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Prevalence and associated factors of self-medication with antibiotics among pediatric population in India: a systematic review and meta-analysis

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Abstract

Background Antibiotic resistance presents a substantial threat to global public health. One of the primary contributors to antibiotic resistance is the irrational use of antibiotics. This study aimed to comprehensively assess the prevalence and associated factors of antibiotic self-medication (ASM) practices among the pediatric population in India.

Methods A comprehensive search was conducted in PubMed, Embase, Scopus, and Google Scholar to identify relevant articles published up to December 2024. Inclusion criteria included studies reporting the prevalence rate of ASM practices among the pediatric population in India. Quality assessment of the included studies was conducted using the JBI tool for prevalence studies. Data were extracted using a standardized form and analyzed using R software with a random-effects model.

Results Seventeen studies involving 7847 children were analyzed. The pooled prevalence of pediatric ASM in India was 19.8% (95% CI: 13.5; 28.2; $I^2 = 98.2\%$; $p < 0.01$). Regional disparities were observed ($p < 0.01$), with the northern region exhibiting the highest prevalence at 30.7%. No significant difference in prevalence was found between studies that recruited participants from hospital and community settings ($p = 0.0552$). Key factors associated with pediatric ASM included financial constraints, time constraints, perceptions of mild illness, and limited healthcare access. Common sources for procuring antibiotics were local pharmacies, leftover medications, and friends/family members. Information sources regarding the use of antibiotics included previous prescriptions, friends/family members, media, past experiences, and pharmacists. The mean duration of antibiotic consumption was 2.5 days.

Conclusion Self-medication with antibiotics was prevalent among the pediatric population in India. Therefore, government and policymakers should take necessary measures to promote the responsible use of antibiotics.

Highlights

- The prevalence of antibiotic self-medication among children in India was 19.8%.

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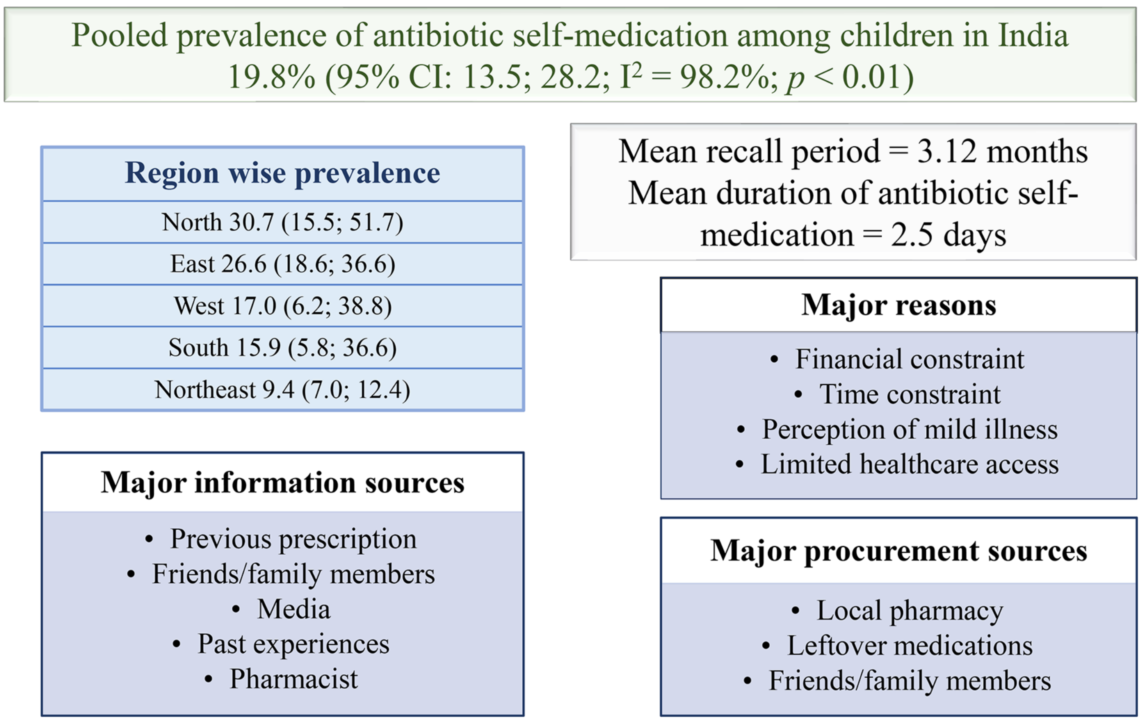
- Significant regional differences were observed, with the highest prevalence in North region.
- Financial constraints, time limitations, and the perception of mild illness were main reasons.
- Antibiotics were mainly sourced from pharmacies, leftover medicines, and family/friends.
- Urgent measures are needed to promote the responsible use of antibiotics in children.

Keywords Antibiotics, Self-medication, Pediatric, Children, Epidemiology, India

Graphical Abstract



Introduction

Antibiotics have substantially revolutionized the treatment of bacterial infections, leading to a substantial decline in both morbidity and mortality rates. However, their widespread availability and ease of access have given rise to a concerning global phenomenon - antibiotic self-medication (ASM). ASM involves the use of antibiotics without a medical prescription or supervision, including the practice of altering prescribed medication dosages [1]. While self-medication is acknowledged for its potential to reduce the burden on the healthcare system for minor ailments, it is associated with significant risks and challenges. Several studies have reported high prevalence rates of ASM. Globally, the prevalence of ASM among adults was estimated to be 43.0% [2]. In Ethiopia, the prevalence has been reported as 46.1% [3]. In low- and middle-income countries, the prevalence is even higher, reaching 78% [4]. Parents often engage in self-medication for their children, driven by various factors, including limited access to healthcare facilities, financial constraints, time limitations, and cultural beliefs in the healing power of antibiotics. However, this practice poses significant risks, such as antibiotic resistance, adverse reactions, and allergic responses, with potential long-term implications for child health [5].

