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Non-prescription antibiotic use among children in the Kurdistan Region of Iraq: a multicentre cross-sectional survey of caregivers

Himat Mamand

himat.hussein@uor.edu.krd

University of Raparin

Handren Murad

University of Raparin

Saya Hama

University of Raparin

Ako Ahmed

University of Raparin

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Abstract

Background

Non-prescription antibiotic use in children drives antimicrobial resistance, yet data from Iraq are scarce. We estimated its prevalence, patterns and determinants in the Kurdistan Region of Iraq.

Methods

In this multicentre, hospital-based cross-sectional study (September–October 2026), 300 caregivers of children aged 6 months to < 12 years were recruited consecutively at hospitals in Ranya, Sulaymaniyah and Erbil (100 per site; participation 93.8%) and interviewed face-to-face. Determinants were assessed with multivariable and Firth penalised logistic regression.

Results

In the previous 6 months, 67.3% (95% CI 61.8–72.4) of children had received a non-prescription antibiotic, ranging from 48.0% in Sulaymaniyah to 83.0% in Ranya. Most courses were obtained from pharmacies (69.3%), given for fever (44.6%) and lasted < 5 days (60.4%); 39.6% were WHO Watch antibiotics. Half of households (51.3%) stored antibiotics, and 75.7% of caregivers had poor knowledge. Residence in Ranya (aOR 12.21, 95% CI 3.19–46.75; adjusted prevalence ratio 1.30, 1.13–1.61), higher knowledge (aOR 0.74 per correct answer, 0.62–0.87) and more appropriate attitudes (aOR 0.78 per point, 0.68–0.90) were independently associated with non-prescription use; Firth estimates were consistent.

Conclusions

Two in three children received antibiotics without a prescription, mainly from pharmacies. Enforcing prescription-only dispensing, engaging pharmacists in stewardship and educating caregivers are urgently needed.

Key message

What is already known on this topic

- Non-prescription antibiotic use in children is common in many low- and middle-income countries and drives antimicrobial resistance.
- Community pharmacies frequently dispense antibiotics without a prescription in the Middle East.

What this study adds

- In the Kurdistan Region of Iraq, 67.3% of children had received a non-prescription antibiotic in the previous 6 months, and four in five antibiotic-exposed children had at least one such course.
- Most courses were obtained from pharmacies, given for fever and lasted less than 5 days, and two in five were WHO Watch antibiotics.
- Lower knowledge and less appropriate attitudes independently predicted non-prescription use, and prevalence varied almost twofold between sites.

How this study might affect research, practice or policy

- The findings support enforcement of prescription-only antibiotic dispensing, pharmacist-focused stewardship, and caregiver education on viral illness and fever, alongside reducing the cost of paediatric consultations.

1. Introduction

Antimicrobial resistance (AMR) ranks among the most serious threats to global health. In 2019 alone, an estimated 1.27 million deaths were directly attributable to bacterial AMR and 4.95 million deaths were associated with it, and the greatest burden fell on low- and middle-income countries [1]. The inappropriate use of antibiotics in the community is a key driver of resistance. Children are especially exposed, because they frequently develop respiratory and gastrointestinal infections, most of which are viral [1–3].

Non-prescription antibiotic use occurs when caregivers give a child an antibiotic that was bought without a prescription, left over from an earlier course, reused from an old prescription or obtained from relatives. The practice has been reported across Asia [2–9], Africa [10, 11], the Middle East [12, 13], Europe [14–19] and the Americas [20–23]. In China, parents commonly self-medicate their children with antibiotics. This behaviour has been linked to parental uncertainty, emotions and beliefs [5, 6, 9], and to later over-prescribing by physicians during medical visits [7, 24]. Research among parents of different nationalities shows that cultural background and the health-system context influence this practice [25]. Qualitative studies further suggest that parents' decisions are driven by previous experience, perceived illness severity, convenience, and the cost and accessibility of medical care [26–28], while physicians describe feeling pressured by parents' expectations [29].

Community pharmacies lie at the centre of this problem. Antibiotics are widely dispensed without a prescription in Tanzania [30], Pakistan [31], China [32] and South Africa [33], and a survey covering 19 Arab countries identified pharmacies as a common source of antibiotics [13]. Community pharmacists in Palestine and Lebanon have shown gaps in their knowledge of paediatric antibiotic use and dosing [34, 35]. Keeping leftover antibiotics at home is also common, and it provides a ready supply for future self-medication [36–39]. Self-medication with antibiotics among adults remains widespread in neighbouring and comparable countries, including Iran [40], Pakistan [41], Saudi Arabia [42], China [43] and Georgia [44], and public awareness of AMR is low in many settings [45, 46].

In Iraq, antibiotics are easy to obtain from community pharmacies. Recent studies have documented frequent dispensing without a prescription [47] and gaps in parents' knowledge, attitudes and practices regarding antibiotic use in children [48]. However, evidence from the Kurdistan Region of Iraq (KRI) is lacking. No multicentre study has measured how often children actually receive non-prescription antibiotics, which agents they receive, how these are obtained, or which household, access and knowledge factors are associated with the practice. Such evidence is essential for designing stewardship interventions aimed at caregivers and pharmacies [49, 50].

The aims of this study were therefore to (1) estimate the prevalence of non-prescription antibiotic use among children aged 6 months to < 12 years in three cities of the KRI; (2) describe how these antibiotics were obtained, which agents were used and for which symptoms; (3) assess caregivers' knowledge of and attitudes towards antibiotics, and their home storage practices; and (4) identify factors independently associated with non-prescription antibiotic use.

2. Methods

2.1. Study design and setting

We conducted a multicentre, hospital-based cross-sectional study in three cities of the Kurdistan Region of Iraq (KRI): Ranya, Sulaymaniyah and Erbil. We chose these sites to compare a smaller, more traditional district town with fewer job opportunities (Ranya) with the region's two largest cities (Sulaymaniyah and Erbil). Data were collected between 10 September and 1 October 2026 at Ranya Maternal and Children Hospital, Sulaimanyah Children Hospital and Erbil Maternal and Children Hospital. Each is a public referral hospital offering paediatric outpatient and inpatient care for its area. We followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines in reporting the study [51].

2.2. Participants and sampling

We included main caregivers aged 18 years or older who brought a child aged 6 months to under 12 years to one of the participating hospitals on a data-collection day. Each caregiver contributed one child, the index child attending that day. At each site, we invited caregivers consecutively until 100 interviews had been completed. Caregivers who declined to take part or did not meet the eligibility criteria were excluded.

2.3. Sample size

We calculated the sample size for a single proportion. We assumed a prevalence of 50%, the most conservative value, with a 95% confidence level and an absolute precision of ±6%. This gave a minimum of 267 participants. To allow for roughly 10% of questionnaires being incomplete or invalid, we set the target at 300 caregivers, split equally between the three sites (100 per site).

2.4. Questionnaire

We developed a structured questionnaire after reviewing earlier studies of parental antibiotic use and of knowledge, attitudes and practices [2,5,16,18,22,48]. It was written in English and then translated into Kurdish Sorani. Five experts reviewed it for content validity. Three were from the [institution blinded for review], with expertise in nursing and paediatrics. The other two were from the Research and Health Safety Department, and they also checked the Kurdish version for language and cross-cultural equivalence. We made minor wording changes in response to their comments. We then piloted the questionnaire with 10 caregivers, who were not included in the final analysis, to check that the questions were clear and easy to understand and to estimate how long an interview would take.

The final questionnaire had eight sections:
(A) study information;
(B) caregiver and household characteristics: relationship to the child, age, education, employment, residence, household size, number of children, monthly income, and whether anyone in the household worked in health care;
(C) characteristics of the index child: age in months, sex, any doctor-diagnosed chronic condition, and the number of illness episodes and of doctor-prescribed antibiotic courses in the previous 6 months;
(D) access to and cost of care: usual first place of care, travel time to the nearest paediatric clinic, doctor visits forgone because of cost, difficulty paying 25,000 IQD for an unexpected visit, health insurance, and three barriers to seeing a doctor;
(E) antibiotic use in the previous 6 months;
(F) home storage of antibiotics;
(G) twelve knowledge statements (true/false/don’t know);
(H) six attitude statements rated on a five-point Likert scale.

2.5. Outcome and definitions

The primary outcome was non-prescription antibiotic use. We defined this as the child having taken, in the previous 6 months, an antibiotic that a doctor had not prescribed for that illness. It covered antibiotics bought at a pharmacy without a current prescription, leftovers kept at home, reused old prescriptions, and antibiotics obtained from relatives, friends or neighbours. When a caregiver reported that the child had taken any antibiotic, we asked whether any course had been given without a prescription (yes/no/not sure). In the primary analysis, we compared “yes” with “no or not sure”; in a sensitivity analysis, we excluded caregivers who answered “not sure”. For the most recent non-prescription episode, caregivers told us how the antibiotic was obtained, the main symptom, the product and its dosage form, how many days it was given, and who had advised it. We grouped the products by pharmacological class and by the World Health Organization (WHO) Access, Watch and Reserve (AWaRe) categories [52].

Each correct answer to a knowledge statement scored 1 point, and “don’t know” counted as incorrect, so knowledge scores ranged from 0 to 12. We classified knowledge as poor (<60%), moderate (60–79%) or good (≥80%) using Bloom’s cut-offs. For the attitude statements, items H1–H5 were reverse-scored,

because agreeing with them reflects an inappropriate attitude. This gave an attitude score from 6 to 30, with higher scores indicating more appropriate attitudes.

2.6. Data collection and quality control

Three trained interviewers, all members of the research team, carried out face-to-face interviews in Kurdish Sorani, one at each site. Interviews took place in a private area of the hospital, and all three interviewers used the same questionnaire, show-card and procedure. During data collection we approached 320 caregivers. Fifteen declined to take part: 10 because they lacked time and 5 because their child was unwell. Of the 305 caregivers assessed for eligibility, 5 were excluded because they were younger than 18 years. This left 300 caregivers (100 per site; 93.8% of those approached) for the final analysis (Figure 1).

Answers were recorded on paper questionnaires. These were checked for completeness and then entered into a KoboToolbox form (Kobo Inc., Cambridge, MA, USA) between 3 and 9 October 2026. The form had built-in skip logic, range checks and consistency warnings. For example, it flagged implausible caregiver–child age differences, more prescribed courses than illness episodes, and tablet use in children younger than 24 months. The investigators then checked the dataset record by record for duplicate entries, site–interviewer mismatches, logical inconsistencies and implausible values. Every correction was verified against the paper questionnaire and recorded in a cleaning log, and one duplicate data entry was removed.

2.7. Statistical analysis

Categorical variables are reported as frequencies and percentages. Continuous variables are reported as mean ± standard deviation (SD), or as median and interquartile range (IQR) when they were not normally distributed on the Shapiro–Wilk test. We calculated 95% confidence intervals (CI) for prevalence estimates using the Wilson score method. Differences between sites were tested with Pearson's χ^2 test. When more than 20% of cells had expected counts below 5, we used the Fisher–Freeman–Halton exact test instead (Monte Carlo, 20,000 samples). Continuous variables were compared between sites with one-way ANOVA or the Kruskal–Wallis test. We assessed the internal consistency of the knowledge scale with the Kuder–Richardson-20 coefficient (KR-20) and of the attitude scale with Cronbach's α, and the correlation between the two scores with Spearman's correlation.

We used binary logistic regression to examine factors associated with non-prescription antibiotic use, and estimated crude odds ratios (OR) with 95% CI for each variable. Variables with $p < 0.20$ in the crude analysis that were also conceptually relevant were considered for the multivariable model. To avoid overfitting, we allowed roughly one model parameter for every 8–10 participants in the smaller outcome group (n = 98). Because the cost variables overlapped heavily, we represented them with a single indicator: forgone care because of cost. Home storage of antibiotics was left out of the model, because it reflects the same behaviour as the outcome rather than a cause of it. The final model included study site, caregiver education, household income, having a health-care worker in the household, number of

illness episodes, using a pharmacy as the first place of care, forgone care because of cost, knowledge score and attitude score. We checked for multicollinearity using variance inflation factors (VIF), and assessed model fit with the likelihood-ratio test, Nagelkerke R^2, the Hosmer–Lemeshow test and the area under the receiver operating characteristic curve (AUC).

