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Review Article

Drug-related problems of antibiotics in outpatients' settings: a scoping review

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Abstract

Antibiotic use in outpatient settings accounts for the majority of overall antibiotic consumption, yet inappropriate prescribing and drug-related problems (DRPs) remain prevalent and underreported. Conducting a scoping review on antibiotic-related DRPs in outpatients is essential to comprehensively map existing evidence, identify gaps, and inform targeted interventions aimed at optimizing antibiotic use and improving patient safety. The review was conducted following the five-stage methodology developed by Arksey and O'Malley, with studies identified through a PubMed database search. Of the 400 studies retrieved, 22 met the inclusion criteria. The most frequently prescribed antibiotic classes for outpatients were penicillins, macrolides, fluoroquinolones, tetracyclines, and cephalosporins. Commonly reported antibiotic-related DRPs included inappropriate dose and frequency, incorrect duration of therapy, lack of indication for therapy, non-adherence to guideline-recommended treatment, absence of therapy despite indication, potential drug interactions, and adverse drug reactions. Targeted outpatient antimicrobial stewardship is urgently needed to optimize antibiotic use and reduce resistance.

Keywords

Anti-bacterial agent, drug-related problems, DRPs, outpatient

Introduction

Antibiotics are among the most widely used therapeutic agents in modern healthcare and have saved countless lives (Leekha et al. 2011; Yimenu et al. 2019). However, inappropriate use, including misuse and overuse, can lead to several negative consequences, such as increased antibiotic resistance and adverse clinical outcomes for patients (Holmes et al. 2016; WHO 2022; Salam et al. 2023). Antibiotic resistance is a significant global health concern. In an era marked by limited discovery of new antibiotic molecules, infections caused by resistant pathogens pose a significant global health threat due to their association with higher mortality risks and longer hospital stays (Freire-Moran et al. 2011; Dadgostar 2019; Chinemerem Nwobodo et al. 2022; WHO 2023; Ahmed et al. 2024; CDC 2025).

A deeper understanding of how inappropriate antibiotic use contributes to resistance can be achieved by examining it through the lens of drug-related problems

(DRPs). Misuse and overuse encompass a range of DRPs, including inappropriate antibiotic selection, dosing errors, incorrect duration, preparation or administration issues, non-adherence, drug interactions that reduce therapeutic efficacy, and untreated indications, which could further increase the risk of avoidable mortality—particularly in resource-limited settings (Lodise et al. 2007; Bollenbach 2015; Cox et al. 2017; PCNE 2020; Otaigbe and Elikwu 2023). Notably, subtherapeutic antibiotic levels resulting from interactions with concomitant medications may promote the development of resistance. Identifying and quantifying these DRPs is essential for designing targeted interventions and establishing measurable indicators to reduce inappropriate antibiotic use. Understanding the types and magnitude of misuse and overuse is essential for designing effective interventions and establishing success indicators to minimize inappropriate antibiotic use (Drekonja et al. 2015; Dobson et al. 2017; Tedijanto et al. 2020; Donà et al. 2020; St. Louis and Okere 2021; Frost et al. 2022; Amin et al. 2022; Grigoryan and Trautner 2024).

Research on DRPs associated with antibiotic use in outpatient settings remains limited, despite the high volume of prescriptions in ambulatory care (Li et al. 2016; Sanchez et al. 2016; CDC 2022). A scoping review is therefore warranted to map existing evidence, identify knowledge gaps, and generate insights to improve prescribing practices, enhance patient safety, and reduce antimicrobial resistance. This review aims to provide insights into the common DRP associated with antibiotic use among outpatients.

Methods

This scoping review was conducted following the methodology developed by Arksey and O'Malley (2005). Their framework, widely implemented in health research (Yahya et al. 2021; Kylén et al. 2022; Kolle et al. 2023; Zhang et al. 2023; Abawaji et al. 2024), outlines five main stages for conducting a scoping review. An optional sixth stage, involving consultation with experts, can also be included. However, this optional step was not performed in the present review, as four members of the author team (RY, FH, PJZ, and ES) have extensive experience in research on infections and antibiotic use.

Stage one: formulation of the research question

Considering the absence of published literature comprehensively describing the types and magnitude of antibiotic misuse and overuse in outpatient settings, the research question addressed in this scoping review is: What are the types and what is the magnitude of antibiotic misuse and overuse reported in published articles on outpatient settings? In addition to answering this research question, the types of antibiotics and outpatient settings described in each study will be presented to clarify the context.

Stage two: identification of relevant research articles

A comprehensive search was conducted using the PubMed database to identify relevant articles published from database inception through October 2024. The search strategy employed the following keywords: (((DRP OR "drug related problem*" OR "drug therapy problem*" OR "medication therapy problem*" OR "therapy related problem*" OR "medication error*" OR "treatment related problem*")) AND ((antibacterial agents[MeSH Terms]) OR (antibiotic*) OR (antimicrobial*) OR (antiviral*) OR (antifungal*))) AND ((outpatient OR ambulatory OR "community health care*" OR "primary care*" OR "ambulatory care*" OR "outpatient care*" OR "ambulatory care facility*" OR "clinic*")). No restrictions were applied during the literature search.

Stage three: study selection

Studies were included if they addressed and clearly reported data on the types of antibiotic-related drug problems (DRPs) occurring in outpatient settings. Studies focusing on antibiotic-related DRPs in inpatient populations were excluded from this review. Additionally, inaccessible articles, case studies, review articles, letters to the editor, editorials, studies involving tuberculosis patients, and studies discussing outpatient DRPs without detailed data on antibiotic-related DRPs were excluded. One author (MSL) screened all titles and abstracts in October 2024. Full-text articles of relevant records were then assessed against the inclusion and exclusion criteria.

Stage four: data extraction and mapping

For each study meeting the inclusion criteria, the following data were documented using a standardized extraction form (MS Excel):

1. Study characteristics, including author list and publication year, country where the study was conducted, study design (retrospective or prospective), study duration, and the age and diagnoses of patients involved. Additionally, countries were classified as low-income, middle-income, or high-income economies according to the World Bank classification based on gross national income (GNI) per capita for the year the study began (The World Bank 2024).
2. Characteristics of the antibiotics used.
3. Characteristics of the drug-related problems (DRPs) as reported in each study.

Two other authors (E.S. and R.Y.) performed a random check to verify the accuracy of the data extraction process.

Stage five: presentation of results

The results of the scoping review were presented descriptively. Where appropriate, data were displayed in tables and charts to facilitate interpretation of the findings.

