crisis characterised by (i) its transboundary nature and associated collective action challenges,

(ii) its designation as an existential threat to humanity and a gradually emerging crisis, (iii) its emergence as a consequence of addressing other global threats, (iv) a notable deficiency in advocacy efforts, and (v) the generation of significant distributional and ethical issues (Baekkeskov et al., 2020). Although AMR is a major public health concern (O'Neil, 2014), there is little public engagement when it comes to tackling this problem. It suggests that these crisis lenses provide valuable perspectives for social science research, enriching the discourse on national governance and the conceptualisation of AMR as a critical global health issue not really perceived in the same way by the general public (lay referral system (Synowiec-Piłat, 2014)). There is an extensive discussion in the scientific and public health community on how to share the current understanding of the AMR problem and solutions involving the lay people, promoting interdisciplinary collaboration on an important public health issue, and encouraging the patients to become more active (patient empowerment (Freidson, 1988)).

Abx controversy on the Internet focusing on the pandemic era

Country-specific factors (Rahul et al., 2023) shape trends of interest in antibiotics. ABx for UTI – urinary tract infections – are much more popular in Africa, while ABx for strep throat are more searched for in Anglo- American countries. In Poland, the COVID-19 pandemic has contributed to many changes in the medical practice, including a wider access to teleconsultations (Sołomacha et al., 2022). It not only influenced the type of treatment, but also shed light on mistakes often made by doctors, such as the misuse of antibiotics in Polish hospitals (Siewierska et al., 2023) and outpatients (Romaszko-Wojtowicz et al., 2024). With the arrival of spring 2022, the demand for ABx decreased, resolving the previous shortage in the refugee community. Only minor problems were observed in March 2022, when most antibiotic suspensions used to treat bacterial upper respiratory tract infections in children were in short supply at pharmacies, but thanks to the efficient exchange of medicines between regions and assistance of EU countries were brought under control (Jarynowski, 2022). Due to the 2022/2023 season of a severe influenza like illness (ILI), such as influenza/COVID-19/RSV, the shortage of ABx (ECDC, 2022) caused also interest in

ABx (Jarynowski et al., 2023). In Poland, patients can obtain ABx easily in small amounts (i.e. for self-medication or medication of companion animals) from e-prescription systems without medical consultation (Grabowska et al., 2021), and in larger amounts from the social networking sites or darknet (Harviainen et al., 2021; Jarynowski, Płatek, et al., 2021). Thus, if patients want to have a given ABx, they will get it even from a reserve group in the AWaRe protocol (Mudenda et al., 2023). For instance, the so-called "post-Lyme" syndrome patients (Moniuszko-Malinowska et al., 2024) are on self-medication for more than a year with a cocktail of ABx such as TB-reserved Rifampicin or Ceftaroline (Jarynowski et al., 2023). The trade of these medicines is happening via social networking sites.

Knowledge and intensity of discussion on AMR in Poland

Poland is a country in which employment in the agri-food industry still reaches 25%. Paradoxically, the level of interest and knowledge about infectious diseases of animals or plants among city dwellers in Poland is one of the lowest in the EU (Eurobarometer, 2018). According to studies on the Polish population, patients interested in ABx may be subdivided (Porzak et al., 2024; Wójta-Kempa & Jarynowski, 2023) into three main groups: i) two-thirds suffered recently an acute disease (probably an infection) and are searching for information on how to use ABx (period of treatment, dosage, adverse events, contraindication, etc.); ii) a quarter often suffer from acute infections and are sharing knowledge with other Internet users; iii) one tenth of patients who "know better" than professionals are using ABx without medical consultation or seek for natural, and alternative medicine (*altmed*). Thus, there is little awareness in the general population especially in Poland and even among some professionals (Wojkowska-Mach et al., 2018), who use antimicrobials, about the extent of this problem and how their actions could contribute to it. Besides, social factors significantly influence antibiotic prescription and use. For instance, doctors face a social dilemma in balancing the immediate benefits of antibiotics for individual patients against the long-term collective risk of AMR. During the hard lockdown in Poland circa 15% of patients (Makowska et al., 2020) refrained from consulting a doctor and got ABx from alternative sources. Those include automatic prescription without consultation, gray market, bought in advance or the remnants of previous therapies. This tension suggests that prosocial concerns (acceptance of these practices above due to social pressure) about patients might drive overprescription, emphasising the need for greater awareness and education on AMR among both healthcare providers and the public (Krockow et al., 2021).

