



## Original Article

## Use of antibiotics and other treatments in Chinese adults with acute cough: An online survey



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## ARTICLE INFO

## Article history:

Received 1 November 2022

Revised 15 December 2022

Accepted 19 December 2022

Available online 23 December 2022

## Keywords:

Antibiotics

Acute cough

Respiratory tract infection

Chinese herbal medicine

Survey

## ABSTRACT

**Background:** Acute respiratory tract infections are common worldwide and there has been a rapid increase in antibiotic consumption. This study aimed to identify use of various treatments and their association with the use of antibiotics and patient reported clinical recovery in Chinese adults with acute cough.

**Methods:** An online survey recruiting people who had recently experienced cough was conducted. Their sociodemographic, clinical characteristics, treatments received and their perceived changes in symptoms were collected. Factors influencing avoidance of antibiotics and improvement in symptoms were explored. **Results:** A total of 22,787 adults with recent acute cough completed the questionnaire, covering all 34 province-level administrative units in China. Most respondents were male (68.0%), young (89.4%, aged 18–45), educated to university/degree or postgraduate level (44.6%), with a median cough severity of 6/10 on a numerical rating scale. Nearly half of the participants (46.4%) reported using antibiotics, among which 93.1% were for presumed upper respiratory tract infections (URTIs). Pharmacies (48.8%) were the most common source of antibiotics. Fewer patients took antibiotics after taking CHM (14.9%), compared to those who started with home remedies (18.0%), or allopathic non-antibiotic medication (25.0%). Antibiotics, allopathic non-antibiotic medications, CHM and home remedies were all perceived beneficial in relieving cough.

**Conclusions:** Chinese adult responders report use of a considerable variety of treatments alone or in combination for acute cough. Patient-reported clinical recovery was similar regardless of treatment. There is likely a high proportion of inappropriate use of antibiotics for treatment of simple acute cough. As the majority of respondents did not use antibiotics as a first-line, and use of CHM was associated with relief of cough symptoms and reduction in the use of antibiotics, this presents an important opportunity for prudent antibiotic stewardship in China.

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## 1. Introduction

Acute respiratory tract infections (ARTIs) are among the most common acute complaints worldwide. They are predominantly of

viral etiology<sup>1</sup> and antibiotics are of limited benefit in the majority of uncomplicated infections.<sup>2,3</sup> Nevertheless antibiotics are widely used<sup>4,5</sup> and this is associated with higher rates of resistance, especially with longer duration and multiple courses of antibiotics.<sup>6</sup> Anti-microbial resistance is a complex and evolving global public health threat with potential serious consequences such as increased time spent in hospital, mortality, and economic constraints.<sup>7–9</sup>

There has been a rapid increase in antibiotic consumption over the past decades. Globally, there was a 90.9% increase in per-capita consumption of Watch antibiotics (applied only to a limited group

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of well-defined syndromes) from 3.3 to 6.3 defined daily doses (DDDs) per 1000 inhabitants per day [DIDs] and an increase of 26.2% from 8.4 to 10.6 DIDs in Access antibiotics (first or second line treatments for common infections) between 2000 and 2015.<sup>10</sup> Three countries, namely India (6.3 billion DDDs), China (3.8 billion DDDs), and the USA (2.9 billion DDDs) consume the highest volume of antibiotics.<sup>10</sup> Since the 2009 health system reform, China has paid considerable attention to improving the use of antibiotics through strengthening national antimicrobial stewardship.<sup>11</sup> Following this, in 2011, a national campaign for the rational use of antibiotics was launched by the Ministry of Health,<sup>12</sup> which enacted the implementation of the most stringent decree in 2012 including comprehensive regulations on selection, procurement, prescription, and use of antibiotics.<sup>11,13,14</sup> Data released by the National Health Commission of the People's Republic of China suggested a decrease in the proportion of inpatients receiving antibiotics from 59.4% in 2011 to 36.4% in 2018; and in outpatients from 17.2% in 2011 to 8.9% in 2018.<sup>15</sup> This decrease was repeatedly reported at tertiary hospitals,<sup>16,17</sup> for both inpatients and outpatients, but less progress was observed at primary care facilities and county hospitals.<sup>11</sup> Data from Shan Dong province suggested a total of all healthcare setting antibiotic consumption increased from 16.07 DID in 2012, peaked at 17.44 DID in 2015, and decreased to 11.35 DID in 2017 with a 34.9% reduction.<sup>18</sup>