Results

A total of 400 studies were identified from the search, of which 22 met the inclusion criteria (Fig. 1). Most studies originated from the United States (11), followed by Canada (3), China (2), and other countries, including Ethiopia, South Korea, France, Spain, Australia, and Côte d'Ivoire, each contributing one study. The majority of studies were conducted in hospital outpatient settings (19 studies), while three were performed in primary healthcare facilities. Seventeen of the 22 studies reviewed (73.9%) were published between 2015 and 2022. Only one study originated from a country classified as a low-income economy. Detailed information on the characteristics of each included study is presented in Table 1.

Seventeen studies reported data on antibiotic prescribing, identifying the most frequently prescribed antibiotic classes for outpatients as penicillins, macrolides, fluoroquinolones, tetracyclines, and cephalosporins (Caminal and Rovira 2005; Shariatzadeh and Marrie 2006; Tobia et al. 2008; Williams et al. 2011; Farag et al. 2014; Song et al. 2014; Kim et al. 2015; Abrogoua et al. 2016; Grenet et al. 2016; Avery et al. 2018; Havers et al. 2018; Zhu et al. 2018; Barstow et al. 2020; Kassahun and Ayfokru 2020; Parsels et al. 2022; Tan et al. 2022; Woods et al. 2023) (Table 2). Regarding antibiotic-related drug problems (DRPs), inappropriate dosage and frequency were among the most commonly reported issues in outpatients, with prevalence rates ranging from 3.2% to 67.8% (Rinke et al. 2008; Tobia et al. 2008; Williams et al. 2011; Farag et al. 2014; Song et al. 2014; Abrogoua et al. 2016; Grenet et al. 2016; Hale et al. 2017; Avery et al. 2018; Zhu et al. 2018; Dickinson et al. 2019; Barstow et al. 2020; Kassahun and Ayfokru 2020; Parsels et al. 2022; Tan et al. 2022; Hiryak et al. 2023; Woods et al. 2023). Other frequently reported DRPs included inappropriate therapy duration (five studies reported duration of antibiotic treatment was too long/prevalence 4.8%–35.4%; and four studies reported short duration of antibiotic treatment/prevalence 0.5%–35.4%) (Abrogoua et al. 2016; Grenet et al. 2016; Hale et al. 2017; Dickinson et al. 2019; Parsels et al. 2022; Hiryak et al. 2023), lack of indication for therapy (Grenet et al. 2016; Havers et al. 2018; Kassahun and Ayfokru 2020; Parsels et al. 2022; Hiryak et al. 2023; Woods et al. 2023), non-adherence to guideline-recommended therapy (Caminal and Rovira 2005; Song et al. 2014; Allison et al. 2015; Grenet et al. 2016; Hale et al. 2017; Parsels et al. 2022; Woods et al. 2023), absence of therapy despite indication (Caminal and Rovira 2005; Allison et al. 2015; Hale et al. 2017; Kassahun and Ayfokru 2020; Parsels et al. 2022; Hiryak et al. 2023; Woods et al. 2023), potential drug interactions (Williams et al. 2011; Hale et al. 2017; Hale et al. 2017; Avery et al. 2018; Hiryak et al. 2023; Parsels et al. 2022), and adverse drug reactions (Shariatzadeh and Marrie 2006; Hale et al. 2017; Avery et al. 2018; Parsels et al. 2022; Woods et al. 2023). The prevalence of these DRPs in

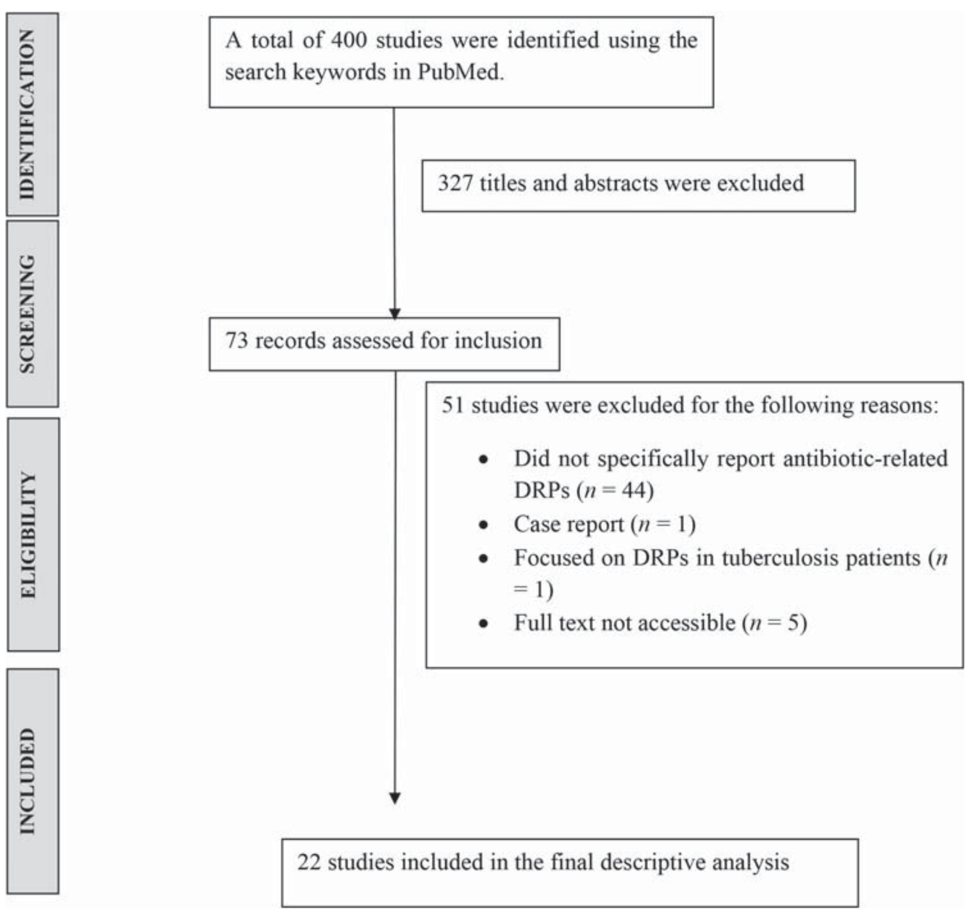

Figure 1. Diagram of study selection process.

Table 1. Characteristics of studies meeting the inclusion criteria.