Social construct of ABx

The social concept of health reflects the most desirable characteristics and behaviour of a member of a given community at a given time (Taranowicz, 2023). Misconceptions about antibiotics are prevalent. Many people believe antibiotics

are necessary for treating conditions like the common cold (Essack et al., 2023), which are usually caused by viruses, not bacteria. There is also a significant misunderstanding about the importance of completing antibiotic courses, leading to behaviour such as saving part of an antibiotic course for future use (Micalizzi et al., 2021). This lack of knowledge and the prevalence of misconceptions underscore the necessity for targeted public health interventions to improve antibiotic literacy (Shan et al., 2019). According to a survey among Polish general practitioners ABx is the 6th most common category of topics patients are asking questions about, but are not in the top 7 of most discussed concepts in Polish traditional Internet media (Chlabicz, et al., 2024). Social networking plays a critical role in shaping individuals' behaviour and perceptions regarding antibiotic use. Research shows that individuals' social networks can influence decisions about seeking help for illnesses and the subsequent use of antibiotics. Different types of networks may either facilitate or hinder the spread of accurate information about antibiotic use, highlighting the importance of considering social relationships in interventions aimed at reducing antibiotic misuse (Ellis et al., 2019). By emphasising the One Health and Well-Being perspective within the UN-2030 Sustainable Development Goals (1HC 2021) we will also attempt to generalise the developed guidelines to the global health setting. COVID-19 pandemic demonstrated that the medicalisation paradigm where the interactions are described in purely biological terms, has some limits (Siuda & Pluta, 2020). In particular, actions of human actors, concerning the health of themselves, their relatives and their animals, are driven by social dynamics. Along with the advance of internet technology (Ćwiklicki et al., 2022), online search (Wójta-Kempa & Jarynowski, 2023) for and discussion of ABx is becoming more and more popular among patients (the general population) and i.e. *altmed* users (groups of specific subpopulations).

Methods

Mentions related to Antibiotics (antybiotyk/antybiotyki) in Polish language for the time period 01.11.2023 - 31.12.2023 were collected via Brand 24 and qualitatively analysed. Use of the Internet and social media represents a complementary approach that allows fast identification of potential outbreaks and changes in the trends of AMU/AMR. The primary purpose of this study was to detect the shortage of ABx, to show the potential of monitoring the Internet as predictors of what pharmaceutics must be secured in real time in settings where sales data is not shared on a equal basis between pharmacy industry and state agencies responsible for stocking and logistics of drug supply chain. However, despite the usefulness of this approach, internet/new media listening is not widely used in the AMU epidemiology. Our approach combines microbiology, sociology, political science, media research, and computational techniques to promote effective antimicrobial stewardship and the importance of listening to the media as an early warning system. Media data may be used as an adjunctive monitoring tool for antibiotic consumptions.

2668 mentions were analysed together or separately in the given medium [Fig. 1]:

- Blogs: Personal or official narratives offer in-depth insights into the experiences and perspectives of individuals or organisations regarding antibiotics, providing a platform for detailed discussions and analysis.
- News: Articles on antibiotics disseminated through traditional media channels such as press, TV, and radio, as well as internet portals, serve to inform the public about developments, research findings, and policy changes related to antibiotic usage and resistance.
- Forums: Online forums facilitate discussions, questions, and exchanges of information among individuals interested in antibiotics, fostering community engagement and knowledge sharing on a wide range of topics.
- Facebook: Posts, mentions or discussions. On Facebook, users set up "profiles", which are personal websites. Within a profile, users have their own "wall" or "timelines" where all of a person's posts are saved. This is the most popular social media platform in Poland (Jarynowski, Wójta-Kempa, & Belik, 2020b). This can be compared to an interactive blog on people activities with the opinions of others. People post texts, photos, links and other users can enter into discussion with them in the comments (Khanom, 2023; Ubaedillah et al., 2021).
- Instagram: Image posts provide a visually engaging platform for discussions on antibiotics, utilising captivating visuals to convey important messages and encourage audience engagement.
- Twitter/X: Tweets or replies/quotes about antibiotics. Twitter is comparable to a microblog. It is often used to quickly exchange information, knowledge and opinions (Ubaedillah et al., 2021).
- TikTok: Short videos on TikTok offer a creative and engaging medium for raising awareness about antibiotics, delivering educational content in short format which digital natives like, and promoting positive (but not only)

Figure 1
Methods & Data
Source: own collage based on logotypes of given media platforms from the public domain.

behaviour related to antibiotic usage and stewardship in an entertaining format.
- YouTube: Longer Video content (we include into this category non-YouTube long videos such as Podcast as well). YouTube is a video-sharing service that permits users to view videos posted by other users and upload their videos. Although several companies and organisations use YouTube to promote their business, most of the YouTube videos are created and uploaded by amateurs (Khanom, 2023).