Strategies to limit unnecessary antibiotic use may include better infection prevention (e.g. hand washing interventions),<sup>19</sup> better targeting (development of clinical scores and near patient tests),<sup>20</sup> and the use of delayed or 'just in case prescription'.<sup>2</sup> Using a 'just in case' prescription appears to reduce infective complications and to reduce rates of re-consultation.<sup>21</sup> Symptomatic relief is commonly advised for self-limiting cough, focusing on reducing the effects of the infection, for example with throat lozenges, decongestants, anti-pyretics (paracetamol / ibuprofen), and health advice such as taking plenty of fluids and bed rest. In China, traditional herbal medicines have been used for thousands of years, both to prevent and to treat RTIs.

This study adopted the design from a series of successful surveys,<sup>22-26</sup> aiming to identify the patterns of use of different treatments for acute cough in the adult Chinese population and their association with clinical outcomes.

## 2. Methods

Findings of this survey are reported following the checklist for reporting results of internet E-surveys (CHERRIES) checklist.<sup>27</sup>

### 2.1. Study participants

We included adult patients ( $\geq 18$  years old) who (1) were experiencing or had experienced acute cough ( $< 28$  days) in the last 3 months, irrespective of having chronic underlying lung diseases such as COPD or asthma or not; (2) were able to read and understand Chinese, and to participate through an online survey; (3) were willing to disclose information on all treatments they took for the last episode of cough and their clinical outcomes. Implied consent was obtained. There was no restriction on gender for this study. Participants could also answer the questionnaire on behalf of a family member.

### 2.2. Questionnaire

The survey was piloted with five Chinese-speaking lay persons, and amended according to their feedback, before opening the survey to the public. All survey materials were translated and back translated by two team members [RYX and XYH].<sup>28</sup>

The online cough survey takes 5–10 min to complete. It contains three sections: socio-demographic and lifestyle characteristics (15 questions), cough symptoms and other health conditions (10 questions), and treatments to alleviate cough. Participants' subsequent clinical outcomes were collected and analysed to explore potential correlations with the treatments taken.

For participants' convenience, a list of the most commonly used antibiotics, allopathic non-antibiotic medications (e.g. NSAIDs), patent Chinese Herbal Medicines (PCHMs), and the most frequent home remedies (including special foods, e.g. pear soup) were provided as drop-down lists. One case of cough was collected from each survey response. The full questionnaire is available in S1 File.

### 2.3. Method of recruitment

In order to approach a large representative sample, potential participants were recruited through the largest Chinese social media platform WeChat. A QR code or a link to the online survey developed using Wen Juan Xing survey (<https://www.wjx.cn>) was circulated with an invite to participate through a snowballing approach starting with researchers' WeChat contacts and WeChat moments, discussion groups e.g. university student groups, medical associations groups, and general groups. We endeavoured to approach the general population from different regions in China and circulated the invites to specific general groups. The participant information sheet appeared at the top as part of the survey and consent was implied through survey participation.

### 2.4. Data collection and management

All survey data were collected and managed by researchers familiar with the use of online questionnaires, on taking consent, confidentiality and data management. No identifiable data were collected therefore participants could not be identified from the information collected. Each record was linked with a unique ID number. Data were stored on a password-protected laptop in a secure location, with data backups being made on a regular basis.

### 2.5. Data analysis

Participants' basic characteristics, cough and other health conditions, and the treatment used for their cough were analysed descriptively. For descriptive analyses, we grouped respondents into those with possible LRTIs, which were defined as: presence of at least one of shortness of breath or yellow sputum or green sputum or wheezing, but excluding sore throat and coryza. Patients whose symptoms did not fit these criteria were presumed to have had URTIs. Avoidance of antibiotics was assessed as the number and proportion of participants not taking subsequent antibiotics after various treatments. Relief of symptoms was self-reported on a 0–5 Likert scale. There is no precise measure for appropriate use of antibiotics following self-report of acute cough. However, European estimates for appropriate use following consultation with a physician are substantially lower than those reported here. European standards suggest 0–30% for acute bronchitis,<sup>29</sup> whereas more recent guidelines and expert elicitation put the figure at 10%, interquartile range (IQR) (6%–16%) in patients with acute cough without comorbidities.<sup>30</sup>