Authors (year)	Setting (country)	Level income (The World Bank 2024)	Type of study	Duration of study	Study subject (n)	Age (mean +- SD; median / min-max; in years)
(Parsels et al. 2022)	Hospital discharge patients (USA)	High	Retrospective, descriptive study	(-)	Prophylaxis (168), skin and soft tissue (159), cystitis/ pyelonephritis (120), intra-abdominal (120), pneumonia (99), ENT (240), bacteremia (23), *Clostridioides difficile* (19), odontogenic (19), bone/joint (17), COPD exacerbation (15), and other (20).	(-)
(Hale et al. 2017)	Clinic discharge patients (USA)	High	A retrospective, noninterventional chart analysis	(-)	Type of infection: bone/joint (56), skin/skin structure (27), bacteremia (20), central nervous system (14), intra-abdominal (9), and other (14)	55.6 ± 14.8
(Hiryak et al. 2023)	Hospital discharge patients (USA)	High	Prospective	4 months	Skin and skin-structure infections (-), lower respiratory tract infections (-), complicated urinary tract infections (-), and intra-abdominal infections (-).	18–74
(Kassahun and Ayfokru 2020)	Outpatient (Ethiopia)	Lower	Retrospective cross-sectional study	4 months	acute febrile illness (97), respiratory infection (44), and urinary tract infection (39)	(-)
(Avery et al. 2018)	Outpatient (USA)	High	Longitudinal cohort study	(-)	Kidney transplant (5130)	57.5 ± 10.6
(Havers et al. 2018)	Outpatients (USA)	High	Cohort	(-)	Influenza (3381), pharyngitis (2494), sinusitis (1707), and suppurative OM (1212)	32 (24)
(Zhu et al. 2018)	Outpatients (Canada)	High	Retrospective cross-sectional study	(-)	Kidney disease (13,875)	81 (75–86)
(Kim et al. 2015)	Ambulatory care patients (South Korea)	High	Retrospective	(-)	Patients who received prescriptions for acid-related disorder drugs (10,049,292), antimicrobials (7,584,131), antihypertensives (4,349,945), and lipid-modifying drugs (1,425,292) in ambulatory care settings	(-)
(Woods et al. 2023)	Outpatient (USA)	High	Retrospective	(-)	Infections caused by non-tuberculous mycobacteria found in the lungs (64), skin and soft tissue (6), bones and joints (5), cervical lymphadenitis (1), and disseminated (1)	68.5 (62.2–73)
(Grenet et al. 2016)	Outpatients (France)	High	Retrospective monocentric study	(-)	urinary tract infections (263), cutaneous infections (198), respiratory tract infections (101), ENT infections (62), genital infections (18), uncomplicated acute diarrhea (15), and other indications (26)	46.5 (15–103)
(Allison et al. 2015)	Hospital discharge patients (USA)	High	Retrospective study	(-)	Hospital discharge patients with intravenous antibiotics (286)	57 (53.9, 60.2)/ 62 (58.6, 65.0)
(Williams et al. 2011)	Community pharmacies (Australia)	High	Prospective	12 weeks	Not clearly described (prescriptions for outpatients assessed by 531 community pharmacists)	(-)
(Caminal and Rovira 2005)	Primary Health Care patients (Spain)	High	Observational cross-sectional design	(-)	Acute upper respiratory tract infection (1114), acute bronchitis (327), influenza syndrome: influenza (140), gastroenteritis (78), urinary tract infection (284), acute tonsillitis (95), and COPD exacerbation (76)	(-)
(Barstow et al. 2020)	Hospital discharge patients (USA)	High	Retrospective chart review	(-)	Skin soft tissue (126), genitourinary (94), dental (5), and gastrointestinal (8)	(-)
(Dickinson et al. 2019)	Hospital discharge patients (USA)	High	Descriptive study	(-)	Bloodstream infection (5), bone/joint infection (6), gastrointestinal infection (6), pneumonia (7), prophylaxis (2), skin/soft tissue infection (3), surgical site infection (7), urinary tract infection (11), and other (3)	(-)
(Shariatzadeh and Marrie 2006)	Outpatient (Canada)	High	Prospective	17 months	CAP (75)	(-)
(Song et al. 2014)	Outpatient (China)	Upper middle	Prospective	12 months	Not clearly described (prescriptions for outpatients in the databases were used in the study)	(-)
(Tan et al. 2022)	Outpatient (China)	Upper middle	Cross-sectional study	(-)	Acute upper respiratory infections of multiple or unspecified sites (980), acute nasopharyngitis (common cold) (373), acute tonsillitis (225), acute bronchitis (154), acute sinusitis, and unspecified (85)	6.3 ± 3.2 (1–18)
(Tobia et al. 2008)	Outpatient (USA)	High	Retrospective cross-sectional study	(-)	CAP, sinusitis, or acute exacerbations of chronic bronchitis with: One or more comorbidities (87), chronic pulmonary disease (62), heart disease (33), diabetes (36), and renal disease (5)	58 ± 15
(Farag et al. 2014)	Ambulatory patients (Canada)	High	Retrospective time series analysis	(-)	CKD (1028)	81 ± 5
(Rinke et al. 2008)	Ambulatory patients (USA)	High	Retrospective	(-)	Pediatric patients (3523)	(-)

Authors (year)	Setting (country)	Level income (The World Bank 2024)	Type of study	Duration of study	Study subject (n)	Age (mean +- SD; median / min-max; in years)
(Abrogoua et al. 2016)	Outpatient (Côte d'Ivoire)	Lower middle	Descriptive cross-sectional	(-)	Respiratory infections (73), infectious conjunctivitis (12), nasopharyngitis (11), bronchial rales (10), otitis (7), furunculosis (6), dermatosis (3), pharyngitis (3), cutaneous staphylococcus (3), soiled umbilical cord (2), bronchiolitis (2), gastroenteritis (2), ulceration of the left ear and face (1), others (10), and unspecified (5)	11.75 ± 15.12 months

ENT: ear, nose, and throat; COPD: chronic obstructive pulmonary disease; CAP: community acquired pneumonia; CKD: chronic kidney disease

outpatients ranged from 4.8% to 41%, 1.0% to 43.7%, 0.5% to 15.3%, 5.4% to 22.6%, and 1.3% to 54.7%, respectively (Table 3). Table 4 summarizes the most commonly reported antibiotic-related problems in outpatient settings.

