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The global prevalence of antibiotic self-medication among the adult population: systematic review and meta-analysis

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Abstract

Background Antibiotic self-medication (ASM) is when a person takes antibiotics without a prescription or consulting a healthcare professional. These practices contribute to the misuse of medicines and antibiotic resistance which is a growing global health threat that can lead to longer hospital stays, higher healthcare costs, and increased mortality rates. Though various studies have been conducted on ASM in different countries, there has not yet been a systematic review that comprehensively assesses the problem in the entire globe. Hence, this systematic review and meta-analysis aimed to evaluate the global pooled prevalence of antibiotic self-medication and the reasons for its practice.

Method A systematic search of electronic registers and databases was conducted on PubMed, Medline, Embase, Scopus, Web of Science, Google Scholar, and gray literature including institutional repositories, and national health databases. It used carefully selected keywords and indexing terms in the past ten years. The Joanna Briggs Institute's critical checklist extracted relevant data after appraisal. Narrative analysis was used for descriptive data while Comprehensive Meta-Analysis (CMA) Software was used to analyze quantitative data. Statistics were used to look for heterogeneity, publication bias, and correlations. Sensitivity tests and sub-group analysis were employed to compare outcomes. A p-value < 0.05 was considered significant in all cases.

Results Seventy-one studies were included in this systematic review and meta-analysis. The total number of participants was 63,251 with sample sizes ranging from 110 to 15,526. In primary outcomes, ASM ranged from 0.65 to 92.2%. The pooled prevalence of ASM globally was 43.0% (95% CI: 38.0, 48.1%). A high degree of heterogeneity across studies was shown with $I^2 = 99.2\%$, $p < 0.001$ assuming a random effect model. In subgroup analysis, the highest ASM pooled prevalence was 55.2% (95% CI: 47.2, 63.2) in sub-Saharan Africa followed by the Middle East, North Africa, and Greater Arabia at 48.3% (95% CI: 38.3, 58.4), Europe at 34.7% (95% CI:18.0, 56.4), and Asia at 25.8% (95% CI: 18.6, 34.6). Students have been identified as the major users of ASM at 62.1% (95% CI: 53.7, 69.7). The meta-regression showed a coefficient of 0.0365, -0.0117, and -0.0001 for a year of publication, recall time, and total sample size, respectively. Publication bias was demonstrated from the asymmetrical distribution of the funnel plot, and the Eggers regression p-value was greater than 0.05 (0.264). Moreover, knowledge of antibiotics (46.19% (95% CI: 27.99, 65.46)), previous successful experiences (39.13% (95% CI: 30.13, 48.93)), and perceiving illness as minor (38.10% (95% CI: 27.19, 50.37)) were the top three reasons pooled proportion for practicing ASM.

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Conclusion ASM practice was higher among African and student users. The previous successful experience was the most frequent reason reported. Educational level, gender, and age were often mentioned as predictor factors. Hence, designing interventional approaches that consider the different burdens among the target population and tackle the reasons for the practices might benefit averting antimicrobial resistance.

Keywords Antibiotics, Self-medication, Pooled prevalence, Global, Systematic review, Meta-analysis

Introduction

Antibiotic self-medication is when a person takes antibiotics without a prescription or consulting a healthcare professional. This means that the person has not been properly diagnosed with a bacterial infection, and instead, they are self-diagnosing and self-treating with antibiotics [1]. Patients frequently follow improper dosing regimens, discontinue antibiotics before the specified time, and exchange drugs with friends and family without professional guidance [2, 3]. These consumer practices contribute to the misuse of medicines, including antibiotics.

There may be several reasons why people engage in antibiotic self-medication. Some people may self-medicate because they believe that antibiotics are a cure-all for any infection, while others may not have access to healthcare or may not be able to afford a doctor's visit. Additionally, they do not want to take time off work or school to see a doctor [4]. However, regardless of the reasons, antibiotic self-medication is dangerous and can lead to the development of antibiotic resistance [5]. Antibiotic resistance is a growing global health threat that can lead to longer hospital stays, higher healthcare costs, and increased mortality rates. In addition, taking antibiotics unnecessarily can lead to side effects and can also mask the symptoms of a more serious underlying condition, such as cancer or tuberculosis. By not seeking proper medical attention, the person may delay the diagnosis and treatment of their condition, which can have serious consequences [5, 6].

World Health Organization (WHO) has labeled AMR as one of the top 10 global public health threats [7]. Estimated AMR deaths worldwide grew to over 5 million in 2019 [8]. According to research prediction, by 2050, AMR might inflict a 1% annual decrease in gross domestic product (GDP). This would result in losses of between 100 and 200 trillion euros worldwide [9]. Furthermore, it has been stated that drug-resistant infections account for 700,000 fatalities per year; if nothing is done to address this issue immediately, it is anticipated that this figure will rise to 10 million deaths per year by 2050 [10]. In general, the magnitude and consequences of antimicrobial resistance development vary across regions due to different reasons. Low- and middle-income countries (LMICs) are disproportionately affected partly due to the double burden of communicable and non-communicable diseases, lack of water, sanitation, and hygiene, and limited health care systems. The dynamics that drive AMR in these regions are inseparable from the political, economic, socio-cultural, and environmental forces that shape these nations [11]. Many of them already have high levels of resistance, which are expected to rise excessively in the future. For example, resistant microbes cause 40–60% of morbidity and mortality in Brazil, Indonesia, and Russia. Resistance is expected to grow 4–7 times faster in these nations than in other European countries [12].

Moreover, major new medication developments have occurred in Western pharmaceutical companies [13]. Pharmaceutical corporations are for-profit businesses that absorb the costs of failing drug concepts through regressive research and development procedures while generating high financial profits from approved pharmaceuticals. As a result, pharmaceutical corporations have focused their inventions on ailments common in high-income countries, where there may be a substantial market for new drugs. However, this market-driven policy has resulted in a "fatal imbalance" against diseases that are critical to poor countries [14]. It is also well-acknowledged that the rate at which new medications are developed outstrips the rate at which resistance develops. Furthermore, the majority of recently approved medications have very minor therapeutic benefits over current treatments [15]. Hence, appropriate use of existing antibiotics leaves no option to tackle AMR, especially focusing on self-medication practices and driving factors. Accordingly, the authors found a gap in a systematic review and meta-analysis that provides a comprehensive global ASM practice, even though various studies have been conducted in multiple countries [4, 16–18]. Hence, this systematic review and meta-analysis aimed to determine the global pooled prevalence of antibiotic self-medication and the reasons for the practice in the past decade to generate evidence-based recommendations to contain and reduce ASM.

Methods

Study protocol

The Preferred Reporting Items for Systematic Review and Meta-analysis (PRISMA) flow diagram was used to check for the inclusion of data, titles, and abstracts. Furthermore, whole texts were examined. In addition, this systematic review strictly followed the PRISMA checklist [19] (Supplementary T1). The study protocol was registered on the International Prospective Register of Systematic Reviews (PROSPERO) with registration number CRD 42024542406 at https://www.crd.york.ac.uk/PROSPERO.

Data sources and search strategy

A thorough search was conducted on many electronic registers and databases, including PubMed, Medline, Embase, Scopus, Web of Science, Google Scholar, and gray literature including institutional repositories, and national health databases employed to locate and incorporate potential material. Sophisticated search algorithms were used to extract relevant information closely related to the practice of self-medication with antibiotics. To ensure that no similar reviews had already been registered or completed, a preliminary scoping search was conducted on the following registries: PubMed, Google Scholar, International Prospective Register of Systematic Reviews (PROSPERO), International Platform of Registered Systematic Review and Meta-Analysis (INPLASY).

The search utilized carefully selected keywords and indexing terms within a specified period of ten years. It involved a combination of terms such as "anti-bacterial agents" [MeSH Terms], "antibiotic," "self-medication" [MeSH Terms], and "prevalence" [MeSH Terms], using appropriate Boolean operators (AND, OR) and truncation. The search was conducted from 23 April to 5 May 2024, and all published and unpublished articles available online until the day of data collection were considered. The search terms were refined based on preliminary searches and expert input to ensure that all possible relevant studies were captured.

