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Cross-sectional study of the use of antimicrobials following common infections by rural residents in Anhui, China

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ABSTRACT

Objective To describe help seeking behaviour from a medical doctor and antimicrobial use for common infections among rural residents of Anhui province, China.
Design A cross-sectional retrospective household survey.
Setting 12 administrative villages from rural Anhui, China.
Participants 2760 rural residents selected through cluster-randomised sampling using an interviewer administered questionnaire.
Method Logistic regression models were used to estimate associations between exposures (health insurance and antimicrobial-related knowledge), adjusted for confounders (sex, age and education), and help-seeking behaviour from a medical doctor and antimicrobial use following common infections, including acute respiratory tract infections (ARTIs), gastrointestinal tract infections (GTIs) and urinary tract infections (UTIs).
Results In total 2611 (94.6%) rural residents completed the questionnaire. Help seeking from a medical doctor was highest for ARTIs (59.4%) followed by GTIs (42.1%), and UTIs (27.8%). Around two-thirds (82.3% for ARTIs, 87.0% for GTIs and 66.0% for UTIs) of respondents sought help within 3 days following symptom onset and over three quarters (88% for ARTIs, 98% for GTIs and 77% for UTIs) reported complete recovery within 7 days. Of the help-seeking respondents, 94.5% with ARTI symptoms recalled being prescribed either oral or intravenous antimicrobials (GTIs 81.7% and UTIs 70.4%). Use of antimicrobials bought from medicine shops without prescriptions ranged from 8.8% for GTIs to 17.2% for ARTIs; while use of antimicrobials leftover from previous illnesses or given by a relative ranged from 7.6% for UTIs to 13.4% for ARTIs. Multivariate logistic regression analysis revealed that respondents with a higher antimicrobial-related knowledge score and lack of insurance were associated with lower levels of help-seeking for ARTIs; while respondents with a higher antimicrobial-related knowledge score were less likely to be prescribed either oral or intravenous antimicrobials.
Conclusions Excessive antimicrobial use in the studied primary care settings is still prevalent.

INTRODUCTION

Antimicrobial resistance (AMR) is a global health problem which claims at least 50 000

Strengths and limitations of this study

► The study added new data about the magnitude and determinants of antimicrobial use in China.
► The study distinguished doctor-dominated versus patient-dominated responses towards infections and revealed misperceptions of patients' demand for antimicrobials.
► The study collected data from healthcare users via a household survey while most of the existing research on antimicrobial use in China uses data from medical records or reports by medical caregivers.
► Self-reported antimicrobial use is prone to biases due to recall problems, inability to distinguish antimicrobials from other drugs, conformity to social norms and research expectations.

lives each year across Europe and the USA, with many hundreds of thousands more dying in other parts of the world.[1] According to the WHO, AMR is threatening our ability to treat common infections in both the community and healthcare settings.[2] Antimicrobial use, even when appropriate and conservative, contributes to the development of resistance, and inappropriate or excessive use should be avoided.[2 3] Numerous studies have reported the relationship between antimicrobial use and the development of resistance.[4–7] Countries consuming the highest amount of antimicrobials per capita have the highest rates of resistance.[8]

Excessive use of antimicrobials is a widespread problem. Evidence suggests that half of antimicrobial prescriptions are unnecessary or inappropriate for the illness being treated.[9–11] For instance, it is known that the majority of acute respiratory tract infections (ARTIs) and gastrointestinal tract infections (GTIs) are caused by viruses,[12] and yet antimicrobial treatment for such infections is common.[13–15]

Inappropriate use of antimicrobials and AMR are prevalent in China. Studies published from 2009 to 2013 found that over half of outpatients and around 70% of inpatients of hospitals in China were prescribed one or more antimicrobials.[16–21] The problem was even more acute in primary care settings, particularly in rural areas. It had been estimated that, in the same period, 70%–90% of patients visiting village clinics with symptoms of respiratory tract infection were prescribed antimicrobials.[22–24] Widespread overuse and misuse of antimicrobials parallels rapid growth of AMR in the nation.[25–27] Comparative studies on the patterns of AMR between different countries indicate that China has one of the highest levels and the fastest growth rates of AMR.[26 28–32]

The antimicrobial use/AMR problem in China has been attributed to a variety of factors.[26 33–36] China has a long history of nearly free consultations in which most patients only pay for prescribed medicines, making prescriptions an important source of revenue for care providers. These remuneration mechanisms have provided a perverse financial incentive for healthcare practitioners resulting in excessive prescribing of antimicrobials,[33 34] particularly in the lower levels of the health system. Other determinants of antimicrobial use include expectations and beliefs about antimicrobials among patients[35 36]; diagnostic uncertainty, prescribing habits and misperceptions among clinicians' about service-seekers expectations to receive antimicrobials.[37–39]