Discussion

To our knowledge, this is the first scoping review to identify the types and extent of antibiotic misuse and overuse in outpatient settings. Although the terms "antibiotic misuse" and "overuse" are sometimes used interchangeably, "overuse of antibiotics" could refer to the unnecessary use of antibiotics or their use for longer than required (Vaughn et al. 2021). Key drug-related problems found in this scoping review, including inappropriate selection and dosing regimen (Rinke et al. 2008; Tobia et al. 2008; Williams et al. 2011; Farag et al. 2014; Song et al. 2014; Abrogoua et al. 2016; Grenet et al. 2016; Hale et al. 2017; Avery et al. 2018; Zhu et al. 2018; Dickinson et al. 2019; Barstow et al. 2020; Kassahun and Ayfokru 2020; Parsels et al. 2022; Tan et al. 2022; Hiryak et al. 2023; Woods et al. 2023), prolonged duration (Abrogoua et al. 2016; Grenet et al. 2016; Hale et al. 2017; Dickinson et al. 2019; Parsels et al. 2022; Hiryak et al. 2023), and missed prescriptions (Caminal and Rovira 2005; Allison et al. 2015; Hale et al. 2017; Kassahun and Ayfokru 2020; Parsels et al. 2022; Hiryak et al. 2023; Woods et al. 2023), could contribute to antimicrobial resistance, toxicity, and treatment failure, with broad-spectrum antibiotics frequently prescribed, often inappropriately. Notably, 95.45% of included studies in this scoping review were conducted in upper-middle- to high-income countries, where antibiotic use is substantial, highlighting a critical evidence gap in low- and middle-income settings, which often experience even higher rates of prescriptions and overuse (Albarqouni et al. 2023; Chen et al. 2025). Given the growing global public health threat of AMR, identifying and addressing antibiotic-related DRPs is, therefore, essential (Naghavi et al. 2024; Sati et al. 2025).

This scoping review shows that broad-spectrum antibiotics, including penicillins, macrolides, fluoroquinolones, tetracyclines, and cephalosporins, are the most commonly prescribed in outpatient settings (Caminal and Rovira 2005; Shariatzadeh and Marrie 2006; Tobia et al. 2008; Williams et al. 2011; Farag et al. 2014; Song et al. 2014; Kim et al. 2015; Abrogoua et al. 2016; Grenet et al. 2016; Avery et al. 2018; Havers et al. 2018; Zhu et al. 2018; Barstow et al. 2020; Kassahun and Ayfokru 2020; Parsels et al. 2022; Tan et al. 2022; Woods et al. 2023). Due to limited diagnostics, the antibiotics are often used based on symptoms as a precaution (Gebretekle et al. 2018; Nguyen et al. 2022; Otaigbe and Elikwu 2023; Kasse et al. 2024; Kanan et al. 2025). However, this can disrupt normal microbiota (Holmes et al. 2016; Salam et al. 2023) and promote resistance, as they are often unnecessary for common infections that are viral or treatable with narrow-spectrum antibiotics (King et al. 2019; White et al. 2019; Kanan et al. 2025). Inappropriate prescribing reflects systemic challenges such as patient expectations, clinician time constraints, and weak stewardship programs, especially in low-resource settings, where the problem is further amplified (Cox et al. 2017; King et al. 2019; Amin et al. 2022; Otaigbe and Elikwu 2023; Kasse et al. 2024).

In addition to the issue of inappropriate antibiotic selection, this scoping review identified inappropriate antibiotic duplication as a related concern, reported in five studies (Tobia et al. 2008; Kim et al. 2015; Hale et al. 2017; Parsels et al. 2022; Hiryak et al. 2023). In general, such duplication offers no added therapeutic benefit and instead contributes to increased healthcare expenditures and increases the risk of adverse drug reactions (Glowacki et al. 2003). Not all antibiotic combinations within the same class are inappropriate. The appropriateness depends on the infection type and pathogen involved. For instance, while dual beta-lactam use is generally discouraged, it may be suitable in cases such as bacterial meningitis. When *Listeria monocytogenes* is a concern, adding ampicillin to cefotaxime or ceftriaxone is recommended for infants under 1 month and adults over 50 (Tunkel et al. 2004).

Eighteen studies reported inappropriate dosing and frequency of antibiotics (Abrogoua et al. 2016; Avery et al. 2018; Barstow et al. 2020; Dickinson et al. 2019; Farag et al. 2014; Grenet et al. 2016; Hale et al. 2017; Hiryak et al. 2023; Allison et al. 2015; Kassahun and Ayfokru 2020; Parsels et al. 2022; Rinke et al. 2008; Song et al. 2014; Tan et al. 2022; Tobia et al. 2008; Williams et al. 2011; Woods et al. 2023; Zhu et al. 2018). Incorrect dosing—whether subtherapeutic or excessive—compromises treatment efficacy and promotes the survival of resistant organisms (Abushaheen et al. 2020; Andersson and Hughes 2014; Costelloe et al. 2010; Holmes et al. 2016). In particular, underdosing may not fully eliminate the pathogen, allowing it to adapt and develop resistance mechanisms, while overdosing increases the risk of toxicity and contributes to unnecessary selective pressure (Andersson and Hughes 2014; McKenzie 2011; Opatowski et al. 2010; Shehab et al. 2008; Steinke and Davey 2001). Irregular dosing intervals

Table 2. Numbers and classes of antibiotics prescribed in outpatient settings.

	N (number of prescription)												
Authors (year)	**PN**	**TET**	**CEP**	**FQ**	**LIN**	**RIF**	**ETA**	**MAC**	**SUL**	**GLP**	**AG**	**PLP**	**CRE**
(Parsels et al. 2022)	171	33	156	141	15	(-)	(-)	29	111	27	(-)	(-)	(-)
(Hale et al. 2017)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
(Hiryak et al. 2023)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
(Kassahun and Ayfokru 2020)	45	34	28	56	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
(Avery et al. 2018)	1283	(-)	1283	1996	(-)	(-)	(-)	1141	(-)	(-)	(-)	(-)	(-)
(Havers et al. 2018)	2761	307	(-)	184	(-)	(-)	(-)	2270	(-)	(-)	(-)	(-)	(-)
(Zhu et al. 2018)	388	69	2191	2043	(-)	(-)	(-)	1283	718	(-)	(-)	(-)	(-)
(Kim et al. 2015)	11,249,816	204,068	(-)	1,393,057	17,675	(-)	(-)	2,245,283	132,486	(-)	813	(-)	(-)
(Woods et al. 2023)	(-)	4	2	1	(-)	71	64	71	(-)	(-)	14	(-)	2
(Grenet et al. 2016)	319	2	22	314	(-)	(-)	(-)	6	(-)	(-)	(-)	(-)	(-)
(Allison et al. 2015)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
(Williams et al. 2011)	53,652	(-)	(-)	(-)	(-)	(-)	(-)	35,371	(-)	(-)	(-)	(-)	(-)
(Caminal and Rovira 2005)	558	(-)	152	209	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
(Barstow et al. 2020)	895	36	598	42	(-)	(-)	(-)	217	(-)	(-)	(-)	(-)	(-)
(Dickinson et al. 2019)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
(Shariatzadeh and Marrie 2006)	4	1	14	37	1	(-)	(-)	43	1	(-)	(-)	(-)	(-)
(Song et al. 2014)	1924	(-)	5627	3974	161	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
(Tan et al. 2022)	(-)	(-)	460	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
(Tobia et al. 2008)	33	(-)	2	19	(-)	(-)	(-)	42	3	(-)	(-)	(-)	(-)
(Farag et al. 2014)	(-)	9	550	271	(-)	(-)	(-)	251	214	(-)	(-)	(-)	(-)
(Rinke et al. 2008)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
(Abrogoua et al. 2016)	87	(-)	28	4	(-)	12	(-)	10	2	(-)	4	3	(-)