World Health Organization (WHO) warns that a significant proportion of antibiotics are used for self-medication, raising concerns about antibiotic resistance globally. Antibiotic resistance arises as bacteria undergo evolutionary changes to shield themselves from the effects of antibiotics. Consequently, antibiotic resistance implies that bacteria causing specific infections no longer respond to the particular antibiotic. This lack of responsiveness leads to the persistence of untreated infectious conditions, thereby extending the patient's morbidity status. Antibiotic resistance represents a critical public health challenge, as it diminishes the effectiveness of antibiotics, making previously manageable infections more difficult to treat [6, 7]. The consequences of antibiotic resistance are indeed severe, with this phenomenon directly causing over 1.27 million deaths annually and contributing to an additional 4.95 million fatalities worldwide [8]. Due to its huge impact on human health, the WHO identified antibiotic resistance as one of the top ten threats to global health in 2019 [9]. This problem is particularly critical in low and middle-income countries (LMICs), where the burden of antibiotic resistance is disproportionately high, further worsening already challenging healthcare systems [6, 7, 10]. A recent meta-analysis published in 2024 [11] showed that 64.4% of people in India practice self-medication, which is higher than the 53.6% reported in a 2020 meta-analysis [12]. This increase in self-medication practices is especially worrying in children, as improper use of antibiotics in this population can lead to resistance and other health complications [13].

Schedule H of the Drugs and Cosmetics Rules, 1945, India classifies certain drugs, including most antibiotics, as prescription-only medicines. According to this regulation, Schedule H drugs should not be sold without a prescription from a registered medical practitioner. However, despite this legal restriction, many pharmacies in India continue to dispense antibiotics without proper prescriptions. Additionally, high medical consultation costs, long waiting times at public healthcare facilities, and the belief in the effectiveness of antibiotics for common illnesses further encourage the practice of self-medication [14–17].

Several studies from India have reported a very high prevalence of ASM in children [6, 7, 15, 18, 19], with one study documenting it as high as 68% [10]. This shows the magnitude of this problem. The prevalence and associated factors of pediatric ASM in India need special attention due to the complexity of healthcare system and diverse sociocultural determinants. Despite the imperative need for comprehensive data on ASM among children in India, existing literature remains fragmented, providing inconsistent prevalence rates and associated factors [6, 7, 15, 18, 19]. By rigorously analyzing the available evidence, this study aimed to provide a holistic understanding of the prevalence of parental ASM practices among children in India along with its associated factors. We anticipate that our findings will offer valuable insights into this critical public health issue and inform evidence-based interventions to prevent the irrational use of antibiotics. It will consequently lead to reduction in the spread of antibiotic resistance and contribute to improved child healthcare practices in India.

Methodology

This systematic review has been reported as adhering to the PRISMA 2020 statement [20]. It has been registered with PROSPERO under the identifier CRD42024572332.

Search strategy

The literature search was carried out using different search engines, including MEDLINE (via PubMed), Embase, Scopus, and Google Scholar. This search covered articles published from the inception of these databases up to December 31, 2024. The search strategy employed MeSH terms and keywords, along with synonyms and variations for the terms "self-medication," "antibiotic," "children," "caregivers," and "India," using Boolean operators "OR" and "AND." Additionally, a review of the references cited in all the selected full-text articles was conducted to identify any additional relevant studies. The search strategy used is provided in Supplementary Table 1.

Selection criteria

Predetermined inclusion and exclusion criteria were applied to ensure systematic and unbiased screening. Articles published in English or Hindi were included. Hindi is the common language used in India. Inclusion criteria focused on studies employing any design that reported or allowed the calculation of pediatric ASM prevalence in different regions of India. We also considered studies that reported pediatric ASM prevalence as a subgroup in their results. Additionally, conference presentations and preprint articles were eligible for inclusion if they provided ASM prevalence data. However, studies that solely addressed knowledge, attitudes, and practices related to ASM without assessing its prevalence were excluded. Reviews, meta-analyses, case reports, case series, correspondences, editorials, commentaries, and letters to the editor were also excluded.

Selection of studies

The screening and selection of studies were conducted in two stages. Firstly, duplicate articles were identified and removed by importing the records into a Microsoft Excel sheet. Two reviewers separately evaluated the titles and abstracts of all eligible studies, following the predefined inclusion criteria during the first stage. Any article deemed unrelated at this stage was removed from further consideration. In the second stage, both authors independently performed a full-text screening of the remaining studies, and only the appropriate studies were included in our review. Any conflict that emerged during the full-text screening was resolved with input from a senior author. Additionally, the references of all the included studies were thoroughly searched for any additional relevant articles that could be incorporated into the study.

Assessment of risk of bias

Quality assessment of the included articles was conducted independently by two authors using the JBI critical appraisal checklist for prevalence studies [21]. The checklist consists of 9 items, each of which was scored as "yes", "no", or "unclear". An overall risk of bias score ranging from 0 to 9 was assigned to each study by summing the scores for each item. Studies with scores of 7–9 were rated as low risk, 4–6 as moderate risk, and scores of 1–3 were rated as high risk of bias. Any disagreements between the two authors were resolved through discussion or with the involvement of a third author.

Data extraction

A standardized data extraction process was employed using Google Sheets, in which two independent reviewers extracted information from selected studies. The extracted data included the name of the first author, publication year, study location (state/union territory), study design, source of participants, sample size, gender distribution, and prevalence of ASM. Additionally, information such as the mean duration of ASM, recall period, source of antibiotics, source of information, reasons for ASM, and type of antibiotics used were also extracted from the included articles, whenever available.

Data synthesis

Quantitative analysis was performed using R software (version 4.2.2). A random-effects model (DerSimonian and Laird) [22] meta-analysis was employed with the "metaprop" function within "meta" R package [23] to estimate the pooled prevalence of pediatric ASM. The findings were visually represented using a forest plot with a 95% confidence interval (CI). To assess the degree of heterogeneity among studies, we utilized the I^2 test, which indicates the level of variation associated with sampling error. Heterogeneity was considered present and statistically significant if the $I^2 > 50\%$ and the p-value < 0.05. Subgroup analysis was conducted for different variables, such as different regions of India and the source of study participants. Potential publication bias was assessed by visually examining the funnel plot and confirmed through Egger's test [24] and Begg's test [25]. Additionally, we conducted a critical appraisal to provide descriptive summaries of outcomes from the included studies. These results were organized around key topics, such as the reasons for ASM, the source of antibiotics procurement, the source of drug information, and the type of antibiotics used for self-medication.

Results

Screening results

The search yielded 200 potentially relevant citations for this study. Additionally, a comprehensive search was performed on the reference lists of articles that satisfied the inclusion criteria. After removing duplicates, there remained 188 unique citations for further evaluation. Upon screening the titles and abstracts, 162 studies were excluded as they did not align with the predefined inclusion criteria. Subsequently, a thorough assessment was conducted on the remaining 26 articles, resulting in the exclusion of 9 articles due to various reasons. As a result, a total of 17 studies that met the inclusion criteria were included in the systematic review and meta-analysis. Figure 1 provides a visual representation of the study selection process.