China has witnessed fundamental reforms of its healthcare system during the past decade. In 2003, the Chinese government introduced a new rural cooperative medical insurance system available to rural residents at a relatively small per capita annual cost. By 2009, almost 96% of rural residents were covered by this insurance. Starting in 2011, the central government implemented a nation-wide Special Antimicrobials Use Rectification programme.[40 41] This programme included antimicrobial stewardship in hospitals, AMR monitoring systems, mandatory negative lists of clinical conditions and antimicrobial prescription limits.[42 43] There is some evidence from county and tertiary hospitals of reductions in antimicrobial use following these initiatives.[44–46] However, little is known about the effects of these reforms and programmes on antimicrobial use in primary care settings, particularly those in resource-poor rural areas.

Our study aimed to describe current antimicrobial use and help-seeking from a medical doctor for three common infections, including ARTIs, urinary tract infections (UTIs) and GTIs, among rural residents in Anhui province, China to help inform future interventions aimed at reducing AMR. Most previous studies examining antimicrobial use in rural China were based on extracted data from incomplete service logs preserved at primary care settings or exit surveys of patients visiting these caregivers.[47 48] Studies using community samples in China are few, and it is hoped that the findings of this survey will add to this literature and inform future policy reforms and interventions both in Anhui province and other rural settings in China.

METHODS
Study design and population
Participants were recruited using a stratified-cluster randomised sampling approach targeting rural residents of Anhui province. Anhui is one of the three self-selected pilot provinces in China and as such has been proactive in implementing the New Health System Reformation which includes optimisation of antimicrobial use. Being the baseline survey of a pilot intervention supported by the UK-China Strategic Prosperity Fund, the sample size was determined by the need to detect difference in antimicrobial use between intervention and control arms. A sample size of 2760 was required to identify (n=140) cases of UTIs (the lowest incidence among ARIs, GTIs and UTIs) based on empirical estimates of the infections (UTIs=5%), use of antimicrobials following the infection (45%) and assumed effectiveness of the intervention (reduction in antimicrobial use by 30%) adjusted for a 90% response rate. Participants were randomly selected from 12 administrative villages via a four step process. Step 1 classified all the counties in Anhui province into southern, northern and middle areas. Step 2 randomly selected four counties from each area (n=12) and then one township from each of the counties and one administrative village from each of the townships. Step 3 randomly selected 230 households from each of the 12 administrative villages. Step 4 consisted of randomly selecting one eligible member from each household. The randomisation used a web-based aid, a simple self-developed webpage which had an input box for entering the last number (say, n) of order (in terms of age) of eligible members within the household which randomly selecting a number between 1 and n. Eligibility criteria included men and women who were: (a) living in the sampled village when the survey was conducted, (b) aged 18 years or over and (c) deemed able to answer the survey questions.

Questionnaire
A structured questionnaire was developed to collect information on the prevalence of symptoms of common infections, help-seeking from medical doctors in any setting and recall of antimicrobial prescription for those infections and other potential determinants (online supplementary Appendix 1). An annual rate (R1) of experience of possible ARTIs was determined based on self-reported symptoms. Rates of self-reported symptoms of GTIs (R2) and UTIs (R3) in the past 3 months were also calculated. Here R1 (or R2 or R3) equals the number of respondents who had reported symptoms of ARTIs (or GTIs or UTIs) in the past year (or 3 months) divided by the total number

of respondents. Self-medication was defined as the use of medicines without prescription including those: (a) bought from a pharmacy or medicine shop, (b) left-over from previous illnesses or given by relatives. An antimicrobials-related knowledge score was calculated using responses to a selected subset of tailored questions related to AMR. Responses to these questions were scored, post-hoc, as incorrect (score=0) or correct (score=1). An antimicrobials-related knowledge score was derived by summing all of the scores for the knowledge questions with a higher score indicative of better knowledge about antimicrobials (for detailed scoring system, please see online supplementary appendix 2). Data were also collected on factors identified a priori as potential confounders including sex, age, education and health insurance cover (new rural cooperative medical system, other health insurance systems).

Data collection
Data collection took place from 22 July to 11 August 2015. The structured questionnaire was administered face-to-face by selected students from Anhui Medical University at the households of the respondents. Twelve students were divided into two equal teams and led by a quality supervisor, with each team conducting data collection at six study villages consecutively. The study used face-to-face interviews with residents following informed consent. Data collection took three to 4 days per village and each interview took about 15 min. Measures taken to ensure data quality included: (a) piloting and revision of the questionnaire, (b) training and examination of field data collectors (including questionnaire administration and taking informed consent), (c) daily checks by quality supervisors of all the questionnaires completed during the day, (d) retest of a 5% randomly selected sample of subjects and (e) feedback of errors found via the daily checks and retests.