We tested the robustness of the model in several sensitivity analyses: adding residence and child age group, replacing forgone care with the cost barrier, adding home storage, and excluding “not sure” responses. Because some sites had few non-users, which can bias estimates in small samples and make them imprecise, we also re-estimated the multivariable models with Firth’s penalised-likelihood logistic regression and profile-likelihood 95% CIs. Results are reported as adjusted odds ratios (aOR) with 95% CI. When an outcome is common, odds ratios overstate the corresponding prevalence ratios. We therefore also derived adjusted prevalence ratios (aPR) from the multivariable logistic model by marginal standardisation (predictive margins) [53], with 95% CIs from 5,000 bootstrap resamples. Analyses were performed in IBM SPSS Statistics, version 26.0 (IBM Corp., Armonk, NY, USA), and the Firth models and marginal standardisation in Python 3.13 with NumPy 2.5 and SciPy 1.18. A two-sided $p < 0.05$ was considered statistically significant.

2.8. Ethical considerations

The Research Ethics Committee of [institution blinded for review] approved the study (approval number [blinded for review], 5 September 2026), and it was conducted in line with the Declaration of Helsinki. Interviewers read the information sheet aloud to each caregiver and obtained informed consent before starting the interview. Taking part was voluntary and anonymous. No personal identifiers were recorded, and each questionnaire was identified only by a study code.

3. Results

3.1. Participants

Of the 320 caregivers approached, 15 declined and 5 were ineligible, which left 300 caregivers (100 per site) for analysis (Fig. 1). Most respondents were mothers (65.0%), followed by fathers (27.0%) and grandparents (7.0%). Caregivers had a mean age of 36.4 ± 9.9 years. Just over half held a diploma or higher qualification (51.7%), 31.3% were housewives or unemployed, 81.3% lived in urban areas, and 22.3% had a health-care worker in the household. The children had a median age of 23.5 months (IQR 13–39.5). Half were younger than 2 years, 54.3% were girls, and 16.7% had a doctor-diagnosed chronic condition. Over the previous 6 months, the children had a median of 4 illness episodes (IQR 3–7) and 1 doctor-prescribed antibiotic course (IQR 0–2).

A pharmacy was the first place of care for 56.7% of families. Seventy percent had skipped a needed doctor visit because of the cost, 41.3% said paying 25,000 IQD for a visit would be very difficult or impossible, and only 6.3% of children had health insurance. Most characteristics differed significantly between sites (Table 1). Caregivers in Erbil were younger, more often lived in rural areas and had larger

households. They also reported more illness episodes and turned to pharmacies first more often. Families in Sulaymaniyah reported far fewer barriers related to cost, waiting time and work schedules than those in Ranya and Erbil.

Table 1
Characteristics of caregivers, households and children, overall and by study site (N = 300).

Characteristic	Total (N = 300)	Ranya (n = 100)	Sulaymaniyah (n = 100)	Erbil (n = 100)	p-value
Caregiver					
Relationship to child					0.543
Mother	195 (65.0)	65 (65.0)	61 (61.0)	69 (69.0)	
Father	81 (27.0)	26 (26.0)	30 (30.0)	25 (25.0)	
Grandparent	21 (7.0)	8 (8.0)	9 (9.0)	4 (4.0)	
Other relative/guardian	3 (1.0)	1 (1.0)	0 (0.0)	2 (2.0)	
Age, years, mean ± SD	36.4 ± 9.9	37.7 ± 9.8	38.7 ± 9.9	32.8 ± 9.2	< 0.001
Age group					< 0.001
18–29 years	73 (24.3)	21 (21.0)	13 (13.0)	39 (39.0)	
30–39 years	140 (46.7)	41 (41.0)	54 (54.0)	45 (45.0)	
≥ 40 years	87 (29.0)	38 (38.0)	33 (33.0)	16 (16.0)	
Education					< 0.001
Cannot read/write	6 (2.0)	1 (1.0)	3 (3.0)	2 (2.0)	
Primary	44 (14.7)	13 (13.0)	14 (14.0)	17 (17.0)	
Intermediate	42 (14.0)	5 (5.0)	13 (13.0)	24 (24.0)	
Secondary	53 (17.7)	10 (10.0)	18 (18.0)	25 (25.0)	
Diploma (institute)	85 (28.3)	44 (44.0)	20 (20.0)	21 (21.0)	
Bachelor or higher	70 (23.3)	27 (27.0)	32 (32.0)	11 (11.0)	

Note: Values are n (%) unless otherwise stated. p-values are from Pearson's χ^2 test unless marked. Fisher–Freeman–Halton exact test (Monte Carlo, 20,000 samples). One-way ANOVA. Kruskal–Wallis test. IQD, Iraqi dinar; IQR, interquartile range; SD, standard deviation.

Characteristic	Total (N = 300)	Ranya (n = 100)	Sulaymaniyah (n = 100)	Erbil (n = 100)	p-value
Caregiver					
Employment					< 0.001
Housewife/unemployed	94 (31.3)	26 (26.0)	41 (41.0)	27 (27.0)	
Public sector	69 (23.0)	39 (39.0)	17 (17.0)	13 (13.0)	
Private sector	64 (21.3)	19 (19.0)	28 (28.0)	17 (17.0)	
Self-employed	65 (21.7)	15 (15.0)	11 (11.0)	39 (39.0)	
Student/retired	8 (2.7)	1 (1.0)	3 (3.0)	4 (4.0)	
Household					
Rural residence	56 (18.7)	14 (14.0)	5 (5.0)	37 (37.0)	< 0.001
Household size, median (IQR)	5 (4–6)	4 (4–5)	4 (3–5)	6 (5–7)	< 0.001
Children < 18 years, median (IQR)	2 (2–3)	2 (1–2)	2 (1–3)	3 (2–4)	< 0.001
Monthly income (IQD)					< 0.001
< 500,000	75 (25.0)	16 (16.0)	23 (23.0)	36 (36.0)	
500,000 – <1,000,000	176 (58.7)	75 (75.0)	44 (44.0)	57 (57.0)	
1,000,000 – <1,500,000	40 (13.3)	7 (7.0)	29 (29.0)	4 (4.0)	
≥ 1,500,000	9 (3.0)	2 (2.0)	4 (4.0)	3 (3.0)	
Health-care worker in household	67 (22.3)	14 (14.0)	23 (23.0)	30 (30.0)	0.025
Index child					

Note: Values are n (%) unless otherwise stated. p-values are from Pearson's χ^2 test unless marked. Fisher–Freeman–Halton exact test (Monte Carlo, 20,000 samples). One-way ANOVA. Kruskal–Wallis test. IQD, Iraqi dinar; IQR, interquartile range; SD, standard deviation.

Characteristic	Total (N = 300)	Ranya (n = 100)	Sulaymaniyah (n = 100)	Erbil (n = 100)	p-value
Caregiver					
Age, months, median (IQR)	23.5 (13–39.5)	34.5 (18–78)	21 (11–34.8)	18 (12–29.8)	< 0.001
Age group					< 0.001
6–23 months	150 (50.0)	32 (32.0)	54 (54.0)	64 (64.0)	
24–59 months	107 (35.7)	37 (37.0)	39 (39.0)	31 (31.0)	
60–143 months	43 (14.3)	31 (31.0)	7 (7.0)	5 (5.0)	
Female sex	163 (54.3)	50 (50.0)	63 (63.0)	50 (50.0)	0.103
Doctor-diagnosed chronic condition	50 (16.7)	19 (19.0)	9 (9.0)	22 (22.0)	0.036
Illness episodes, past 6 months, median (IQR)	4 (3–7)	5 (4–6)	2 (2–3)	8 (6–10)	< 0.001
Doctor-prescribed antibiotic courses, past 6 months, median (IQR)	1 (0–2)	2 (1–2)	0 (0–1)	2 (0–4)	< 0.001
Access to and cost of care					
First place of care when child is sick					< 0.001
Public clinic/hospital	54 (18.0)	25 (25.0)	16 (16.0)	13 (13.0)	
Private clinic	74 (24.7)	27 (27.0)	34 (34.0)	13 (13.0)	
Pharmacy	170 (56.7)	48 (48.0)	49 (49.0)	73 (73.0)	
Treat at home	2 (0.7)	0 (0.0)	1 (1.0)	1 (1.0)	

Note: Values are n (%) unless otherwise stated. p-values are from Pearson's χ^2 test unless marked. Fisher–Freeman–Halton exact test (Monte Carlo, 20,000 samples). One-way ANOVA. Kruskal–Wallis test. IQD, Iraqi dinar; IQR, interquartile range; SD, standard deviation.

Characteristic	Total (N = 300)	Ranya (n = 100)	Sulaymaniyah (n = 100)	Erbil (n = 100)	p-value
Caregiver					
Travel time to paediatric clinic, minutes, median (IQR)	25 (18.5–35)	40 (30–50)	25 (20–35)	19 (10–29.5)	< 0.001
Forgone doctor visit because of cost, past 6 months	210 (70.0)	83 (83.0)	46 (46.0)	81 (81.0)	< 0.001
Difficulty paying 25,000 IQD for a visit					< 0.001
Not difficult	56 (18.7)	8 (8.0)	42 (42.0)	6 (6.0)	
Somewhat difficult	120 (40.0)	29 (29.0)	36 (36.0)	55 (55.0)	
Very difficult	112 (37.3)	56 (56.0)	22 (22.0)	34 (34.0)	
Impossible	12 (4.0)	7 (7.0)	0 (0.0)	5 (5.0)	
Health insurance	19 (6.3)	1 (1.0)	1 (1.0)	17 (17.0)	< 0.001
Barriers to visiting a doctor					
High cost of the visit	233 (77.7)	90 (90.0)	52 (52.0)	91 (91.0)	< 0.001
Long waiting time	208 (69.3)	95 (95.0)	24 (24.0)	89 (89.0)	< 0.001
Busy work schedule	167 (55.7)	79 (79.0)	9 (9.0)	79 (79.0)	< 0.001

Note: Values are n (%) unless otherwise stated. p-values are from Pearson's χ^2 test unless marked. Fisher–Freeman–Halton exact test (Monte Carlo, 20,000 samples). One-way ANOVA. Kruskal–Wallis test. IQD, Iraqi dinar; IQR, interquartile range; SD, standard deviation.

3.2. Prevalence and patterns of non-prescription antibiotic use

In the 6 months before the interview, 84.3% of children had received at least one antibiotic. In 67.3% (202/300; 95% CI 61.8–72.4), at least one antibiotic had not been prescribed by a doctor for that illness (Table 2). Among children who had taken any antibiotic, 79.8% had received at least one course without a prescription. Prevalence varied significantly by site ($p < 0.001$). It was highest in Ranya at 83.0% (95% CI 74.5–89.1), followed by Erbil at 71.0% (61.5–79.0), and lowest in Sulaymaniyah at 48.0% (38.5–57.7)

(Fig. 2). Excluding the 22 “not sure” responses raised the prevalence to 72.7% (202/278; 95% CI 67.1–77.6).

Table 2
Antibiotic use, non-prescription antibiotic use and home storage, overall and by study site.

Variable	Total	Ranya	Sulaymaniyah	Erbil	p-value
A. All children (N = 300; 100 per site)					
Any antibiotic, past 6 months					< 0.001
Yes	253 (84.3)	89 (89.0)	74 (74.0)	90 (90.0)	
No	41 (13.7)	10 (10.0)	26 (26.0)	5 (5.0)	
Not sure	6 (2.0)	1 (1.0)	0 (0.0)	5 (5.0)	
Non-prescription antibiotic use, past 6 months					< 0.001
Yes	202 (67.3)	83 (83.0)	48 (48.0)	71 (71.0)	
No	76 (25.3)	15 (15.0)	50 (50.0)	11 (11.0)	
Not sure	22 (7.3)	2 (2.0)	2 (2.0)	18 (18.0)	
Prevalence, % (95% CI)	67.3 (61.8–72.4)	83.0 (74.5–89.1)	48.0 (38.5–57.7)	71.0 (61.5–79.0)	
B. Antibiotic-exposed children (n = 253; 89/74/90)					
Non-prescription use					< 0.001
Yes	202 (79.8)	83 (93.3)	48 (64.9)	71 (78.9)	
No	35 (13.8)	5 (5.6)	24 (32.4)	6 (6.7)	
Not sure	16 (6.3)	1 (1.1)	2 (2.7)	13 (14.4)	
C. Most recent non-prescription episode (n = 202; 83/48/71)					

Note: Values are n (%) unless otherwise stated. p-values are from Pearson's χ^2 test unless marked. Fisher–Freeman–Halton exact test (Monte Carlo, 20,000 samples). Kruskal–Wallis test. Wilson score 95% confidence interval. Clarithromycin, erythromycin and cefuroxime (n = 1 each). n = 201; one caregiver did not remember. AWaRe, WHO Access, Watch and Reserve classification; no Reserve antibiotics were reported.