Screening and eligibility of studies

A set of inclusion and exclusion criteria had already been created for the identified records. Original research published in the last 10 years on the prevalence of antibiotic self-medication among adults (18 years and older) globally was considered. Publications lacking original data (e.g., reviews, correspondence, guidelines, letters, and editorials), abstracts with irrelevant data, publications written in languages other than English, original articles reporting incomplete or irrelevant data, case reports, case series, qualitative studies, and consideration of specific diseased populations were excluded.

Inclusion and exclusion criteria of participants

Articles on the prevalence of antibiotic self-medication with a cross-sectional study design among adults were included. However, articles on antibiotic self-medication in specific diseased groups (e.g., COVID-19) were excluded. Considerations of specific disease status were found to be a major cause of variability in the magnitude and type of medications used in ASM practice. Besides, in the case of public health emergencies, the way of management deviates from the standard recommendations as proven and efficacious interventions are yet to be established depending on clinical trials in consideration of benefit-risk. Finally, comparing the contents of the tools/questions varies significantly in these studies.

Data extraction (selection and registration)

After conducting a thorough search of electronic databases and registrations, the studies discovered were linked in the appropriate formats to the Endnote reference software version 20.1.1 (Thomson Reuters, Stamford, CT, USA). Duplicate records were removed, and any remaining duplicates due to differences in citation styles between databases and indexing interfaces were manually repaired. Three investigators (TG, FW, and AJ) reviewed potential papers individually, utilizing titles and abstracts to determine inclusion criteria. Two investigators (LD and YAT) acquired the entire texts of the retained papers and evaluated them for eligibility and quality; a third author (NA) resolved any differences between the writers. The data abstraction was done using a prepared Microsoft Excel sheet to extract relevant data for the study, including the first author's name, year of publication, study setting/country, study design, determinant factors, target population, and recall time.

Risk of bias (quality) assessment

Two independent investigators (TG and FW) utilized the Joanna Briggs Institute's (JBI) critical appraisal checklist to evaluate the methodological quality of each paper (Supplementary Table 2). The methodological aspects of the studies were graded according to the total number of affirmative responses marked as "yes" to the evaluation questions. Articles with average positive scores of 50% or above were considered for the systematic review. The risk-of-bias assessment was conducted using the JBI appraisal tool for prevalence studies [20].

Outcome measurements

The prevalence of antibiotic self-medication worldwide is the primary outcome measure in this systematic review and meta-analysis. Two secondary end measures were also examined: the pooled prevalence of reasons for antibiotic self-medication and a description of the global determinants influencing antibiotic self-medication. To reduce bias in establishing the overall prevalence, the sample size was adjusted based on response rates and numerous individual studies.

In terms of secondary outcomes, the denominator was changed to include patients who self-medicated with antibiotics to extract reasons for self-medication explanations. For the overall estimates, comparable responses from each study were combined.

Data processing and statistical analysis

For statistical analysis and data processing, the random effect model was utilized in Comprehensive Meta-Analysis (CMA) Software (version 3), whereas narrative analysis was employed for qualitative data. Eggers tests and funnel plots were used to detect publication bias, while statistics were used to assess heterogeneity. Subgroup and sensitivity analyses were conducted to see how each study influenced the relevant outcomes. In addition, meta-regression was carried out using sample size, recall time, and a year of publication as moderators. In all cases, a *p*-value less than 0.05 was considered significant.

Results

Search results

The databases were searched from 23 April to 5 May 2024. A total of 3231 articles were identified: through Google Scholar (1190), PubMed (864), Embase (556), Web of Science (219), Scopus (302), Medline (20), PsychINFO (44), and other sources (gray literature) (36). The 2136 duplicate articles were discarded. The titles and abstracts of the remaining 1095 studies were screened and 880 records were excluded as they did not meet the inclusion criteria. References in the selected 198 studies were searched and another 17 studies were retrieved for full text, rendering 215 studies for full-text review. After reviewing the full text of the selected studies, 141 studies were excluded due to the outcome of interest missing, insufficient, and/or ambiguous. The remaining 74 studies underwent appraisal and 71 were included in qualitative and quantitative synthesis (Fig. 1).

Study characteristics

Seventy-one studies were included in the systematic review and meta-analysis of which 29 were from sub-Saharan Africa, the Middle East, North Africa, and Greater Arabia (19), Asia (14), Europe (6), Central America and the Caribbean (1), South America (1), and Australia and Oceania (1) regions. All the included studies employed a common prospective cross-sectional study design. The year of publication of included studies ranges from 2014 to 2024 indicating the maximum number in 2019 (Fig. 2). The study included a wide range of population characteristics: general population, students, health care providers, and patients/attendants at health care facilities. Twenty-seven studies were carried out in households, 20 in academic settings (universities), 15 in healthcare facilities, 4 in other settings (mass gatherings, markets, streets), and 3 by online platforms. All studies together included 63,251 participants with sample sizes ranging from 110 to 15,526. The recall period used in data collection ranged from 2 weeks to over 12 months of experience (Table 1).

Quality assessment of included studies

Quality assessments of included eligible for review (74 studies) were assessed for risk of bias using the JBI appraisal tool. 58 of these studies showed a low risk of bias meeting 70% or above criteria. 13 studies showed a moderate risk of bias (50–69%) and 3 studies showed a high risk of bias (< 50%). They were excluded from qualitative synthesis (71 studies included) (Supplementary Table 3).

Study outcome measures

Primary outcomes

Prevalence of antibiotic self-medication (ASM) The prevalence of ASM ranged from 0.65% (South America, Brazil) to 92.2% (Nigeria, sub-Saharan Africa). From the 71 studies describing antibiotic self-medication practice, the pooled prevalence globally was found to be 43.0% (95% [CI]: 38.0, 48.1%). As the I2 statistic revealed, there is a high degree of heterogeneity across studies (I2 = 99.2%, p < 0.001). A random effects model was assumed for this meta-analysis (Supplementary Fig. 1).

Subgroup analysis A subgroup analysis was conducted based on geographical distribution and population characteristics. The highest pooled prevalence was observed in sub-Saharan Africa at 55.2% (95% CI: 47.2, 63.2) (Fig. 3) followed by the Middle East, North Africa, and Greater Arabia at 48.3% (38.3, 58.4) (Fig. 4), Europe at 34. 7 (18.0, 56.4) (Fig. 5). Relatively, a lower pooled estimate was observed in Asia at 25.8 (18.6, 34.6) (Fig. 6) as depicted in the forest plot. From population characteristics subgroup analysis, students had been the major users of antibiotic self-medication at 62.1% (95% CI: 53.7, 69.7) (Fig. 7) followed by the general public at 32.6% (95% CI: 27.1, 38.7) (Fig. 8). Publication year-based analysis indicated that there was an increasing practice from the last 5 years (2014–2018) 41.5% (95% CI: 34.0, 49.4) to 44.3% (95% CI: 37.1, 51.7) in late years (2019–2024) (Table 2).

Sensitivity test There was no significant change in the degree of heterogeneity even if we attempted to exclude the expected outliers as well as one or more of the studies from the analysis. Performing one leave-out study showed a pooled prevalence of ASM ranging from 42% (95% CI: 37.1–47.2) to 44.6% (95% CI: 39.6–49.7). Therefore, we were subjected to include all the studies for the meta-analysis.