A Chi-square test of independence was performed to examine how 5 factors, namely age, smoking, presumed upper or lower RTIs, severity of cough and comorbidities, might influence outcomes on subsequent antibiotic usage and relief in cough. A significance level of 0.05 with 95% CI level was utilised. Percentages were presented throughout the analysis with one decimal place. Any means, medians and ranges/interquartile ranges were given

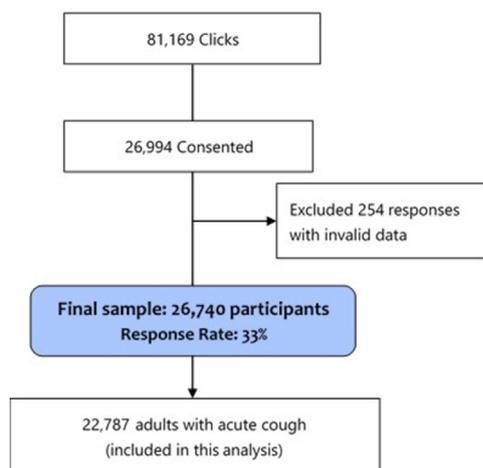


Fig. 1. Recruitment flow diagram.

to one decimal place. For standard deviations, two decimal places were presented.

The data analysis for this study was generated using Microsoft Excel (2016) and IBM SPSS Statistics for Windows, Version 23.0. Armonk, NY: IBM Corp.

## 2.6. Sample size calculation

Considering that 70% of people surveyed would have been likely to have used antibiotics,<sup>4</sup> with a 95% CI around a 2% margin of error, we estimated that 2017 participants would be required for this survey. However, we planned to continue recruitment until February 2019 as larger numbers would be needed for the secondary outcome measures.

## 2.7. Ethical considerations

Ethical approval was sought from the University of Southampton ethics committee (ERGO 31,602) and the Beijing University of Chinese Medicine ethics committee (2018BZHLL0101). Participants' implied consent was obtained through the online survey. Personal information from this study was confidential. We guaranteed the anonymity of each participant, with any personally identifiable information in questionnaires being removed. All data were handled in China and only aggregated data were sent to the UK. All completed surveys were collected through online social media and online surveys, with data stored in a password protected laptop. A total value of 2000 GBP (approximately 16,060 CNY/RMB) were circulated as incentives with a random amount of money (around 1 to 2 CNY/RMB) allocated to participants upon completion of the questionnaires.

## 3. Results

### 3.1. Response rate

The online survey was circulated to researchers' WeChat contacts for cascading, which generated 81,169 visits between January 25, 2019 and February 11, 2019 (Fig 1). Of those who opened the survey, 26,994 gave consent and completed the online questionnaire, among which 1411 provided invalid data and were removed.

Among the 26,740/81,169 (33.0%) valid responses, 22,787 were adult participants (or their family members) with acute cough and are included in this analysis. The majority (78.5%) of the responses were collected from patients themselves. Over half (52.1%) had experienced their most recent episode of cough within 2 weeks and

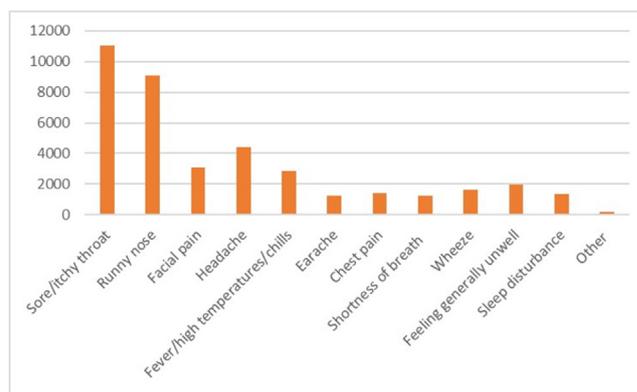


Fig. 2. Other symptoms experienced relating to this episode of cough.

31.3% between 2 and 4 weeks when they were completing this online survey.

The responses collected were across all 34 province-level regions in China, mostly from North and East China, with Hebei province at the top (16.6%), followed by Shanxi (16.0%), Beijing (15.4%), and Tianjin (9.2%). There were 29 (0.1%) responses from overseas.

### 3.2. Sociodemographic, lifestyle and health condition characteristics

There were 2.1 times more male respondents than females. Most (89.4%) were young participants between 18 and 45 years old and had a university/degree or above (44.6%). Almost half (49.6%) were employed full-time, and 40.0% were smokers (Table 1). The vast majority (92.0%) reported symptoms consistent with a URTI.

