



Public Health  
England

Protecting and improving the nation's health

# **What the public know about antibiotic use and resistance, and how we may influence it**

Findings from a 2017 national survey

## About Public Health England

Public Health England exists to protect and improve the nation's health and wellbeing, and reduce health inequalities. We do this through world-leading science, research, knowledge and intelligence, advocacy, partnerships and the delivery of specialist public health services. We are an executive agency of the Department of Health and Social Care, and a distinct delivery organisation with operational autonomy. We provide government, local government, the NHS, Parliament, industry and the public with evidence-based professional, scientific and delivery expertise and support.

Public Health England

Wellington House

133-155 Waterloo Road

London SE1 8UG

Tel: 020 7654 8000

[www.gov.uk/phe](http://www.gov.uk/phe)

Twitter: [@PHE\\_uk](https://twitter.com/PHE_uk)

Facebook: [www.facebook.com/PublicHealthEngland](https://www.facebook.com/PublicHealthEngland)

Prepared by: Professor Cliodna A M McNulty

For queries relating to this document, please contact: [Cliodna.McNulty@phe.gov.uk](mailto:Cliodna.McNulty@phe.gov.uk)



© Crown copyright 2020

You may re-use this information (excluding logos) free of charge in any format or medium, under the terms of the Open Government Licence v3.0. To view this licence, visit [OGL](https://www.ogil.io). Where we have identified any third party copyright information you will need to obtain permission from the copyright holders concerned.

Published: September 2020

PHE publications

gateway number: GW-1520

PHE supports the UN

Sustainable Development Goals



# Contents

Contents.....	3
Introduction .....	4
Background .....	4
Methodology .....	5
Questionnaire schedule .....	6
Data analysis.....	7
Results .....	8
Knowledge and perceptions .....	8
Use of antibiotics .....	13
Expectations, prescriptions, information and advice .....	15
Delayed antibiotics .....	20
Parents of young children .....	20
Discussion.....	22
References.....	24
Appendices .....	26

# Introduction

## Background

The term 'antibiotic' was introduced by Selman Waksman in 1942, meaning 'against life'. Antibiotic is now in common parlance, indicating a medicine (drug) which is active against bacteria, but not viruses, fungi or protozoa. The term 'antimicrobial' is used by doctors and scientists to indicate a drug which is active against any microorganism (microbe), including bacteria, fungi and protozoa.

Antimicrobial resistance (AMR) means that a particular microorganism has become resistant to a particular drug, so that that drug is no longer effective in treating an infection caused by that microorganism. Antimicrobial resistance among some bacteria has become more prevalent internationally, including in the UK (1). Patients who have an infection caused by resistant bacteria will have longer hospital stays, worse outcomes and poorer quality of life (2).

The UK Department of Health and Social Care (DHSC) have formulated two 5-year national action plans to address the threat posed by AMR (3, 4). The plan published in 2019 focuses on three key ways of tackling AMR including:

- reducing the need for and unintentional exposure to antimicrobials
- optimising the use of antimicrobials
- investing in innovation supply and access to antimicrobials

This will include reducing infections by promoting better infection, prevention and control practices and engaging the public around issues specific to antimicrobial resistance.

Public Health England (PHE) has conducted a series of household surveys since 2003 to gauge the level of public understanding about antibiotics and AMR (5-11). This information is important in designing campaigns and strategies to improve public understanding, as a means of reducing inappropriate use of antibiotics and of raising general awareness of the threat posed by AMR.

The 2014 survey found that GPs and health care professionals are trusted to decide whether an antibiotic should be prescribed, but that they could provide more information to patients (especially younger patients and those of lower social grade) about the need (or not) for antibiotics, and about self-care and the issue of antimicrobial resistance (9). The survey also concluded that wider acceptance of delayed antibiotic prescribing was needed. As a result, the term 'delayed' was changed to 'back-up' in national guidance (12).

This report presents the findings of our most recent (2017) national household survey, describing current public knowledge and recent use of antibiotics, including delayed /back-up antibiotics and awareness among parents of young children.

We have compared responses with those obtained in previous surveys, to determine whether there have been any significant changes. This information will help us determine how we should be targeting public and professional education and interventions to improve antibiotic use.

## Aims and objectives

Our overall aim was to gain an understanding of public knowledge about antibiotics and antimicrobial resistance in order to inform future information needs and targets for education. We asked the following questions:

- what are antibiotics?
- what illnesses can antibiotics treat?
- how does antibiotic resistance spread?
- what are back-up/delayed antibiotics?
- who do you trust to give advice about antibiotics?
- what advice have you received from healthcare professionals?

We also aimed to collect data on the use of antibiotics (prescribed, unprescribed, back-up/delayed) and compare responses to those obtained in a previous (2014) survey.

## Methodology

The market research company Ipsos MORI conducted interviews as part of their weekly Face-to-Face Omnibus (Capibus) survey, which collects a wide range of information from across England in a single week (13). The survey was conducted from 24 January to 5 February 2017. Multistage sampling was used to recruit 1,691 adults aged 15 and over for face-to-face interviews in their own homes. Interviews were computer-assisted, meaning that responses were entered immediately into the computer during the interview.

Capibus uses two-stage random location sampling. The initial sampling frame is an amalgamation of Output Areas (OAs, used for output from the Census in Great Britain), regrouped into Primary Sampling Units (PSUs) taking into account ACORN characteristics (geodemographic classification of residential neighbourhoods). A total of 170 to 180 of these PSUs are randomly selected from the stratified groupings with probability of selection proportional to size. At the second stage two adjacent OAs, each comprising approximately 125 addresses, are randomly selected from each PSU.

Interviewers are given age, gender, household tenure and working status quotas of respondents for each sample point. Interviewers go door-to-door and invite persons

aged 15 and over to participate. Households are visited throughout the week during the daytime, evenings and at weekends to ensure that working people are not excluded. Non-responding households are not revisited. Typically, one interview is completed for every 3 or 4 doors knocked.

To ensure a sufficiently large sample size for our study, a second survey was undertaken to obtain more respondents for the delayed prescribing question, and a third survey was undertaken to capture more data from parents of children aged under 5.