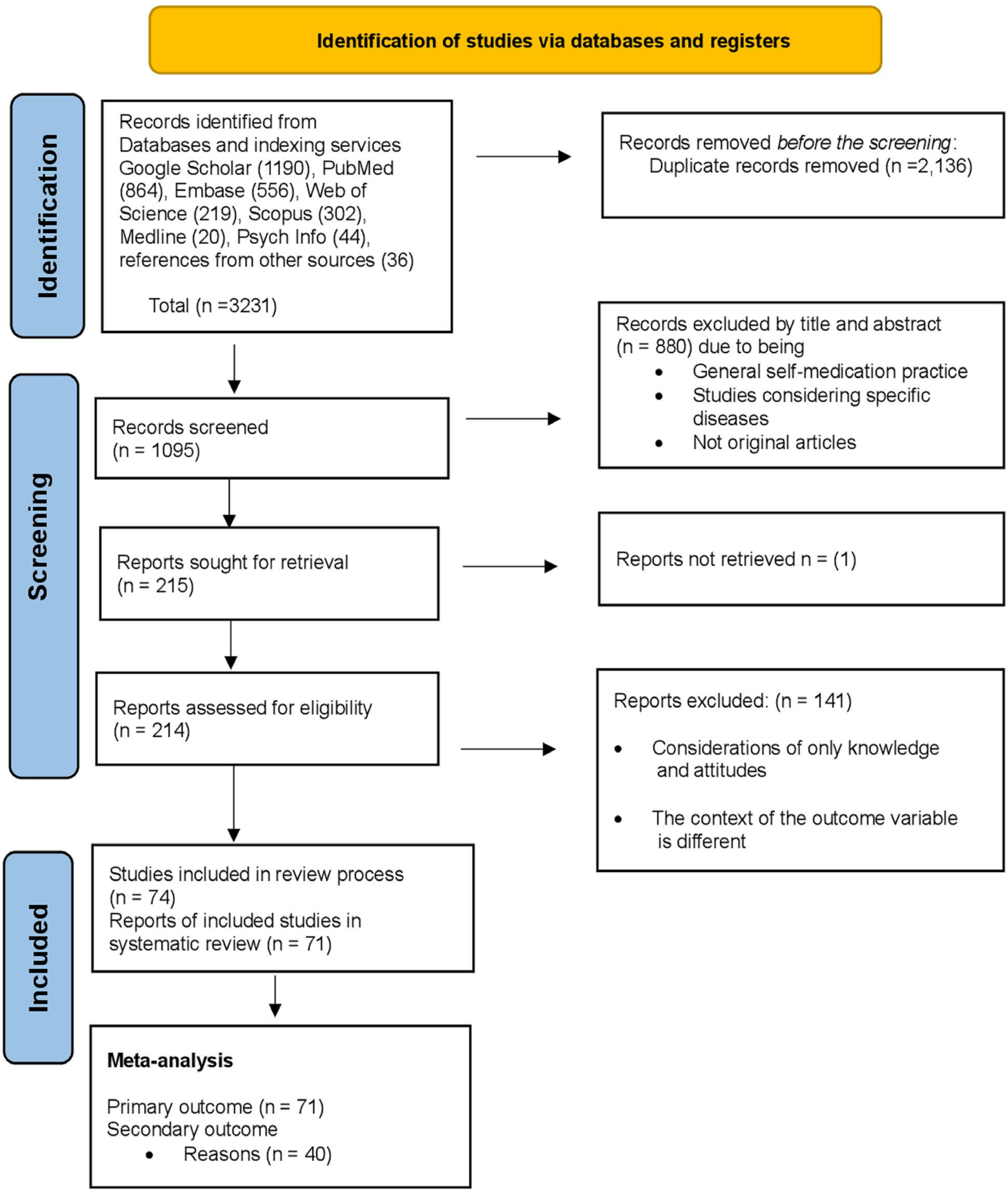

Fig. 1 PRISMA flow chart depicting the selection process of studies

Publication bias Publication bias was checked visually by funnel plot (Fig. 9) and statically using Egger's regression. An asymmetrical distribution was portrayed on the funnel plot. In the Eggers regression, the intercept (2.72) was different from the origin with the p-value = 0.264 which is greater than 0.05 indicating the absence of publication bias statistically.

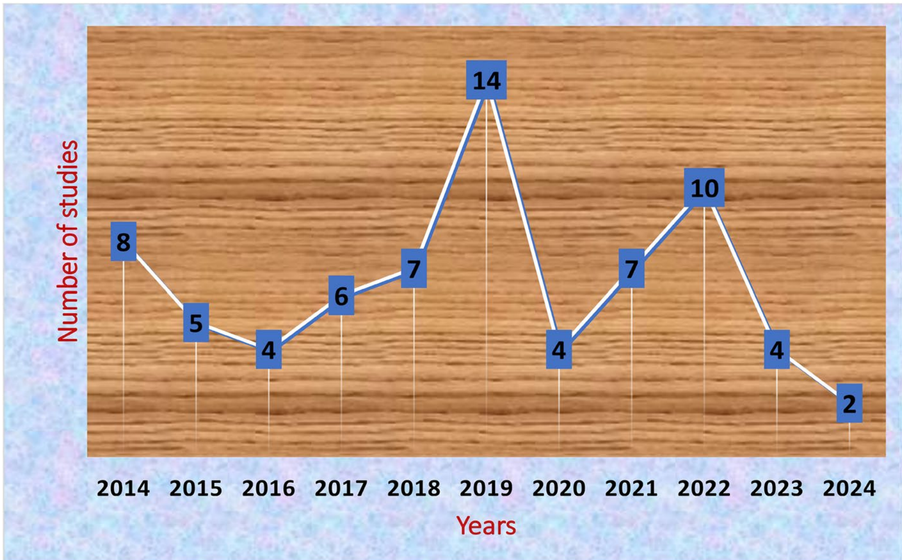

Fig. 2 Study distribution by the year

Meta-regression The result showed a unit change in the year of publication, which resulted in a 0.0365 proportional change in the magnitude of ASM. However, the coefficient for recall time was − 0.0117, and the total sample size was − 0.0001 which dictated a proportional decrease in the magnitude of ASM with the mentioned coefficients. A simultaneous test showed a p-value of 0.6194 greater than 0.05 inferring at least one of the covariates was affecting effect size and antibiotic self-medication.

Secondary outcomes

Reasons for self-medication practice Thirty studies were included in analyzing the pooled proportions of reasons for practicing ASM. The main reason was perceived knowledge about antibiotics 46.19% (95% CI: 27.99, 65.46) followed by previous experience 39.13% (95% CI: 30.13, 48.93) and minor illness 38.10% (95% CI: 27.19, 50.37) (Table 3).

Factors associated with SMA Twenty-two studies reported results of multivariable logistic regression analysis to determine factors associated with SMA. This systematic review frequently reported some determinants of ASM. These include age, gender, educational level, and income (Supplementary Table 4).

Discussion

Main findings and interpretations

In this systematic review and meta-analysis, the global pooled prevalence of antibiotic self-medication was determined to be 43.0%. The studies' heterogeneity has been high ($I^2 > 99\%$), accounting for variability between studies and sampling error. To describe or manage this inconsistency; a subgroup analysis, outlier detection followed by sensitivity analysis, and meta-regression were applied to explore and reduce heterogeneity. The random effects model was also employed to report the pooled effect sizes [92]. A subgroup analysis based on geographical distribution showed a prevalence of 55.2% ($I^2 = 98.8$) in Africa followed by the Middle East, North Africa, and Greater Arabia at 48.3% ($I^2 = 99.1$), Asia at 25.8% ($I^2 = 99.3$), and Europe at 34.7% ($I^2 = 99.2$). Among populations, students had been the major users of ASM at 62.1% ($I^2 = 98.4$) followed by the general public at 32.6% ($I^2 = 99.8$). Publication year analysis indicated an increasing practice from the last 5 years (2014–2018) 41.5% ($I^2 = 99.1$) to 44.3% ($I^2 = 99.1$) in late years (2019–2024). Performing one study leave-out sensitivity test showed a prevalence ranging from 42 to 44.6% ($I^2 = 99.2$). Moreover, methodological variations in data collection procedures such as self-reporting and no cross-checking mechanisms might predispose to social-desirability bias. Hence, heterogeneity is expected in prevalence estimates due to a genuine difference across place, populations, and time where studies are conducted [93].