Variable	Total	Ranya	Sulaymaniyah	Erbil	p-value
A. All children (N = 300; 100 per site)					
Episodes in past 6 months, median (IQR)	2 (2–3)	2 (2–3)	2 (1–2)	3 (3–4)	< 0.001
How the antibiotic was obtained					0.008
Pharmacy, caregiver asked for it	85 (42.1)	37 (44.6)	29 (60.4)	19 (26.8)	
Pharmacy, pharmacist suggested it	55 (27.2)	19 (22.9)	8 (16.7)	28 (39.4)	
Reused an old prescription	47 (23.3)	19 (22.9)	10 (20.8)	18 (25.4)	
Leftover at home	14 (6.9)	8 (9.6)	1 (2.1)	5 (7.0)	
Relative/friend/neighbour	1 (0.5)	0 (0.0)	0 (0.0)	1 (1.4)	
Main symptom					0.016
Fever	90 (44.6)	44 (53.0)	23 (47.9)	23 (32.4)	
Diarrhoea/vomiting	34 (16.8)	9 (10.8)	10 (20.8)	15 (21.1)	
Sore throat	30 (14.9)	9 (10.8)	8 (16.7)	13 (18.3)	
Cough/cold/runny nose	26 (12.9)	7 (8.4)	4 (8.3)	15 (21.1)	
Ear pain	22 (10.9)	14 (16.9)	3 (6.2)	5 (7.0)	
Antibiotic					< 0.001
Amoxicillin	51 (25.2)	30 (36.1)	12 (25.0)	9 (12.7)	
Azithromycin	51 (25.2)	23 (27.7)	14 (29.2)	14 (19.7)	
Amoxicillin-clavulanate	43 (21.3)	8 (9.6)	9 (18.8)	26 (36.6)	

Note: Values are n (%) unless otherwise stated. p-values are from Pearson's χ^2 test unless marked. Fisher–Freeman–Halton exact test (Monte Carlo, 20,000 samples). Kruskal–Wallis test. Wilson score 95% confidence interval. Clarithromycin, erythromycin and cefuroxime (n = 1 each). n = 201; one caregiver did not remember. AWaRe, WHO Access, Watch and Reserve classification; no Reserve antibiotics were reported.

Variable	Total	Ranya	Sulaymaniyah	Erbil	p-value
A. All children (N = 300; 100 per site)					
Metronidazole	28 (13.9)	8 (9.6)	10 (20.8)	10 (14.1)	
Cefixime	23 (11.4)	11 (13.3)	3 (6.2)	9 (12.7)	
Ceftriaxone	3 (1.5)	0 (0.0)	0 (0.0)	3 (4.2)	
Other	3 (1.5)	3 (3.6)	0 (0.0)	0 (0.0)	
Antibiotic class					0.294
Penicillins	94 (46.5)	38 (45.8)	21 (43.8)	35 (49.3)	
Macrolides	53 (26.2)	25 (30.1)	14 (29.2)	14 (19.7)	
Nitroimidazoles	28 (13.9)	8 (9.6)	10 (20.8)	10 (14.1)	
Cephalosporins	27 (13.4)	12 (14.5)	3 (6.2)	12 (16.9)	
WHO AWaRe category					0.478
Access	122 (60.4)	46 (55.4)	31 (64.6)	45 (63.4)	
Watch	80 (39.6)	37 (44.6)	17 (35.4)	26 (36.6)	
Dosage form					< 0.001
Syrup/suspension	187 (92.6)	75 (90.4)	48 (100.0)	64 (90.1)	
Tablet/capsule	7 (3.5)	7 (8.4)	0 (0.0)	0 (0.0)	
Injection	8 (4.0)	1 (1.2)	0 (0.0)	7 (9.9)	
Days given, median (IQR)	4 (3–5)	3 (3–4)	4 (3–5)	5 (4–5)	< 0.001
Given for < 5 days	122 (60.4)	64 (77.1)	28 (58.3)	30 (42.3)	< 0.001

Note: Values are n (%) unless otherwise stated. p-values are from Pearson's χ^2 test unless marked. Fisher–Freeman–Halton exact test (Monte Carlo, 20,000 samples). Kruskal–Wallis test. Wilson score 95% confidence interval. Clarithromycin, erythromycin and cefuroxime (n = 1 each). n = 201; one caregiver did not remember. AWaRe, WHO Access, Watch and Reserve classification; no Reserve antibiotics were reported.

Variable	Total	Ranya	Sulaymaniyah	Erbil	p-value
A. All children (N = 300; 100 per site)					
Who advised giving it					< 0.001
Pharmacist	90 (44.8)	32 (38.6)	9 (19.1)	49 (69.0)	
Caregiver's own experience	74 (36.8)	42 (50.6)	16 (34.0)	16 (22.5)	
Relative/friend	34 (16.9)	9 (10.8)	20 (42.6)	5 (7.0)	
Internet/social media	3 (1.5)	0 (0.0)	2 (4.3)	1 (1.4)	
D. Home storage					
Antibiotics stored at home now (N = 300)	154 (51.3)	66 (66.0)	18 (18.0)	70 (70.0)	< 0.001
Origin of stored antibiotics (n = 154; 66/18/70)					0.416
Bought without prescription	121 (78.6)	55 (83.3)	16 (88.9)	50 (71.4)	
Leftover from a prescription	28 (18.2)	9 (13.6)	2 (11.1)	17 (24.3)	
From relative/friend	5 (3.2)	2 (3.0)	0 (0.0)	3 (4.3)	

Note: Values are n (%) unless otherwise stated. p-values are from Pearson's χ^2 test unless marked. Fisher–Freeman–Halton exact test (Monte Carlo, 20,000 samples). Kruskal–Wallis test. Wilson score 95% confidence interval. Clarithromycin, erythromycin and cefuroxime (n = 1 each). n = 201; one caregiver did not remember. AWaRe, WHO Access, Watch and Reserve classification; no Reserve antibiotics were reported.

Children who had received a non-prescription antibiotic had a median of 2 such episodes (IQR 2–3). In the most recent episode, the antibiotic came from a pharmacy, either at the caregiver's request (42.1%) or on the pharmacist's suggestion (27.2%), from an old prescription (23.3%), or from leftovers at home (6.9%). The commonest reasons were fever (44.6%), diarrhoea or vomiting (16.8%), sore throat (14.9%), cough or cold (12.9%) and ear pain (10.9%). The agents used most often were amoxicillin and azithromycin (25.2% each), followed by amoxicillin-clavulanate (21.3%). Under the WHO AWaRe classification, 60.4% were Access and 39.6% Watch antibiotics, and this split did not differ significantly between sites (p = 0.478). Almost all courses were given as syrup (92.6%); 3.5% were tablets and 4.0% injections. The median duration was 4 days (IQR 3–5), and 60.4% of courses lasted less than 5 days. Pharmacists had advised 44.8% of courses, and caregivers relied on their own previous experience for 36.8% (Fig. 3).

Half of households (51.3%) were keeping antibiotics at home at the time of the interview, and 78.6% of these stored antibiotics had been bought without a prescription. Home storage was much less common in Sulaymaniyah (18.0%) than in Ranya (66.0%) or Erbil (70.0%) ($p < 0.001$).

3.3. Knowledge and attitudes

Overall, caregivers' knowledge of antibiotics was limited (Table 3A). The median score was 5 out of 12 (IQR 2–7). Three-quarters of caregivers (75.7%) had poor knowledge, 8.3% moderate and 16.0% good knowledge. Most (81.7%) knew that antibiotics work against bacteria, yet only half (49.7%) knew that they do not kill viruses. Fewer than a third understood that antibiotics do not speed up recovery from a cold (30.0%), or that a child with fever does not always need one (26.0%). Knowledge of how antibiotics should be used was also poor. Only 32.0% knew that a course should not be stopped as soon as the child feels better, 37.3% that leftover antibiotics should not be reused, and 27.7% that a sibling's antibiotic should not be shared. Fewer than half were aware that unnecessary use leads to resistance (47.3%) or that resistant bacteria can spread from person to person (39.3%).

Knowledge levels differed by site ($p < 0.001$). Good knowledge was found in 29.0% of caregivers in Sulaymaniyah and 19.0% in Ranya, but in none in Erbil, although median scores did not differ significantly ($p = 0.071$). The gaps were widest for the items on appropriate use. Caregivers in Sulaymaniyah were three to four times more likely than those in Erbil to answer correctly about stopping a course early (51.0% vs 15.0%), reusing leftovers (64.0% vs 21.0%) and sharing a sibling's antibiotic (43.0% vs 11.0%). In Erbil, only a quarter of caregivers (25.0%) knew that antibiotics do not kill viruses (Fig. 4). The knowledge scale showed good internal consistency (KR-20 = 0.85).

Table 3

A. Caregivers' knowledge about antibiotics, overall and by study site.

Statement (correct answer)	**Total (N = 300)**	**Ranya (n = 100)**	**Sulaymaniyah (n = 100)**	**Erbil (n = 100)**	**p-value**
G1. Antibiotics kill viruses (False)	149 (49.7)	68 (68.0)	56 (56.0)	25 (25.0)	< 0.001
G2. Antibiotics are effective against bacteria (True)	245 (81.7)	95 (95.0)	67 (67.0)	83 (83.0)	< 0.001
G3. Most coughs and colds in children get better without antibiotics (True)	146 (48.7)	47 (47.0)	52 (52.0)	47 (47.0)	0.716
G4. Antibiotics make a child recover faster from the common cold (False)	90 (30.0)	20 (20.0)	45 (45.0)	25 (25.0)	< 0.001
G5. Every child with fever needs an antibiotic (False)	78 (26.0)	21 (21.0)	36 (36.0)	21 (21.0)	0.020
G6. Most sore throats in young children are caused by viruses (True)	123 (41.0)	44 (44.0)	40 (40.0)	39 (39.0)	0.749
G7. Using antibiotics when not needed makes them stop working in the future (True)	142 (47.3)	56 (56.0)	52 (52.0)	34 (34.0)	0.004
G8. Resistant bacteria can spread from person to person (True)	118 (39.3)	45 (45.0)	26 (26.0)	47 (47.0)	0.004
G9. Antibiotics can cause side effects such as diarrhoea, rash or allergic reactions (True)	150 (50.0)	62 (62.0)	37 (37.0)	51 (51.0)	0.002
G10. An antibiotic can be stopped as soon as the child feels better (False)	96 (32.0)	30 (30.0)	51 (51.0)	15 (15.0)	< 0.001
G11. Leftover antibiotics are safe to use for a later illness (False)	112 (37.3)	27 (27.0)	64 (64.0)	21 (21.0)	< 0.001
G12. An antibiotic prescribed for one child can be given to a sibling with similar symptoms (False)	83 (27.7)	29 (29.0)	43 (43.0)	11 (11.0)	< 0.001
Knowledge score (0–12), median (IQR)	5 (2–7)	5 (3–7.75)	6 (1–10)	4 (3–5)	0.071
Knowledge score, mean ± SD	5.11 ± 3.48	5.44 ± 3.28	5.69 ± 4.62	4.19 ± 1.76	

Note: Values are n (%) of caregivers answering correctly unless otherwise stated. "Don't know" was scored as incorrect. p-values are from Pearson's χ^2 test unless marked. Kruskal–Wallis test. KR-20 = 0.85.

Statement (correct answer)	Total (N = 300)	Ranya (n = 100)	Sulaymaniyah (n = 100)	Erbil (n = 100)	p-value
Knowledge level					< 0.001
Poor (< 60%)	227 (75.7)	75 (75.0)	57 (57.0)	95 (95.0)	
Moderate (60–79%)	25 (8.3)	6 (6.0)	14 (14.0)	5 (5.0)	
Good (≥ 80%)	48 (16.0)	19 (19.0)	29 (29.0)	0 (0.0)	

Note: Values are n (%) of caregivers answering correctly unless otherwise stated. "Don't know" was scored as incorrect. p-values are from Pearson's χ^2 test unless marked. Kruskal–Wallis test. KR-20 = 0.85.

Many caregivers held attitudes that favoured antibiotic use (Table 3B; Fig. 5). More than half expected to be given an antibiotic for a cold (55.7%) and believed that starting antibiotics early keeps an illness from getting worse (51.7%). Almost half (48.7%) said they would get an antibiotic elsewhere if a doctor did not prescribe one, and nearly three-quarters (73.0%) regarded a pharmacist's advice as being as good as a doctor's. Most caregivers (61.9%) agreed that antibiotic resistance could affect their own family, yet 39.3% still thought it sensible to keep antibiotics at home. Attitude scores differed between sites ($p < 0.001$) and were highest in Sulaymaniyah. Caregivers with better knowledge tended to hold more appropriate attitudes, with a moderate correlation between the two scores (Spearman $\rho = 0.54$, $p < 0.001$).