Characteristics of included studies

A total of 17 studies conducted throughout India, with publication years ranging from 2005 [26] to 2024 [27], were included for assessment. All were of cross-sectional design. In all studies, the respondents were caregivers of children, including parents and guardians. Out of the 17 studies, 9 were conducted in hospital settings [10, 14–17, 26, 28–30], while 8 were in the community [6, 7, 18, 19, 27, 31–33]. The overall sample size across all the studies combined was 7847 children. The highest number of studies in terms of geographical distribution was conducted in Maharashtra [7, 26, 32] and Tamil Nadu [6, 16, 18], with three studies each. One study was conducted in each of the following states: Uttar Pradesh [10], Kerala [30], Punjab [15], Manipur [14], Odisha [17], Jammu and Kashmir [28], Haryana [19], Gujarat [33], Karnataka [29], Andhra Pradesh [31], and Bihar [27]. Most studies employed simple random sampling for participant enrollment, and the majority of participants were male. Of all the studies included, only one reported side effects, which included diarrhea, abdominal pain, nausea, fever, and allergic reactions [7]. The details of study characteristics are summarized in Table 1. Regarding the quality assessment of the studies, 14 studies achieved scores ranging from 7 to 9, indicating a classification of "low risk of bias," while 3 studies received a score of 6, corresponding to a "moderate risk of bias." The outcomes of this methodological quality evaluation are comprehensively presented in Supplementary Table 2.

Meta-analysis results

The pooled prevalence of ASM among the pediatric population in India was found to be 19.8% ([95% CI: 13.5; 28.2], 17 studies, 1572/7847 children) (Fig. 2). However, significant heterogeneity was observed among the studies ($\tau^2 = 0.9198$; $I^2 = 98.2\%$; $p < 0.01$). Assessment of publication bias using a funnel plot indicated symmetry (Fig. 3), suggesting no substantial publication bias. This was further established by Egger's test (t = -1.30, $p = 0.2116$) and Begg's test (z = -1.07, $p = 0.2842$). Furthermore, sensitivity analysis signified that the pooled prevalence remained stable, as the exclusion of any single study did not significantly alter the overall estimate (Supplementary Fig. 1).

Subgroup analysis results

Subgroup analysis revealed significant variations in prevalence across regions ($p < 0.01$), ranging from 9.4% ([95% CI: 7.0; 12.4], 1 study, 46/487 children) in the northeast to 30.7% ([95% CI: 15.5; 51.7], 4 studies, 522/1725 children)