Authors (year)	**IMD**	**NTF**	**STG**	**OXZ**	**FUS**	**APH**	**MCA**	**PN and MAC**	**CEP and TET**	**MAC, LIN and STG**	**CEP and FQ**	**Other AB**
(Parsels et al. 2022)	57	(-)	(-)	24	(-)	(-)	(-)	(-)	(-)	(-)	(-)	39
(Hale et al. 2017)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
(Hiryak et al. 2023)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
(Kassahun and Ayfokru 2020)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	29	35	(-)	(-)	21
(Avery et al. 2018)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
(Havers et al. 2018)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	614
(Zhu et al. 2018)	(-)	1100	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	82	(-)
(Kim et al. 2015)	14,892	(-)	(-)	(-)	(-)	9,937	(-)	(-)	(-)	(-)	(-)	(-)
(Woods et al. 2023)	(-)	(-)	(-)	2	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
(Grenet et al. 2016)	8	(-)	8	1	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
(Allison et al. 2015)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
(Williams et al. 2011)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
(Caminal and Rovira 2005)	(-)	9	(-)	(-)	(-)	(-)	(-)	(-)	(-)	307	(-)	(-)
(Barstow et al. 2020)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	146
(Dickinson et al. 2019)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
(Shariatzadeh and Marrie 2006)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
(Song et al. 2014)	507	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
(Tan et al. 2022)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
(Tobia et al. 2008)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
(Farag et al. 2014)	(-)	169	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
(Rinke et al. 2008)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
(Abrogoua et al. 2016)	(-)	(-)	(-)	(-)	11	(-)	1	(-)	(-)	(-)	(-)	(-)

Note: PN: penicillins; TET: tetracyclines; CEP: cephalosporins; FQ: fluoroquinolons; LIN: lincosamide; RIF: rifamycin; ETA: ethambutol; MAC: macrolides; SUL: sulfonamides; GLP: glycopeptide antibiotics; AG: aminoglycosides; PLP: polypeptide; CRE: Carbapenems; IMD: imidazole derivate; NTF: nitrofuran; STG: streptogramin; OXZ: oxazolidone; FUS: fusidadin; APH: amphenicol; MCA: monocarboxylic acid.

also create inconsistent drug exposure, which can facilitate bacterial adaptation (Opatowski et al. 2010; Svara and Daniel 2011). These issues are often exacerbated in outpatient settings due to limited access to diagnostic tools, empirical treatment practices, and insufficient adherence to treatment guidelines (Kasse et al. 2024; King et al. 2019; Sijbom et al. 2023). The high prevalence of this problem underlines the urgent need for enhanced antimicrobial stewardship in primary care, including prescriber education, standardized dosing protocols, and integration of decision-support systems to guide appropriate antibiotic use (Avent et al. 2020; Goebel et al. 2021; Sanchez et al. 2016).

The issue of antibiotic pressure contributing to the development of antimicrobial resistance (AMR) is increasingly concerning, not only due to dosing errors but also because six articles included in this scoping review reported inap-

Table 3. Type of antibiotic-related problems in outpatient settings.

N (%): number of DRP event

Authors (year)	Inappropriate duration (%)	No indication for drug (%)	Inappropriate drug selection (%)	Drug interaction (%)	No drug prescribed but clear indication (%)	Inapproppriate combintaion therapy (%)	Inappropriate coadministration with non-antibacterials (%)	Drug use problems (%)
(Parsels et al. 2022)	164 (35.9)	63 (35.2)	37 (8.1)	45 (9.8)	4 (0.9)	(-)	(-)	(-)
(Hale et al. 2017)	1 (0.5)	(-)	2 (1.0)	45 (22.6)	1 (0.5)	(-)	(-)	11 (5.5)
(Hiryak et al. 2023)	19 (35.4)	4 (7.3)	(-)	3 (5.4)	3 (5.4)	1 (1.82)	(-)	(-)
(Kassahun and Ayfokru 2020)	(-)	12 (4.8)	(-)	(-)	38 (15.3)	(-)	(-)	(-)
(Avery et al. 2018)	(-)	(-)	(-)	57 (9.0)	(-)	(-)	(-)	(-)
(Havers et al. 2018)	(-)	2522 (41.0)	(-)	(-)	(-)	(-)	(-)	(-)
(Zhu et al. 2018)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
(Kim et al. 2015)		(-)	(-)	(-)	(-)	(-)	(-)	(-)
(Woods et al. 2023)	(-)	18 (12.6)	5 (3.5)	(-)	17 (11.9)	(-)	(-)	(-)
(Grenet et al. 2016)	136 (28.09)	197 (40.7)	119 (24.59)	(-)	(-)	(-)	(-)	(-)
(Allison et al. 2015)	(-)	(-)	6 (6.0) / 1 (1.0)	(-)	4 (4.0)/ 4 (4.0)	(-)	(-)	(-)
(Williams et al. 2011)		(-)	(-)	9 (13.0)	(-)	(-)	(-)	(-)
(Caminal and Rovira 2005)	(-)	(-)	680 (43.7)	(-)	306 (12.5)	(-)	(-)	(-)
(Barstow et al. 2020)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
(Dickinson et al. 2019)	2 (5)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
(Shariatzadeh and Marrie 2006)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
(Song et al. 2014)	(-)	(-)	28 (29.8)	(-)	(-)	20 (21.3)	10 (10.6)	(-)
(Tan et al. 2022)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
(Tobia et al. 2008)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
(Farag et al. 2014)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
(Rinke et al. 2008)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
(Abrogoua et al. 2016)	5 (7.9)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
Range	0.5–35.9%	4.8–41%	1.0–43.7%	5.4–22.6%	0.5–15.3%	1.82–21.3%	0–10.6%	0–5.5%