Data management and analysis
Questionnaire responses were double-entered into a database using EPI DATA V.3.1 and then extracted and analysed using SPSS V.10.01 and Microsoft Excel 2013. Data analysis comprised descriptive estimations including non-parametric tests of association (Kruksal-Wallis) and multivariate logistic regression modelling to assess factors associated with help-seeking from a medical doctor, use of prescribed oral antimicrobials, use of prescribed intravenous antimicrobials and use of prescribed oral or intravenous antimicrobials or both (oral/intravenous antimicrobials) adjusted by sex, age (years), education. Cases with missing data were excluded from the data analyses.

Patient and public involvement
Development of the research questions and outcome measures were informed by qualitative interviews and pilot tests with a purposively selected sample of rural residents and village doctors within the study site

communities in Anhui province. Summary reports about the study results will be disseminated to the participating individuals and communities through relevant local websites, newspapers and workshops.

RESULTS
Sociodemographic characteristics and reported symptoms of common infections
Of the 2760 rural residents sampled, 2611 (95%) completed the questionnaire. Participants had a mean age of 53 years, ranging from 18 to 95 years old (table 1). Female rural residents made up 60% of the sample. One-third (n=865) of the sample had no formal education and 2558 (98%) had health insurance. A third (n=886) of respondents had an antimicrobials-related knowledge score of zero, with only 317 (12.1%) participants scoring three or above (maximum score 6). A large proportion of respondents reported having symptoms of ARTI in the past year (n=2223; 85%), with smaller number, 425 (16%) and 133 (5%) reporting GTI and UTI symptoms in the past 3 months, respectively.

Help-seeking from a medical doctor following reported symptoms of common infections
Of the respondents who had reported ARTI symptoms in the past year, 1319 (59.4%) reported seeking help from a medical doctor in response to the symptoms, compared with 28% of respondents reporting GTI symptoms and 42% of those reporting UTI symptoms, in the past 3 months (table 2). The proportion of respondents with symptomatic infections who sought help from a medical doctor within 3 days of first experiencing symptoms varied (82% for ARTIs, 87% for GTIs and 66% for UTIs). Of those participants who had recovered from the reported infection when the survey was conducted, over three quarters (88% for ARTIs, 98% for GTIs and 77% for UTIs) reported complete recovery within 7 days. The median recovery period for ARTI type illness was 4 days, compared with 2 days for GTIs and 4 days for UTIs. Kruskal-Wallis test revealed mixed differences in recovery period for the three categories of infections between participants who had sought help from a doctor and those who had not. Respondents who had sought medical help reported a longer recovery period for ARTIs than those who had not (p<0.001) but the recovery period was shorter for GTIs (p<0.001); while no significant difference in recovery time was found for UTIs (p=0.073). Online supplementary appendix 3 gives details of help-seeking from a medical doctor for perceived symptoms of ARTIs by different subgroups. The proportion of respondents with ARTI symptoms who reported help-seeking from a medical doctor increased by age-group (OR=1.23, 95% CI: 1.16 to 1.31), but decreased with years of education (OR=0.72, 95% CI: 0.66 to 0.78). These trends were consistent for males and females. The time-lag between ARTI onset and help-seeking from a medical doctor did not vary by age or education. A higher proportion of

Table 1 Sociodemographic characteristics and reported symptoms of common infections among rural residents (n=2611)