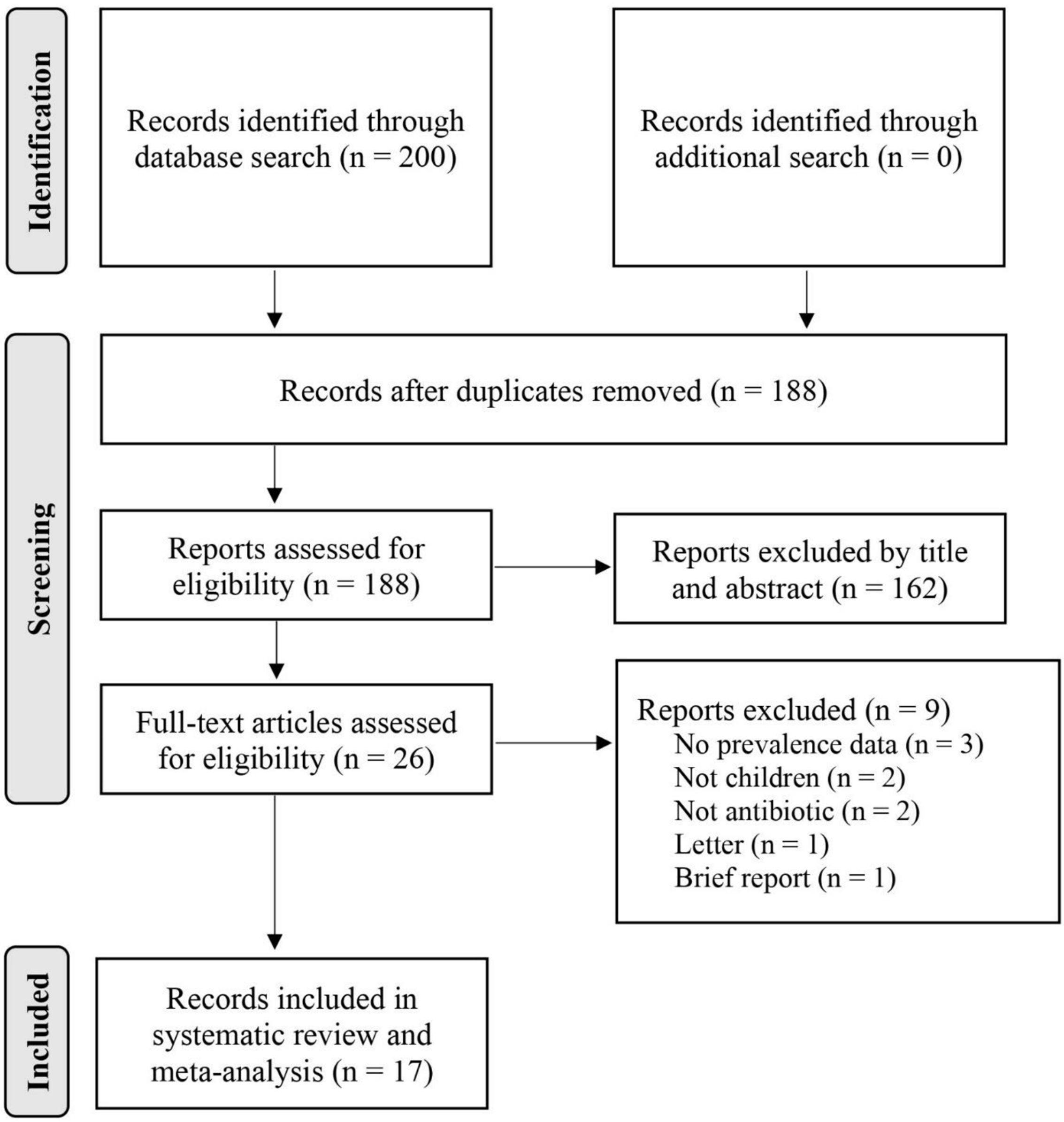


Fig. 1 PRISMA flow diagram showing the process of study selection

in the north region, although it is important to note that the former figure was based on a single study. Prevalence in the west region was 17.0% ([95% CI: 6.2; 38.8], 4 studies, 524/3023 children), in the south it was 15.9% ([95% CI: 5.8; 36.6], 6 studies, 335/2039 children), and in the east, it was 26.6% ([95% CI: 18.6; 36.6], 2 studies, 145/573 children) (Fig. 4). Furthermore, when categorizing studies by source of participants (hospital-based versus community-based), we found a higher prevalence in community settings (29.0%; [95% CI: 19.8; 40.3], 8 studies, 1006/3714 children) than in hospital settings (13.6%; [95% CI: 6.4; 26.6], 9 studies, 566/4133 children), but this difference did not reach statistical significance ($p = 0.0552$) (Fig. 5). Similarly, studies published after 2016 reported a higher prevalence (24.0%; [95% CI: 15.6; 35.1], 12 studies, 1054/4427 children) compared to those published in 2016 or earlier (12.1%; [95% CI: 4.7; 27.7], 5 studies, 518/3420 children), but this difference was also not statistically substantial ($p = 0.1596$) (Fig. 6).

Qualitative synthesis of results

In qualitative synthesis, we summarized various attributes of ASM in children in India. These included reasons for self-medication, sources of antibiotic information and procurement, antibiotics used, recall period, and mean duration of ASM. Table 2 summarizes various attributes regarding the practice of ASM in children.

Table 1 Characteristics of included studies

Author	Year	Study location (state/UT)	Study design	Source of participant	Sampling method	Sample size	Gender (M: F)	Age (years)	Prevalence of ASM (%)
Gupta [10]	2018	Uttar Pradesh	CS	Hospital	NM	145	NM	NM	67.6
Revathi et al. [6]	2020	Tamil Nadu	CS	Community	Random	250	NM	0.5–12	44.8
Shaji et al. [30]	2023	Kerala	CS	Hospital	Simple random	108	47:61	≤ 12	10.2
Dhir et al. [15]	2016	Punjab	CS	Hospital	NM	486	279:207	≤ 14	38.1
Chakraborty et al. [14]	2012	Manipur	CS	Hospital	NM	487	NM	≤ 15	9.4
Panigrahi et al. [17]	2022	Odisha	CS	Hospital	NM	400	244:156	0.08-14	22.5
Tibdewal et al. [26]	2005	Maharashtra	CS	Hospital	Random	976	NM	< 6	2.5
Naaraayan et al. [16]	2016	Tamil Nadu	CS	Hospital	NM	754	455:299	0.08-12	6.4
Gupta et al. [28]	2021	Jammu and Kashmir	CS	Hospital	NM	377	227:150	0.08-18	6.4
Sakhare et al. [7]	2022	Maharashtra	CS	Community	NM	200	NM	≤ 8	56.0
Subha C et al. [18]	2020	Tamil Nadu	CS	Community	Convenient	204	NM	< 5	52.5
Kadam et al. [32]	2018	Maharashtra	CS	Community	Cluster	1407	NM	NM	22.8
Nazir et al. [19]	2015	Haryana	CS	Community	Simple random	717	NM	< 5	30.0
Patel et al. [33]	2020	Gujarat	CS	Community	Simple random	440	180:260	5–15	15.2
Nayyar et al. [29]	2018	Karnataka	CS	Hospital	Random	400	218:182	≤ 12	10.0
Kakollu et al. [31]	2023	Andhra Pradesh	CS	Community	NM	323	172:151	≤ 15	5.3
Kumar et al. [27]	2024	Bihar	CS	Community	Simple random	173	NM	0–12	31.8

UT union territory; CS cross-sectional study; ASM antibiotic self-medication; M male; F female; NM not mentioned/not mentioned clearly

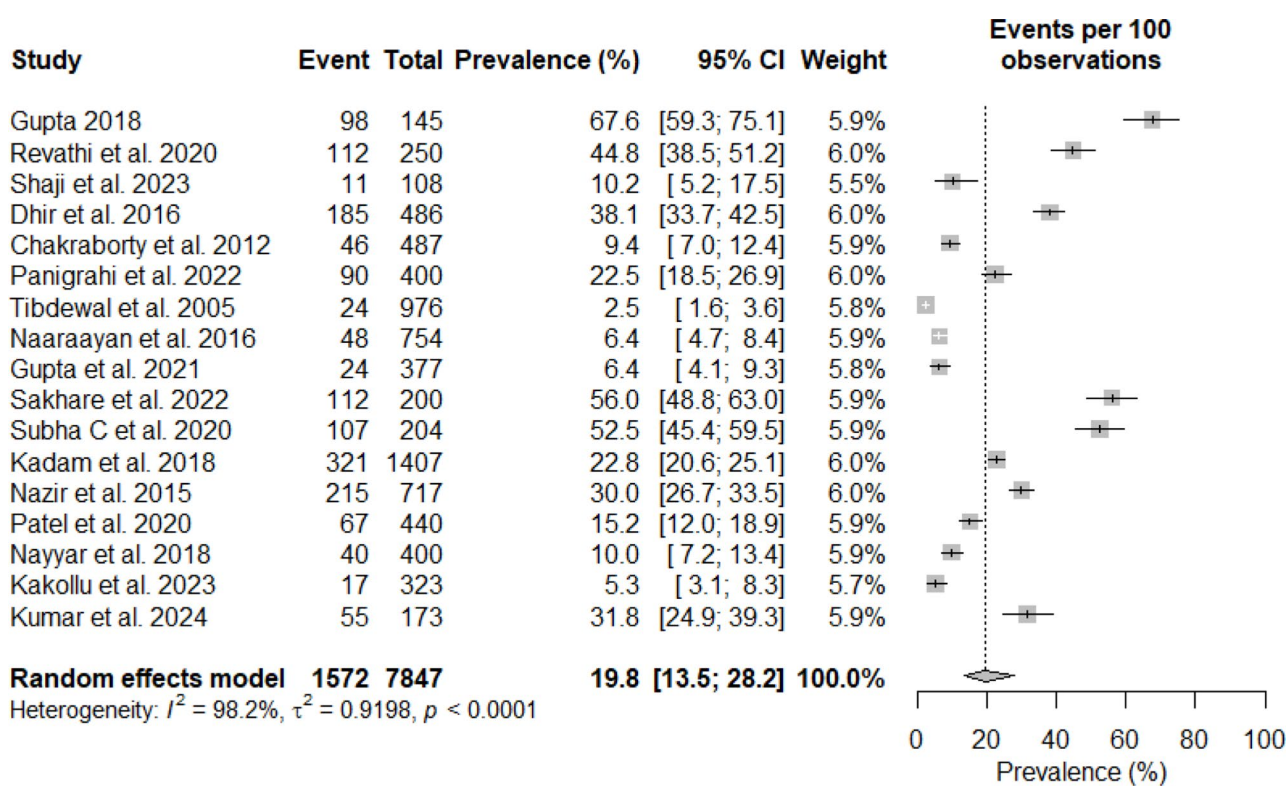


Fig. 2 Forest plot showing pooled prevalence of ASM in pediatric population in India