Authors (year)	Inappropriate duplication therapy (%)	Potential drug allergy (%)	ADR (%)	Contrain-dication (%)	Inappropriate Drug dose and frequent (%)	Instructions wrong, unclear, or missing (%)	Inadequate drug monitoring (%)	Insufficient awareness of health/disease (%)
(Parsels et al. 2022)	3 (0.7)	1(0.2)	8 (1.8)	(-)	69 (15.1)	23 (5.0)	(-)	(-)
(Hale et al. 2017)	1 (0.5)	9 (4.5)	109 (54.7)	(-)	16 (8.0)	(-)	1 (0.5)	1 (0.5)
(Hiryak et al. 2023)	2 (3.64)	(-)	(-)	(-)	15 (27.3)	1 (1.82)	4 (7.3)	(-)
(Kassahun and Ayfokru 2020)	(-)	(-)	(-)	(-)	24 (9.6)	(-)	(-)	(-)
(Avery et al. 2018)	(-)	221 (36.0)	31 (5.1)	(-)	135 (22.0)	(-)	(-)	(-)
(Havers et al. 2018)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
(Zhu et al. 2018)	(-)	(-)	(-)	(-)	5343 (67.8)	(-)	(-)	(-)
(Kim et al. 2015)	2,352,759 (15.3)	(-)	(-)	(-)		(-)	(-)	(-)
(Woods et al. 2023)	(-)	(-)	23 (16.1)	(-)	71 (49.3)	(-)	(-)	(-)
(Grenet et al. 2016)	(-)	(-)	(-)	(-)	32 (6.6)	(-)	(-)	(-)
(Allison et al. 2015)	(-)	(-)	(-)	(-)	18 (18.0)/ 10 (10.0)	(-)	(-)	(-)
(Williams et al. 2011)	(-)	(-)	(-)	4 (5.7)	24 (34.9)	(-)	(-)	(-)
(Caminal and Rovira 2005)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
(Barstow et al. 2020)	(-)	(-)	(-)	(-)	776 (40.0)	(-)	(-)	(-)
(Dickinson et al. 2019)	(-)	(-)	(-)	(-)	8 (20.0)	(-)	7 (18.0)	(-)
(Shariatzadeh and Marrie 2006)	(-)	(-)	1 (1.3)	(-)	(-)	(-)	(-)	(-)
(Song et al. 2014)		(-)	(-)	(-)	13 (13.8)	(-)	(-)	(-)
(Tan et al. 2022)	(-)	(-)	(-)	4 (0.5)	412 (52.2)	(-)	(-)	(-)
(Tobia et al. 2008)	2 (1)	(-)	(-)	(-)	17 (11.0)	32 (21)	(-)	(-)
(Farag et al. 2014)	(-)	(-)	(-)	(-)	970 (66.0)	(-)	(-)	(-)
(Rinke et al. 2008)	(-)	(-)	(-)	(-)	7 (43.8)	9 (56.2)	(-)	(-)
(Abrogoua et al. 2016)	(-)	(-)	(-)	(-)	2 (3.2)	(-)	(-)	(-)
Range	0.5–15.3%	0.2–36.0%	1.3–54.7%	0.5–5.7%	3.2–67.8%	1.82–56.2%	0.5–18.0%	0–0.5%

Authors (year)	Therapy failure (reason unknown) (%)	Stability issues (%)	Patient cannot afford (%)	Prior au-thorization issue (%)	Inappropriate drug form/formulation (%)	Adherence (%)	Inappropriate administration route (%)	Ignorance of patient's other diseases (%)
(Parsels et al. 2022)	(-)	10 (2.2)	4 (0.9)	3 (0.7)	23 (5.0)	(-)	(-)	(-)
(Hale et al. 2017)	2 (1.0)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
(Hiryak et al. 2023)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
(Kassahun and Ayfokru 2020)	22 (8.9)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
(Avery et al. 2018)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
(Havers et al. 2018)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
(Zhu et al. 2018)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
(Kim et al. 2015)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)

Authors (year)	Therapy failure (reason unknown) (%)	Stability issues (%)	Patient cannot afford (%)	Prior authorization issue (%)	Inappropriate drug form/formulation (%)	Adherence (%)	Inappropriate administration route (%)	Ignorance of patient's other diseases (%)
(Woods et al. 2023)	(-)	(-)	(-)	(-)	(-)	6 (4.2)	(-)	(-)
(Grenet et al. 2016)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
(Allison et al. 2015)	(-)	(-)	(-)	(-)	(-)	8 (17.8)	2 (4.4)	(-)
(Williams et al. 2011)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
(Caminal and Rovira 2005)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
(Barstow et al. 2020)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
(Dickinson et al. 2019)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
(Shariatzadeh and Marrie 2006)	(-)	(-)	(-)	(-)	(-)	6 (8.0)	(-)	(-)
(Song et al. 2014)	(-)	(-)	(-)	(-)	17 (18.1)	(-)	1 (1.1)	4 (4.26)
(Tan et al. 2022)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
(Tobia et al. 2008)	4 (3)	(-)	60 (39.0)	(-)	(-)	(-)	1 (1.0)	(-)
(Farag et al. 2014)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
(Rinke et al. 2008)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
(Abrogoua et al. 2016)	(-)	(-)	(-)	(-)	(-)	(-)	56 (88.9)	(-)
Range	1.0–8.9%	0–2.2%	0.9–39.0%	0–0.7%	5.0–18.1%	4.2–17.8%	1.0–88.9%	0–4.26%

Table 4. Most commonly reported antibiotic-related problems in outpatient settings.

Type DRPs	Range of prevalence		Number of studies
	n	%	
Inappropriate dosage and frequency	2–5,343	3.2–67.8	18
Inappropriate drug selection	1–680	1.0–43.7	7
Absence of therapy despite indication	1–306	0.5–15.3	7
Inappropriate duration of therapy	1–164	0.5–35.9	6
No indication for therapy	4–2,522	4.8–41	6

propriate therapy durations (Abrogoua et al. 2016; Dickinson et al. 2019; Grenet et al. 2016; Hale et al. 2017; Hiryak et al. 2023; Parsels et al. 2022). It should be acknowledged that determining the optimal duration of antibiotic therapy is challenging, and there is no universal approach applicable to all types of infections. A recently published meta-analysis reported higher odds of AMR development in patients receiving extended-duration antibiotics compared to those on shorter regimens, although the difference was not statistically significant [OR 1.03; 95% CI 0.98–1.07] (Curran et al. 2022; Mo et al. 2025). Current trends regarding the duration of antibiotic use for several types of infections emphasize shortening the course of therapy, as no significant differences in effectiveness have been observed when compared to longer treatment durations (Grillo Perez et al. 2024). In addition to its association with AMR, prolonged use of antibiotics may also increase the risk of adverse drug reactions (ADRs) (Hashemian et al. 2018).