Table 3

B. Caregivers' attitudes towards antibiotic use, overall and by study site.

Statement	Agree□	Neutral	Disagree□	Agree, Ranya	Agree, Sulaymaniyah	Agree, Erbil	p-value
H1. I expect the doctor to prescribe an antibiotic when my child has a cold	167 (55.7)	48 (16.0)	85 (28.3)	61 (61.0)	56 (56.0)	50 (50.0)	0.528
H2. It is sensible to keep antibiotics at home in case my child gets sick	118 (39.3)	90 (30.0)	92 (30.7)	51 (51.0)	28 (28.0)	39 (39.0)	< 0.001
H3. The pharmacist's advice on antibiotics is as good as the doctor's	219 (73.0)	57 (19.0)	24 (8.0)	62 (62.0)	72 (72.0)	85 (85.0)	0.003
H4. Giving antibiotics early stops a child's illness from getting worse	155 (51.7)	51 (17.0)	94 (31.3)	65 (65.0)	48 (48.0)	42 (42.0)	< 0.001
H5. If a doctor did not prescribe an antibiotic, I would get one elsewhere	146 (48.7)	51 (17.0)	103 (34.3)	68 (68.0)	41 (41.0)	37 (37.0)	< 0.001
H6. Antibiotic resistance is a problem that could affect my own family□	185 (61.9)	76 (25.4)	38 (12.7)	83 (83.0)	55 (55.6)	47 (47.0)	< 0.001
Attitude score (6–30), median (IQR)□	16 (15–20)			15 (14–17.75)	18 (15–21)	17 (15–18)	< 0.001□
Attitude score, mean ± SD	17.25 ± 3.26			16.94 ± 3.97	18.14 ± 2.85	16.67 ± 2.64	

Note: Values are n (%) unless otherwise stated. □ Agree or strongly agree. □ Disagree or strongly disagree. □ n = 299. □ Higher scores indicate more appropriate attitudes; H1–H5 were reverse-scored; n = 299. □ Kruskal–Wallis test. Other p-values are from Pearson's χ^2 test (agree/neutral/disagree by site). Cronbach's α = 0.57.

3.4. Factors associated with non-prescription antibiotic use

In the crude analysis, many factors were linked to non-prescription use (Table 4). These were study site, caregiver age, lower education and income, rural residence, having no health-care worker in the household, older child age, more illness episodes, using a pharmacy as the first place of care, cost and access barriers, home storage, lower knowledge and less appropriate attitudes.

After adjustment, three factors remained independently associated with non-prescription use. Children in Ranya had much higher odds than those in Sulaymaniyah (aOR 12.21, 95% CI 3.19–46.75). Each additional correct knowledge answer was associated with 26% lower odds (aOR 0.74, 95% CI 0.62–0.87), and each one-point rise in attitude score with 22% lower odds (aOR 0.78, 95% CI 0.68–0.90) (Fig. 6). Using a pharmacy as the first place of care (aOR 2.38, 95% CI 0.98–5.79; p = 0.055) and the number of illness episodes (aOR 1.16 per episode, 95% CI 0.99–1.34; p = 0.059) were of borderline significance. The model was significant overall (likelihood-ratio $\chi^2 = 189.72$, df = 12, $p < 0.001$; Nagelkerke $R^2 = 0.655$). It fitted the data adequately (Hosmer–Lemeshow $\chi^2 = 14.28$, df = 8, p = 0.075), classified 86.6% of children correctly, and discriminated very well (AUC 0.92, 95% CI 0.89–0.95). Multicollinearity was not a concern, with all VIFs ≤ 2.37.

Because odds ratios exaggerate effects when an outcome is common, we also expressed these associations as adjusted prevalence ratios (Table 4). On this scale, children in Ranya were 30% more likely than those in Sulaymaniyah to have received a non-prescription antibiotic (aPR 1.30, 95% CI 1.13–1.61). Each additional correct knowledge answer and each one-point rise in attitude score was associated with a 4% lower prevalence (aPR 0.96, 95% CI 0.93–0.98, and aPR 0.96, 0.94–0.99, respectively).

Table 4

Factors associated with non-prescription antibiotic use in children: crude and multivariable binary logistic regression, with adjusted prevalence ratios (N = 300).

Variable	NPA use n/N (%)	Crude OR (95% CI)	p	aOR (95% CI)	p	aPR (95% CI)
Study site						
Sulaymaniyah (ref.)	48/100 (48.0)	1		1		1
Ranya	83/100 (83.0)	5.29 (2.75–10.16)	< 0.001	12.21 (3.19–46.75)	< 0.001	1.30 (1.13–1.61)
Erbil	71/100 (71.0)	2.65 (1.48–4.75)	0.001	0.58 (0.18–1.86)	0.359	0.90 (0.71–1.18)
Respondent						
Other caregiver (ref.)	69/105 (65.7)	1		—		—
Mother	133/195 (68.2)	1.12 (0.68–1.85)	0.661	—		—
Caregiver age						
18–29 years (ref.)	54/73 (74.0)	1		—		—
30–39 years	76/140 (54.3)	0.42 (0.23–0.78)	0.006	—		—
≥ 40 years	72/87 (82.8)	1.69 (0.79–3.62)	0.178	—		—
Caregiver education						
Primary or less (ref.)	40/50 (80.0)	1		1		1

Note: NPA, non-prescription antibiotic use (yes, n = 202; no or not sure, n = 98); OR, odds ratio; aOR, adjusted odds ratio; aPR, adjusted prevalence ratio; CI, confidence interval; ref., reference; "—", not included in the multivariable model. [1] Model (n = 299) including all variables with an aOR shown. Likelihood-ratio $\chi^2 = 189.72$, df = 12, $p < 0.001$; Nagelkerke $R^2 = 0.655$; Hosmer–Lemeshow p = 0.075; AUC = 0.92. [2] Mean ± SD among children with vs without non-prescription use. [3] Derived from the multivariable logistic model by marginal standardisation (predictive margins); 95% CIs from 5,000 bootstrap resamples.

Variable	NPA use n/N (%)	Crude OR (95% CI)	p	aOR (95% CI)	p	aPR (95% CI)
Study site						
Intermediate/secondary	75/95 (78.9)	0.94 (0.40–2.20)	0.882	1.29 (0.44–3.83)	0.644	1.04 (0.88–1.25)
Diploma or higher	87/155 (56.1)	0.32 (0.15–0.69)	0.003	1.09 (0.35–3.36)	0.885	1.01 (0.84–1.22)
Caregiver employed (yes vs no)	129/198 (65.2) vs 73/102 (71.6)	0.74 (0.44–1.25)	0.262	—		—
Rural residence (yes vs no)	46/56 (82.1) vs 156/244 (63.9)	2.60 (1.25–5.40)	0.011	—		—
Monthly income (IQD)						
< 500,000 (ref.)	61/75 (81.3)	1		1		1
500,000 – <1,000,000	128/176 (72.7)	0.61 (0.31–1.20)	0.150	0.75 (0.30–1.86)	0.537	0.96 (0.83–1.11)
≥ 1,000,000	13/49 (26.5)	0.08 (0.04–0.20)	< 0.001	0.73 (0.18–3.00)	0.662	0.96 (0.70–1.18)
Health-care worker in household (yes vs no)	26/67 (38.8) vs 176/233 (75.5)	0.21 (0.12–0.37)	< 0.001	0.60 (0.25–1.44)	0.248	0.92 (0.77–1.07)
Child age						
6–23 months (ref.)	94/150 (62.7)	1		—		—
24–59 months	74/107 (69.2)	1.34 (0.79–	0.281	—		—

Note: NPA, non-prescription antibiotic use (yes, n = 202; no or not sure, n = 98); OR, odds ratio; aOR, adjusted odds ratio; aPR, adjusted prevalence ratio; CI, confidence interval; ref., reference; "—", not included in the multivariable model. Model (n = 299) including all variables with an aOR shown. Likelihood-ratio $\chi^2 = 189.72$, df = 12, $p < 0.001$; Nagelkerke $R^2 = 0.655$; Hosmer–Lemeshow p = 0.075; AUC = 0.92. Mean ± SD among children with vs without non-prescription use. Derived from the multivariable logistic model by marginal standardisation (predictive margins); 95% CIs from 5,000 bootstrap resamples.

Variable	NPA use n/N (%)	Crude OR (95% CI)	p	aOR⁂ (95% CI)	p	aPR⁂ (95% CI)
Study site						
		2.26)				
60–143 months	34/43 (79.1)	2.25 (1.01–5.04)	0.048	—		—
Child female (yes vs no)	107/163 (65.6) vs 95/137 (69.3)	0.85 (0.52–1.37)	0.496	—		—
Chronic condition (yes vs no)	38/50 (76.0) vs 164/250 (65.6)	1.66 (0.83–3.34)	0.155	—		—
Illness episodes, past 6 months (per episode)	5.97 ± 3.33 vs 3.72 ± 2.83⁂	1.31 (1.18–1.45)	< 0.001	1.16 (0.99–1.34)	0.059	1.02 (1.00–1.04)
Pharmacy as first place of care (yes vs no)	146/172 (84.9) vs 56/128 (43.8)	7.22 (4.19–12.44)	< 0.001	2.38 (0.98–5.79)	0.055	1.16 (0.99–1.42)
Forgone doctor visit because of cost (yes vs no)	179/210 (85.2) vs 23/90 (25.6)	16.82 (9.16–30.90)	< 0.001	1.39 (0.51–3.81)	0.525	1.05 (0.90–1.33)
Very difficult/impossible to pay 25,000 IQD (yes vs no)	109/124 (87.9) vs 93/176 (52.8)	6.49 (3.50–12.00)	< 0.001	—		—
Health insurance (yes vs no)	13/19 (68.4) vs 189/281 (67.3)	1.06 (0.39–2.86)	0.917	—		—

Note: NPA, non-prescription antibiotic use (yes, n = 202; no or not sure, n = 98); OR, odds ratio; aOR, adjusted odds ratio; aPR, adjusted prevalence ratio; CI, confidence interval; ref., reference; "—", not included in the multivariable model. ⁂ Model (n = 299) including all variables with an aOR shown. Likelihood-ratio $\chi^2 = 189.72$, df = 12, $p < 0.001$; Nagelkerke $R^2 = 0.655$; Hosmer–Lemeshow p = 0.075; AUC = 0.92. ⁂ Mean ± SD among children with vs without non-prescription use. ⁂ Derived from the multivariable logistic model by marginal standardisation (predictive margins); 95% CIs from 5,000 bootstrap resamples.

Variable	NPA use n/N (%)	Crude OR (95% CI)	p	aOR (95% CI)	p	aPR (95% CI)
Study site						
Barrier: high cost of visit (yes vs no)	187/233 (80.3) vs 15/67 (22.4)	14.09 (7.29–27.23)	< 0.001	—		—
Barrier: long waiting time (yes vs no)	161/208 (77.4) vs 41/92 (44.6)	4.26 (2.52–7.20)	< 0.001	—		—
Barrier: busy work schedule (yes vs no)	130/167 (77.8) vs 72/133 (54.1)	2.98 (1.81–4.91)	< 0.001	—		—
Antibiotics stored at home (yes vs no)	132/154 (85.7) vs 70/146 (47.9)	6.51 (3.74–11.36)	< 0.001	—		—
Knowledge score (per 1-point increase)	3.68 ± 2.44 vs 8.04 ± 3.47	0.63 (0.57–0.70)	< 0.001	0.74 (0.62–0.87)	< 0.001	0.96 (0.93–0.98)
Attitude score (per 1-point increase)	15.89 ± 2.20 vs 20.03 ± 3.32	0.59 (0.53–0.67)	< 0.001	0.78 (0.68–0.90)	0.001	0.96 (0.94–0.99)

Note: NPA, non-prescription antibiotic use (yes, n = 202; no or not sure, n = 98); OR, odds ratio; aOR, adjusted odds ratio; aPR, adjusted prevalence ratio; CI, confidence interval; ref., reference; "—", not included in the multivariable model. Model (n = 299) including all variables with an aOR shown. Likelihood-ratio $\chi^2 = 189.72$, df = 12, $p < 0.001$; Nagelkerke $R^2 = 0.655$; Hosmer–Lemeshow p = 0.075; AUC = 0.92. Mean ± SD among children with vs without non-prescription use. Derived from the multivariable logistic model by marginal standardisation (predictive margins); 95% CIs from 5,000 bootstrap resamples.