Reasons for self-medication

The reasons for self-medication practices identified were financial constraints (14/17; 82.4%), time constraints (9/17; 52.9%), previous experiences with medicines (6/17; 35.3%), limited accessibility to healthcare facilities (5/17; 29.4%), the perception of mild illness (4/17; 23.5%), lower educational levels (2/17; 11.8%), limited knowledge on the use of antibiotics (2/17; 11.8%) convenience

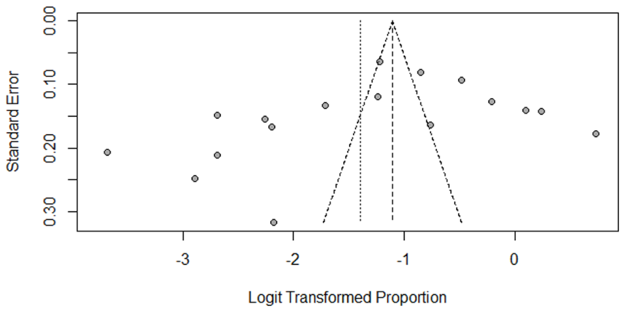


Fig. 3 Funnel plot for assessing publication bias

(2/17; 11.8%), the availability of medications at home (1/17; 5.9%), and the COVID-19 pandemic (1/17; 5.9%) (Table 2).

Source of information for self-medication

The sources of information for self-medication commonly included previous prescriptions (9/17; 52.9%), guidance from pharmacists (10/17; 58.8%), advice from family members, friends, and neighbors (6/17; 35.3%), past experiences regarding the effectiveness of certain