Subgroups	Total in sample, n (%)	Age-range in years, n (%)					
		≤30	31–40	41–50	51–60	61–70	≥71
Sex							
Male	1082 (41.4)	76 (7.0)	106 (9.8)	244 (22.6)	190 (17.6)	289 (26.7)	177 (16.4)
Female	1529 (58.6)	164 (10.7)	186 (12.2)	382 (25.0)	327 (21.4)	309 (20.2)	161 (10.5)
Education							
No formal education	865 (33.1)	1 (0.1)	19 (2.2)	126 (14.6)	194 (22.4)	321 (37.1)	204 (23.6)
Primary school	694 (26.6)	7 (1.0)	58 (8.4)	239 (34.4)	122 (17.6)	189 (27.2)	79 (11.4)
Middle school	778 (29.8)	124 (15.9)	163 (21.0)	221 (28.4)	152 (19.5)	72 (9.3)	46 (5.9)
Higher school	274 (10.5)	108 (39.4)	52 (19.0)	40 (14.6)	49 (17.9)	16 (5.8)	9 (3.3)
Health insurance							
Insured	2558 (98.3)	231 (9.0)	290 (11.3)	612 (23.9)	507 (19.8)	587 (22.9)	331 (12.9)
Uninsured	45 (1.7)	7 (15.6)	1 (2.2)	11 (24.4)	10 (22.2)	9 (20.0)	7 (15.6)
ARKS* (max score 6)							
≥3 score	317 (12.1)	81 (25.6)	69 (21.8)	85 (26.8)	43 (13.6)	31 (9.8)	8 (2.5)
1–2 score	1408 (53.9)	141 (10.0)	175 (12.4)	368 (26.1)	289 (20.5)	295 (21.0)	140 (9.9)
No ARKS	886 (33.9)	18 (2.0)	48 (5.4)	173 (19.5)	185 (20.9)	272 (30.7)	190 (21.4)
Acute respiratory tract infections†							
Yes	2223 (85.1)	222 (10.0)	266 (12.0)	535 (24.1)	435 (19.6)	495 (22.3)	270 (12.1)
No	388 (14.9)	18 (4.6)	26 (6.7)	91 (23.5)	82 (21.1)	103 (26.5)	68 (17.5)
Gastrointestinal tract infections‡							
Yes	425 (16.3)	60 (14.1)	60 (14.1)	89 (20.9)	84 (19.8)	84 (19.8)	48 (11.3)
No	2186 (83.7)	180 (8.2)	232 (10.6)	537 (24.6)	433 (19.8)	514 (23.5)	290 (13.3)
Urinary tract infections‡							
Yes	133 (5.1)	3 (2.3)	14 (10.5)	39 (29.3)	29 (21.8)	34 (25.6)	14 (10.5)
No	2477 (94.9)	237 (9.6)	278 (11.2)	586 (23.7)	488 (19.7)	564 (22.8)	324 (13.1)

*Antimicrobials-related knowledge score.
†Most recent episode within the past 12 months.
‡Episode within the past 3 months.
ARKS, antimicrobial-related knowledge score.

respondents recalled seeking help from a medical doctor on days 2 and 3 following illness onset for all age and education subgroups.

Use of prescribed antimicrobials after infections

Of the respondents who recalled seeking help from a medical doctor for their ARTI symptoms, 1059 (80%) reported visiting a village clinic, 176 (13%) visited a township health centre, 60 (5%) a county hospital and 29 (2%) a higher level hospital. Of the respondents who sought medical help for an ARTI, 1051 (95%) said that they had been prescribed oral, intravenous antimicrobials or both (table 3). The proportion of respondents who recalled being prescribed antimicrobials for a GTI or UTI was slightly lower at 82% and 70%, respectively. Oral antimicrobials were more frequently prescribed than intravenous antimicrobials. There was no statistical evidence of an association between timing of help-seeking and being prescribed antimicrobials.

Self-medication with antimicrobials following infections

Three-hundred and fifty-four (17%) people reported self-medication with antimicrobials for ARTIs, 36 (9%) for GTIs and 22 (17%) for UTIs, respectively (table 4). Reported self-medication with antimicrobials left-over from previous illnesses or given by relatives to treat these symptoms was 290 (13%) for ARTIs, 43 (11%) for GTIs and 10 (8%) for UTIs. The majority of customers to medicine shops bought antimicrobials, being 354 out of 658 (63%) customers with ARTIs, 36 out of 83 (51%) customers with GTIs and 22 out of 33 (73%) customers with UTIs.

Determinants of help-seeking from a medical doctor and antimicrobials use

Table 5 and online supplementary appendix 4 present the results of our descriptive analysis and multivariate logistic regression modelling, respectively, aimed at exploring determinants of help-seeking from a medical

Table 2 Help-seeking from medical doctor following reported symptoms of selected common infections

Service use	ARTIs* (n=2223)		Gastrointestinal tract infections (GTIs)† (n=425)		UTIs‡ (n=133)	
	n	%	n	%	n	%
(1) Help-seeking from a medical doctor (Q2.3, Q2.21 and Q2.37)						
Yes	1319	59.4	118	27.8	56	42.1
No	902	40.6	307	72.2	77	57.9
Not stated	2	NA	0	NA	0	NA
(2) Days until complete recovery after onset of symptoms (Q2.18, Q2.34 and Q2.50)						
Day 1	52	2.4	98	25.9	6	4.7
Day 2	262	12.3	114	30.2	18	14.1
Day 3	520	24.4	65	17.2	19	14.8
Day 4	301	14.1	30	7.9	10	7.8
Day 5	167	7.8	12	3.2	5	3.9
Day 6	64	3.0	4	1.1	1	0.8
Day 7	365	17.1	8	2.1	11	8.6
Day 8+	231	10.9	7	1.9	21	16.4
Not yet recovered	167	7.8	40	10.6	37	28.9
Not stated	94	NA	47	NA	5	NA
(3) Days until first help-seeking from a medical doctor after onset of symptoms‡ (Q2.6, Q2.24 and Q2.40)						
Day 1	257	19.8	41	35.7	4	7.5
Day 2	471	36.3	46	40.0	19	35.9
Day 3	339	26.1	13	11.3	12	22.7
Day 4+	230	17.7	15	13.0	18	34.0
Not stated	22	NA	3	NA	3	NA