As depicted in the funnel plot, the asymmetrical distribution of publication dictates the presence of bias. However, in Egger's regression test, the *p*-value was greater

Table 1 Data extracted showing characteristics of studies included for systematic review and meta-analysis

S. N	Region	References (year)	Country	Study design	Study site	Study participant	Sample size	Event	PASM%
	South America	Pereira et al., 2018 [21]	Brazil	CS	Household	Public	4001	26	0.65
	Asia	Rathish and Wickramasinghe, 2020 [22]	Sri Lanka	CS	Household	Public	384	10	2.60
	Asia	Rajendran et al., 2019 [23]	India	CS	Household	Public	755	25	3.31
	Europe	Barkus and Lisauskienė, 2016 [24]	Vilnius	CS	University	Student	249	10	4.00
	Asia	Yin et al., 2021 [25]	China	CS	Household	Public	3206	331	10.32
	Asia	Zawahir et al., 2021 [26]	Sri Lanka	CS	Household	Public	998	108	11
	SSA	Tuyishimire et al., 2019 [27]	Rwanda	CS	University	Students	570	69	12.10
	Asia	Aslam et al., 2021 [28]	Malaysia	CS	Household	Public	480	72	15.10
	SSA	Bulabula et al., 2020 [29]	South Africa	CS	HCF	Pregnant	301	50	17
	Europe	Ramalhinho et al., 2014 [30]	Portugues	CS	Public Place	Public	1198	218	18.9
	Australia and Oceania	Hu and Wang, 2016 [31]	Australia	CS	Household	Public	426	86	20.20
	SSA	Nabaweesi et al., 2021 [32]	Uganda	CS	HCF	Attendant	212	47	22.2
	SSA	Kassa et al., 2022 [33]	Ethiopia	CS	HCF	HP	317	72	22.7
	ME, NA, and GA	Jamhour et al., 2017 [34]	Lebanon	CS	Household	Public	400	95	23.7
	ME, NA, and GA	Nazir and Azim, 2017 [35]	Pakistan	CS	HCF	Public	527	35	26
	Asia	Biswas et al., 2014 [36]	Bangladesh	CS	Household	Public	1300	347	26.69
	ME, NA, and GA	Awad and Aboud, 2015 [37]	Kuwait	CS	Household	Public	680	187	27.50
	Asia	Mannan et al.,2024 [38]	Bangladesh	CS	Household	Public	1336	382	28.6
	SSA	Jimah et al., 2020 [39]	Ghana	CS	Household	Public	400	125	30
	Europe	Bianco et al., 2020 [40]	Italy	CS	HCF	Attendant	568	174	30.6
	Europe	Pavydė et al., 2015 [41]	Lithuania	CS	Household	Public	1005	313	31.1
	ME, NA, and GA	Aslam et al., 2022 [42]	Pakistan	CS	Household	Public	480	156	32.50
	ME, NA, and GA	Alghadeer et al., 2018 [43]	Saudi Arabia	CS	Online	Public	1264	430	34
	ME, NA, and GA	Gaygısız et al., 2021 [44]	Turkey	CS	Online	Public	945	323	34.2
	Asia	Yin et al., 2022 [45]	China	CS	Online	Public	15,526	5,760	37.10
	ME, NA, and GA	Jairoun et al., 2019 [46]	Arab Emirates	CS	University	Student	1200	458	38.20
	SSA	Demissie et al., 2022 [47]	Ethiopia	CS	Household	Public	826	321	38.90
	Asia	Haque et al., 2019 [48]	Malaysian	CS	Household	Public	649	239	39.30
	Asia	Lv et al., 2014 [49]	China	CS	University	Student	294	118	40.20
	ME, NA, and GA	Al-Qahtani et al., 2018 [50]	Saudi Arabia	CS	Household	Public	519	198	40.80
	ME, NA, and GA	Al-Tarawneh et al., 2024 [51]	Jordan	CS	Household	Public	984	413	42
	SSA	Bogale et al., 2019 [52]	Ethiopia	CS	Household	Public	595	254	42.6
	ME, NA, and GA	Horvat et al., 2022 [53]	Seria	CS	University	Student	400	171	42.80

Table 1 (continued)

S. N	Region	References (year)	Country	Study design	Study site	Study participant	Sample size	Event	PASM%
	SSA	Ateshim et al., 2019 [54]	Eretria	CS	Household	Public	580	262	45.10
	CA and Caribbean	Moise et al., 2017 [55]	Haiti	CS	HCF	Attendant	200	91	45.50
	ME, NA, and GA	Al-Taie et al., 2021 [56]	Iraq	CS	Household	Public	384	176	45.80
	ME, NA, and GA	Shah et al., 2014 [57]	Karachi	CS	University	Student	431	205	47.60
	Asia	Zhu et al., 2016 [58]	China	CS	University	Students	660	316	47.9
	SSA	Tadesse et al., 2023 [59]	Ethiopia	CS	HCF	Public	403	195	48.30
	Asia	Mandal et al., 2020 [60]	Nepal	CS	University	Student	558	285	51.10
	SSA	Simegn and Moges, 2022 [61]	Ethiopia	CS	Household	Public	407	225	55.30
	SSA	Chuwa et al., 2021 [62]	Tanzania	CS	University	Student	374	213	57
	SSA	Horumpende et al., 2018 [63]	Tanzania	CS	Household	Public	300	174	58
	ME, NA, and GA	Gillani et al., 2017 [64]	Pakistan	CS	University	Students	727	326	58.30
	ME, NA, and GA	Benameur et al., 2019 [65]	KSA	CS	University	Student	300	175	58.40
	ME, NA, and GA	Naseef et al., 2022 [66]	Palestine	CS	HCF	Public	423	256	60.50
	SSA	Elmahi et al., 2022 [67]	Sudan	CS	University	Student	1110	675	60.80
	Asia	Wahab et al., 2023 [68]	Bangladesh	CS	University	Students	1000	610	61.00
	Asia	Nabi et al., 2022 [69]	India	CS	University	Student	360	244	68
	SSA	Hussain et al., 2023 [70]	Sudan	CS	Household	Public	1492	1064	71.30
	Europe	Belkina et al., 2017 [71]	Russia	CS	HCF	HP	316	230	72.08
	ME, NA, and GA	Roien et al., 2022 [72]	Afghanistan	CS	HCF	Public	385	282	73.20
	SSA	Mudenda et al., 2023 [73]	Zambia	CS	University	Student	433	332	76.7
	Europe	Jorgji et al., 2014 [74]	Albania	CS	HCF	Public	343	273	78.14
	ME, NA, and GA	Al Rasheed et al., 2016 [75]	KSA	CS	HCF	Attendant	681	627	78.7
	ME, NA, and GA	Bilal et al., 2016 [76]	Sindh	CS	HCF	attendant	400	325	81.25
	SSA	Badger-Emeka et al., 2018 [77]	Nigeria	CS	University	student	400	344	86
	ME, NA, and GA	Yezli et al., 2019 [78]	Saudi Arabia	CS	Gathering	public	1401	1,219	87
	SSA	Nakato et al., 2023 [79]	Uganda	CS	University	student	326	300	92
	SSA	Ahmed et al.,2014 [80]	Sudan	CS	Households	general public	442	181	41
	SSA	Amin et al.,2019 [81]	Cameroon	CS	HCF	patients	329	225	68.4
	SSA	Bundukiet al., 2017 [82]	DR Congo	CS	University	students	500	454	90.7
	SSA	Umar et al.,2018 [83]	Nigeria	CS	University	students	115	94	81.9
	SSA	Ajibola et al.,2018 [84]	Nigeria	CS	Hall of residence	public &students	1450	624	43
	SSA	Khalid et al.,2019 [85]	Nigeria	CS	University	students	217	200	92.2
	SSA	Bassoumet al., 2019 [86]	Senegal	CS	Bus station	public	400	300	75

Table 1 (continued)

S. N	Region	References (year)		Country	Study design	Study site	Study participant	Sample size	Event	PASM%
	SSA	Eticha et al.,2014	[87]	Ethiopia	CS	University	students	422	188	44.5
	SSA	Nyambegaet al., 2017	[88]	Kenya	CS	Market area and households	public	385	231	60
	SSA	Sambakunsi et al., 2019	[89]	Malawi	CS	Households	public	110	45	41
	SSA	Ocan et al., 2014	[90]	Uganda	CS	Households	public	892	675	75.7
	SSA	Pereko et al., 2015	[91]	Namibia	CS	Pharmacies	public	600	93	15.47