Knowledge and attitude stayed strongly associated with non-prescription use in every sensitivity analysis. Adding residence and child age, replacing forgone care with the cost barrier, or adding home storage made almost no difference: knowledge aORs ranged from 0.73 to 0.74 and attitude aORs from 0.77 to 0.79. When we left out the “not sure” responses (n = 277), both remained significant (knowledge aOR 0.66, 95% CI 0.50–0.87; attitude aOR 0.65, 0.51–0.84). Two further factors became significant in that model: using a pharmacy as the first place of care (aOR 6.28, 1.75–22.55) and having a health-care worker in the household (aOR 0.22, 0.06–0.81). The Ranya estimate, however, became very imprecise, because so few Ranya children were non-users.

Firth's penalised logistic regression told the same story. Living in Ranya (aOR 10.05, 95% CI 3.01–39.14), better knowledge (aOR 0.75, 0.64–0.88) and more appropriate attitudes (aOR 0.80, 0.70–0.91) remained independently associated with non-prescription use, and the other estimates barely changed (Fig. 6). With the "not sure" responses excluded, knowledge (aOR 0.70, 0.53–0.88) and attitude (aOR 0.70, 0.55–0.86) were still significant. The Ranya estimate stayed high but was again imprecise (aOR 46.93, 8.44–387.10) (Supplementary Table S1).

4. Discussion

This multicentered study conducted in the Kurdistan Region of Iraq has shown that two-thirds of children (67.3%) received an antibiotic over the previous six months without a prescription. In addition, four out of five kids who received any form of antibiotic has had at least one non-prescription course. The primary source of antibiotics was community pharmacies, while the most usual reason for taking an antibiotic was a fever. It was established that short courses were the major type of treatment being employed; 40% of the courses were performed by WHO Watch antibiotics, while half of the families kept the drugs at home. This study shows that caregivers had poor knowledge and the attitude towards antibiotics was rather positive. It is proved that there is a connection between a low level of knowledge and less proper practice.

4.1. Prevalence of non-prescription antibiotic use

The prevalence we found is high. Giving children antibiotics without a prescription has been widely documented in China, where national, multi-province and regional surveys have repeatedly found substantial non-prescription use [2, 3, 5, 8, 9]. Similar practices have been reported in Bangladesh [4], Saudi Arabia [12], Tanzania [10], Egypt [11], Mexico [21] and Romania [14]. Levels are lower in high-income settings such as the United States [20], and where the supply of paediatric antibiotics is more tightly regulated, the routes by which families obtain them also differ [15]. Our findings agree with a recent national survey of Iraqi parents, which reported frequent inappropriate antibiotic practices for children [48]. Our study adds to that evidence by measuring actual use over a defined recall period in three cities. The high prevalence is worrying for two reasons. The burden of AMR is greatest in low- and middle-income regions [1], and children given non-prescription antibiotics before a visit are more likely to be prescribed antibiotics by the physician they then see [7, 24]. Self-medication and over-prescribing may therefore feed each other.

The almost twofold difference between sites (83.0% in Ranya vs 48.0% in Sulaymaniyah) is an important finding. Ranya is a smaller, more traditional town with fewer employment opportunities than the two regional capitals. Its caregivers reported the longest travel time to paediatric care (median 40 minutes), and the highest proportions who had forgone a doctor visit because of cost (83.0%) or found 25,000 IQD very difficult or impossible to pay (63.0%). They also held the least appropriate attitudes: 68.0% would obtain an antibiotic elsewhere if a doctor refused. Ranya caregivers did not have the lowest knowledge scores, which were lowest in Erbil. This suggests that in Ranya, the cost of consultations and a long-

standing local habit of obtaining medicines directly from pharmacies drive non-prescription use more than knowledge gaps alone. By contrast, Sulaymaniyah families reported markedly fewer cost, waiting-time and work-schedule barriers and had the lowest home storage. These differences indicate that local economic conditions, health-system access and community norms shape non-prescription use, as reported in studies comparing populations and regions [25, 43]. The Ranya effect persisted after adjustment and after correction for small-sample bias with penalised regression. Its large and imprecise odds ratio reflects both the common outcome and the small number of non-users in Ranya; expressed as a prevalence ratio, children in Ranya were about 30% more likely than those in Sulaymaniyah to receive a non-prescription antibiotic (aPR 1.30), which is a more interpretable measure of the effect.

4.2. Sources, symptoms and agents

Nearly seven in ten non-prescription courses came directly from community pharmacies, either at the caregiver's request or on the pharmacist's suggestion, and pharmacists were the most common advisers. This mirrors evidence that antibiotics are readily dispensed without a prescription in Iraqi community pharmacies [47], across the Arab region [13] and in other low- and middle-income countries [30–33]. Pharmacists' knowledge of paediatric antibiotic indications and dosing is often limited in the region [34, 35]. Caregivers in our study also placed high trust in pharmacists: 73.0% considered their advice as good as a doctor's. Pharmacists are therefore both a key driver of and a key opportunity for paediatric stewardship.

Fever, diarrhoea/vomiting, sore throat and cough/cold, conditions that are mostly viral or self-limiting in children, accounted for most episodes. This is consistent with the widespread belief that antibiotics speed recovery and that every febrile child needs one [5, 17, 18]. Amoxicillin, azithromycin and amoxicillin-clavulanate dominated. The frequent use of azithromycin, cefixime and ceftriaxone meant that 39.6% of courses were WHO Watch antibiotics, which carry a higher resistance potential and should be prioritised for stewardship [50, 52]. Most courses lasted less than 5 days, which suggests that antibiotics were often stopped when symptoms improved, in line with the 68.0% of caregivers who did not know that a course should not be stopped early. The eight non-prescription injections, seven of them in Erbil, are particularly concerning because of the risks of parenteral administration outside clinical supervision.

4.3. Home storage and reuse

Half of households stored antibiotics at home, and most of these had been bought without a prescription. Reusing old prescriptions and leftover antibiotics accounted for almost a third of non-prescription episodes. Similar storage and reuse practices have been reported in Türkiye [36], in a seven-country study in developing countries [37], in Pakistan [38] and in Bangladesh [39]. Home stockpiles create an immediate, low-cost alternative to medical consultation and normalise self-treatment, so safe-disposal and "no leftovers" messaging should be part of caregiver education [36, 37].

4.4. Knowledge and attitudes

Caregivers' knowledge was poor: only half knew that antibiotics do not kill viruses, and fewer than one-third knew that antibiotics do not speed recovery from a cold or that not every child with fever needs one. Knowledge of resistance was also limited. These findings are consistent with KAP studies of parents in Iraq [48], Bosnia and Herzegovina [16], Romania [17], Greece [18], Georgia [54], Peru [22], Kosovo [19] and Mexico [23], and with population surveys showing limited public understanding of AMR in the WHO European region [45, 46]. Each additional correct knowledge answer and each more appropriate attitude point independently lowered the prevalence of non-prescription use by about 4%. These are modifiable targets, and educational interventions for family caregivers in primary care have improved antibiotic knowledge and practices [49]. However, knowledge alone may be insufficient: qualitative studies show that parents' decisions are also shaped by uncertainty, previous experience, convenience and trust in pharmacists [6, 26–28]. In our study, 48.7% of caregivers would obtain an antibiotic elsewhere if a doctor declined to prescribe one, and over half expected an antibiotic for a cold. Parental expectations of this kind put pressure on prescribers [29].

4.5. Access, cost and health-system factors

Cost was a striking barrier: 70.0% of caregivers had forgone a needed doctor visit because of cost, and fewer than 7% of children had health insurance. In the crude analysis, cost barriers, difficulty paying, rural residence and lower income were strongly associated with non-prescription use. These associations weakened after adjustment for site, knowledge and attitudes, suggesting that they act largely through local access patterns and caregivers' beliefs. Comparable links between self-medication with antibiotics and access to care have been reported in Iran [40], Pakistan [41], China [43] and Georgia [44]. In Saudi Arabia, public attitudes towards antibiotic use have been examined following the enforcement of prescription-only regulations [42]. Similar regulatory enforcement in the KRI, combined with affordable access to paediatric consultations, is likely to be needed alongside education.

4.6. Implications for policy and practice

Four complementary actions follow from these findings. The first is stronger enforcement of prescription-only dispensing of antibiotics in community pharmacies [13, 42, 47]. The second is to train and engage community pharmacists in paediatric stewardship, including advice for viral illness and appropriate referral [34, 35]. The third is caregiver education focused on fever and viral illness, completing courses and avoiding leftovers and sharing [49]. The fourth is to reduce the financial and time barriers to paediatric consultations. Monitoring paediatric antibiotic use with the AWaRe framework would help track progress [50, 52].

4.7. Strengths and limitations

This study has a number of strengths. To our knowledge, no previous multicentre study has looked at non-prescription antibiotic use in children in the KRI. We recruited the same number of caregivers in each of three cities, and very few declined: 93.8% of those approached took part. The questionnaire had been piloted, and the show-card helped caregivers point to the exact product their child had taken. Rather than asking what parents *would* do, we asked what they had actually done in the past 6 months, including

where the antibiotic came from, which one it was, its AWaRe category and whether any was kept at home. Each record was checked against its paper questionnaire, and our main findings held up in every sensitivity analysis we ran, including penalised regression and prevalence ratios.

There are also limitations to keep in mind. Everything we know about antibiotic use comes from what caregivers told us. Six months is a long time to remember every course, and some parents may have played down giving antibiotics without a prescription, so the true figure could be higher than ours. We recruited at hospitals, and families who come to hospital are not necessarily typical of all families in the region, which limits how far the results can be generalised across the KRI. Because the study is cross-sectional, it cannot show cause and effect. Poor knowledge may encourage non-prescription use, but the reverse is also possible: families used to treating their children this way may hold beliefs that justify it. Each site had a single interviewer, so a site effect cannot be fully separated from an interviewer effect. All three were trained and used the same tools, but the bimodal spread of knowledge scores in Sulaymaniyah may partly reflect how interviews were conducted there. The attitude scale had only modest internal consistency ($\alpha = 0.57$). Counting “not sure” answers as non-use was a conservative choice; excluding them raised prevalence to 72.7%. Lastly, so few Ranya children were non-users that the odds ratio for Ranya was imprecise, although penalised regression and prevalence ratios both pointed in the same direction.

5. Conclusions

Two in three children in the Kurdistan Region of Iraq received an antibiotic without a prescription in the previous 6 months, mainly obtained from community pharmacies, often for fever and other self-limiting illnesses, frequently as short courses and in two of five cases as WHO Watch antibiotics. Half of households stored antibiotics at home, caregivers' knowledge was poor, and lower knowledge and less appropriate attitudes were independently associated with non-prescription use. Enforcing prescription-only dispensing, engaging pharmacists in stewardship, educating caregivers and reducing financial barriers to paediatric care should be prioritised to curb non-prescription antibiotic use and the spread of resistance in children.

Abbreviations

Abbreviation	Definition
AMR	Antimicrobial resistance
ANOVA	Analysis of variance
aOR	Adjusted odds ratio
aPR	Adjusted prevalence ratio
AUC	Area under the receiver operating characteristic curve
AWaRe	Access, Watch and Reserve (WHO antibiotic classification)
CI	Confidence interval
IQD	Iraqi dinar
IQR	Interquartile range
KAP	Knowledge, attitudes and practices
KR-20	Kuder–Richardson Formula 20
KRI	Kurdistan Region of Iraq
NPA	Non-prescription antibiotic (use)
OR	Odds ratio
SD	Standard deviation
STROBE	Strengthening the Reporting of Observational Studies in Epidemiology
VIF	Variance inflation factor
WHO	World Health Organization

Declarations

Author Contribution

Himat Mamand. conceived and designed the study, supervised data collection, performed the statistical analysis, interpreted the data, and drafted the original manuscript. Handren Murad. collected the data in Erbil, contributed to data curation and verification, and critically revised the manuscript for important intellectual content. Saya Hama. collected the data in Ranya and contributed to data curation and verification. Ako Ahmed. collected the data in Sulaymaniyah and contributed to data curation and verification. All authors reviewed and approved the final version of the manuscript and agreed to be accountable for all aspects of the work.