*Most recent episode within the past 12 months.
†Episode within the past 3 months.
‡Includes only those who stated 'yes' to use of professional healthcare service.
ARTI, acute respiratory tract infection; NA, not applicable; Q plus a number, the reference number of question used in the questionnaire; UTI, urinary tract infection.

doctor at village clinic, township health centre or higher level service, and determinants of prescribing of oral/intravenous antimicrobials, oral antimicrobials only and intravenous antimicrobials only following an ARTI. We did not explore factors associated with help-seeking from a medical doctor for GTIs and UTIs due to the relatively small number of cases. The descriptive analysis showed statistically significant differences in these healthcare behaviours between groups with different sex, age, education, insurance and knowledge status. After controlling for a priori confounders (age, sex and education). Help-seeking from a medical doctor was inversely associated to the antimicrobial-related knowledge score with people with a higher knowledge score having a lower odds of help-seeking from a medical doctor in response to their ARTI. There was no association between antimicrobial-related knowledge score and reported prescription of oral or intravenous antimicrobials. However, respondents with a higher antimicrobial-related knowledge score (three or more) were less likely to be prescribed oral/intravenous antimicrobials compared with those with a score

of zero (OR=0.32, 95% CI: 0.13 to 0.78). Age displayed a negative association with prescribed oral antimicrobial use (OR=0.81, 95% CI: 0.71 to 0.93) but a positive relationship with prescribed intravenous antimicrobial use (OR=1.21, 95% CI: 1.10 to 1.33). Health insurance was associated with help-seeking from a medical doctor (OR=0.33, 95% CI: 0.17 to 0.66). Uninsured respondents had a lower odds of help-seeking from a medical doctor at village clinics (OR=0.17, 95% CI: 0.06 to 0.51) but a higher odds of help-seeking from a medical doctor from township or higher tier facility (OR=5.90, 95% CI: 1.99 to 17.47) compared with insured respondents.

DISCUSSION
Key findings
This study has provided an important insight into help-seeking from a medical doctor for common infections in rural China. Symptoms of infections were commonly reported and most people sought help soon after developing symptoms. The majority of people seeking help from

Table 3 Reported use of prescribed antimicrobials for common infections following help-seeking from a medical doctor

Antimicrobial use	ARTIs* (n=1319)		GTIs† (n=118)		UTIs† (n=56)	
	n	%	n	%	n	%
(1) Respondents with clear memory of receiving prescribed oral antimicrobials (Q2.7, Q2.25 and Q2.41)						
Yes	638	72.7	34	49.3	32	74.4
No	240	27.3	33	50.7	11	25.6
Not clear	409	NA	43	NA	12	NA
Not stated	32	NA	8	NA	1	NA
(2) Respondents with clear memory of receiving an intravenous antimicrobial (Q2.10, Q2.27 and Q2.43)						
Yes	705	54.7	48	42.5	12	22.6
No	584	45.3	65	57.5	41	77.4
Not clear	17	NA	3	NA	3	NA
Not stated	13	NA	2	NA	0	NA
(3) Respondents with clear memory of receiving oral/intravenous antimicrobials (Q2.7, Q2.10, Q2.25 Q2.27, Q2.41 and Q2.43)						
Yes	1051	94.5	67	81.7	38	70.4
No	61	5.5	15	18.3	16	29.6
Not clear	197	NA	32	NA	1	NA
Not stated	10	NA	4	NA	1	NA
(4) Prescribed oral/intravenous antimicrobials by days after onset of symptoms when the first professional service seeking took place‡ (Q2.6, Q2.7, Q2.10, Q2.24, Q2.25 Q2.27, Q2.40, Q2.41 and Q2.43)						
Day 1	178	91.8	20	80.0	1	25.0
Day 2	383	93.9	27	79.4	14	77.8
Day 3	286	96.0	8	88.9	8	66.7
Day 4+	189	95.9	12	85.7	13	76.5
Not stated	15	NA	0	NA	2	NA