## Questionnaire schedule

The interview schedule was based on previously-published PHE public survey questionnaires about antibiotics and delayed/back-up antibiotic prescribing (5-8, 10, 11). Questions were developed in collaboration with GPs, non-healthcare advisors, PHE's marketing team, and Ipsos MORI's health questionnaire team. To facilitate comparison with previous surveys, many of the questions were asked in an identical manner. Computer-assisted interviewing ensures that the questionnaire is followed correctly for all respondents. Partially-completed interviews (if participants terminated the interview) are excluded.

One new questionnaire item exploring antibiotic resistance and its relationship to antibiotic use was added (Box 1). This item comprised 8 statements covering a range of concepts where we know that the public have some misunderstanding. Participants were asked to indicate whether they agreed or disagreed with the statements or thought that statements were true or not true. Possible responses were:

- strongly agree or definitely true
- tend to agree or probably true
- neither agree nor disagree or don't know
- tend to disagree or probably not true
- strongly disagree or definitely not true

The statements were randomly ordered and the response scale was reversed for half of respondents. The question was piloted by the PHE Peoples' Panel and was the final question in the survey.

**Box 1: New question asked in 2017 about antibiotic resistance (correct answers in bold)**

1. People can carry antibiotic resistant bacteria for over a year. **True**
2. Antibiotics don't work for everything. **True**
3. Taking antibiotics when you don't need them encourages bacteria that live inside you to become resistant. **True**
4. Antibiotic resistance is not caused by taking antibiotics. **False**
5. If you have taken antibiotics recently and then have a new infection, antibiotics are more likely to work on this new infection. **False**
6. All antibiotic-resistant bacteria are harmful. **False**
7. Antibiotics work for colds or flu because they're viral infections. **False**
8. We can carry antibiotic resistant bacteria in our bodies without knowing. **True**

## Data analysis

Weights provided by Ipsos MORI were used to correct for known selection biases. Capibus uses a Random Iterative Method (RIM) weighting system which weights to the latest set of census data or mid-year estimates and National Readership Survey profiles for age, social grade, region and working status, within gender and additional profiles on tenure and ethnicity. Pearson's Chi-squared test corrected for survey design (14) was used to test for differences in proportions across levels of categorical variables and between responses to identical questions in the current and 2014 survey (which used the same survey methodology) (8, 9). Unweighted frequencies and weighted percentages are shown for all results. Stata was used for all analyses (StataCorp. 2017. Stata Statistical Software: Release 15. College Station, TX: StataCorp LLC).

## Results

Data was available for 2,283 adult respondents, 1,691 original respondents plus 777 parents of children under 5 (all results reported below and in tables show unweighted frequencies and weighted percentages).

### Knowledge and perceptions

Overall, 56% of respondents answered that antibiotics fight bacteria or bacterial infections. Respondents who were female, in higher social grades, had formal qualifications and who had visited a doctor or pharmacy in the past year were more knowledgeable about the term antibiotic than other groups (Table 1). Younger adults were less knowledgeable, as were black and minority ethnic adults. Parents were not more knowledgeable.

**Table 1: Respondents who know that antibiotics fight bacterial infections**

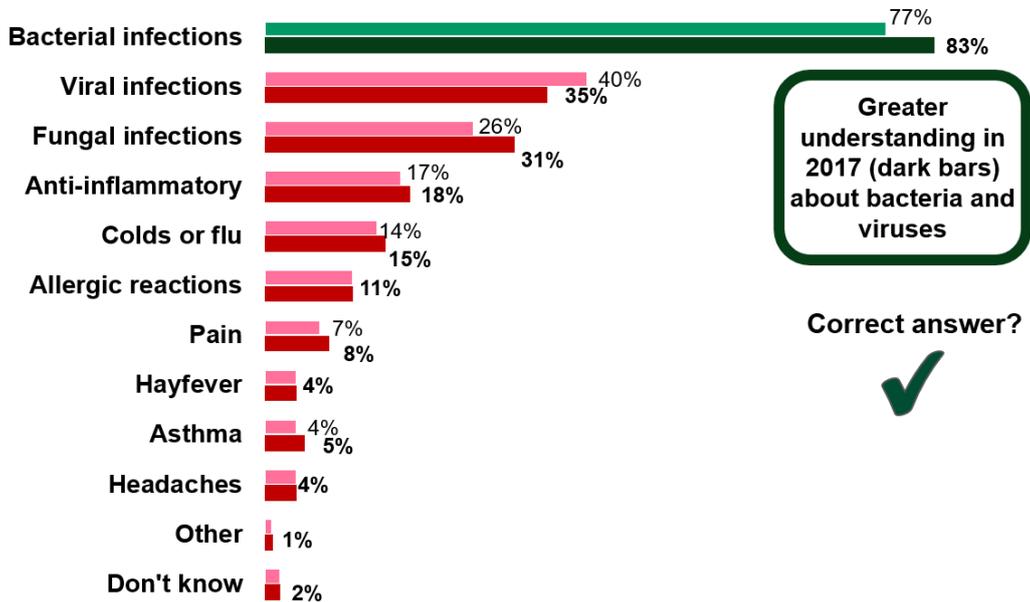
		% correct	p-value*
Overall (N=1,691)		56%	
Age (years)	15-24	37%	p=0.002
	25-34	59%	
	35-44	53%	
	45-54	57%	
	55-64	64%	
	65+	60%	
Sex	Female	60%	p=0.001
	Male	51%	
Social Grade	AB	68%	p<0.001
	C1	58%	
	C2	49%	
	DE	46%	
Education	Degree	71%	p<0.001
	A-level or equivalent	58%	
	GCSE or equivalent	51%	
	No formal education	38%	
Has children age under 15 years in household	Yes	56%	p=0.72
	No	55%	
Been to doctor or pharmacy in past year	Yes	62%	p<0.001
	No	43%	
Ethnic grouping	White	58%	p<0.001
	BAME	44%	

\* Pearson's chi-squared

When asked specifically which conditions could be treated effectively with antibiotics, 83% of respondents ‘agreed’ or ‘strongly agreed’ that bacteria could effectively be treated by antibiotics. This is an increase from 77% in the 2014 survey (p=0.001) (Figure 1). One-third of respondents (35%) thought that viral infections could be treated with antibiotics, a slight decrease from 40% in 2014 (p=0.01). These figures suggest some improvement in key knowledge, albeit with a persistent substantial minority who believe incorrectly that antibiotics treat viral and fungal infections.