The cough had resolved in 34.9% of respondents when they were completing the survey. The median severity of cough was 6 (IQR 3) on a 0–10 numerical rating scale (NRS) (Table 1). Most participants (65.7%) had a productive cough; the sputum color reported most was yellow (40.3%), white (33.8%), and clear (19.3%). One fifth of participants reported only a cough (21.6%), whereas others experienced a range of symptoms, including sore/itchy throat (48.6%), runny nose (39.8%), headache (19.3%), and facial pain (13.4%) (Fig. 2).

More than half (63.8%) of the participants had no underlying medical condition. Among the rest, asthma (14.9%), other chest conditions (14.9%), and heart disease (11.1%) were most frequently reported.

### 3.3. Treatments for acute cough

Although 46.4% of adult participants with acute cough used antibiotics, only 12.7% (2886/22,787) took antibiotics alone or together with another treatment as their first treatment. 39.2% used individualised or patent CHM, 28.3% and 21.2% used allopathic non-antibiotic medications and home remedies respectively; these figures include both treatments used on their own, and those used as part of a combination (Table 2). Only 7.2% of the respondents did not use any treatment. The most common combinations were antibiotics with allopathic non-antibiotic medications (7.6%), antibiotics combined with CHM (5.7%), and antibiotics combined with home remedies (4.2%) (S1 Table). Of those 19,901 (87.3%) who did not initially take antibiotics, 8314 (41.8%) took CHM, 5586 (28.1%) took allopathic non-antibiotic Western medicines and 4280 (21.5%) used home remedies (Table 3).

#### 3.3.1. Patterns of use of antibiotics

Nearly half of the participants (46.4%) had used antibiotics, among which 93.1% (9828/10562) were for presumed URTIs

**Table 1**  
Characteristics of respondents.

Characteristic	Overall (n = 22,787)	Presumed URTIs* (n = 20,965)	Presumed LRTIs* (n = 1822)
Sex (n (%))			
Male	15,502 (68.0%)	14,217 (67.8%)	1285 (70.5%)
Female	7285 (32.0%)	6748 (32.2%)	537 (29.5%)
Age, years (Median (IQR, range))	28 (13, 18 to 120)	28 (13, 18 to 120)	28 (17, 18 to 99)
Educational level (n (%))			
Preschool	591 (2.6%)	550 (2.6%)	41 (2.3%)
Primary school	1028 (4.5%)	926 (4.4%)	102 (5.6%)
Secondary school	3880 (17.0%)	3527 (16.8%)	353 (19.4%)
College/ Diploma#	6754 (29.6%)	6227 (29.7%)	527 (28.9%)
University/ Degree	8029 (35.2%)	7445 (35.5%)	584 (32.1%)
Postgraduate	2149 (9.4%)	1974 (9.4%)	175 (9.6%)
Other	356 (1.6%)	316 (1.5%)	40 (2.2%)
Occupational status (n (%))			
Employed full time	11,292 (49.6%)	10,544 (50.3%)	748 (41.1%)
Employed part time	3467 (15.2%)	3196 (15.2%)	271 (14.9%)
Retired	1317 (5.8%)	1166 (5.1%)	151 (8.3%)
Unemployed	740 (3.2%)	649 (3.1%)	91 (5.0%)
Casual worker	1050 (4.6%)	922 (4.4%)	128 (7.0%)
Not working due to ill health	436 (1.9%)	377 (1.8%)	59 (3.2%)
Homemaker	917 (4.0%)	843 (4.0%)	74 (4.1%)
Student	3275 (14.4%)	3012 (14.4%)	263 (14.4%)
Others	293 (1.3%)	256 (1.2%)	37 (2.1%)
Smoker (n (%))	9118 (40.0%)	8300 (39.6%)	818 (44.9%)
Comorbidities (n (%))			
No underlying condition	14,545 (63.8%)	13,471 (64.3%)	1074 (58.9%)
Asthma or other chest diseases	6032 (26.5%)	5545 (26.4%)	487 (26.7%)
All other underlying conditions	2210 (9.7%)	1949 (9.3%)	261 (14.3%)
Severity of cough: Median (IQR)	6 (3)	6 (3)	6 (3)

IQR: interquartile range, SD: standard deviation.

URTIs: upper respiratory tract infections.