*Most recent episode within the past 12 months.
†Episode within the past 3 months.
‡Includes only those who stated 'yes' to clearly remembering receiving oral or intravenous antimicrobials or both; oral/intravenous antimicrobials mean oral or intravenous antimicrobials or both.
ARTI, acute respiratory tract infection; GTI, gastrointestinal tract infection; NA, not applicable; Q plus a number, the reference number of question used in the questionnaire; UTI, urinary tract infection.

village clinics for ARTI (94%) recalled being prescribed either oral or intravenous antimicrobials or a combination of both. The reported antimicrobial prescription rates for GTIs and UTIs were lower than that for ARTIs but were still very high at 82% and 70%, respectively. We found evidence that receiving a prescription intravenous antimicrobials was associated with antimicrobial-related knowledge score and older age. Self-medication with antimicrobials bought from a medicine shop without prescription was reported by nearly 17% of people for ARTIs, 9% for GTIs and 17% for UTIs; while self-medication with antimicrobials left-over from previous illness, or given by relatives, was reported by 13% of respondents for ARTIs, 11% for GTIs and 8% for UTIs. Greater knowledge about antimicrobials and higher level of educational attainment were associated with lower levels of help-seeking from a medical doctor which suggests better education may reduce unnecessary attendances. As expected, lack of insurance was also associated with a lower odds of help-seeking from a medical doctor.

Implications in context of other research and for policy

The study findings have important implications. The very high reported rate of antimicrobial prescriptions in our study indicates that prescription rates remain high in rural areas and contradicts a common belief among policy-makers in China that overuse and misuse of antimicrobials is being brought under control as a result of the nationwide Special Antimicrobials Use Rectification Program (initiated in 2011) and the New Health System Reforms.[44–46] Rates of antimicrobial prescribing at primary care settings in European countries range from 10% to 52% for respiratory tract infections, from 3% to 22% for genitourinary infections and from 1% to 55% for other infections.[49] Given that about 57% of China's vast population lives in rural areas, and over 70% of antimicrobial prescriptions occur at primary care settings,[50 51] there is a clear need for policies and interventions focused primarily on inappropriate antimicrobial use in primary care settings and communities. This is further supported by the finding of no apparent

Table 4 Use of self-medication with antimicrobials for suspected infections

Self-medication	ARTIs* (n=2223)		GTIs† (n=425)		UTIs† (n=133)	
	N	%	N	%	N	%
(1) Respondents who bought medicines for suspected infection without prescriptions (Q2.14, Q2.30 and Q2.46)						
Yes	658	29.8	83	19.8	33	24.8
No	1551	70.2	337	80.2	100	75.2
Not stated	14	NA	5	NA	0	NA
(2) Antimicrobials bought for suspected infection without prescriptions‡ (Q2.16, Q2.32 and Q2.48)						
Yes	354	62.5	36	51.4	22	72.7
No	212	37.5	34	48.6	6	27.3
Not stated	92	NA	13	NA	5	NA
(3) Respondents who bought antimicrobials for suspected infection without prescriptions (Q2.14, Q2.16, Q2.30, Q2.32, Q2.46 and Q2.48)						
Yes	354	16.7	36	8.8	22	17.2
No	1763	83.3	371	91.2	106	82.8
Not stated	106	NA	18	NA	5	NA
(3) Use of antimicrobials leftover from previous illness or given by relatives (Q2.17, Q2.33 and Q2.49)						
Yes	290	13.4	43	10.8	10	7.6
No	1872	86.6	356	89.2	122	92.4
Not stated	61	NA	26	NA	1	NA

*Most recent episode within the past 12 months.
†Episode within the past 3 months.
‡Includes only those who stated 'yes' to buy medicines for suspected infection without prescriptions.
ARTI, acute respiratory tract infection; GTI, gastrointestinal tract infection; NA, not applicable; Q plus a number, the reference number of question used in the questionnaire; UTI, urinary tract infection.

association between antimicrobial prescribing and days to service seeking after ARTIs.

The study also highlights the need for action to reduce self-medication with antimicrobials leftover from previous illnesses or given by relatives or bought over-the-counter without prescriptions. Self-medication of antimicrobials is very common worldwide.[52] It has been associated with the risk of inappropriate antimicrobial use which predisposes patients to drug interactions, masks symptoms of underlying disease and promotes the development of microbial resistance.[52] The reported high level of self-medication with left-over antimicrobials from previous illnesses is likely to be indicative of both overprescription by clinicians, and poor compliance by patients. While reasons underlying the use of self-obtained antimicrobials may be complex, our study identified higher use of reported self-medication in the younger and more educated groups which is in line with previous studies[53] despite policies which ban the sale of antimicrobials without prescriptions. Future interventions to increase knowledge about appropriate use of antimicrobials should include information about the harms of self-medication.