**Figure 1: Which of the following conditions, if any, do you think can be effectively treated with antibiotics?**

*Question VQ1: Which of the following conditions, if any, do you think can be effectively treated by antibiotics?*



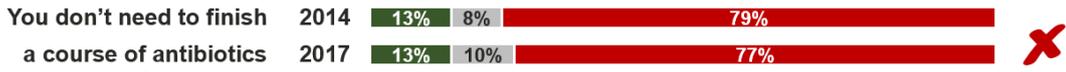
Base: All respondents (n=1,691 in 2017)

Most people (85%) agreed or strongly agreed that coughs, colds and sore throats get better on their own without the need for antibiotics, and very few (13%) agreed with the statement that a course of antibiotics didn’t need to be completed if symptoms improved. These proportions were the same as in 2014 (Figure 2).

**Figure 2: Further perceptions (and misperceptions) about antibiotics**

**Question VV28. Antibiotic statements: Please tell me to what extent you agree or disagree with the following?**

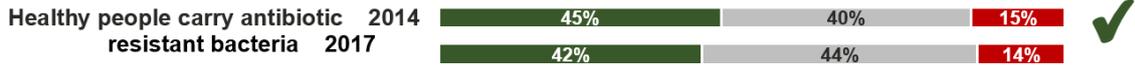
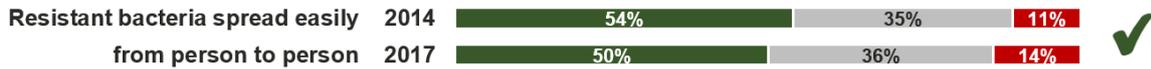
**Perceptions are correct**



**Perceptions are incorrect**



**Lack of knowledge**

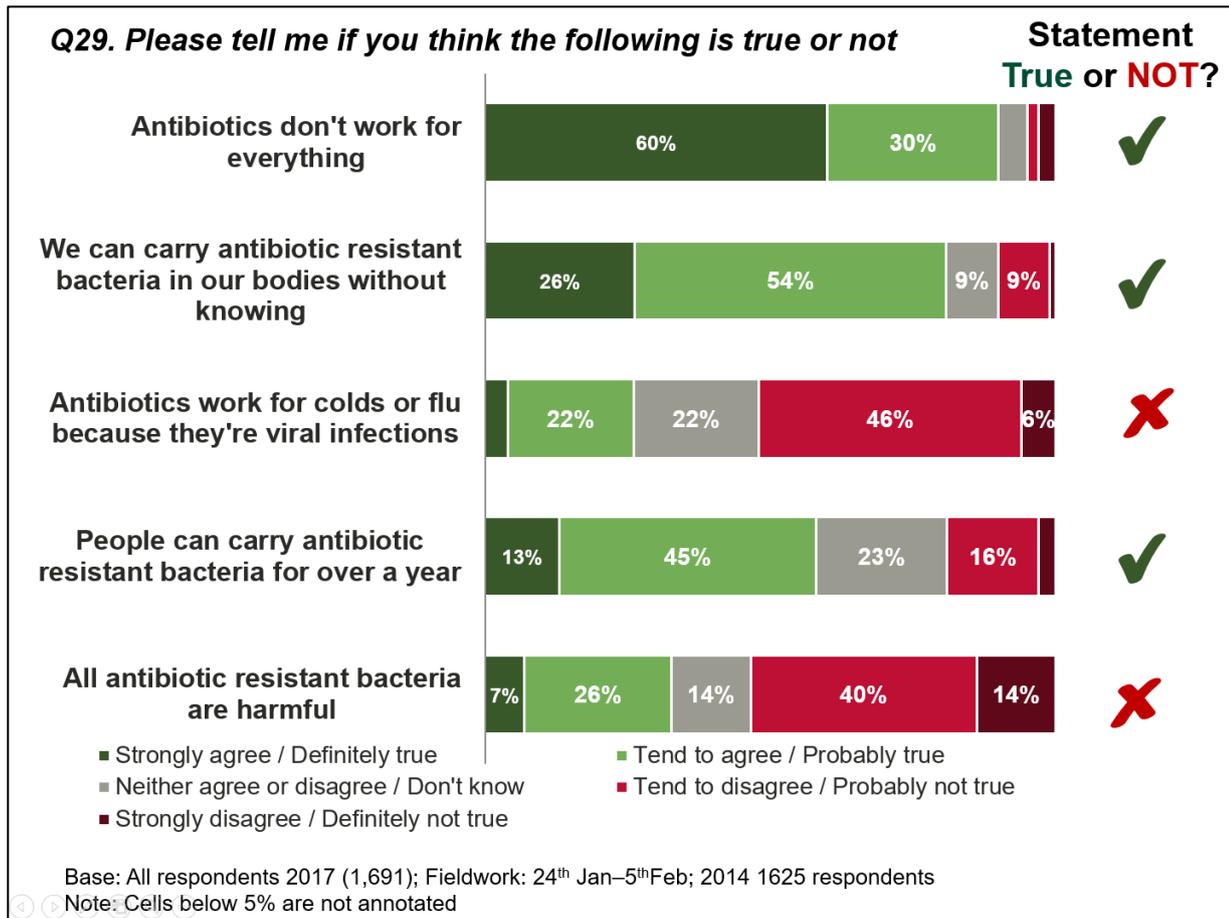


■ Strongly/Tend to agree   ■ Neither / nor or Don't know   ■ Tend to/Strongly disagree