References

1. Antimicrobial Resistance Collaborators (2022) Global burden of bacterial antimicrobial resistance in 2019: a systematic analysis. Lancet 399(10325):629–655. https://doi.org/10.1016/S0140-6736(21)02724-0
2. Lin L, Harbarth S, Wang X, Zhou X (2020) Survey of parental use of antimicrobial drugs for common childhood infections, China. Emerg Infect Dis 26(7):1517–1520. https://doi.org/10.3201/eid2607.190631
3. Lin L, Harbarth S, Hargreaves JR, Zhou X, Li L (2021) Large-scale survey of parental antibiotic use for paediatric upper respiratory tract infections in China: implications for stewardship programmes and national policy. Int J Antimicrob Agents 57(4):106302. https://doi.org/10.1016/j.ijantimicag.2021.106302
4. Dash S, Sultana E, Rahman MR, Naz F, Ali M, Faruque ASG et al (2026) Antibiotic use and care-seeking practices for childhood diarrhea and respiratory illnesses in community settings in Bangladesh: a cross-sectional caregiver survey. Antibiot (Basel) 15(6):603. https://doi.org/10.3390/antibiotics15060603
5. Qu W, Wang X, Liu Y, Mao J, Liu M, Zhong Y et al (2023) Self-medication with antibiotics among children in China: a cross-sectional study of parents' knowledge, attitudes, and practices. Infect Drug Resist 16:7683–7694. https://doi.org/10.2147/IDR.S431034
6. Pei D, Kreps G, Zhao X (2023) The role of uncertainty and negative emotion in Chinese parents' self-medication of children with antibiotics. Int J Environ Res Public Health 20(16):6603. https://doi.org/10.3390/ijerph20166603
7. Wang NC (2022) Pre-visit use of non-prescribed antibiotics among child patients in China: prevalence, predictors, and association with physicians' prescribing of antibiotics at medical visits. Antibiot (Basel) 11(11):1553. https://doi.org/10.3390/antibiotics11111553
8. Yuan J, Du W, Li Z, Deng Q, Ma G (2022) Prevalence and risk factors of self-medication among the pediatric population in China: a national survey. Front Public Health 9:770709. https://doi.org/10.3389/fpubh.2021.770709
9. Sun H, Wang Z, Huang J, An N, Jiao M, Zhu X et al (2025) Prevalence of inappropriate use behaviors of antibiotics and related factors among parents in eastern China: an online cross-sectional survey. Front Public Health 13:1654293. https://doi.org/10.3389/fpubh.2025.1654293
10. Simon B, Kazaura M (2020) Prevalence and factors associated with parents self-medicating under-fives with antibiotics in Bagamoyo District Council, Tanzania: a cross-sectional study. Patient Prefer Adherence 14:1445–1453. https://doi.org/10.2147/PPA.S263517
11. Ahmed DS, AboElela AM, Ismail SS, Hammour ZE, Fawaz RA, Abdelmoniem ME (2024) Pattern of antibiotic use among children caregivers: a cross-sectional study. J Egypt Public Health Assoc 99(1):33. https://doi.org/10.1186/s42506-024-00176-6
12. Paulsamy P, Venkatesan K, Hamoud Alshahrani S, Hamed Mohamed Ali M, Prabahar K, Prabhu Veeramani V et al (2023) Parental health-seeking behavior on self-medication, antibiotic use, and

antimicrobial resistance in children. Saudi Pharm J 31(9):101712. https://doi.org/10.1016/j.jsps.2023.101712

13. Hafez H, Rakab MS, Elshehaby A, Gebreel AI, Hany M, BaniAmer M et al (2024) Pharmacies and use of antibiotics: a cross sectional study in 19 Arab countries. Antimicrob Resist Infect Control 13(1):104. https://doi.org/10.1186/s13756-024-01458-6
14. Tarciuc P, Stanescu AMA, Diaconu CC, Paduraru L, Duduciuc A, Diaconescu S (2020) Patterns and factors associated with self-medication among the pediatric population in Romania. Med (Kaunas) 56(6):312. https://doi.org/10.3390/medicina56060312
15. Sultana J, Trifirò G, Ientile V, Fontana A, Rossi F, Capuano A et al (2020) Traceability of pediatric antibiotic purchasing pathways in Italy: a nationwide real-world drug utilization analysis. Front Pharmacol 11:1232. https://doi.org/10.3389/fphar.2020.01232
16. Mijović B, Aćimović J, Đaković Dević J, Kralj J, Lučić Samardžija V, Djermanović M et al (2022) Knowledge, attitudes and practices of parents and pediatricians regarding antibiotic use among children: differences in relation to the level of education of the parents in the Republic of Srpska Bosnia and Herzegovina. Antibiot (Basel) 11(10):1325. https://doi.org/10.3390/antibiotics11101325
17. Iuhas A, Galiș R, Rus M, Balmoș A, Marinău C, Niulaș L et al (2025) Misconceptions and behavioral risks in parental antibiotic use on Romanian children: a cross-sectional study on knowledge, attitudes, and practices. Antibiot (Basel) 14(5):479. https://doi.org/10.3390/antibiotics14050479
18. Oikonomou ME, Gkentzi D, Karatza A, Fouzas S, Vervenioti A, Dimitriou G (2021) Parental knowledge, attitude, and practices on antibiotic use for childhood upper respiratory tract infections during COVID-19 pandemic in Greece. Antibiot (Basel) 10(7):802. https://doi.org/10.3390/antibiotics10070802
19. Imeri M, Krasniqi S, Raka L, Humolli I, Hoti K, Imeri Z et al (2023) Evaluation of parents' attitudes and practices related to antibiotic use for their children in Kosovo: a cross-sectional survey. J Pharm Policy Pract 16(1):168. https://doi.org/10.1186/s40545-023-00676-4
20. Olmeda K, Trautner BW, Laytner L, Salinas J, Marton S, Grigoryan L (2023) Prevalence and predictors of using antibiotics without a prescription in a pediatric population in the United States. Antibiot (Basel) 12(3):491. https://doi.org/10.3390/antibiotics12030491
21. Alonso-Castro AJ, Ruiz-Noa Y, Martínez-de la Cruz GC, Ramírez-Morales MA, Deveze-Álvarez MA, Escutia-Gutiérrez R et al (2022) Factors and practices associated with self-medicating children among Mexican parents. Pharmaceuticals (Basel) 15(9):1078. https://doi.org/10.3390/ph15091078
22. Paredes JL, Navarro R, Watanabe T, Morán F, Balmaceda MP, Reateguí A et al (2022) Knowledge, attitudes and practices of parents towards antibiotic use in rural communities in Peru: a cross-sectional multicentre study. BMC Public Health 22(1):459. https://doi.org/10.1186/s12889-022-12855-0
23. González-Villoria AM, García Quiroz AD, Osorio Guzmán EU, Suarez-Herrera JC, Abeldaño Zuñiga RA (2024) Knowledge, attitudes, and practices of parents in the use of antibiotics: a case study in a

Mexican indigenous community. Healthc (Basel) 12(3):294. https://doi.org/10.3390/healthcare12030294

24. Xu J, Wang X, Sun KS, Lin L, Zhou X (2020) Parental self-medication with antibiotics for children promotes antibiotic over-prescribing in clinical settings in China. Antimicrob Resist Infect Control 9(1):150. https://doi.org/10.1186/s13756-020-00811-9
25. Zhou Z, Zhao D, Zhang H, Shen C, Cao D, Liu G et al (2021) Understanding parental self-medication with antibiotics among parents of different nationalities: a cross-sectional study. Glob Health Res Policy 6(1):42. https://doi.org/10.1186/s41256-021-00226-y
26. Haq IU, Azhar SH, Zakki SA, Hu X (2025) A qualitative exploration of parental perspectives and behaviors on self-medication for children under five in Abbottabad, Pakistan. Front Pediatr 13:1445219. https://doi.org/10.3389/fped.2025.1445219
27. Marsh SA, Byrne MK, Parsafar S (2023) What influences parental decisions about antibiotic use with their children: a qualitative study in rural Australia. PLoS ONE 18(7):e0288480. https://doi.org/10.1371/journal.pone.0288480
28. Tarciuc P, Plești DA, Duduciuc A, Gimiga N, Tătăranu E, Herdea V et al (2022) Self-medication patterns during a pandemic: a qualitative study on Romanian mothers' beliefs toward self-treatment of their children. Healthc (Basel) 10(9):1602. https://doi.org/10.3390/healthcare10091602
29. Arnau-Sánchez J, Jiménez-Guillén C, Alcaraz-Quiñonero M, Vigueras-Abellán JJ, Garnica-Martínez B, Soriano-Ibarra JF et al (2023) Factors influencing inappropriate use of antibiotics in infants under 3 years of age in primary care: a qualitative study of the paediatricians' perceptions. Antibiot (Basel) 12(4):727. https://doi.org/10.3390/antibiotics12040727
30. Ndaki PM, Mushi MF, Mwanga JR, Konje ET, Ntinginya NE, Mmbaga BT et al (2021) Dispensing antibiotics without prescription at community pharmacies and accredited drug dispensing outlets in Tanzania: a cross-sectional study. Antibiot (Basel) 10(8):1025. https://doi.org/10.3390/antibiotics10081025
31. Aziz MM, Haider F, Rasool MF, Hashmi FK, Bahsir S, Li P et al (2021) Dispensing of non-prescribed antibiotics from community pharmacies of Pakistan: a cross-sectional survey of pharmacy staff's opinion. Antibiot (Basel) 10(5):482. https://doi.org/10.3390/antibiotics10050482
32. Shi L, Chang J, Liu X, Zhai P, Hu S, Li P et al (2020) Dispensing antibiotics without a prescription for acute cough associated with common cold at community pharmacies in Shenyang, northeastern China: a cross-sectional study. Antibiot (Basel) 9(4):163. https://doi.org/10.3390/antibiotics9040163
33. Maluleke TM, Maluleke MT, Ramdas N, Golić Jelić A, Kurdi A, Chigome A et al (2025) Prevalence and associated factors for purchasing antibiotics without a prescription among patients in rural South Africa: implications for addressing antimicrobial resistance. Antibiot (Basel) 14(12):1273. https://doi.org/10.3390/antibiotics14121273
34. Aiesh BM, Saleh S, Matouk N, Labadi M, Kmail S, Baddad Z et al (2024) Assessing pediatric antibiotic knowledge and practices among community pharmacists in Palestine: implications for

antibiotic use and resistance. BMC Pediatr 24(1):582. https://doi.org/10.1186/s12887-024-05060-y

35. Akiki S, Saab J, Safwan J, Chahine B, Rahal M (2025) Knowledge and barriers among Lebanese community pharmacists in pediatric antibiotic dosing: a cross-sectional study. Front Pediatr 13:1630682. https://doi.org/10.3389/fped.2025.1630682
36. Köksoy S, Can B (2026) Parental practices and perspectives on unused pediatric medications at home: a community-based cross-sectional study in Burdur-Türkiye. PLoS ONE 21(3):e0344779. https://doi.org/10.1371/journal.pone.0344779
37. Iskandar K, Kotb R, Cherfane M, Yeretzian J, Bou Dib J, Chahine B et al (2025) Household knowledge of clinical risks, storage, and disposal of leftover antibiotics: a multinational study in seven developing countries. Antibiot (Basel) 14(12):1212. https://doi.org/10.3390/antibiotics14121212
38. Khan FU, Mallhi TH, Khan Q, Khan FU, Hayat K, Khan YH et al (2022) Assessment of antibiotic storage practices, knowledge, and awareness related to antibiotic uses and antibiotic resistance among household members in post-conflict areas of Pakistan: bi-central study. Front Med (Lausanne) 9:962657. https://doi.org/10.3389/fmed.2022.962657
39. Hicks JP, Latham SM, Huque R, Das M, Newell J, Abdullah SM et al (2021) Antibiotic practices among household members and their domestic animals within rural communities in Cumilla district, Bangladesh: a cross-sectional survey. BMC Public Health 21(1):406. https://doi.org/10.1186/s12889-021-10457-w
40. Nazari J, Ghafoury R, Chezani-Sharahi N, Moradzadeh R, Naghshbandi M (2024) Prevalence and determinants of self-medication consumption of antibiotics in adults in Iran: a population based cross-sectional study, 2019–2020. Front Public Health 12:1502074. https://doi.org/10.3389/fpubh.2024.1502074
41. Aslam A, Zin CS, Jamshed S, Ab Rahman NS, Ahmed SI, Pallós P et al (2022) Self-medication with antibiotics: prevalence, practices and related factors among the Pakistani public. Antibiot (Basel) 11(6):795. https://doi.org/10.3390/antibiotics11060795
42. Almalag HM, Al-Yamani MJ, Alsalloum HF (2022) An exploration of the public's attitude toward antibiotic use and prescription in light of the recent Ministry of Health regulations: a cross-sectional study in the Kingdom of Saudi Arabia. Healthc (Basel) 10(8):1520. https://doi.org/10.3390/healthcare10081520
43. Huang G, Ge P, Sui M, Zhu H, Han S, Shi L (2025) Distribution and determinants of antibiotic self-medication: a cross-sectional study in Chinese residents. Antibiot (Basel) 14(7):701. https://doi.org/10.3390/antibiotics14070701
44. Darakhvelidze M, Kalandadze I, Mirzikashvili N, Tsereteli D, Zakareishvili N, Ketchakmadze I (2024) Self-medication with antibiotics in Georgian population. Front Pharmacol 15:1254817. https://doi.org/10.3389/fphar.2024.1254817
45. Singh-Phulgenda S, Antoniou P, Wong DLF, Iwamoto K, Kandelaki K (2023) Knowledge, attitudes and behaviors on antimicrobial resistance among general public across 14 member states in the WHO