Three main topic categories of interest were selected because of their importance to One health and public health (Aarestrup et al., 2021):
- "Natural antibiotics" were chosen as it is a very important aspect of self-treatment (Makowska et al., 2020) of pharmacological folk knowledge (Smakosz & Dąsal, 2021) and of *altmed*.
- AMR was chosen because of the negative consequence for One health and public health (ECDC/EFSA/EMA, 2021)
- "Informative" were chosen based on the reporting discussion style on the use of antibiotics.

Results

In contrast to seasons 2022/23, in the analysed period there was almost no shortage of antibiotics (except for the pediatric form of clindamycin). Interest in ABx [Fig. 2] may be only to a little extent correlated with ILI outbreaks (Jarynowski et al., 2023; Keller et al., 2023).Thus the slight increasing trend in November and slightly decreasing trend in December are moreover in line with the surveillance data from previous infection seasons and observation of GPs in Poland. The season 2023/2024 was the first one when Polish Sanitary Inspection stopped requiring medical practices in Poland to report ILI (Jarynowski, 2022)) [Fig. 2].

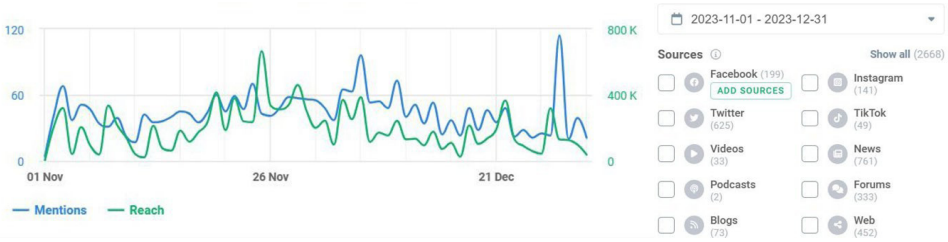

Figure 2
Timeline of interest (left) and sources of information (right) with number of mentions on ABx. Mentions are the crude number of posts/comments/articles/materials and reach is an estimated number of people who see the content
Source: own Research based on Brand24 tool.

As each medium is characterised by a different audience and type of communication, we analyse them separately.

Facebook

In our dataset, there were 199 mentions with content ranges from personal anecdotes about antibiotic use, discussions on effectiveness, to shared articles or news reports about antibiotics [Fig. 3]. There were numerous mentions of antibiotics on parenting pages. Parents shared their experiences with specific medicines and were looking for advice. Many posts and questions revolved around the safety of taking certain antibiotics during pregnancy, sometimes regardless of previous consultation with healthcare professionals. Some shared anecdotes about their children undergoing multiple antibiotic treatments without improvement and asked for advice on natural or home remedies.

Figure 3

Representation of the Abx discourse on Facebook. Own picture base on the Internet material

Source:https://www.facebook.com/GrzesiakMarzena/posts/pfbid02QtFUcotBZ5zrCBn5iisPBHHX XzedekpqO9uepiqEwYjdUJESbMcsMAeWPbqpMGbVl, access date:16.05.2024; https://www.facebook.com/SosnowiecSpotted/posts/pfbid02pPjnw7kQFQs3nkmrwLF6NyhWcU9tySdW5SNUTDyw5MUA4nBpnpxceUzcvcBAJyVpl, access date: 16.05.2024.

Instagram

There were 141 posts with images [Fig. 4], some infographics about antibiotics, their use, and single instances of resistance. Instagram stories might also feature polls or questions to engage followers on the topic (how to sell products). Combined use of ABx with probiotics (with advertisements of given brands) is discussed (Kamiński et al., 2019).

Figure 4
Representation of the ABx discourse on Instagram
Source: own picture based on the Internet material (https://www.instagram.com/reel/C0j5qAnIyRP/?igsh=MXFyaWtxcWZidmk2aQ==, access date: 16.05.2024; https://www.instagram.com/p/C04QnfBI967/?igsh=MTFmZjRyeGs1dW9lZg==, access date: 16.05.2024; https://www.instagram.com/reel/C1eDfWRIIG9/?igsh=d2VydnFlZmNzdmVi, access date: 16.05.2024).