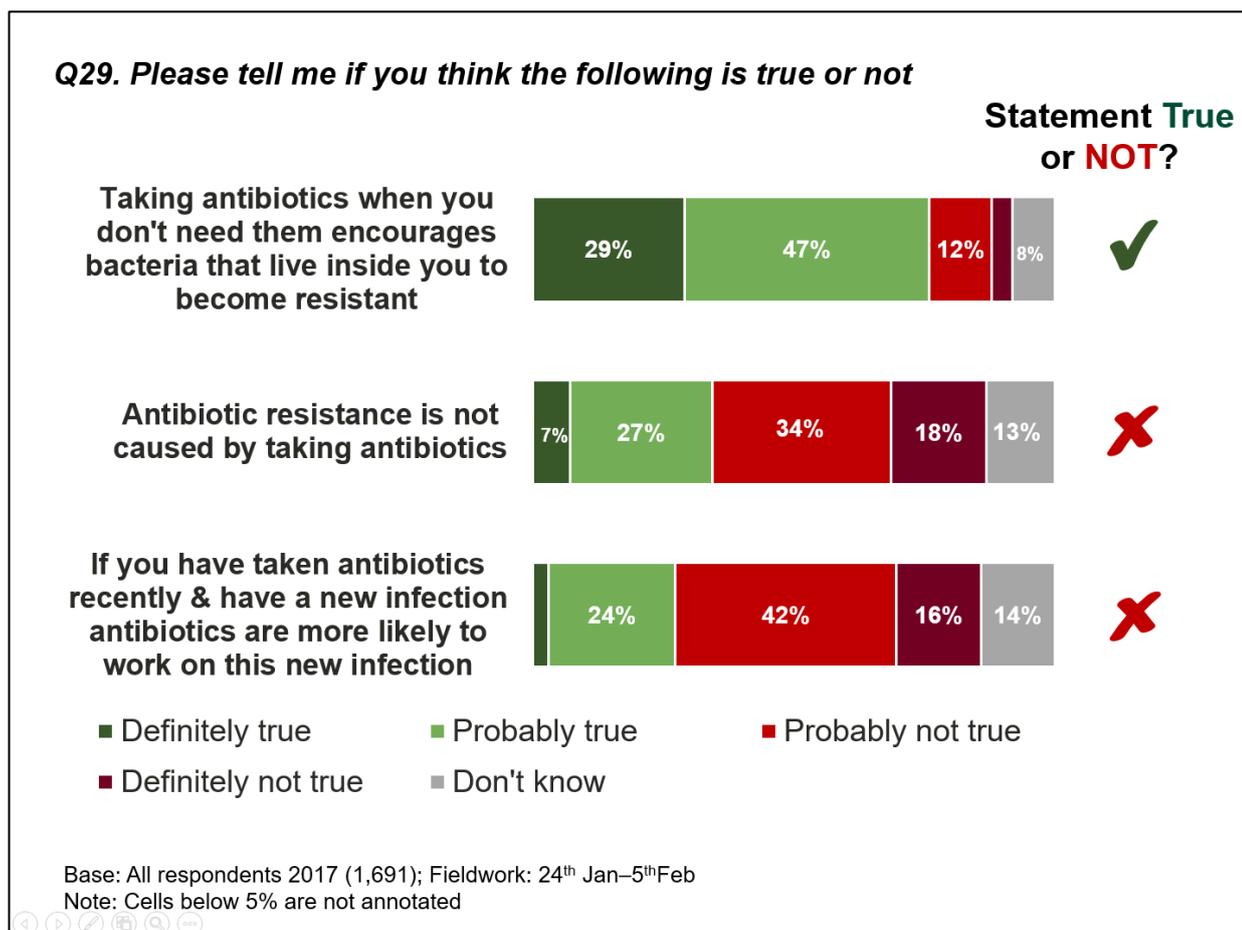
Base: All respondents (n=1,691 in 2017)

Responses elicited by the new question on antibiotic resistance showed uncertainty around concepts such as carriage of resistant bacteria, whether resistance was caused by taking antibiotics and whether all resistant bacteria were harmful (Figures 3a-b).

**Figure 3a: Antibiotic and antimicrobial resistance concepts**



**Figure 3b: Antibiotic and antimicrobial resistance concepts**



If we define good overall knowledge about antibiotics and antimicrobial resistance as 7 or more correct responses to the 9 questions described above (8 questions in Box 1 plus the question ‘What do you think an antibiotic is?’) we see that higher social grade and higher qualifications predict good knowledge, whereas younger and older adults and black and minority ethnic adults are less likely to have a good overall understanding of antibiotics and antimicrobial resistance (Appendix A).

### Implications

The implications are that:

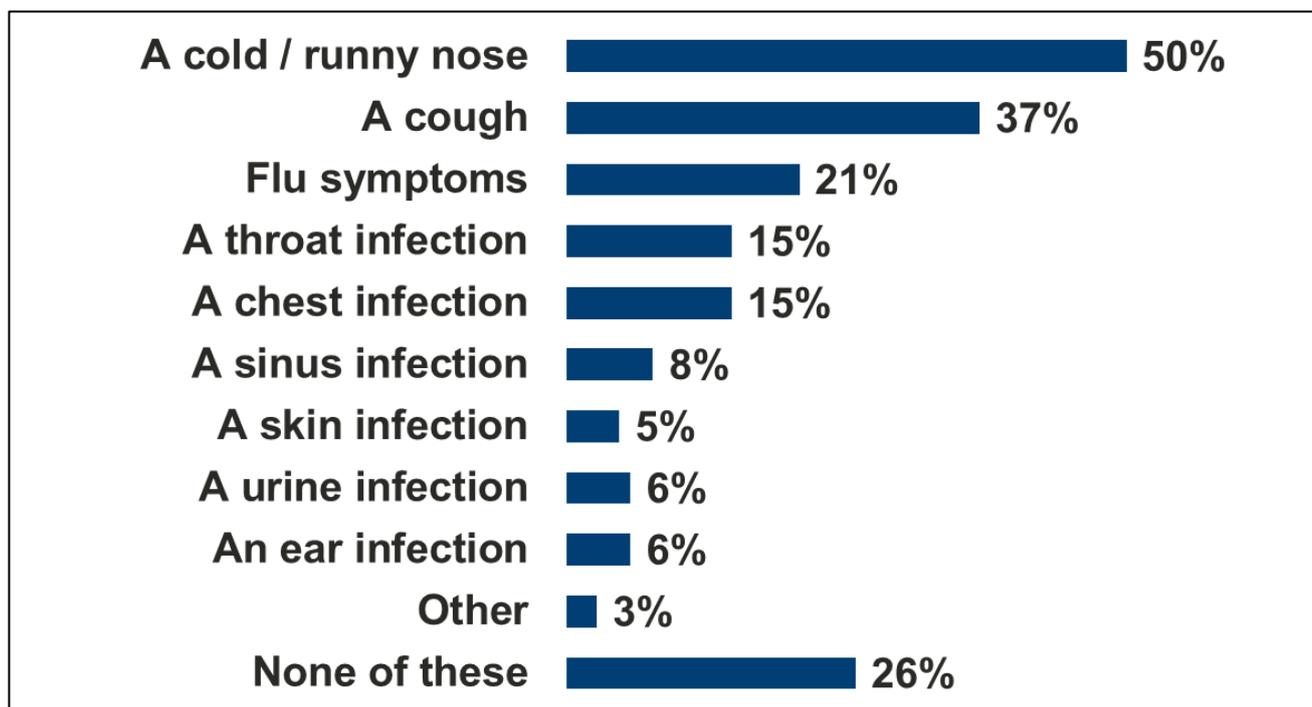
- messages about bacterial *versus* viral infections appear not to be reaching everyone
- more widespread use of specific terms for medicines, for example antibacterial, antiviral, antifungal, anti-pain, anti-fever and anti-inflammatory could be helpful
- information and education could be targeted at younger adults and black and ethnic minority groups
- further research is needed to understand how ethnicity influences knowledge and behaviour around antibiotics and antibiotic resistance; subsequent Capibus studies should allow for multivariable analysis around this area in the sample design
- we should continue to use a syndromic approach, for example most coughs, colds and sore throats get better on their own, while being aware that information and