European region: results from a cross-sectional survey. Front Public Health 11:1274818. https://doi.org/10.3389/fpubh.2023.1274818

46. Pasha F, Krasniqi V, Ismaili A, Krasniqi S, Bahtiri E, Qorraj Bytyqi H et al (2025) Antibiotic resistance awareness in Kosovo: insights from the WHO Antibiotic Resistance: Multi-Country Public Awareness Survey. Antibiot (Basel) 14(6):599. https://doi.org/10.3390/antibiotics14060599
47. Darweesh O, Godman B, Kurdi A (2026) Non-prescription antibiotic dispensing and counseling practices in Iraqi community pharmacies: implications for antimicrobial stewardship and resistance containment. Expert Rev Anti Infect Ther 24(4):435–448. https://doi.org/10.1080/14787210.2026.2663104
48. Darweesh O, Kurdi A, Merkhan M, Ahmed H, Ibrahem S, Al-Zidan RN et al (2025) Knowledge, attitudes, and practices of Iraqi parents regarding antibiotic use in children and the implications. Antibiot (Basel) 14(4):376. https://doi.org/10.3390/antibiotics14040376
49. Binsaleh AY, Abdallah MS, Osman BM, Bahaa MM, Alsubaie N, Elmasry TA et al (2024) Antimicrobial stewardship intervention for the family caregiver attending primary health care setting: a quasi-experimental study. Antibiot (Basel) 13(12):1145. https://doi.org/10.3390/antibiotics13121145
50. Sheikh S, Saleem Z, Afzal S, Qamar MU, Raza AA, Naqvi SZH et al (2025) Identifying targets for antibiotic stewardship interventions in pediatric patients in Punjab, Pakistan: point prevalence surveys using AWaRe guidance. Front Pediatr 12:1469766. https://doi.org/10.3389/fped.2024.1469766
51. von Elm E, Altman DG, Egger M, Pocock SJ, Gøtzsche PC, Vandenbroucke JP (2007) The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. Lancet 370(9596):1453–1457. https://doi.org/10.1016/S0140-6736(07)61602-X
52. World Health Organization. AWaRe classification of antibiotics for evaluation and monitoring of use (2023) Geneva: World Health Organization; 2023 (WHO/MHP/HPS/EML/2023.04). Available from: https://www.who.int/publications/i/item/WHO-MHP-HPS-EML-2023.04
53. Muller CJ, MacLehose RF (2014) Estimating predicted probabilities from logistic regression: different methods correspond to different target populations. Int J Epidemiol 43(3):962–970. https://doi.org/10.1093/ije/dyu029
54. Imnadze T, Mebonia N, Malania L, Ruadze E (2026) Parental knowledge, attitudes and practices on antibiotic use in children: a cross-sectional study from Tbilisi. Ga Antibiot (Basel) 15(3):260. https://doi.org/10.3390/antibiotics15030260

Figures

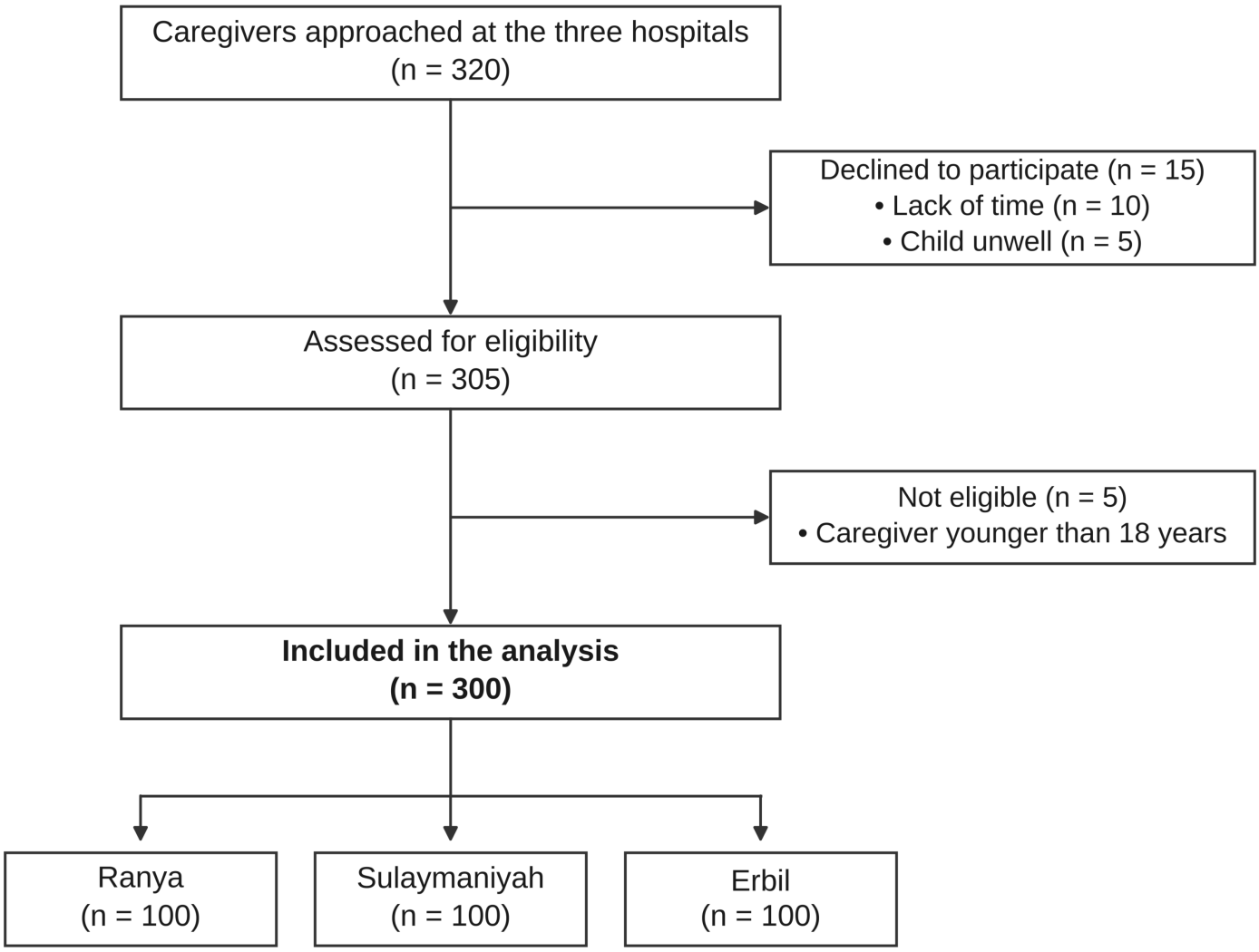


Figure 1

Flow diagram of participant recruitment and inclusion.

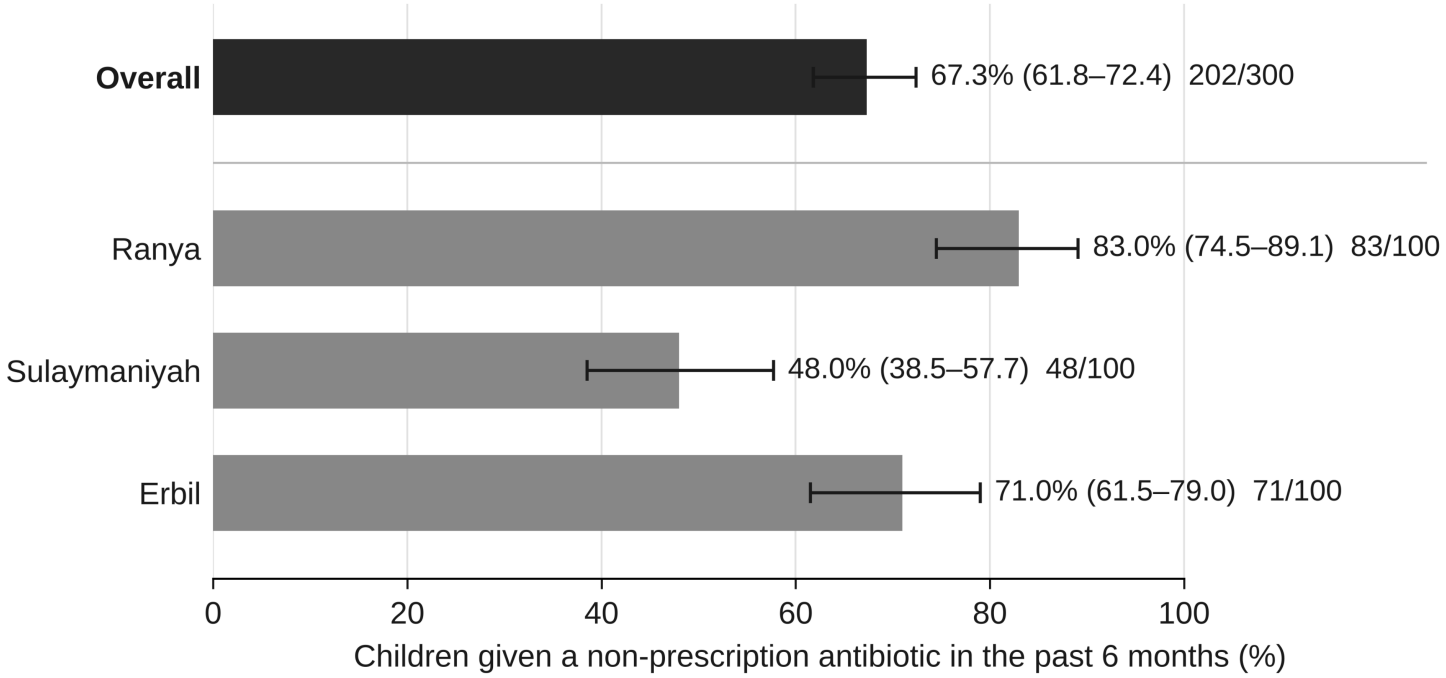


Figure 2

Prevalence of non-prescription antibiotic use among children in the previous 6 months, overall and by study site. Bars show percentages; error bars show Wilson score 95% confidence intervals. Labels give the percentage (95% CI) and the number of children with non-prescription use out of the total. Difference between sites: χ^2 $p < 0.001$.

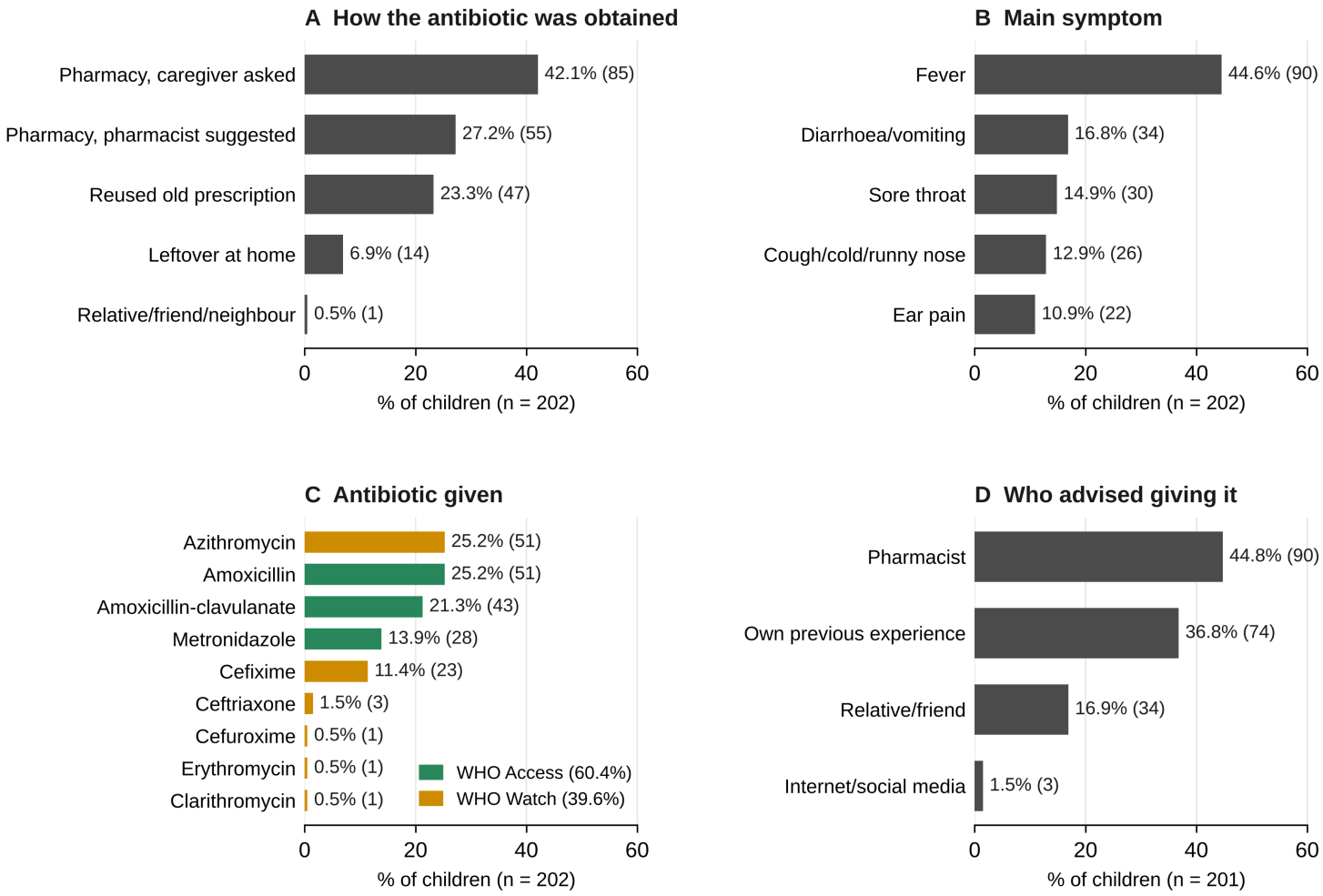


Figure 3

Characteristics of the most recent non-prescription antibiotic episode (n = 202). (A) How the antibiotic was obtained; (B) main symptom; (C) antibiotic given, coloured by WHO AWaRe category; (D) who advised giving it (n = 201; one missing). Labels show the percentage and number of children.