HCF Health Care Facility, *HP* Health Professional, *SSA* sub-Saharan Africa, *ME, NA, and GA*, Middle East, North Africa, and Greater Arabia, *CA and Caribbean* Central America and the Caribbean

Sub-Saharan Africa regions sub-group analysis

Study name	Subgroup within study	Event rate	Lower limit	Upper limit	Z-Value	p-Value
Tuyishimire et al., 2019	SSA	0.121	0.097	0.150	-15.439	0.000
Pereko et al., 2015	SSA	0.155	0.128	0.186	-15.034	0.000
Bulabula et al., 2020	SSA	0.166	0.128	0.213	-10.418	0.000
Nabaweesi et al., 2021	SSA	0.222	0.171	0.283	-7.595	0.000
Kassa et al., 2022	SSA	0.227	0.184	0.277	-9.135	0.000
Jimah et al., 202	SSA	0.313	0.269	0.360	-7.309	0.000
Demissie et al., 2022	SSA	0.389	0.356	0.422	-6.348	0.000
Sambakunsi et al., 2019	SSA	0.409	0.321	0.503	-1.896	0.058
Ahmed et al.,2014	SSA	0.410	0.365	0.456	-3.784	0.000
Bogale et al., 2019	SSA	0.427	0.388	0.467	-3.554	0.000
Ajibola et al.,2018	SSA	0.430	0.405	0.456	-5.287	0.000
Eticha et al.,2014	SSA	0.445	0.399	0.493	-2.235	0.025
Ateshim et al., 2019	SSA	0.452	0.412	0.492	-2.322	0.020
Tadesse et al., 2023	SSA	0.484	0.435	0.533	-0.647	0.517
Simegn and Moges, 2022	SSA	0.553	0.504	0.600	2.127	0.033
Chuwa et al., 2021	SSA	0.570	0.519	0.619	2.680	0.007
Horumpende et al., 2018	SSA	0.580	0.523	0.635	2.759	0.006
Nyambegaet al., 2017	SSA	0.600	0.550	0.648	3.898	0.000
Elmahi et al., 2022	SSA	0.608	0.579	0.636	7.146	0.000
Amin et al.,2019	SSA	0.684	0.632	0.732	6.508	0.000
Hussain et al., 2023	SSA	0.713	0.690	0.736	15.910	0.000
Bassoumet al., 2019	SSA	0.750	0.705	0.790	9.514	0.000
Ocan et al., 2014	SSA	0.757	0.727	0.784	14.542	0.000
Mudenda et al., 2023	SSA	0.767	0.725	0.804	10.472	0.000
Umar et al.,2018	SSA	0.817	0.736	0.878	6.210	0.000
Badger-Emeka et al., 2018	SSA	0.860	0.822	0.891	12.598	0.000
Bundukiet al., 2017	SSA	0.908	0.879	0.930	14.796	0.000
Nakato et al., 2023	SSA	0.920	0.885	0.945	11.963	0.000
Khalid et al.,2019	SSA	0.922	0.878	0.951	9.758	0.000
		0.554	0.472	0.632	1.286	0.199

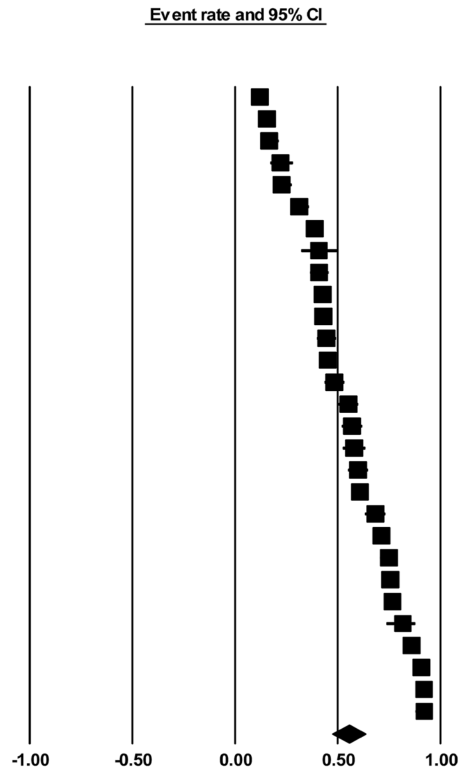

Fig. 3 Forest plot displaying subgroup analysis of ASM pooled prevalence from studies conducted in the sub-Saharan African regions

than 0.05 indicating the statistical insignificance of the bias. However, there might be a potential for bias introduction in each step of the review process [94]. Running meta-regression, a positive correlation was determined with a year of publication, implying that recently published articles reported an increasing magnitude of ASM. In addition, the retrospective prolonged recall period was shown to decrease in the extent of ASM which infers forgetting the practice might be a reason for lowering the event. Considering the sample size, a larger participant number decreases the level of ASM inferring appropriate and representative sample size should be considered to lessen heterogeneity between studies. The meta-regression results imply shortened recall time to curtail the bias of memorizations and representative sample calculations (to minimize sampling error) need to be emphasized to attain true outcome value. The top three reasons for practicing ASM were perceived knowledge about antibiotics followed by previous experience and minor illness.

Antibiotic self-medication

AMR is a huge challenge to public health and directly impacts economic growth globally, with developing countries in Africa bearing the biggest burden of negative outcomes [95, 96]. AMR is the ability of microorganisms to persist or grow in the presence of drugs designed to inhibit or kill them. This results in therapeutic failure, which negatively impacts the global control and management of infectious diseases. Deaths due to antimicrobial-resistant pathogens are increasing globally every year [97, 98]. If no intervention strategies are initiated, it is estimated that by 2050, mortalities attributed to AMR will increase to 10 million annually, with Africa and Asia accounting for the highest burden of deaths [99]. This report is further supported by the finding of the current systematic review and meta-analysis which determined the pooled prevalence of antibiotic self-medication as 55.2% in sub-Saharan Africa followed by 48.3% in the Middle East, North Africa, and Greater Arabia illustrating the problem more in these regions. This might be further related to a lack of effective regulation of antibiotic usage and the availability of different policy options, contributing to the high prevalence of ASM in these regions [100, 101].

In the present review, the global pooled prevalence of ASM was 43%. A similar outcome from LMIC reported 78% [102]. Another review from developing countries reported 38.8% [103]. In subgroup analysis,

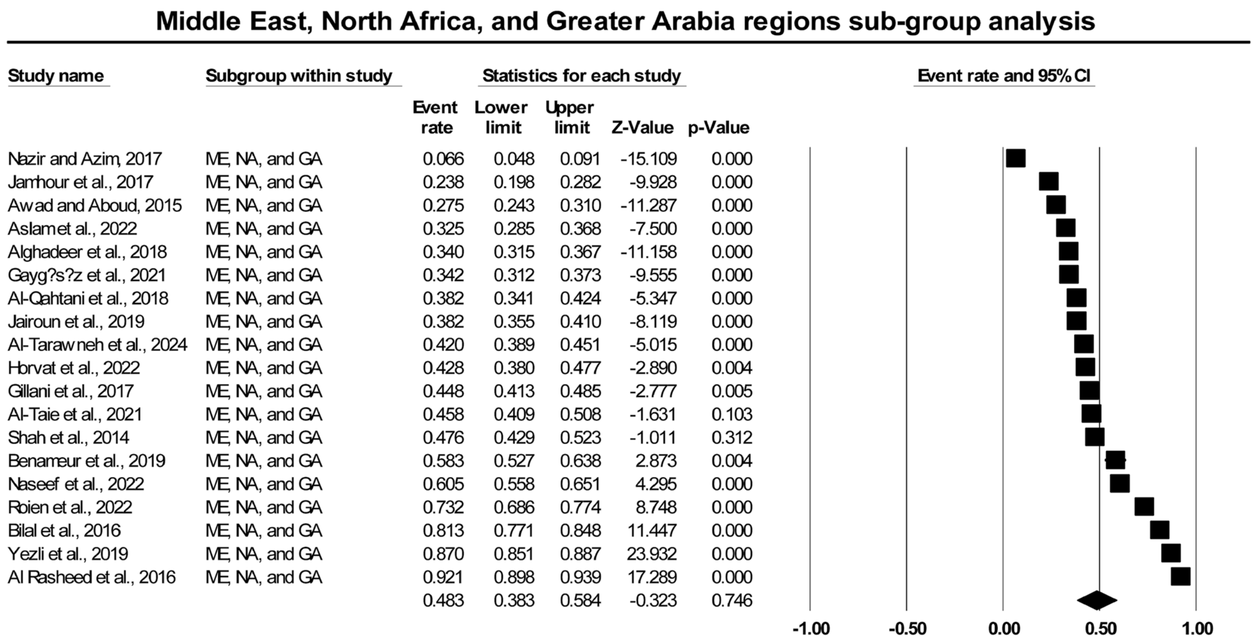

Fig. 4 Forest plot displaying subgroup analysis of ASM pooled prevalence from studies conducted in the Middle East, North Africa, and Greater Arabia regions