campaigns should be inclusive of non-respiratory infections where back-up antibiotics might be used (like urinary tract infections)

### Use of antibiotics

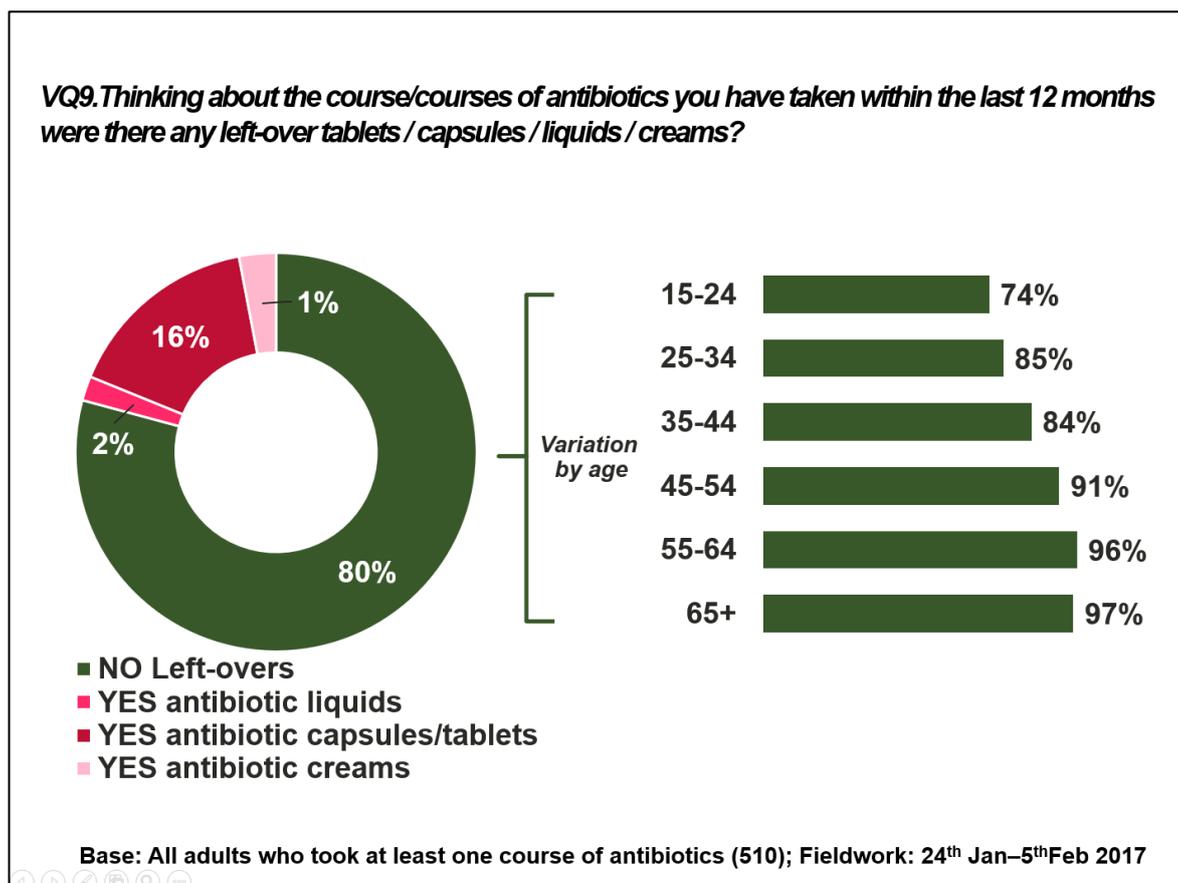
Three quarters of respondents (72% (1226/1691)) reported having had at least one infection in the past 12 months (Figure 4). Reported antibiotic use (one or more courses) for each type of infection was throat 30%, ear 46%, sinus 25%, chest 56%, urinary 78%, and cold or runny nose 4% (Appendix B).