LRTIs: lower respiratory tract infections.

\* Possible LRTIs were defined as presence of at least one of shortness of breath or yellow/ green sputum or wheezing, but excluding sore throat and coryza. Patients whose symptoms did not fit these criteria were presumed to have had URTIs.

# Refers to junior college education/ professional training, including technical secondary school and junior college.

**Table 2**  
Various treatments used for acute cough: interventions used alone or in combination.

Treatment	Overall (n = 22,787)	Presumed URTIs* (n = 20,965)	Presumed LRTIs* (n = 1822)
Antibiotics	10,562 (46.4%)	9828 (46.9%)	734 (40.3%)
CHM	8942 (39.2%)	8311 (39.6%)	631 (34.6%)
Allopathic non-antibiotic medications	6441 (28.3%)	5942 (28.3%)	499 (27.4%)
Home remedies	4825 (21.2%)	4440 (21.2%)	385 (21.1%)
Others	280 (1.2%)	243 (1.2%)	37 (2.0%)
No treatment	1641 (7.2%)	1492 (7.1%)	149 (8.2%)

\* Possible LRTIs were defined as presence of at least one of “shortness of breath” OR “yellow sputum” OR “green sputum” OR “wheezing” BUT EXCLUDING “sore throat” AND “coryza”. Patients whose symptoms did not fit these criteria were presumed to have had URTIs.CHM: Chinese herbal medicineURTIs: upper respiratory tract infectionsLRTIs: lower respiratory tract infections.

**Table 3**  
Subsequent use of antibiotics after each type of treatment.

Initial Treatment	Overall* (n = 7676)	Presumed URTIs# (n = 7150)	Presumed LRTIs# (n = 526)
Allopathic non-antibiotic medication	1394/5586 (25.0%)	1315/5127 (25.6%)	79/459 (17.2%)
Home remedies	769/4280(18.0%)	721/3925 (18.4%)	48/355 (13.5%)
Chinese herbal medicine	1236/8314 (14.9%)	1172/7710 (15.2%)	64/604 (10.6%)
Other	19/257 (7.4%)	16/226 (7.1%)	3/31 (9.7%)

\* Excluded those who started with antibiotics and those who had other treatment and antibiotics as the first treatmentURTIs: upper respiratory tract infectionsLRTIs: lower respiratory tract infections.

# Possible LRTIs were defined as presence of at least one of “shortness of breath” OR “yellow sputum” OR “green sputum” OR “wheezing” BUT EXCLUDING “sore throat” AND “coryza”. Patients whose symptoms did not fit these criteria were presumed to have had URTIs.

(Table 2). The proportions reporting antibiotic use were similar for presumed LRTIs (40.3%) to those with presumed URTIs (46.9%). The most commonly used antibiotics were Amoxicillin (32.5%), followed by Cefprozime (13.0%), Ampicillin (10.8%), Cefoxitin (7.6%), and Cefuroxime (7.6%) (Fig. 3). Under half (44.8%) of the antibiotic users used the full course of antibiotics, others used more than half of the course (19.3%), less than half of the course (13.3%) or it was unclear (22.5%) whether they took the full course of antibiotics.

Of the participants who received antibiotics, almost half received them from a pharmacy (48.8%), and a third from a public community health center (33.1%). In our sample, more antibiotic prescriptions came from TCM hospitals (28.0%) than from Western (22.1%) or integrative medicine hospitals (17.6%). Respondents used antibiotics on the basis of various sources of advice (and sometimes more than one), including health professionals such as doctors (52.4%), drug store staff