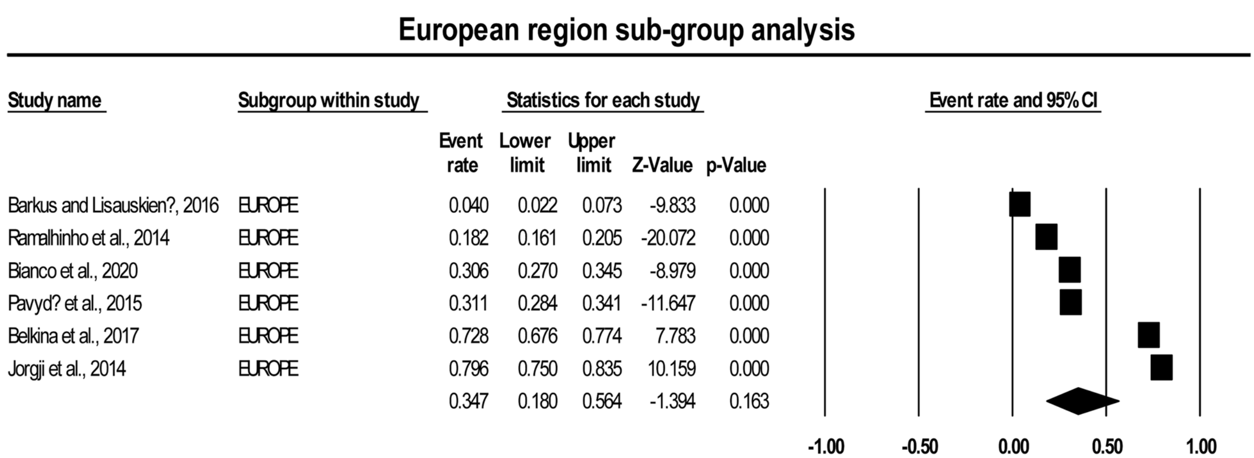

Fig. 5 Forest plot displaying subgroup analysis of ASM pooled prevalence from studies conducted in the European regions

a high prevalence of ASM was shown in sub-Saharan Africa (55.2%) and student users (62.1%). A relatively, lower pooled proportion was reported from a systematic review and meta-analysis among students in LMIC at 46.0% [104]. However, in the present review, a lesser pooled prevalence was observed in the Asian regions, 25.8%. These differences might be due to the regulatory control of prescription-only drugs and the implementation of antibiotic stewardship programs [105, 106] directly impacting ASM practices [107]. In addition, literature on the global trend of total antibiotic consumption between 2000 and 2015 reported that LMICs increased by 39% [108] while in the Organization for Economic Co-operation and Development (OECD) countries by 9% and in European Union (EU) countries by 10%. One of the leading reasons for increasing antibiotic consumption is the nonprescription sale of antibiotics in developing nations which facilitates ASM and the emergence of drug resistance [109–112].

Asia region sub-group analysis

Study name	Subgroup within study	Event rate	Lower limit	Upper limit	Z-Value	p-Value
Rathish and Wickramasinghe, 2020	ASIA	0.026	0.014	0.048	-11.303	0.000
Rajendran et al., 2019	ASIA	0.033	0.022	0.049	-16.589	0.000
Yin et al., 2021	ASIA	0.103	0.093	0.114	-37.243	0.000
Zawahir et al., 2021	ASIA	0.108	0.090	0.129	-20.698	0.000
Aslam et al., 2021	ASIA	0.150	0.121	0.185	-13.570	0.000
Biswas et al., 2014	ASIA	0.267	0.244	0.292	-16.113	0.000
Mannan et al.,2024	ASIA	0.286	0.262	0.311	-15.116	0.000
Haque et al., 2019	ASIA	0.368	0.332	0.406	-6.632	0.000
Yin et al., 2022	ASIA	0.371	0.363	0.379	-31.780	0.000
Lv et al., 2014	ASIA	0.401	0.347	0.458	-3.360	0.001
Zhu et al., 2016	ASIA	0.479	0.441	0.517	-1.090	0.276
Mandal et al., 2020	ASIA	0.511	0.469	0.552	0.508	0.611
Wahab et al., 2023	ASIA	0.610	0.579	0.640	6.899	0.000
Nabi et al., 2022	ASIA	0.678	0.628	0.724	6.593	0.000
		0.258	0.186	0.346	-4.949	0.000

Event rate and 95% CI

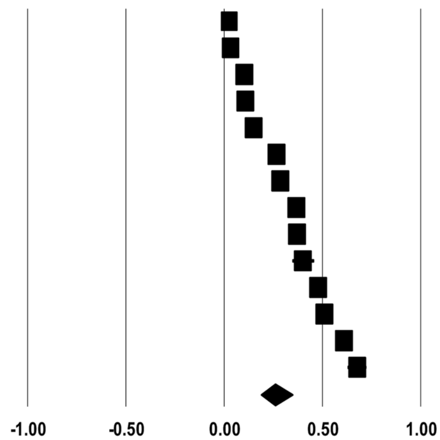

Fig. 6 Forest plot displaying subgroup analysis of ASM pooled prevalence from studies conducted in the Asian regions

Meta Analysis

Study name	Subgroup within study	Event rate	Lower limit	Upper limit	Z-Value	p-Value
Tuyishimire et al., 2019	Student	0.121	0.097	0.150	-15.439	0.000
Jairoun et al., 2019	Student	0.382	0.355	0.410	-8.119	0.000
Lv et al., 2014	Student	0.401	0.347	0.458	-3.360	0.001
Horvat et al., 2022	Student	0.428	0.380	0.477	-2.890	0.004
Eticha et al.,2014	Student	0.445	0.399	0.493	-2.235	0.025
Gillani et al., 2017	Student	0.448	0.413	0.485	-2.777	0.005
Shah et al., 2014	Student	0.476	0.429	0.523	-1.011	0.312
Zhu et al., 2016	Student	0.479	0.441	0.517	-1.090	0.276
Mandal et al., 2020	Student	0.511	0.469	0.552	0.508	0.611
Chuwa et al., 2021	Student	0.570	0.519	0.619	2.680	0.007
Benameur et al., 2019	Student	0.583	0.527	0.638	2.873	0.004
Elmahi et al., 2022	Student	0.608	0.579	0.636	7.146	0.000
Wahab et al., 2023	Student	0.610	0.579	0.640	6.899	0.000
Nabi et al., 2022	Student	0.678	0.628	0.724	6.593	0.000
Mudenda et al., 2023	Student	0.767	0.725	0.804	10.472	0.000
Umar et al.,2018	Student	0.817	0.736	0.878	6.210	0.000
Badger-Emeka et al., 2018	Student	0.860	0.822	0.891	12.598	0.000
Bundukiet al., 2017	Student	0.908	0.879	0.930	14.796	0.000
Nakato et al., 2023	Student	0.920	0.885	0.945	11.963	0.000
Khalid et al.,2019	Student	0.922	0.878	0.951	9.758	0.000
		0.621	0.537	0.697	2.821	0.005