Twitter/X

Among 625 mentions, news shares [Fig. 5], personal opinions, expert advice, and hashtag- driven discussions (e.g., #naturalneantybiotyki) dominated the discourse. Twitter/X is the most explored social medium for healthcare and public health i.e. in epidemic intelligence and surveillance (Jarynowski & Belik, 2022), including health consequences (Jarynowski, Kaczmar, & Madej, 2020), understanding public perceptions (Jarynowski, Wójta-Kempa, & Belik, 2020a) with

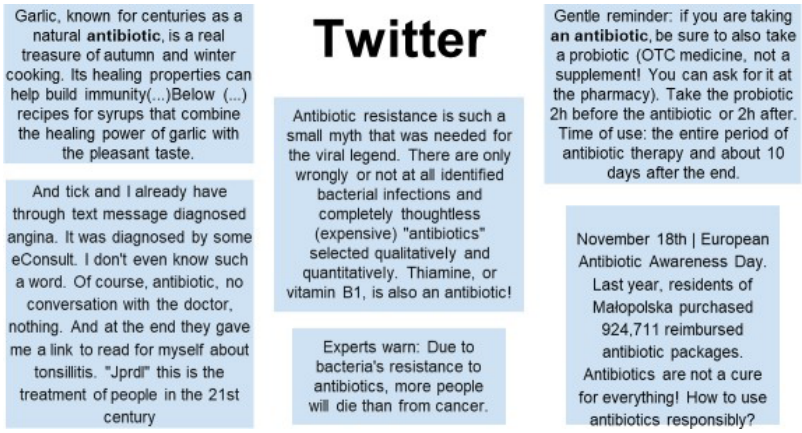

Figure 5
Representation of the ABx discourse on Twitter/X
Source: own picture based on the Internet material.

few studies on ABx (Dyar et al., 2014). Discourse on Twitter/X was widest in the range of topics and quality of the content. *Altmed* was underrepresented on this medium in comparison to others.

TikTok

There are 49 short videos that are supposed to educate (nonprofessional and often not in line with mainstream science), entertain, or inform about antibiotics [Fig. 6]. This might include creative content aiming to raise awareness about antibiotic use and misuse. Promotion of herbs and other natural treatment was presented in an attractive multimedia way (storytelling). Veterinary cases can be found here the most often. The *altmed* is also overrepresented here.

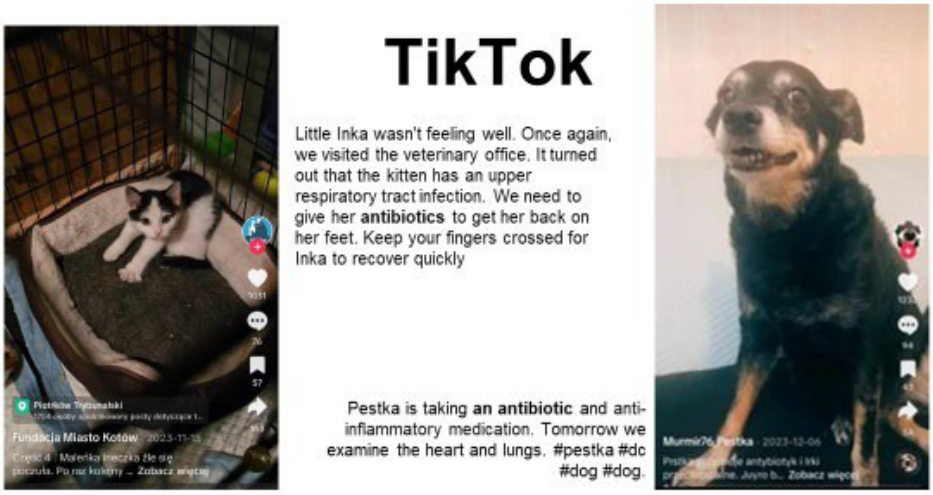

Figure 6

Representation of the Abx discourse on Tik Tok

Source: own picture based on the Internet material (https://vm.tiktok.com/ZGeC37EQV/, access date: 16.05.2024; https://vm.tiktok.com/ZGeC3vRuS/, access date: 16.05.2024).