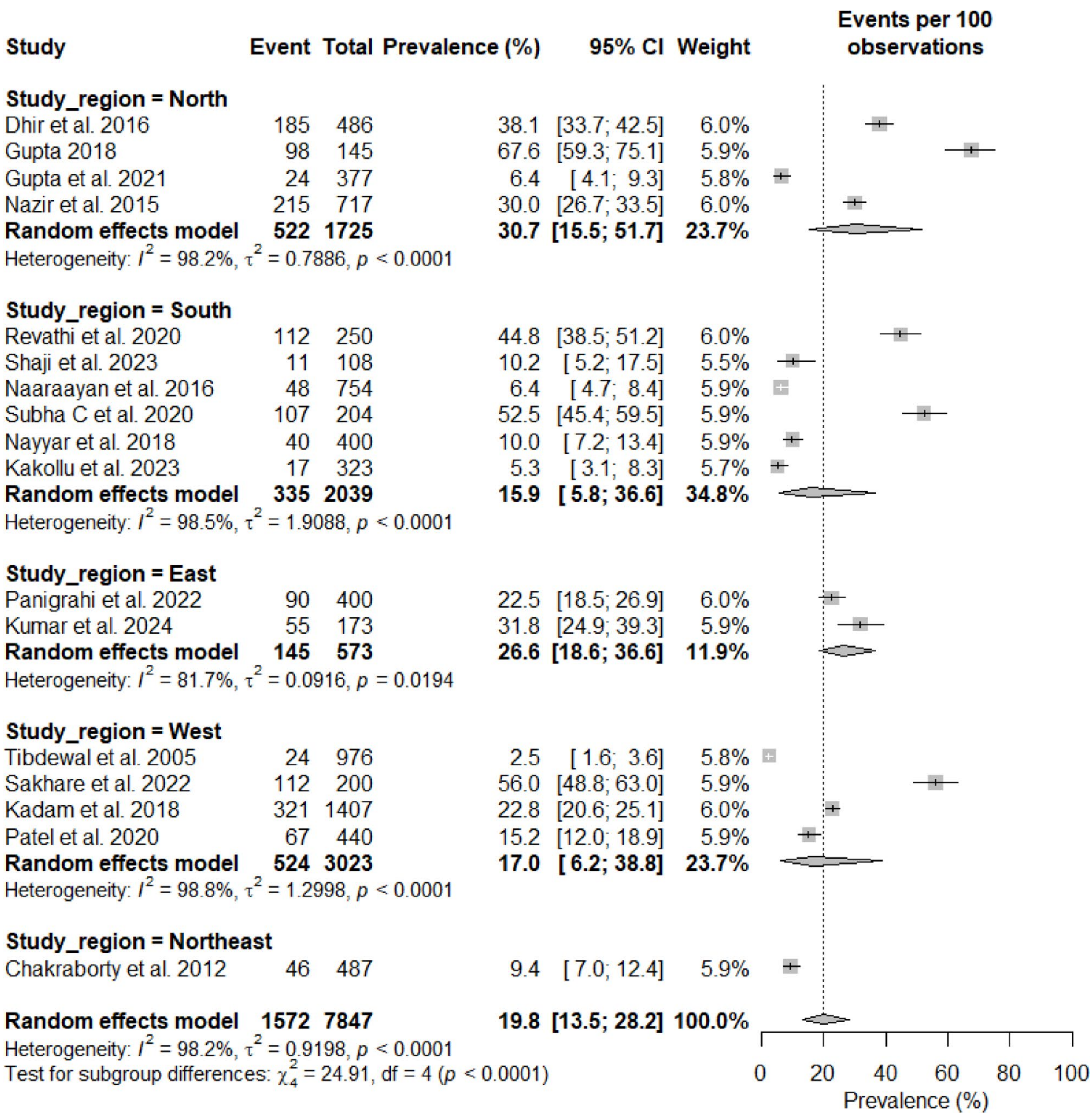


Fig. 4 Subgroup analysis based on study region

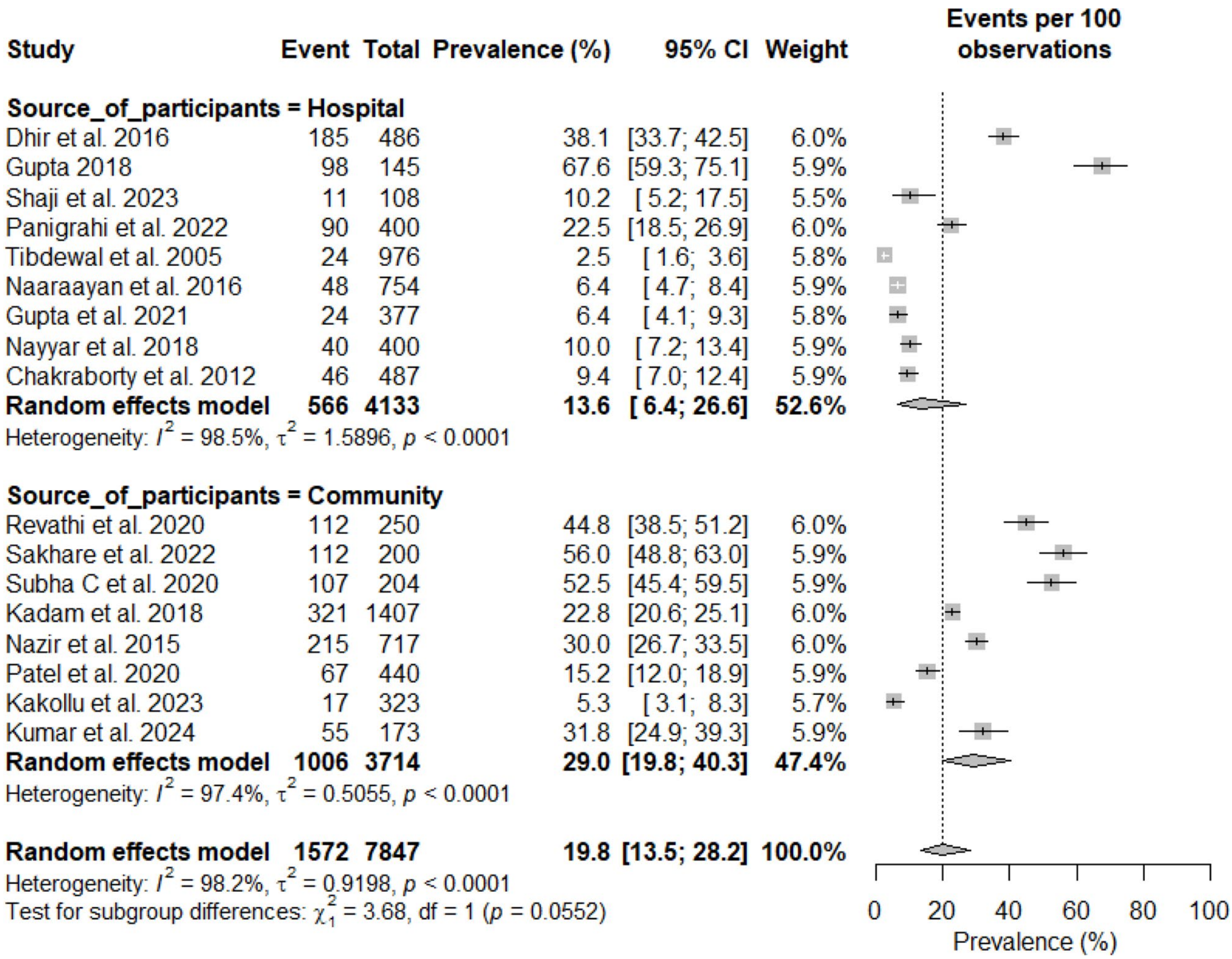


Fig. 5 Subgroup analysis based on source of participants

medications (4/17; 23.5%), and information from media (2/17; 11.8%) (Table 2).

Source of antibiotics for self-medication

The sources of obtaining antibiotics for self-medication were; local pharmacies or retail drug stores or e-pharmacies (11/17; 64.7%), leftover medications from prior treatments or prescriptions (7/17; 41.2%), supplies from family members, neighbors, and friends (5/17; 29.4%), quack practitioners (1/17; 5.9%), and from healthcare workers (1/17; 5.9%) (Table 2).

Antibiotics used for self-medication

Only one study provided data on antibiotics used for self-medication [7]. It identified a range of antibiotics commonly employed in self-medication practices, including amoxicillin, tetracycline, cephalexin, and doxycycline (Table 2).

Recall period and mean duration of ASM

The recall period for pediatric ASM spanned from 1 to 6 months, with a mean recall period of 3.12 months, indicating an emphasis on recent practices. Caregivers typically administered antibiotics for a mean duration of 2.5 days, highlighting the short-term nature of pediatric ASM in India (Table 2).

Discussion

Our study found a substantial prevalence of pediatric ASM in India, with a pooled rate of 19.8% (95% CI: 13.5; 28.2). This is comparable to rates reported in various regions globally, such as Africa (22%), Asia (20%), and South America (17%), but higher than in Europe (8%) [34]. Similar findings were observed in China (23.3%) [35] and Pakistan (21.8%) [36]. However, the prevalence in India falls below the rates observed in the Middle East (34%) [34] and specific countries like Jordan (39.2%) [37], Mongolia (42.3%) [38], Tanzania (47.7%) [39], and Yemen (60%) [40]. These differences may be due to variations in the study setting, sample population, recall period, and