Event rate and 95% CI

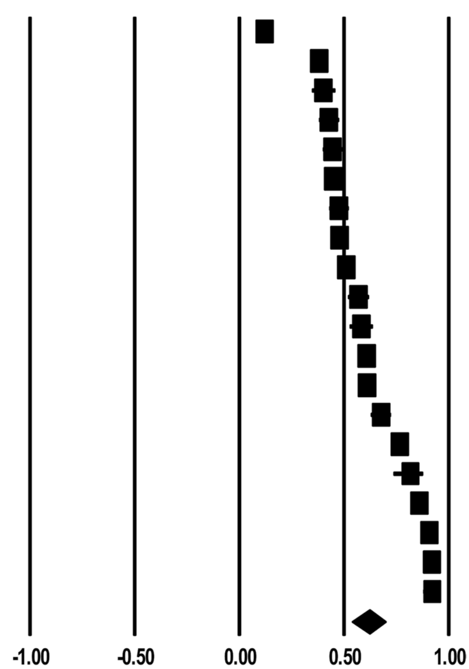

Fig. 7 Forest plot showing subgroup analysis of ASM pooled prevalence among the student population

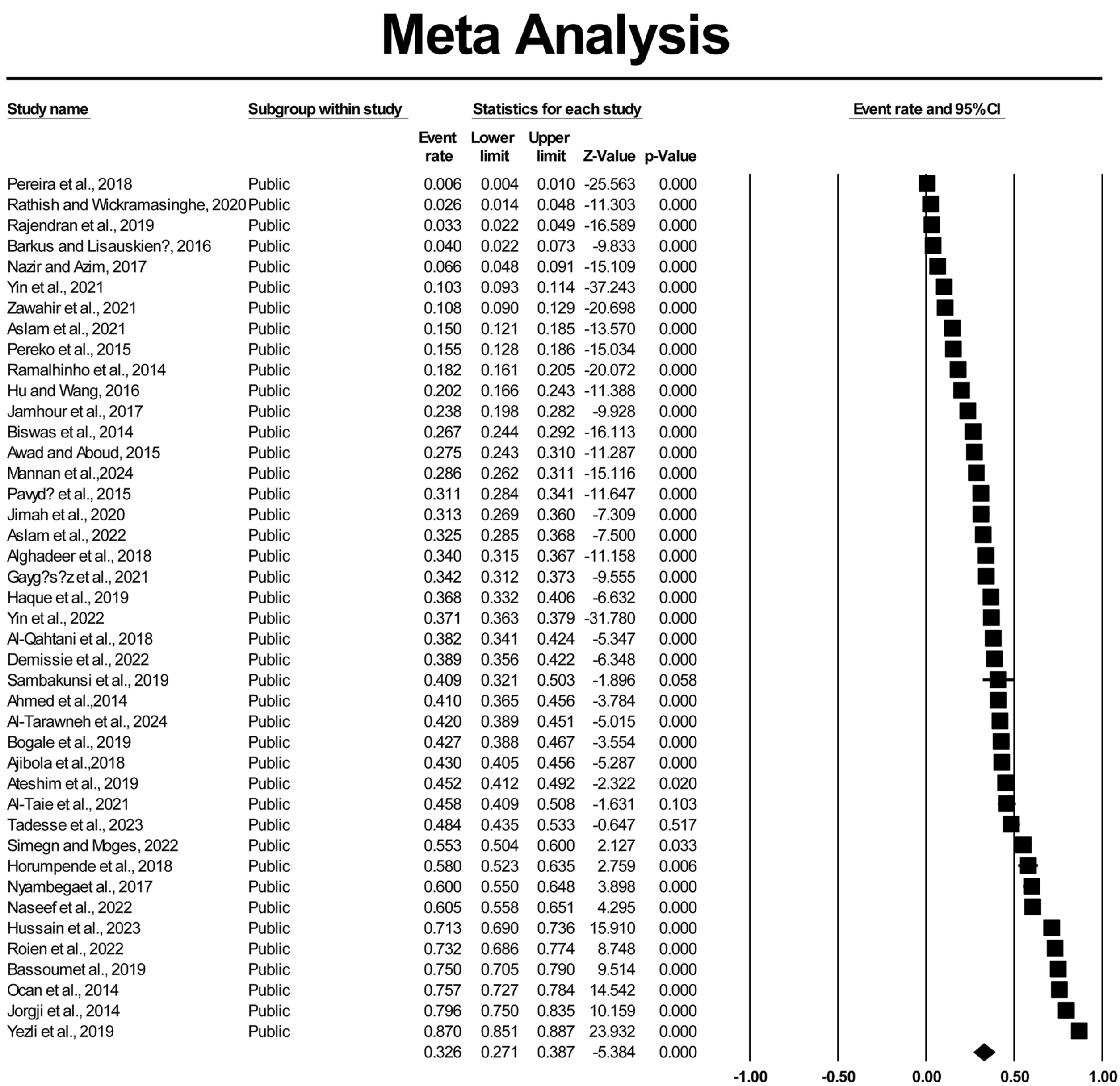

Fig. 8 Forest plot showing subgroup analysis of ASM pooled prevalence among the general population

Reasons for practicing ASM

The motivation for patients to self-medicate with prescription medications in the absence of medical guidance varies depending on the setting and is impacted by a range of healthcare, social, cultural, and economic factors [113]. Therefore, establishing these reasons is critical in designing and implementing interventions against irresponsible self-medication. This review, from the pooled proportion, showed that perceived knowledge about antibiotics, previous successful experiences, illness alleged as mild by the patient, advice from a friend, and access to a community pharmacy were the top five reasons mentioned by the participants. Moreover, in the qualitative analysis of studies, increased educational level, younger age, and male gender were often reported as predictors of ASM. Analogous results were reported elsewhere [114–116].

The evolution of AMR is likewise a natural phenomenon. Microbes are under selective pressure to become resistant and acquire adaptive mutations or genes when antimicrobial agents are misused or overused in healthcare, veterinary, and agricultural settings [117]. This then enables their survival and persistence in environments saturated with antibiotics and antiseptics that would

Table 2 Pooled prevalences of global antibiotic self-medication and subgroup analysis

ASM		Pooled prevalence (%) (95% confidence interval)	I^2	*P*-value
Global		43.0 (38.0, 48.1)	99.2	0.00
Regional	Asia	25.8 (18.6, 34.6)	99.3	0.00
	Europe	34. 7 (18.0, 56.4)	99.2	0.00
	Middle East, North Africa, and Greater Arabia	48.3 (38.3, 58.4)	99,1	0.00
	Sub-Saharan Africa	55.2 (47.2, 63.2)	98.8	0.00
Populations	Students	62.1 (53.7, 69.7)	98.4	0.00
	Public	32.6 (27.1, 38.7)	99.8	0.00
Year of publications	2014–2018	42 (34.3,50)	99.1	0.00
	2019–2024	43.8 (36.8,51.1)	99.1	0.00

previously have readily destroyed them. Bacteria and other microbes have a remarkable ability to rapidly adapt, mutate, and share adaptive genetic elements via horizontal gene transfer mechanisms allowing them to develop diverse resistance mechanisms [118]. Resistance prolongs sickness, increases spread risk, lengthens hospital stays, requires more costly therapies, and raises fatality rates. The availability and quality of healthcare infrastructure are vital components of prevention and response to AMR [119, 120]. Access to healthcare services, trained medical professionals, and essential medications can significantly impact a population's overall health. Disparities in healthcare infrastructure between countries can lead to differences in health outcomes and life expectancy rates [121, 122].