Seven studies reported that no antibiotics were prescribed despite clear clinical indications (Allison et al. 2015; Caminal and Rovira 2005; Hale et al. 2017; Hiryak et al. 2023; Kassahun and Ayfokru 2020; Parsels et al. 2022; Woods et al. 2023). Failure to administer adequate antibiotic therapy is a recognized risk factor for the development of complications. While in some infectious cases a delay in initiating appropriate antibiotics may not adversely affect prognosis, in others—including urinary tract infections (UTIs)—such delays can lead to increased infection severity (Dahlén et al. 2022). The increased severity of infections poses significant clinical and public health challenges. More severe infections are often associated with higher morbidity and mortality, prolonged hospital stays, greater use of broad-spectrum or combination antimicrobial therapies, and increased healthcare costs. This underscores the need for early detection, appropriate antimicrobial stewardship, and targeted interventions to prevent disease progression.

Antibiotic misuse and overuse in outpatient settings, as identified in this study, demand urgent global action through the implementation of antimicrobial stewardship programs (ASPs). Core interventions that have proven effective in inpatient settings are equally applicable to outpatient care, including clinician education, formulary restriction, audit and feedback, and clinical decision-support tools (Narayan et al. 2025; Sadeq et al. 2022). Moreover, evidence suggests that the implementation of ASPs can reduce the use of broad-spectrum antibiotics in outpatient settings (Ya et al. 2023). Importantly, outpatient stewardship must extend beyond healthcare professionals to actively engage patients and communities through shared decision-making and targeted public health campaigns, thereby reducing unnecessary prescribing and promoting appropriate antibiotic use (Narayan et al. 2025; Sadeq et al. 2022). Moreover, quality indicators should be specifically tailored to capture measures relevant to outpatient practice that are often overlooked in inpatient frameworks, such as the proportion of patients with documented adherence monitoring.

Despite the important findings related to drug-related problems (DRPs) documented in this review, several considerations should be considered when interpreting the results. One key limitation of this scoping review lies in the heterogeneity of patient populations across the included studies. Variability in patient demographics, clinical conditions, comorbidities, and care settings may influence the type, frequency, and impact of reported DRPs, thereby limiting the generalizability of the findings. Moreover, the majority of included studies were conducted in middle- to high-income countries, which may limit the generalizability of the findings to low-income settings. Given the substantial differences in healthcare infrastructures, antibiotic prescribing practices, and availability of antimicrobial stewardship programs across income levels, further research in low- and middle-income countries is imperative to address this evidence gap. Another limitation of this scoping review is the use of a single database as the sole source of literature, which represents a methodological limitation. This may have resulted in the omission of relevant studies indexed in other databases, thereby reducing the breadth and diversity of the evidence included. Despite its limitations, this systematic review consolidates and highlights relevant evidence on antibiotic-related DRPs, providing valuable insights to support the development of targeted health strategies for improving antibiotic use in outpatient settings.

Conclusion

This scoping review successfully documented a wide range of DRPs associated with antibiotic use in outpatient settings. These DRPs not only pose direct risks to patient safety but also contribute to the growing threat of antimicrobial resistance (AMR). Notably, some DRPs—such as drug interactions, non-adherence, and subtherapeutic dosing—can silently exacerbate AMR by reducing antibiotic plasma concentrations without obvious clinical signs. In contrast, certain interactions may lead to supratherapeutic levels, increasing the risk of toxicity. Our findings highlight key DRPs—including inappropriate selection, duplication, improper dosing, and prolonged duration—that should be prioritized in outpatient antimicrobial stewardship efforts. Addressing these challenges will require coordinated action among healthcare professionals and strengthened healthcare infrastructure, supported by robust policy engagement. Moreover, effective outpatient antimicrobial stewardship programs, combining clinician education, decision-support tools, patient engagement, and tailored quality indicators, are urgently needed to curb antibiotic misuse and promote appropriate prescribing.

Additional information

Conflict of interest

The authors have declared that no competing interests exist.

Ethical statements

As the nature of scoping review focuses on previously published literature and does not involve direct interaction with animals or human participants, ethical approval is not required.

The authors declared that no animals, humans, human tissues, or commercially available immortalised human and animal cell lines were subjected as participants or used in this study.

Use of AI

In preparing this manuscript, the author(s) used ChatGPT (OpenAI) to assist with language refinement. The author(s) reviewed and verified all AI-generated content to ensure that the scientific ideas, interpretations, and analytical components of the manuscript originate entirely from the authors. The author(s) accept full responsibility for the accuracy, originality, and academic integrity of this work.

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Author contributions

ES, RY: conceptualization; MSL, ES, PJZ: methodology; MSL: data acquisition and management; ES, MSL, FH: analysis; MSL, PJZ: visualization; MSL: writing-original draft; MSL, RY, PJZ, FH, ES: review and editing; ES, RY: supervision.

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Data availability

All of the data that support the findings of this study are available in the main text.

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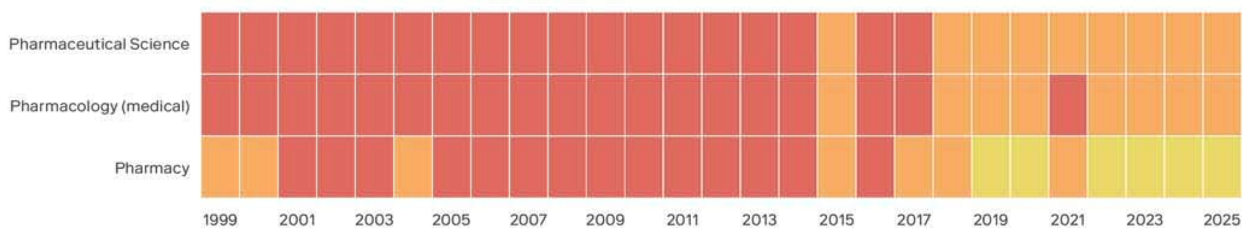

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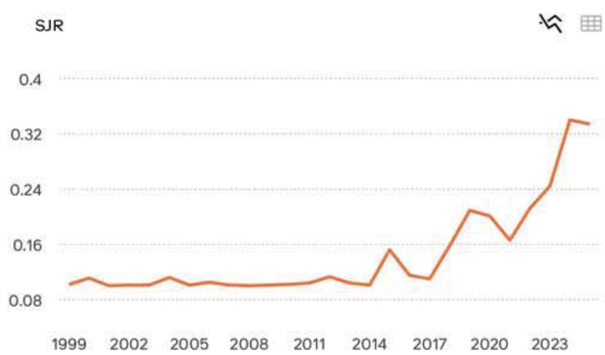