There may be benefit from differentiated strategies in tackling antimicrobial use behaviours. Our finding of an association between sex, education, health insurance and knowledge of antimicrobials with help-seeking from a medical doctor rather than use of prescribed antimicrobial may suggest the former is dominated by patient-side factors, while the latter, may be more influenced by physician-side factors which were not measured in this study. Similarly, the variations in help-seeking from a medical doctor for ARTIs (59%), UTIs (42%) and GTIs (28%) may reflect the severity and pattern of progression of symptoms of the different infections with patients with acute and aggravating or persisting symptoms being more likely, than those with milder and diminishing symptoms, to seek professional healthcare. Although we did not investigate the reasons people chose either to seek or not to seek professional help, it would be useful to explore this in further depth in future research.

Our findings also point to a need for understanding and tackling antimicrobial use and resistance in a socio-culturally sensitive way. Compared with findings from research in the UK and other western countries, our respondents reported more frequent symptoms of infections and higher and earlier help-seeking from a medical doctor following an infection.[54 55] These variations may not be solely explained by differences in pathogens and

Table 5 Help-seeking from a medical doctor and use of prescribed antimicrobials following respiratory tract infections by type of health insurance and antimicrobial-related knowledge score

Category	Help-seeking (Q2.3, n=2216)			Help-seeking at village clinic (Q2.5, n=1317)			Help-seeking at township or higher level (Q2.5, n=1317)			Use of prescribed oral/IV antimicrobials (Q2.7 and Q2.10, n=1111)			Use of prescribed oral antimicrobials (Q2.7, n=877)			Use of prescribed IV antimicrobials (Q2.10, n=1288)		
	n	OR (95% CI)	P value	n	OR (95% CI)	P value	n	OR (95% CI)	P value	n	OR (95% CI)	P value	n	OR (95% CI)	P value	n	OR (95% CI)	P value
Gender																		
Female	1352	Ref.*		780	Ref.		780	Ref.		666	Ref.		531	Ref.		764	Ref.	
Male	864	1.40 (1.15 to 1.70)	<0.01	537	0.83 (0.61 to 1.13)	0.24	537	1.15 (0.84 to 1.56)	0.39	445	1.26 (0.70 to 2.27)	0.44	346	1.13 (0.80 to 1.58)	0.50	524	0.89 (0.70 to 1.15)	0.38
Age group (years)																		
≤30	219	Ref.		107	Ref.		107	Ref.*		91	Ref.*		73	Ref.*		106	Ref.*	
31–40	265	0.89 (0.61 to 1.30)	0.55	139	0.84 (0.42 to 1.68)	0.42	139	0.99 (0.52 to 1.90)	0.98	122	0.70 (0.21 to 2.31)	0.56	108	1.90 (0.92 to 3.92)	0.08	137	0.78 (0.46 to 1.32)	0.35
41–50	534	0.77 (0.54 to 1.10)	0.15	291	0.42 (0.21 to 0.86)	<0.01	291	0.58 (0.30 to 1.10)	0.09	249	0.66 (0.21 to 2.09)	0.48	209	1.42 (0.73 to 2.77)	0.30	289	0.91 (0.55 to 1.48)	0.69
51–60	435	0.82 (0.57 to 1.19)	0.30	254	0.84 (0.42 to 1.65)	0.14	254	1.12 (0.60 to 2.08)	0.73	212	0.75 (0.22 to 2.53)	0.64	173	1.16 (0.59 to 2.30)	0.67	248	0.94 (0.57 to 1.56)	0.82
61–70	494	0.93 (0.62 to 1.38)	0.70	326	0.84 (0.41 to 1.71)	0.25	326	1.22 (0.64 to 2.33)	0.55	282	0.64 (0.18 to 2.23)	0.48	210	0.59 (0.29 to 1.19)	0.14	319	1.81 (1.07 to 3.07)	0.03
≥71	269	1.30 (0.83 to 2.04)	0.25	200	0.70 (0.32 to 1.53)	0.19	200	1.24 (0.63 to 2.46)	0.54	155	0.48 (0.13 to 1.82)	0.28	104	0.77 (0.36 to 1.68)	0.52	189	1.77 (1.00 to 3.11)	0.05
Education group																		
No formal education	718	Ref.*		492	Ref.		492	Ref.		405	Ref.		302	Ref.		476	Ref.	
Primary school	596	0.78 (0.61 to 1.00)	0.05	370	1.04 (0.68 to 1.60)	0.31	370	1.10 (0.76 to 1.59)	0.62	317	0.70 (0.34 to 1.43)	0.32	250	0.86 (0.57 to 1.29)	0.46	364	0.98 (0.72 to 1.32)	0.87
Middle school	658	0.58 (0.44 to 0.76)	<0.01	344	0.84 (0.50 to 1.41)	0.22	344	0.85 (0.55 to 1.33)	0.48	288	0.76 (0.33 to 1.79)	0.53	235	0.80 (0.49 to 1.30)	0.36	337	0.99 (0.70 to 1.40)	0.94
Higher school	244	0.48 (0.33 to 0.70)	<0.01	111	1.23 (0.61 to 2.47)	0.87	111	1.51 (0.83 to 2.76)	0.18	101	0.61 (0.20 to 1.88)	0.39	90	0.59 (0.30 to 1.16)	0.12	111	1.25 (0.75 to 2.08)	0.40
Health insurance																		
Insured	2178	Ref.*		1303	Ref.*		1303	Ref.*		1099	Ref.		868	Ref.		1274	Ref.	
Uninsured	38	0.33 (0.17 to 0.66)	<0.01	14	0.17 (0.06 to 0.51)	<0.01	14	5.90 (1.99 to 17.47)	<0.01	12	0.55 (0.07 to 4.42)	0.57	9	0.57 (0.15 to 2.20)	0.42	14	0.77 (0.27 to 2.25)	0.64
ARKS																		
No ARKS	726	Ref.*		498	Ref.		498	Ref.*		398	Ref.*		302	Ref.		482	Ref.	
1–2 scores	1208	0.77 (0.63 to 0.95)	0.01	707	1.18 (0.82 to 1.71)	0.05	707	1.33 (0.97 to 1.82)	0.08	610	0.80 (0.42 to 1.50)	0.48	484	1.13 (0.81 to 1.59)	0.47	695	1.11 (0.86 to 1.43)	0.41
≥3 scores	282	0.42 (0.31 to 0.58)	<0.01	112	1.46 (0.78 to 2.76)	0.11	112	1.30 (0.73 to 2.31)	0.37	103	0.32 (0.13 to 0.78)	0.01	91	1.16 (0.64 to 2.11)	0.63	111	0.77 (0.48 to 1.21)	0.25