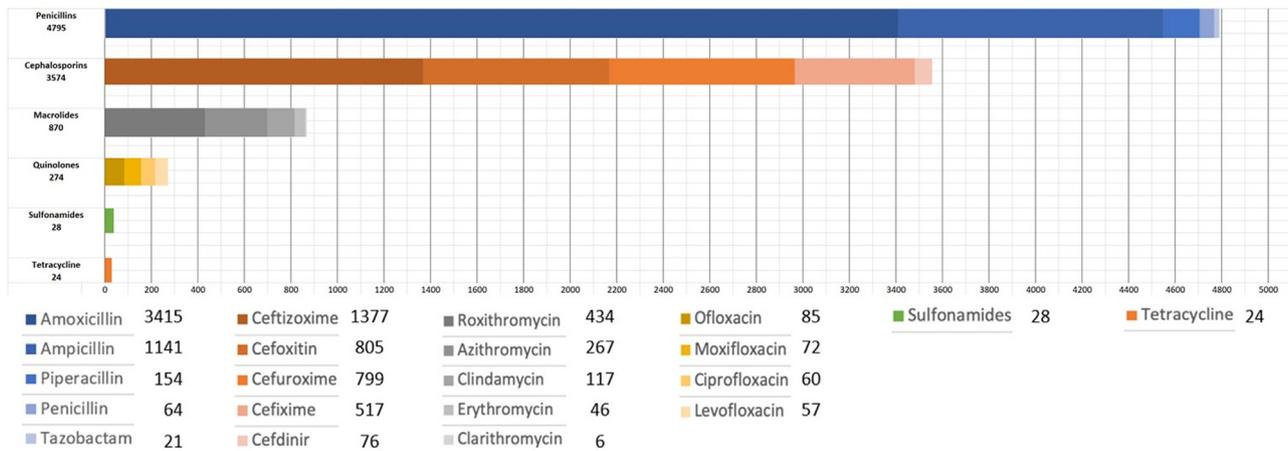


Fig. 3. Antibiotics used by adults with acute cough.

(46.1%), family and friends (29.6%) or their own experience (19.4%).

### 3.3.2. Patterns of the use of allopathic non-antibiotic medications

Of the 6441/22,787 (28.3%) participants who used allopathic non-antibiotic medications to help with their acute cough, non-steroidal anti-inflammatory drugs (NSAIDs, 2023, 31.4%) such as ibuprofen, naproxen, and diclofenac were the most commonly used, followed by paracetamol (1312, 20.4%), cough medicine (834, 12.9%) such as codeine, noscapine, pentoxifyverine, and expectorants (232, 3.6%) such as methoxyphenamine, ambroxol and bromhexine hydrochloride.

### 3.3.3. Patterns of use of Chinese herbal medicine (CHM)

Nearly half 8942/22,787 (39.2%) of participants used CHM to help with their acute cough, including individualised CHM (372, 4.2%) and patent CHM (8786, 98.3%). The top 8 patent CHM products were each taken by more than 500 respondents. Chuan Bei Pi Pa Gao (CBPPG) was the most frequently used (5019, 56.1% of all participants), followed by Gan Mao Ling granule (3316, 37.1%), Ke Chuan Shun pill (1764, 19.7%), and Fu Fang Gan Cao (tablet/liquid) (1643, 18.4%).

### 3.3.4. Patterns of use of home remedies

About one-fifth of participants used home remedies ( $n = 4825$ , 21.2% of total) including boiled pear soup (2720, 56.4%), hot water (2661, 55.2%), lemon/orange juice (1729, 35.8%), pig lung soup (964, 20.0%), bitter melon soup (719, 14.9%) and others (110, 2.3%).

## 3.4. Treatment association with clinical recovery

### 3.4.1. Avoidance of antibiotics

Subsequent use of antibiotics was lower in those who initially took CHM, compared to those who started with home remedies or allopathic non-antibiotic medications ( $p < 0.05$ ). Other initial treatments included cupping, exercise, physically cooling down, heat therapy, hot bath, nasal wash with saline, ginger tea (257, 1.3%).

A Chi-square test of independence was performed to examine the relation between various factors and subsequent use of antibiotics (S2 Table). Participants who smoked ( $\chi^2 = 16.950$ ,  $P < 0.01$ ), were aged  $\geq 65$  ( $\chi^2 = 12.317$ ,  $P = 0.002$ ), with severe cough ( $\chi^2 = 113.535$ ,  $P < 0.01$ ), with presumed URTIs ( $\chi^2 = 9.385$ ,  $P = 0.002$ ), and underlying lung conditions ( $\chi^2 = 145.196$ ,  $P < 0.01$ ) were the most likely to take antibiotics after taking CHM at 16.8%, 15.6%, 20.5%, 15.2%, and 23.8% respectively. Those aged 18–45 ( $\chi^2 = 15.216$ ,  $P < 0.01$ ), with severe cough ( $\chi^2 = 25.763$ ,

Table 4

Cough relief after each type of treatment as measured by 1–5 Likert scale.