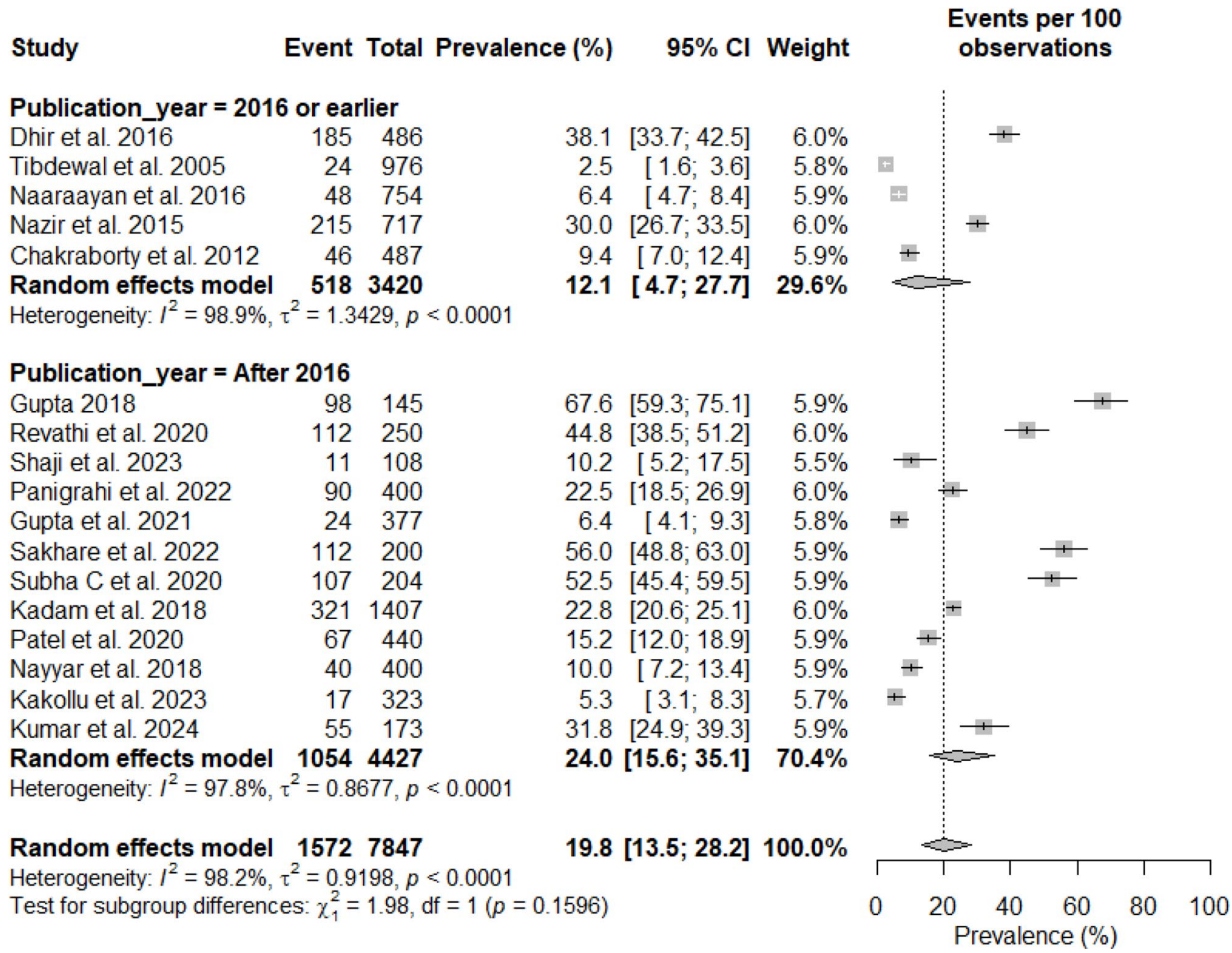


Fig. 6 Subgroup analysis based on year of publication

methodology used. Additionally, the enforcement of laws regulating antibiotic sales varies across countries, influencing access to antibiotics without prescriptions. Other contributing factors include differences in healthcare systems, social norms, cultural practices, and government policies [34, 41]. Despite regulations requiring prescriptions for antibiotics in most countries, self-medication remains widespread.

Interestingly, our results highlighted significant regional disparities in self-medication practices across India ($p < 0.01$), with the highest prevalence observed in the northern region (30.7%), followed by the eastern (26.6%), western (17.0%), southern (15.9%), and northeastern regions (9.4%). These variations may be attributed to varying healthcare infrastructure, socioeconomic conditions, and cultural factors [42, 43]. Furthermore, our study shed light on the influence of healthcare settings on pediatric ASM, showing a higher prevalence in community-based studies (29.0%) compared to hospital-based studies (13.6%), though this difference was not statistically significant ($p = 0.0552$). This trend is consistent with previous research, underscoring the accessibility of antibiotics in community settings, where medications are often readily available without strict prescription requirements [44], emphasizing the need for targeted interventions to mitigate pediatric ASM effectively. Additionally, we analyzed trends in pediatric ASM before and after 2016, following the introduction of the "red line" campaign in India, which aimed to regulate prescription antibiotic sales and reduce misuse [45]. Despite these efforts, our analysis indicates that self-medication rates remain high, with studies published post-2016 still reporting significant prevalence. This suggests that appropriate measures are needed to improve the effectiveness of existing policies and strengthen enforcement to reduce inappropriate antibiotic use.

The socioeconomic status of families in India plays an important role in ASM [6, 14, 19]. Low and middle-income families often resort to self-medication as a cost-saving measure. This cost-driven decision is significant

Table 2 Results of qualitative synthesis

Author	Mean duration of ASM (days) / Recall period (months)	Reasons for ASM	Source of antibiotic	Source of information	Antibiotics used for SM
Gupta, 2018	NM	Low level of education, limited knowledge on the use of antibiotics	Pharmacy, leftover from previous prescription	Previous prescription	NM
Revathi et al., 2020	NM	Financial constraint, limited knowledge on the use of antibiotics, time constraint, previous experience	Pharmacy, friends, leftover from previous prescription	Family members/friends	NM
Shaji et al., 2023	NM	COVID-19 pandemic, financial constraint	NM	Previous prescription, pharmacy, family members	NM
Dhir et al., 2016	NM	Minor illness, previous experience, time constraint, financial constraint	Leftover from previous prescription, pharmacy, quacks	Previous experience, media, pharmacist	NM
Chakraborty et al., 2012	NM / 6	Minor illness, convenience, financial constraint, inaccessibility to healthcare facility	Pharmacy, leftover from previous prescription	NM	NM
Panigrahi et al., 2022	2.7 / 1	Previous experience, minor illness, time constraint, financial constraint	Pharmacy, family members/friends	Previous prescription, pharmacy	NM
Tibdewal et al., 2005	NM / 1	Financial constraint, time constraint, unavailability of healthcare facilities nearby	Pharmacy	Pharmacy, previous prescription	NM
Naaraayan et al., 2016	2.5 / 1	Previous experience, minor illness, time constraint, financial constraint	Pharmacy, family members/neighbors	Previous prescription, pharmacy, family members	NM
Gupta et al., 2021	2.5 / 1	Previous experience, financial constraint	NM	Previous prescription, previous experience	NM
Sakhare et al., 2022	NM	NM	Leftover from previous prescription, pharmacy, e-pharmacy	NM	Amoxicillin, tetracycline, cephalexin, doxycycline
Subha C et al., 2020	NM	Financial constraint, low level of education	NM	Media	NM
Kadam et al., 2018	NM / 6	Convenience, time constraint, financial constraint	Pharmacy, leftover from previous prescription, e-pharmacy	Previous experience, previous prescription, pharmacist	NM
Nazir et al., 2015	NM / 6	Financial constraint, time constraint, unavailability of healthcare facilities nearby	NM	NM	NM
Patel et al., 2020	2.5 / 3	Previous experience, time constraint, financial constraint, availability of medicines at home	Pharmacy, friends/family members, health care workers	Previous prescription, friends/family members/neighbors, pharmacy	NM
Nayyar et al., 2018	NM	Financial constraint, time constraint, unavailability of healthcare facilities nearby	NM	Previous prescription, friends/family members, pharmacist	NM
Kakollu et al., 2023	NM	Financial constraint, unavailability of healthcare facilities nearby, time constraint	NM	Friends/family members, pharmacist, previous prescription	NM
Kumar et al., 2024	NM	NM	Pharmacy, leftover from previous prescription, friends/family members/neighbors	Pharmacist, medication package insert, previous experience	NM