Oral/IV antimicrobials mean oral or IV antimicrobials or both.
*P<0.05 for the variable in the overall regression model.
ARKS, antimicrobial-related knowledge score; IV, intravenous; Q plus a number, the reference number of question used in the questionnaire; Ref., reference.

host immunity between nations. Rather, China's strong culture of collectivism may have played an important role which requires each family member to be sensitive to the health of other members and urges the sick to seek help from a doctor as soon as possible.[56] In addition, the relatively low help-seeking from a medical doctor for UTIs compared with that for ARTIs and GTIs may also be partly attributable to conservative values about sex, and consequently help-seeking for related conditions, held by Chinese, especially those in rural areas.[57]

Strengths and limitations of the study

The study has both strengths and limitations. It is the first survey that collected data from healthcare users via a household survey while most of the existent research on antimicrobial use in China uses data from medical records or reports by medical caregivers who may be incentivised to omit recording overuse or misuse of antimicrobials so as to meet relevant policy requirements.[58] As healthcare receivers, household members may be free from these concerns and hence more willing to report antimicrobial use. However, self-reported antimicrobial use may be prone to bias due, for example, to recall issues particularly among the elderly, inability to distinguish antimicrobials from other drugs which may be an issue among the less-well educated and over or under reporting by the respondents for reasons such as perceived expectations from the researchers. The study asked respondents to recall symptomatic ARTIs in the past year but GTIs and UTIs in the past 3 months. Hence, more episodes of minor ARTIs than GTIs/UTIs may not have been recalled by respondents. In addition, readers should be aware of potential selection biases. The study allowed field data collectors to exclude the household members who were 'unable to answer the questionnaire'. This may result in under recruitment of senior and illiterate residents.

Next steps and future research required

Excessive prescribing of antimicrobials in the studied primary care settings in rural Anhui is prevalent despite China's special rectification programme and health systems reforms aimed at tackling the problem. There is a clear need to target existing interventions at primary care level and to develop bespoke, community-appropriate interventions if we are to reduce antimicrobial prescribing in China. Further work is under way to identify pathways for optimising antimicrobial use in rural Anhui and China via multidisciplinary qualitative research with specific attention on its key social, cultural, economic, clinical, health systems, behavioural and other determinants to help inform future interventions.

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