YouTube/Podcasts

There were 65 videos (mainly on YouTube) ranging from documentary segments on antibiotic resistance to tutorials on proper antibiotic use and "natural antibiotics" such as ginger, garlic or apple cider vinegar, along with various health-boosting recipes [Fig. 7]. Interviews with medical doctors were used to promote proper AMU.

Figure 7

Representation of the Abx discourse on video streaming platforms

Source: https://www.youtube.com/watch?v=VQG7q2E1RAU&pp=ygUMYW50eWdya XBpbmEt, access date: 16.05.2024; https://www.youtube.com/watch?v=RC69EF1Dlmc&t=80s&pp=ygUZYW50eWJpb3R5ayB uaWUgZHppYcWCYSBuYQ%3D%3D, access date: 16.05.2024.

Blogs

There were 73 blog posts that discuss natural antibiotics such as garlic and honey, highlight natural remedies, emphasise the problem of antibiotic resistance, and include advice on responsible antibiotic use [Fig. 8]. Most of the topics of blogs were not professional medical perspectives, but discussing ABx in some special lay contexts (i.e. sickness of an author).

Figure 8

Representation of the ABx discourse in Blogs

Source: own picture based on the Internet material.

Forums

Forums feature user-generated questions or opinions (here: 333 posts) about antibiotics, reflecting public concerns and the demand for clear, accessible information. This medium showcases the online discourse around antibiotics, offering insights into public perceptions, misinformation, and educational efforts. The sense of this medium was community building, where people were sharing their emotionally loaded opinions and knowledge (which often were against evidence-based medicine). Internet users were exchanging experiences and tips for self-medication [Fig. 9].

Figure 9

Representation of the ABx discourse on Forums

Source: own picture based on the Internet material (https://forum.gazeta.pl/forum/w,567,177106062,177106062,Antybiotyk_po_alkoholu_po_jakim_czasie.html, access date:13.05.2024; https://forum.gazeta.pl/forum/w,567,176921032,176921032,Antybiotyk_nie_pomaga_Gardlo_.html, access date: 13.05.2024).

News/Web

A collection of 1203 articles and reports from various news outlets, each categorised by specific topics related to antibiotics, was analysed [Fig. 10]. The mass media, including news, entertainment, advertising and social media, play a key role in disseminating health information and shape understanding and attitudes towards public health issues, including ABx. Particularly, we can distinguish:

- "Natural Antibiotics": bacteriostatic properties of garlic, ginger, and honey or elderberry fruit are discussed. Recipes, guidelines and facts were presented.
- Alternative Medicine: such as anti-inflammatory and bacteriostatic role of Vitamin C in high dosages. Fake news on ABx were fact-checked by medical doctors (i.e. from Wroclaw Medical University).
- AMR and protection from antibiotic resistances: a few reports and interviews that address the issue of antibiotic resistance, including insights from

medical doctors (mainly) and pharmacists on the ABx market. The decreasing effectiveness of ABx in the pediatric population was often discussed.
– "Antibiotics can harm us (so caution)": contains warnings about the overuse and potential harm of antibiotics (Adverse Events), with a focus on public health information.

Substantive, informative content about antibiotics: in-depth and informative content about antibiotics (i.e. co-treatment with probiotics) including comparisons between antibiotics and other treatments, pharmacokinetics and pharmacoepidemiology.

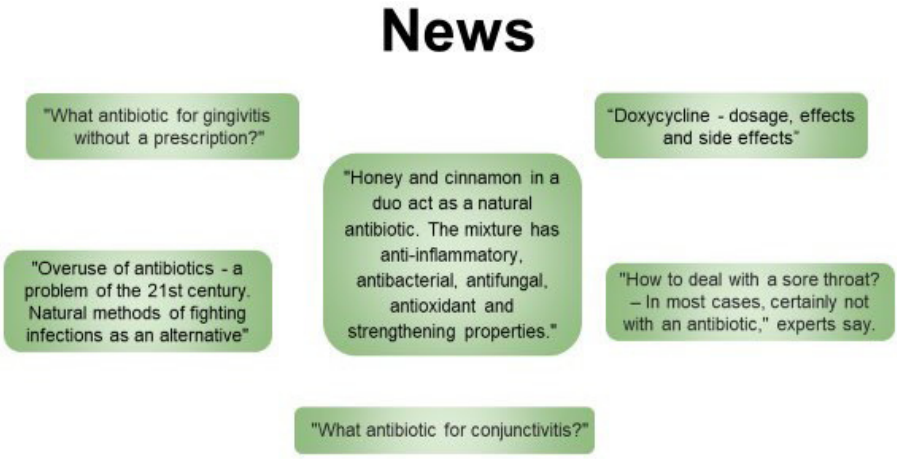

Figure 10
Representation of the ABx discourse in the news
Source: own picture based on the Internet material.