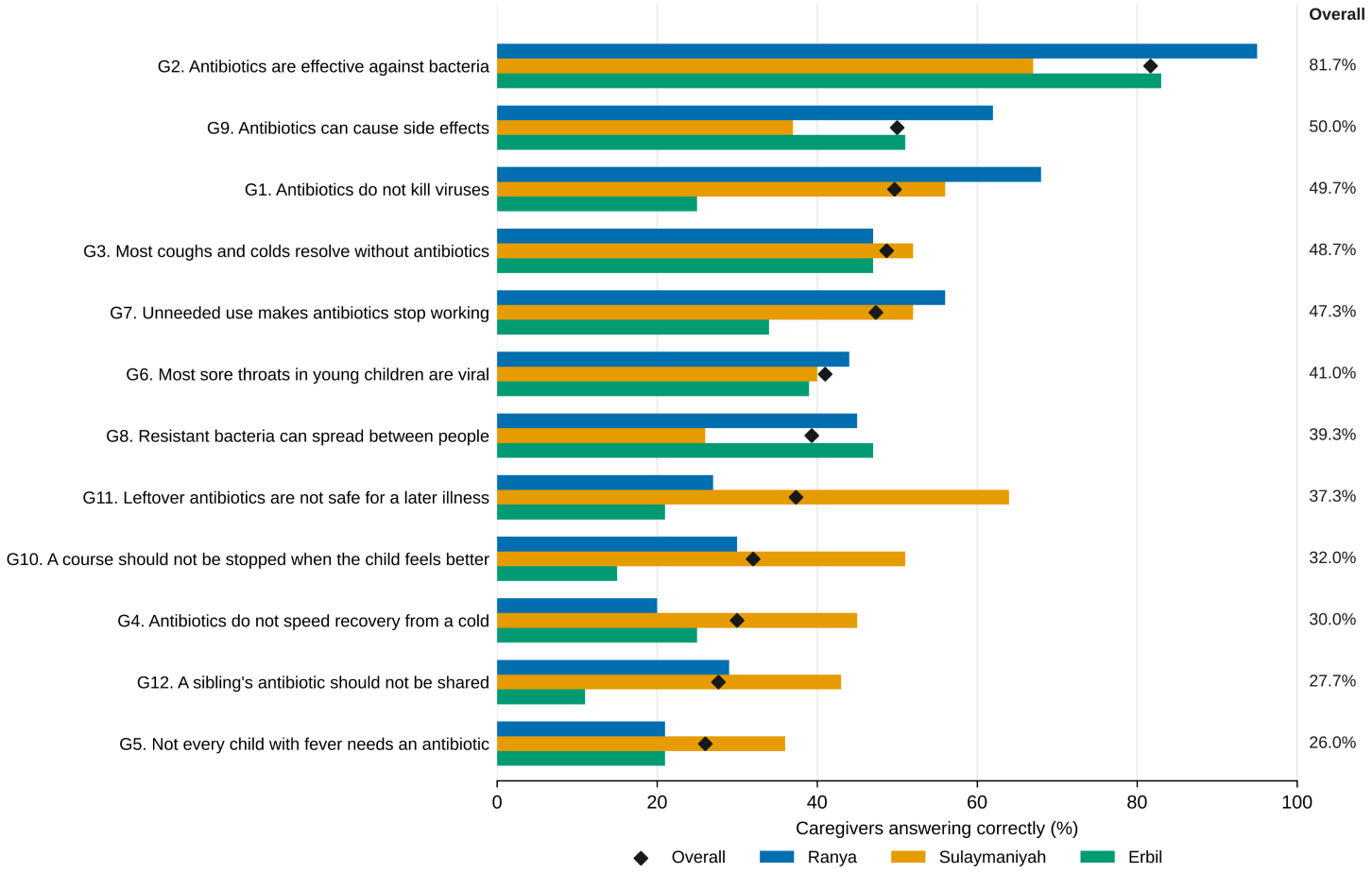


Figure 4

Caregivers answering each knowledge statement correctly, by study site (n = 100 per site). Diamonds and right-hand values show the overall percentage (N = 300). Statements are shown in the correct direction; "don't know" was scored as incorrect. Items are ordered by overall percentage correct.

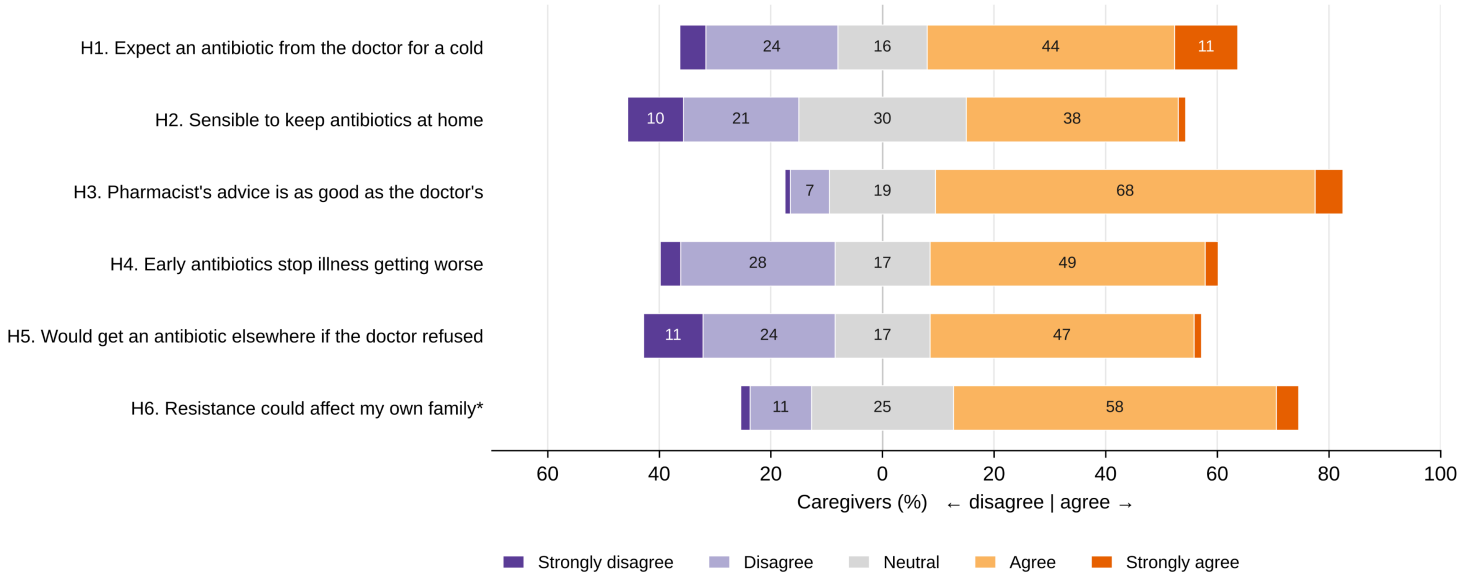


Figure 5

Distribution of caregivers' responses to the six attitude statements (N = 300; n = 299 for H6). Bars are centred on the neutral category; numbers inside bars are percentages (rounded; values <6% not labelled). Agreement with H1–H5 indicates a less appropriate attitude.

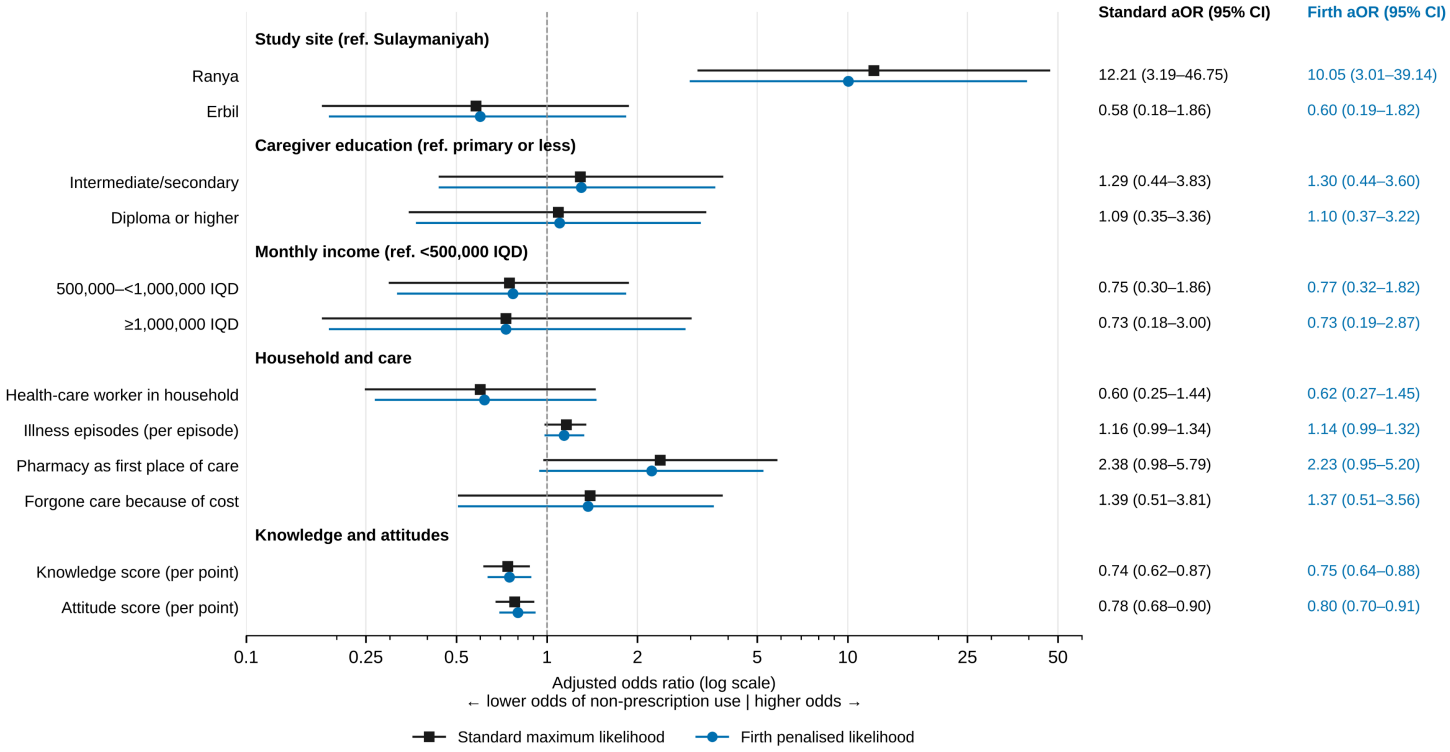


Figure 6

Adjusted odds ratios for non-prescription antibiotic use from the multivariable model (n = 299), estimated by standard maximum likelihood (Wald 95% CI) and Firth penalised likelihood (profile-likelihood 95% CI). The x-axis is on a log scale; the dashed line marks an odds ratio of 1.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- Supplementarymaterial.docx