Treatment	Median	IQR (range)
Antibiotics	4	2 (1 to 5)
Allopathic non-antibiotic medications	4	2 (1 to 5)
Patent Chinese herbal medicines (PCHM)		
Chuan Bei Pi Pa Gao (paste)	4	1 (1 to 5)
Gan Mao Ling Ke Li (granule)	4	2 (1 to 5)
Ke Chuan Shun Wan (pill)	4	1 (1 to 5)
Fu Fang Gan Cao Pian/Kou Fu Ye (tablet/liquid)	4	1 (1 to 5)
Individualised Chinese herbal formulas	4	1 (1 to 5)
Home remedies	4	2 (1 to 5)

IQR: interquartile range.

Relief of cough, as assessed by Likert scale, did not differ largely between participants with varying ages, smokers or non-smokers, with presumed upper or lower RTIs, with varying severity of cough, with or without any comorbidities (S3 Table).

$P < 0.01$ ), URTIs ( $\chi^2 = 16.014$ ,  $P < 0.01$ ), and underlying lung conditions ( $\chi^2 = 24.309$ ,  $P < 0.01$ ) were the most likely to take antibiotics after taking allopathic non-antibiotic medications; while only those with severe cough ( $\chi^2 = 38.126$ ,  $P < 0.01$ ), URTIs ( $\chi^2 = 5.192$ ,  $P = 0.023$ ), and underlying lung conditions ( $\chi^2 = 17.945$ ,  $P < 0.01$ ) were the most likely to take antibiotics after taking home remedies.

### 3.4.2. Relief of cough

Antibiotics, allopathic non-antibiotic medications, CHM and home remedies were considered helpful in relieving cough symptoms, with the same median of 4, with a IQR at 1 or 2 on a 1–5 Likert self-rating scale (5 represents very helpful) (Table 4).

## 4. Discussion

### 4.1. Summary of findings and comparison with the literature

This online survey explored treatment-seeking behavior for acute cough in Chinese adults. Although a series of antimicrobial stewardship guidelines and policies have been released in China since 2009,<sup>11</sup> we found that there is likely high proportion of inappropriate use of antibiotics for the treatment of simple acute cough, even in well-educated young adults. Antibiotics were taken by nearly half of our respondents with acute cough, of whom over 90% possibly had URTIs. These findings are consistent with previous research on overuse of antibiotics by university students in China.<sup>4</sup>

Both doctors and staff in pharmacies played an important role in recommending the use of antibiotics. A considerable number of patients obtained antibiotics from easily accessible pharmacies which are often less strictly regulated. Despite being illegal, it is easy to obtain antibiotics without a prescription in retail pharmacies or from online sources in China.<sup>31</sup> Pharmaceutical companies tend to offer incentives for the prescribing of more expensive broad-spectrum antibiotics.<sup>32</sup> These may be major contributors to antimicrobial resistance.

In our sample, participants reported similar levels of improvement regardless of which treatment they took, although most presented with symptoms consistent with uncomplicated URTIs, the vast majority of which were most probably viral and self-limiting.<sup>2,3</sup> People used various alternatives to antibiotics to help with their acute cough. CHM was the most popular initial treatment other than antibiotics, and its initial use was associated with lower subsequent usage of antibiotics, compared to respondents who initially started with home remedies or allopathic non-antibiotic medicines. PCHMs are commonly used for uncomplicated ARTIs and most of them are readily available for patients to buy themselves over the counter, online, or in pharmacies without a prescription. In 2015, over 60% of the 1231.8 billion RMB market share in China for respiratory conditions was spent on PCHM.<sup>33</sup> The majority of allopathic non-antibiotic medications taken were NSAIDs. While patients with chest infections perceived benefits in symptom relief, evidence suggests they may be associated with worse prognosis.<sup>34</sup>

#### 4.2. Strengths and limitations

Our approach enabled us to recruit a large sample within a comparably short period. We managed to collect responses from adults with acute cough across all regions of China, which increased our ability to understand the extent of antibiotic overuse and the alternatives to help alleviate cough and reduce the use of antibiotics. Although there is clearly an overlap, for the purposes of analysis we divided the respiratory syndromes into those consistent with LRTIs and URTIs.

Our sample may not be representative of the wider Chinese population. There was potentially sampling bias as some participants recruited through researchers' networks with a Chinese medicine background may be systematically more likely to be selected. This may result in bias towards the use of CHM. Those electing to use CHM first line may also have been less likely to use antibiotics regardless of impact on symptoms. Among our sample, 40% were smokers and 27% reported having asthma or other chest diseases. These may not be a true reflection of the population as respondents were more likely to be young and actively using the internet. However, they were encouraged to cascade the survey, in order to include as many people from as many backgrounds as possible. A disadvantage of this method is that it is impossible to know how many people received the invitation, so the presumed response rate was calculated using the number of people who clicked on the survey link.