News (traditional media) has the biggest number of mentions, thus some rare topics such as AMR can be investigated [Tab. 1]. The issue of antibiotic resistance is mainly addressed on professional webportals, often statements by doctors or health professionals with very low reach in the general population.

Table 1
Main sources of information

"Natural antibiotics"	AMR	Informative
zdrowie.interia.pl	rynekzdrowia.pl	stronazdrowia.pl
stronazdrowia.pl	medonet.pl	portal.abczdrowie.pl
zywienie.medonet.pl	termedia.pl	nowiny24.pl
zdrowie.wprost.pl	pulsmedycyny.pl	apo-discounter.pl
mojegotowanie.pl	gazetaprawna.pl	zdrowie.dziennik.pl
	zdrowie.radiozet.pl	

Source: own table based on the Internet material.

Data synthesis

Selected concepts found in the analysed material were categorised into three main topics of interest [Tab. 2].

Table 2

Examples of discussions for selected topics

"Natural antibiotics"	AMR	Informative
Garlic is a natural antibiotic.	Antibiotics previously used to fight common infections in children often no longer work.	Antibiotic vs. blood test.
Onions are a natural antibiotic.	Rational antibiotic therapy is a sign of concern for the life and health of future generations.	Information about a particular antibiotic.
Broth concoction does not only have warming properties, but also antimicrobial properties.	At the moment, the situation is such that any doctor can prescribe virtually any antibiotic without any consequences. (...) In addition, the number of people with increased susceptibility to bacterial infections is growing.	When to take probiotics while on antibiotics?
Honey is a natural antibiotic – protects against the "common cold".	Bacteria resistant to some of the most powerful antibiotics are spreading rapidly across war-torn Ukraine, and U.S. health officials have issued a warning that infections are spreading beyond the country's borders.	Use of antibiotics in legionellosis.
Ginger is a natural antibiotic.	Decline in the effectiveness of antibiotics for children.	European Antibiotic Awareness Day/Week.
Spelt is a natural antibiotic.	Pay special attention to antibiotics during the autumn and winter. After all, when abused, they gradually lose their potency. In turn, their declining effectiveness is a threat to us all.	„The hospital will be provided with equipment for rapid diagnosis of the etiology of infection, which will allow the proper selection of antibiotics."
Altmed - anti-inflammatory role of vitamin C.	Lack of Abx, which work for newborns.	Self-medication tips.
This type of blue cheese is a natural antibiotic.	Microbiological testing helps determine which antibiotic we should take.	Reminders that a sore throat is usually caused by viruses and viral infections are not treated with an antibiotic.

Source: own table based on the Internet material.

Our analysis of the Polish Internet concerning ABx is similar to the previous study on COVID- 19 (Wolska-Zogata, 2022) and indicates the marginality of information questioning the state of the art in biomedical sciences. However, at the same time gray or clearly anti-scientific views have the power to activate the Internet community (i.e. followers on TikTok and other media). Moreover, additional topics were revealed:

- Engaging education in which circumstances to use the antibiotic, contraindications.
- Disease histories (own), personal or relative experience of ABx treatments, opinions on behaviour during an antibiotic therapy.
- Antibiotics for animals only discuss companion animals, while livestock and wild animals are not discussed.

Discussion

Our study has a few limitations. First of all, it is a retrospective study conducted in a short time window, and its results depend on the societal fashion. The study may also be affected by selection bias (the retrieval algorithms). The size of each topic ("natural antibiotics"/AMR/"informative") was not assessed systematically. Our main findings are:

- People, in the context of antibiotic use, primarily focus on issues related to their own or their relatives' or pets' health. The public health perspective is not discussed (Stochmal et al., 2021).
- On the Internet (mainly forums and social media sites) one can find many questions about the rules of antibiotic use. People are also looking for ways to treat themselves without visiting a doctor or asking pharmacists.
- The most common topic on the Internet is children's illnesses, but also bacterial infections in pets are very frequent.
- People believe it is important to use natural treatments, often because of the belief that antibiotics are harmful (i.e. leading to adverse events) for individuals. The most important problems of public health, such as AMR do not draw the attention of the general public.
- Mentions of AMR on the Polish Internet are uncommon (mostly in traditional media), but mainly motivated by the fact that antibiotics may be running out for sick children (not old people). AMR is known to be underrepresented in the Internet discourse (Kamiński et al., 2019) and we see the same pattern in our analysis.
- There is a difference between patterns of antibiotic presentation between various populations and media, while Twitter/X is more scientific, Forums are more patient oriented, and TikTok is more misinformative.
- There is a difference in type of narrations due to psychological factors (Porzak et al., 2024) such as urgency (i.e. asking how to get or use ABx dominating in forums and Facebook) or beliefs about antibiotics use (i.e. preference for natural ABx on YouTube/TikTok).

The number of ABx-related mentions due to infection waves [Fig. 2, 11] and the topic were slightly changing, so secular trend (long-term pattern, such as a gradual increase or decrease) and seasonal variation needs a further long-term investigation (Nandi et al., 2023)).

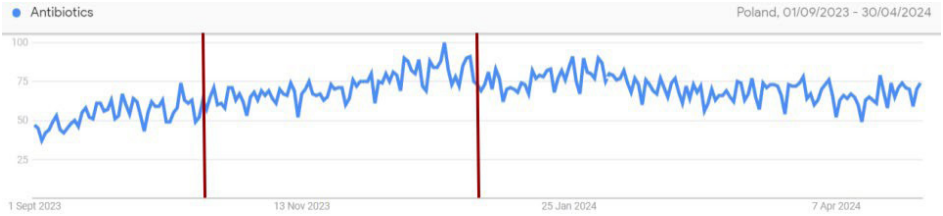

Figure 11
Google Trend daily RSV during infection season 2023/24 with marked investigated period
Source: own Research based on Google Trends™.

Lack of correlations in space and time between the topic of antibiotics and AMR in other studies (Rahul et al., 2023) as well as absence of AMR in social media with little coverage in traditional media, indicates that there are different mechanisms driving these processes in social perception. High interest in natural ABx shows that society is interested in their health (Theodoridis et al., 2023), however part of this interest is taken by *altmed* actors who want to make profits from the illness of people (TikTok had the highest share of pseudo medical advertisements).

Conclusions

It was the first (to our knowledge) netnographic study (Siuda & Pluta, 2020) on antibiotics in the Polish infosphere. The democracy of the virtual space, the mixing of professional and non-professional knowledge, and offers of conventional medicine services provide scope for interaction between specialists (with knowledge on AMR) and lay people. It is important to emphasise that in the Polish infosphere the death toll of NDM (New Delhi metallo-beta- lactamase resistance pattern in Enterobacteriaceae) or *Clostridium difficile* (Bednarska et al., 2023) is not so popular and a great majority of discourse corresponds to children or pets. That may be a consequence of acceptance in society that elderly may die and the expectation that pediatric ABx will be secured in the first place. This is in contradiction with the Western European perspective to secure elderly (see comparison of acceptance of sanitarism in Poland vs. the rest of the EU during COVID-19 (Toshkov, 2023)). We found that the supply of information corresponds [Fig. 2] to epidemiological seasonality of respiratory infections (however a proper epidemiological surveillance is needed to statistically confirm our observation) and with antibiotic consumption (more time series data is needed to verify that (Romaszko-Wojtowicz et al., 2024) as it was done on the Danish sales data

(Dalum Hansen et al., 2018)). Dissemination of information on AMR via social media does not go viral (as assumed by SEO- marketers (Scanfeld et al., 2010)), and only information campaigns in the traditional media are visible (i.e. antibiotic awareness week (Ortiz-Martínez et al., 2018)) by those who are interested (they cannot reach larger audiences (Jarynowski et al., 2022)). Thus, redesign of AMR campaigns may be needed. However, specialists must understand that information needs of the general population are different from their perspective and a good understanding of the current attitude is needed before preparing information campaigns on AMR, otherwise it probably will fail (Rzymski et al., 2024). Unlike more rapid-onset crises (e.g., COVID-19, the 2022 Oder river disaster, the war in Ukraine (Jarynowski, 2023)), in the case of ABx expert agencies cannot depend on having the attention of politicians, the media, or the public for creeping crises. This study is a pilot one as it investigates only a 2-month period of increased interest in immunity and respiratory health. However, it provides a proof of the potential of real time media monitoring in the future.

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