Disparities across countries, including wealth, living standards, healthcare systems, and access to pharmaceuticals, are the root causes of antibiotic resistance. Regions

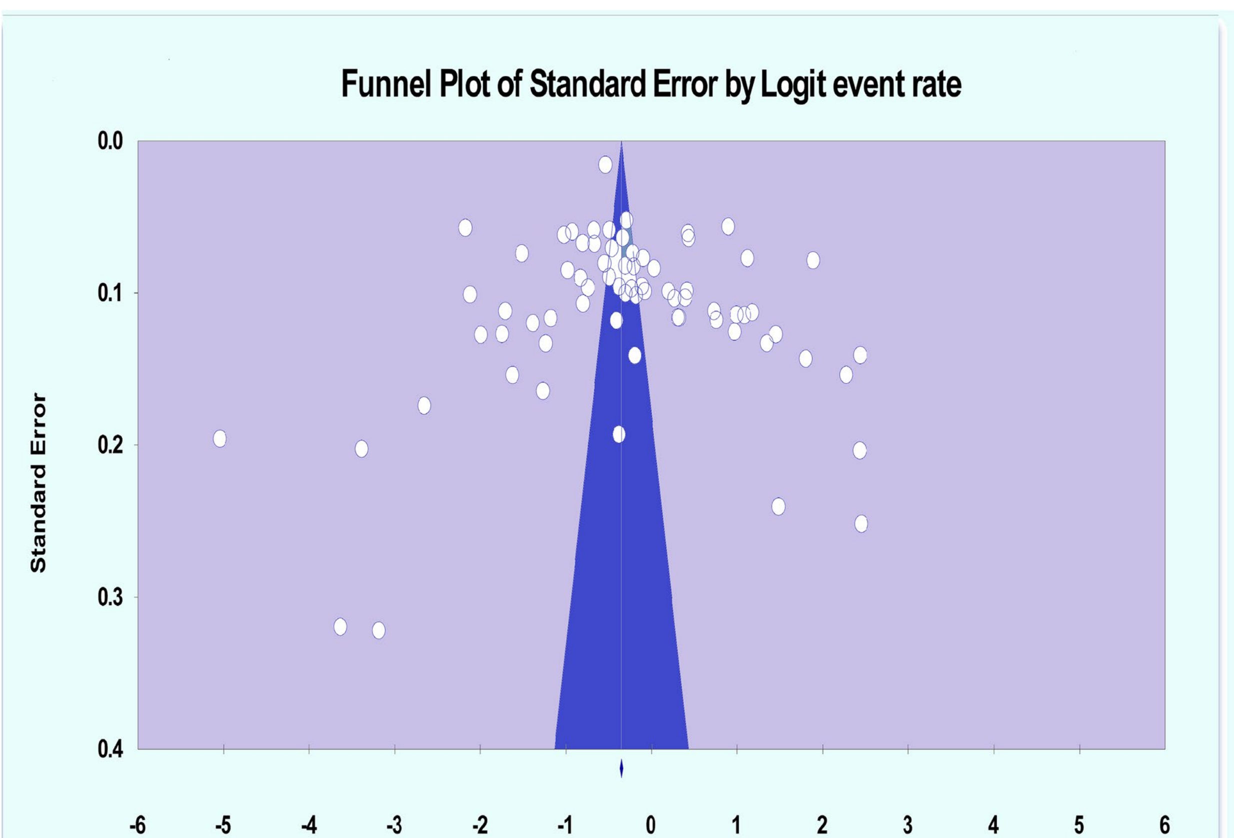

Fig. 9 A funnel plot of the meta-analysis of published studies. Each plotted point represents the standard error and ASM prevalence

Table 3 Pooled prevalences of reasons for practicing antibiotic self-medication globally

Reasons	Pooled prevalence (%) (95% confidence interval)	I^2	*P*-value	No. of studies involved
Knowledge about antibiotics	46.19 (27.99, 65.46)	98.2	0.00	Seven
Previous experience	39.13(30.13, 48.93)	96.9	0.00	Fifteen
Minor illness	38.10 (27.19, 50.37)	97.4	0.00	Nine
Advice from friend	28.64 (14.33, 49.06)	98.2	0.00	Six
Access to community pharmacy	26.86 (19.56, 35.68)	91.7	0.00	Seven
Lack of confidence in HCP	25.74 (11.84, 47.20)	98.4	0.00	Seven
Cost-effectiveness	24.91 (15.58, 37.36)	97.8	0.00	Fifteen
Long waiting time	24.57 (15.90, 35.94)	95.5	0.00	Six
Lack of time	22.01 (17.29, 27.57)	90.2	0.00	Ten

HCP health care professional

of the world with the highest prevalence of drug-resistant infections also have the most severe problems with infection control and overcrowding, which facilitates the rapid spread of infectious diseases among humans and livestock. The irony of the issue is that the same factors that contribute to the high occurrence of infectious diseases also promote the development of resistant pathogens. While treating resistant infections with ineffective antibiotics provides selective pressure that encourages the development of resistant bacteria, the drugs used to treat these diseases are expensive and often unavailable in low- and middle-income countries [123]. These calls for response plans from different perspectives.

In a modeling analysis, it was estimated that improving infection prevention and control programs in LMIC healthcare settings could prevent at least 337,000 AMR-associated deaths annually. Ensuring universal access to high-quality water, sanitation, and hygiene services would prevent 247, 800 AMR-associated deaths and pediatric vaccines 181, 500 AMR-associated deaths, from both direct prevention of resistant infections and reductions in antibiotic consumption. These estimates translate to the prevention of 7·8% of all AMR-associated mortality in LMICs by infection prevention and control, 5·7% by water, sanitation, and hygiene, and 4·2% by vaccination interventions [124]. These findings indicated that reducing the global AMR burden by 10% by the year 2030 is achievable with existing interventions [125]. Moreover, strengthening antibiotic stewardship programs emphasizes on the identified drivers of ASM and implementing drug regulatory policy.

Strength and limitation

The review considered global aspects enabling us to look at the ASM from a wide perspective. However, heterogeneity might be increased due to a wide difference in the prevalence value and variability of study methodologies. Self-reporting was the main data collection method that might increase the recall bias risk, especially in prolonged durations. Non-uniform data collection tools, such as online and face-to-face paper questionnaires could also potentially affect outcomes. Besides, the search is limited to articles published in English, which may exclude relevant studies from non-English speaking countries. However, these language concerns might also be minimized by authors and scientific publishers through translations to increase result dissemination to reach the global community as well as gain visibility.

Conclusion

The practice of ASM is a widespread phenomenon among university students and in sub-Saharan African regions. Recently published articles reported an increasing magnitude while a prolonged recall period and a larger participant number decreased the prevalence of ASM. Knowledge about antibiotics, previous successful experiences, and illness alleged as mild by the patient were reported as the top three reasons for practicing ASM. Educational level and gender are frequently mentioned as factors associated with the practice of ASM. These all practices call for improving infection prevention and control in healthcare settings, improving prescribing practices through guidelines for healthcare workers, conducting public awareness campaigns, increasing human health laboratory capacity and access to diagnostics, strengthening surveillance of antimicrobial use and AMR in human populations, detecting and deterring substandard and falsified antimicrobials to be implemented as per the World Health Organization AMR preventions frameworks.

Recommendation

Antibiotic resistance is diverse and a result of a complex network of related issues. Because of the dynamic links across contexts, actions in one can have indirect or nonlinear impacts on another. Policies and healthcare reforms should stress the key users, reasons, and reported factors of ASM identified in this review. An integrated approach incorporating educational campaigns tailored to local antibiotic consumption and resistance patterns should be mainstreamed in different sectors. Implementing policy actions to regulate over-the-counter antibiotic sales in sub-Saharan Africa and the Middle East, North Africa, and Greater Arabia must be in place. Further, research on ASM in underrepresented regions (e.g., Americans, Oceania) should be promoted.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s13643-025-02783-6.

Additional file 1. Supplementary Table 1. PRISMA 2020 Checklist. Supplementary Table 2. JBI critical appraisal checklist for studies reporting prevalence data. Supplementary Table 3. Score of studies with JBI critical appraisal checklist for studies. Supplementary Fig. 1: Forest plot showing the global pooled prevalence of ASM. Supplementary Table 4. Determinants of ASM reported in different studies.

Authors' contributions

Every author made major contributions to this article, whether through ideation, research design, implementation, data extraction, analysis, or interpretation. Everyone who participated in the article's drafting, editing, or critical review accepted the final version and determined which journal to send it to.

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Data availability

All relevant data that support the findings of this study are included in the manuscript.

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Competing interests

The authors declared that they have no competing interests in this work.

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