Although self-reported data may not accurately reflect participants' disease characteristics, lifestyle characteristics or actual treatment behaviours, 83.9% of our respondents were answering questions about cough within a month, therefore, the recall bias should be low. We did not capture the exact order of treatments received, but recorded key information on which treatments participants took before the antibiotics. The outcomes assessed were symptom relief and subsequent use of antibiotics. No data on hospital admission or adverse events were collected. In such self-reported data, we are unable to address residual confounding and hence more advanced statistical analysis (e.g. regression) would be hard to interpret and the associations described should be treated

with caution. A cross sectional survey can only report on associations and causality cannot be implied.

#### 4.3. Priorities for research and clinical implications

The findings are important to inform public health interventions on appropriate treatment-seeking. There is a need to regulate pharmacy practices of prescribing and selling antibiotics. In-depth qualitative research could help to understand the reasons for inappropriate antibiotic use, especially in young patients with URTIs who typically do not need them. Complementary and alternative medicine (CAM) treatments appeared to be acceptable to people from many different settings as a possible alternative to antibiotics, consistent with research in other countries.<sup>35</sup> Future research could explore expectations of patients with cough in China, the acceptability and experiences of taking CHM, and the reasons behind decision making. These could then inform the development of future antibiotic stewardship interventions, potentially encouraging the use of CHM as an alternative to antibiotics.

Future research is needed to improve the evidence base on which specific herbal medicines should be recommended as alternatives to antibiotics. Further analyses are needed to identify the most promising PTCMs. Severity of cough, upper or lower RTIs, and underlying lung conditions may be considered as potential factors influencing how well allopathic non-antibiotic medications, CHM, or home remedies may help in reducing the use of antibiotics.

#### 4.4. Conclusions

There is likely a high proportion of inappropriate use of antibiotics for the treatment of simple acute cough, even in well-educated young adults. Many obtained antibiotics from easily accessible pharmacies which are less strictly regulated. Antibiotics, CHM, allopathic non-antibiotic medications, and home remedies were often used with similar perceived beneficial in relieving cough regardless of treatment. CHM was the most widely used alternative and has a potential role in relieving cough symptoms and reducing the use of antibiotics. Future research is needed to evaluate the effectiveness of individualised and commonly used CHM for acute cough.

#### Author contributions

Conceptualization: XYH, MW, RYX, TYF; Methodology: All; Formal analysis: RYX; Investigation: RYX, TYF, XYH, ML; Resources: YTF, XYH, RYX, JPL, LZW; Data curation: RYX, YTF; Writing: XYH; Review & Editing: All; Visualization: XYH; Supervision: MW, YTF; Project administration: RYX; Funding acquisition: XYH, MW. All authors have read and agreed to the published version of the manuscript. There is no professional writer involved.

#### Acknowledgements

A warm thank you to all networks that contributed to the dissemination of the survey and to the participants who gave up their time to complete the survey.

#### Conflict of interests

The authors declare no conflict of interest. The views expressed are those of the author(s) and not necessarily those of the NIHR or the Department of Health and Social Care. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

## Funding

The Global Network for Anti-Microbial Resistance and Infection Prevention (Global-NAMRIP) awarded pump-priming funding to support this research through the EPSRC (Grant EP/MO27260/1). XYH was funded by the National Institute of Health Research (NIHR) School for Primary Care Research (SPCR). MLW was funded by the National Institute of Health Research (NIHR), (Grant CL-2016-26-005).

## Ethical statement

Ethical approval was sought from the University of Southampton ethics committee (ERGO 31,602) and the Beijing University of Chinese Medicine ethics committee (2018BZHYLL0101).

## Data availability

The data that support the findings of this study are available within the article and its supplementary material, or are available from the corresponding author upon reasonable request.

## Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.imr.2022.100920.

Supplement 1. Various treatments used for acute cough;

Supplement 2. Factors influencing subsequent use of antibiotics after various interventions;

Supplement 3. Cough relief after each type of treatment in various factors as measured by 1-5 Likert scale: median (IQR); Supplement 4. Questionnaire (Chinese).

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