**Figure 4: Infections in past 12 months (n=1691)**

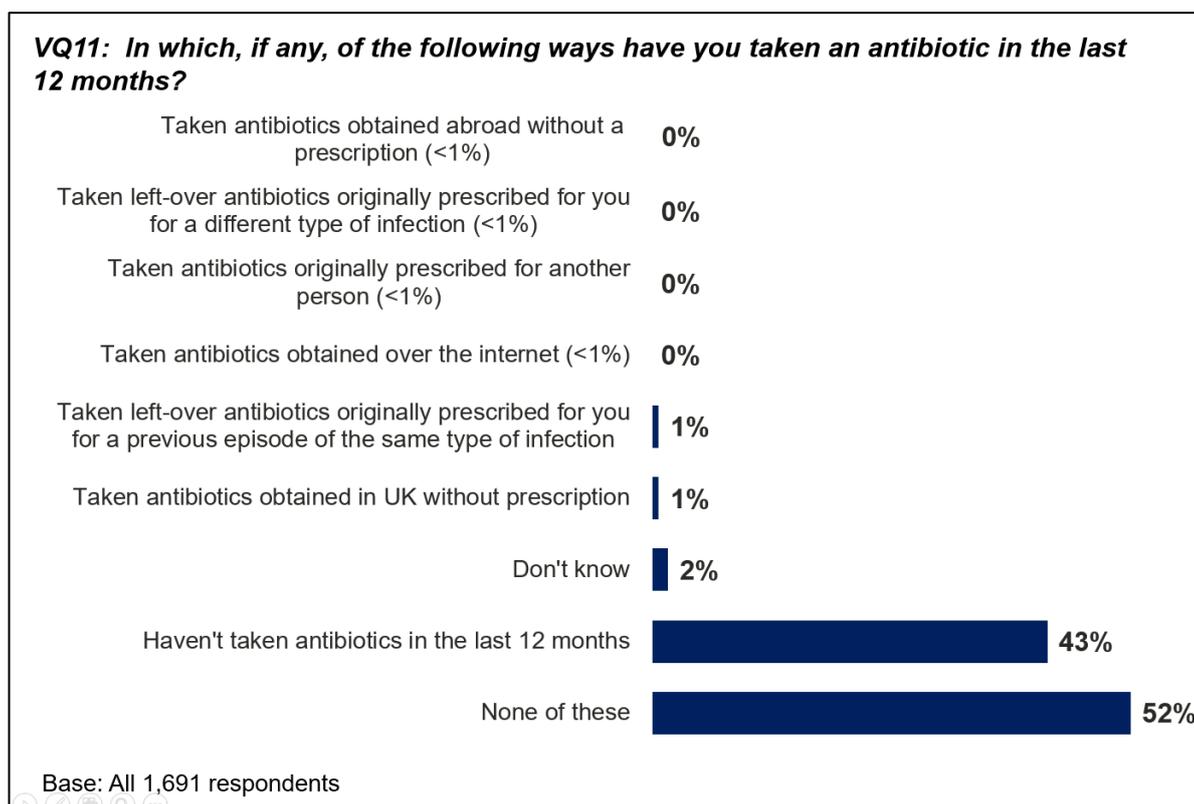


One sixth (14%) of respondents who had taken antibiotics reported having leftover capsules or tablets (Figure 5), of which 33% were kept for possible future use. Only 7% reported returning them to a pharmacist. Only 1% of respondents had taken leftover antibiotics in the preceding 12 months and 1% had taken antibiotics obtained without a prescription (Figure 6).

**Figure 5: Leftover antibiotics**



**Figure 6: Using non-prescribed antibiotics**



## Implications

The implications are that:

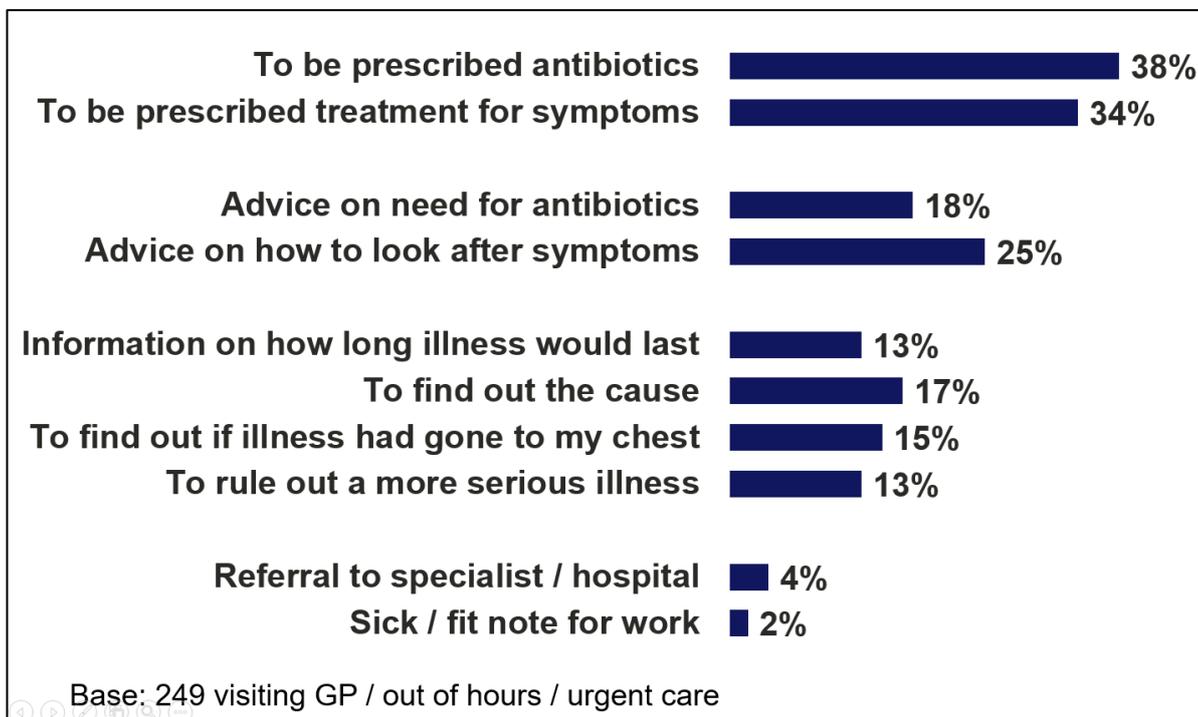
- retention of antibiotics for possible future use is the most common reason for keeping leftover antibiotics
- a very small number of people take antibiotics without prescription
- more publicity about how to dispose of unused antibiotics is needed as few patients return them to a pharmacist

## Expectations, prescriptions, information and advice

### Primary care consultations for respiratory and flu symptoms

Of 959 respondents who reported having respiratory (cough, throat, ear, sinus, chest infection) or flu symptoms in the past 12 months, 249 (27%) reported that they visited or contacted a doctor's surgery or visited a NHS Walk-In Centre or GP out-of-hours service and provided follow up responses. 15 (2%) visited A&E. Among the 249 who provided feedback based on their most recent illness, as many expected antibiotics (38%) as expected treatment for symptoms (34%) (Figure 7). Overall, 56% were prescribed antibiotics (Figure 8) (Appendix C). One third of participants reported that they were examined, fewer were given advice about the length of illness, severity, diagnosis or need for antibiotics.