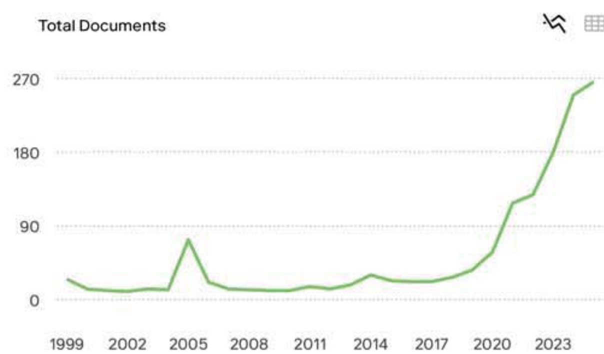

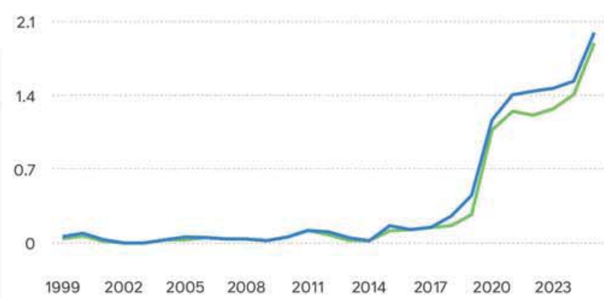

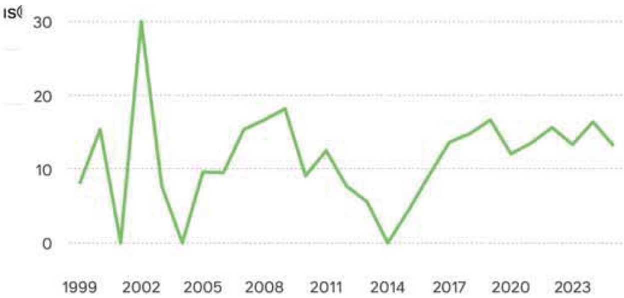

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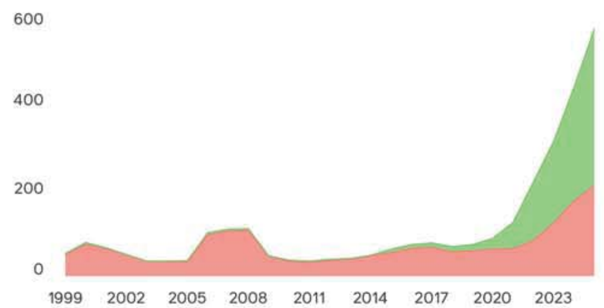

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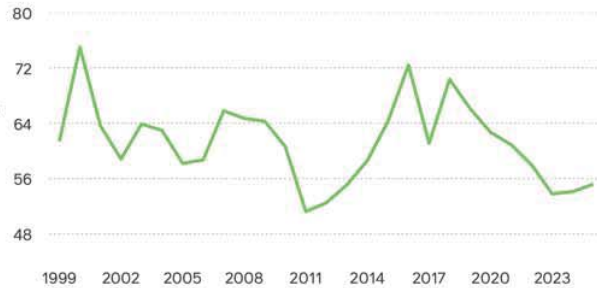

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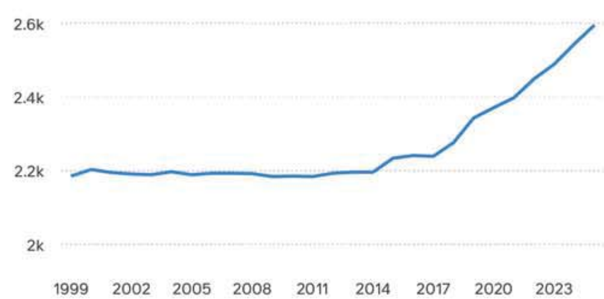

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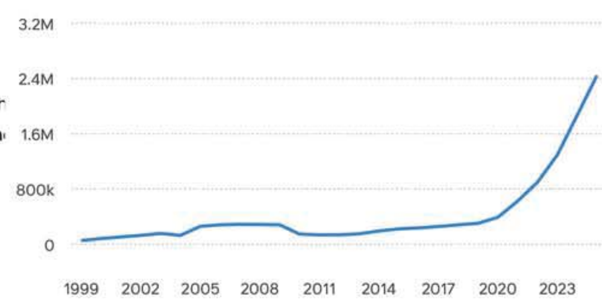

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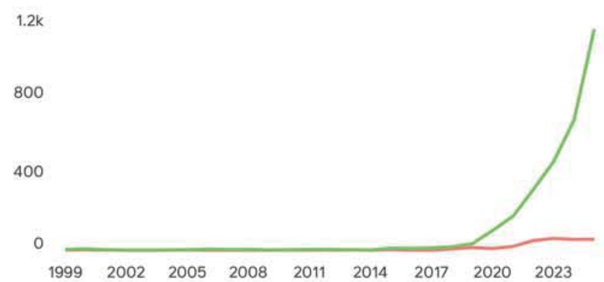

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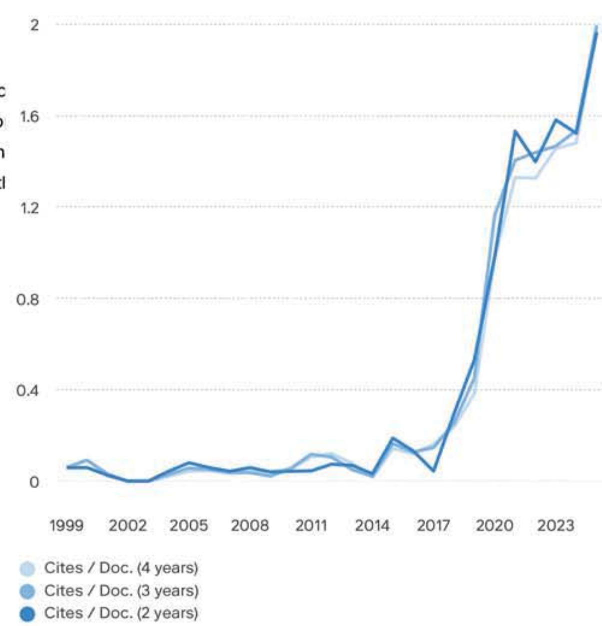

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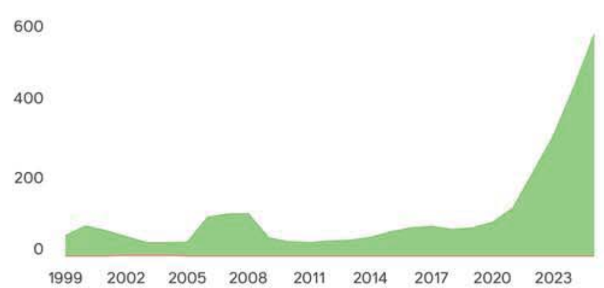

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