ASM antibiotic self-medication; SM self-medication; NM not mentioned/not mentioned clearly

and is primarily due to the financial constraints faced by these families [6, 18, 26, 33]. On the contrary, higher-income households prefer to consult physicians and rely on health insurance, demonstrating the role of financial security in healthcare decision-making. The lack of time and urgency influence the decision of caregivers to engage in such practices [6, 15–17, 19, 26, 29, 31–33]. When caregivers perceive the child's illness as mild, they tend to opt for self-medication [14, 16, 17]. This reflects the balance between daily responsibilities and the need for immediate relief. The effectiveness of specific medicines based on previous experiences significantly influences caregivers' choices [16, 17, 19, 28, 33]. Positive past experiences with self-medication can reinforce the practice, while negative experiences might lead to more cautious approaches, such as consulting a doctor. The impact of caregivers' educational levels on ASM is critical. Lower education levels are often associated with an increased tendency toward self-medication along with limited knowledge regarding the proper use of antibiotics [6, 10, 18, 46]. This correlation suggests that education and health literacy play an important role in healthcare decision-making, as more educated caregivers may better understand the risks and benefits of self-medication [10, 18]. Limited accessibility to healthcare facilities, particularly in rural areas, and long distances from home are linked to a higher prevalence of pediatric self-medication. The lack of convenient access to medical care in certain regions further amplifies the reliance on self-medication [14, 19, 26, 29, 31]. The easy availability of antibiotics from local pharmacies or the presence of leftover antibiotics further contributes to the practice of self-medication [16, 17, 26, 32, 33]. This highlights the need for better regulation of antibiotic distribution to curb potential misuse and antimicrobial resistance. Advertisements in various media outlets play a significant role in promoting and normalizing the behavior of self-medication [15, 18]. The portrayal of over-the-counter medicines as quick and effective solutions in these advertisements can influence caregiver decision-making. These factors collectively contribute to the prevalence of self-medication practices with antibiotics among children. Understanding these dynamics is crucial for developing targeted interventions and policies aimed at promoting responsible and safe healthcare practices for pediatric patients in India.

Alarmingly, antibiotics are often inappropriately administered for viral infections, which can exacerbate health conditions [47]. This use of antibacterial drugs in treating viral infections was mostly reported in studies conducted in the Middle East and Asia [13, 48]. Parents often resort to self-medication for their children when they experience common symptoms like fever, cough, and sore throat [14–16]. It is important to note that these symptoms are often caused by viruses and do not typically require antibiotics. However, they remain among the most common reasons why parents choose to self-medicate their children with antibiotics. The consequences of inappropriate antibiotic use extend beyond ineffectiveness; it can also lead to adverse effects [7].

ASM is a concerning practice in India, as it often defies the regulations established under the Drugs and Cosmetics Act 1945. This Act stringently instructs that antibiotics and drugs classified under Schedule H must only be dispensed with a valid prescription from a qualified healthcare professional. Despite these strict regulations, multiple studies conducted in India consistently reported a high rate of self-medication with antibiotics across the country [6, 7, 10, 15, 18, 19]. This practice not only threatens individual health but also exacerbates the growing problem of antibiotic resistance [13].

Given the high prevalence of ASM among the pediatric population, it is essential for regulatory authorities to strictly enforce existing laws and proactively educate the public on the critical importance of adhering to these legal requirements to effectively mitigate antibiotic misuse and its associated consequences. The ease of accessing antibiotics without a prescription in India significantly contributes to the high prevalence of self-medication [43, 44]. This is similar to the experience in other low- and middle-income countries in the Middle East and Southeast Asia [41, 49]. In contrast, high-income countries typically prohibit non-prescription antibiotic sales, resulting in lower rates of self-medication.

Public health campaigns should educate caregivers about the risks of self-medication, including adverse effects, antibiotic resistance, and treatment failure. Special efforts should be made to reach rural areas, where limited healthcare access increases the likelihood of self-medication [19]. The evolving PharmD program in India can also help address this concern [50]. PharmD graduates, trained in clinical pharmacy, can act as a bridge between doctors, pharmacists, and the public. They can guide caregivers on proper antibiotic use and ensure that prescriptions are followed correctly. Additionally, they can also help monitor antibiotic use and support safe prescribing practices. Strengthening the role of PharmD professionals can contribute to minimizing ASM practices among children.

Limitations

This study has some limitations to consider. Firstly, it relied on self-recall data from primary studies, which may introduce recall bias and affect result accuracy. Furthermore, some studies might lack crucial information about various aspects of self-medication, limiting our comprehensive analysis. Moreover, the constraints imposed by our limited databases restricted the pool of available data for analysis. Some of the included studies had a 'moderate' risk of bias, which could influence the outcomes. Additionally, it is essential to take into account the presence of heterogeneity among the studies, when interpreting the findings.

Conclusion

The practice of self-medication with antibiotics was prevalent among the pediatric population, necessitating immediate public health interventions. Raising awareness among parents and caregivers about the risk of self-medication, especially when it comes to administering antibiotics to children, is essential. It is necessary to emphasize the potential risks and encourage consulting healthcare professionals before using any medication on children.

Further studies are required for a comprehensive global understanding of this problem and to inform the development of effective interventions and policies.

Supplementary Information

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Supplementary Material 1

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Author contributions
T.D.A.: Data curation, Methodology, Formal analysis, Writing– original draft. R.S.: Supervision, Writing– review & editing. V.C.: Data curation, Methodology, Formal analysis, Software, Writing– original draft. B.P.: Conceptualization, Supervision, Validation, Writing– review & editing. D.N.B.: Conceptualization, Supervision, Writing– review & editing.

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Data availability
The authors confirm that the data supporting the findings of this study are available within the manuscript or supplementary information file.

Declarations

Competing interests
The authors declare no competing interests.

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