**Figure 7: Expectations of respondents who accessed primary care for respiratory (cough, throat, ear, sinus or chest infection) or flu symptoms in the past 12 months**



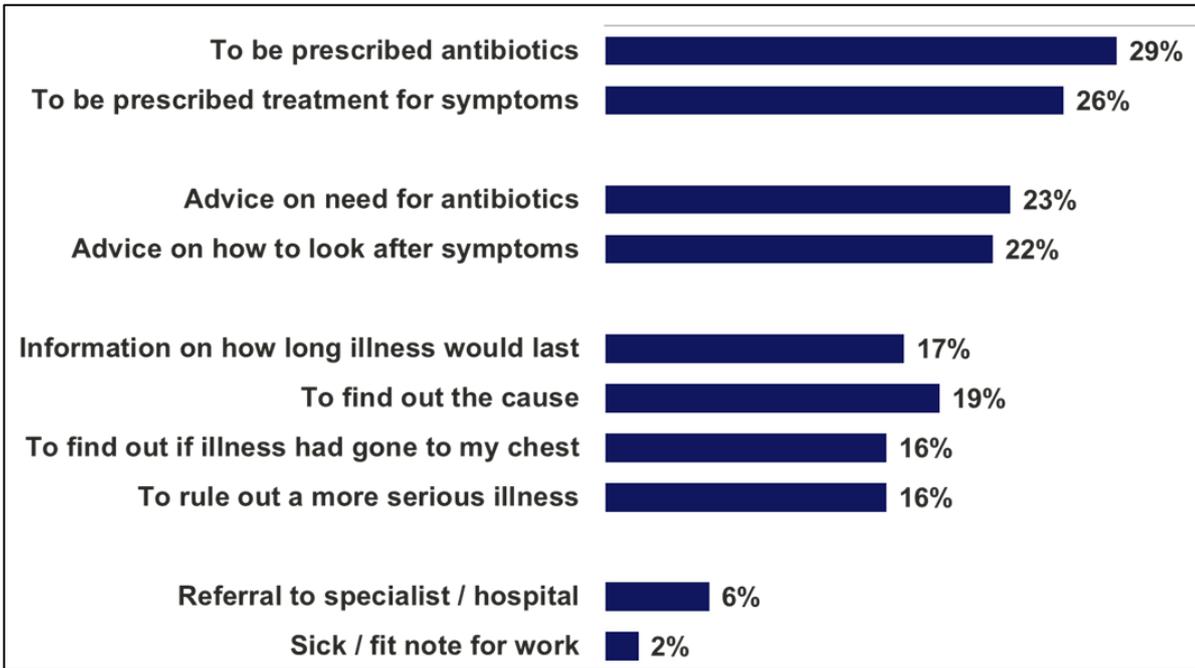
**Figure 8: Outcomes of visits to primary care for respiratory (cough, throat, ear, sinus or chest infection) or flu symptoms**



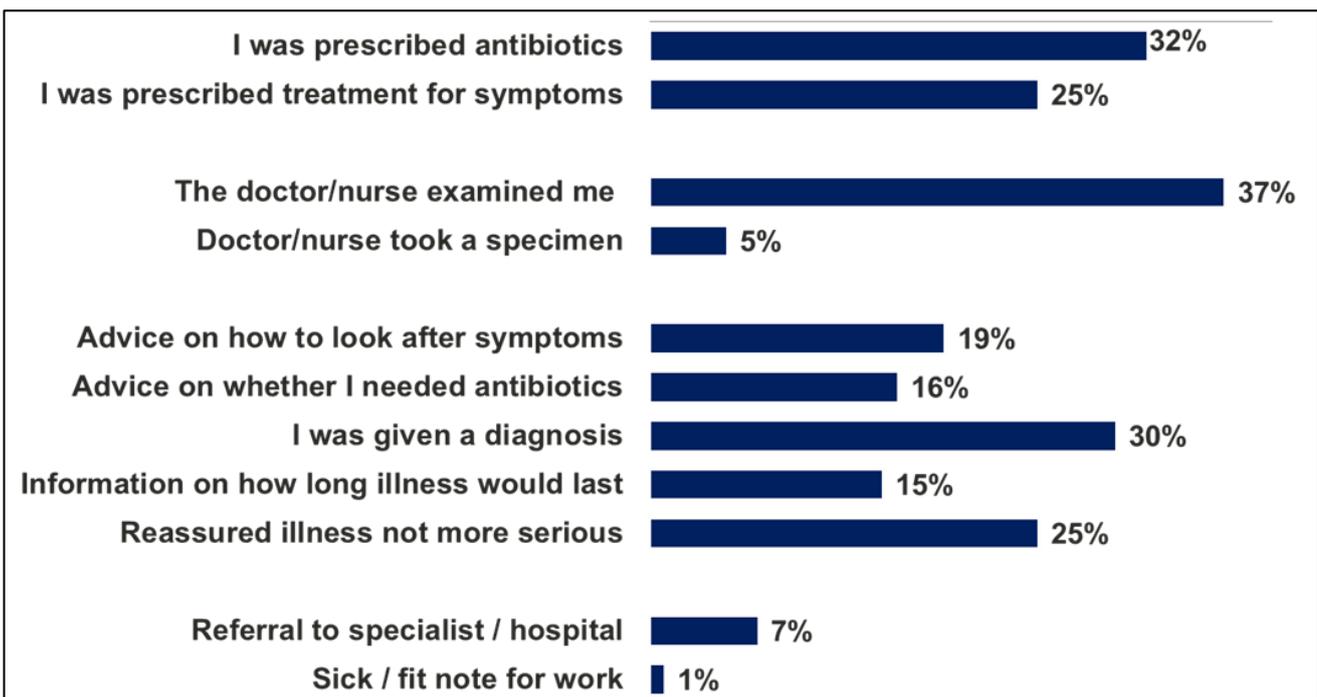
### Primary care consultations for cold or runny nose

Respondents with a cold or runny nose who accessed primary care (7% (61/853)) were less likely to expect antibiotics (29%) or treatment for symptoms (25%) compared to those with other respiratory tract infections (Figure 9). Of these, 31% were prescribed antibiotics (Figure 10) (Appendix C).

**Figure 9: Expectations of respondents who accessed primary care for a cold or runny nose in the past 12 months (n=853)**



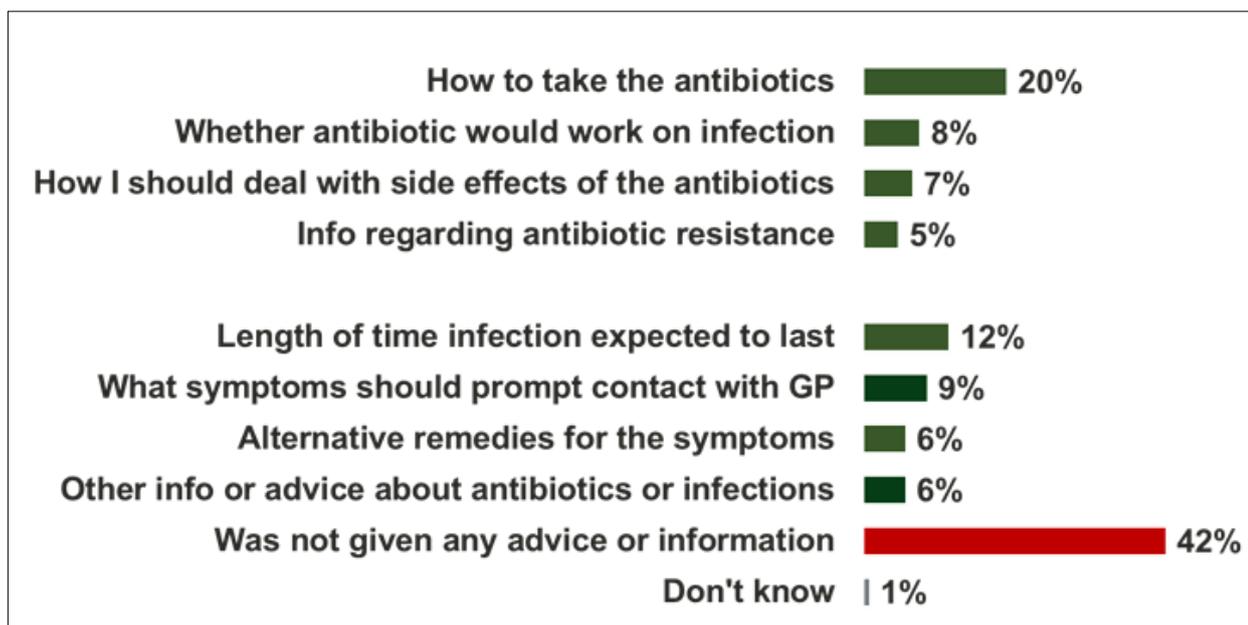
**Figure 10: Outcomes of visits to primary care for a cold or runny nose (n=853)**



## Information and advice

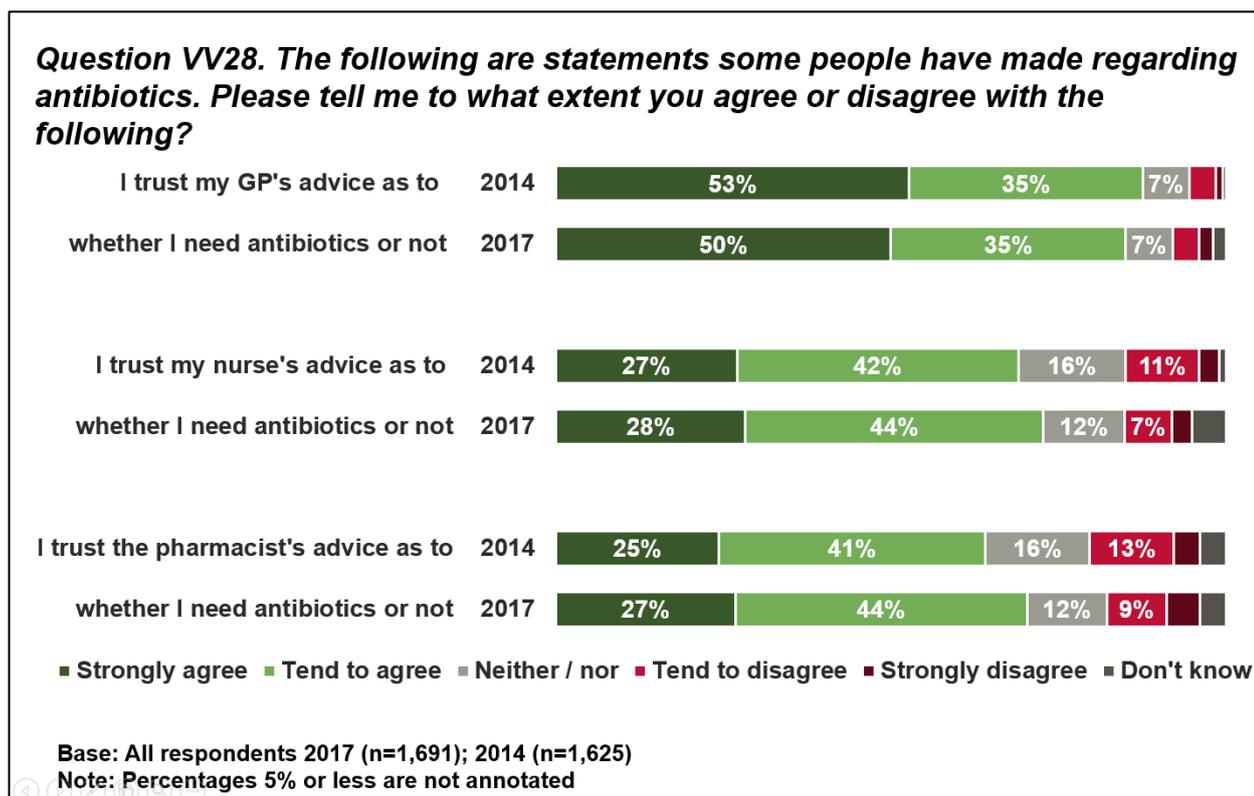
Among 1,319 respondents who had an infection or antibiotics within the past year, 42% said that they did not receive any advice or information about antibiotics (Figure 11). This is lower than in 2014 (55%,  $p < 0.001$ ). The majority (83%) of those who did receive information in 2017 said that it was provided to them verbally by a healthcare professional, whilst 21% received a leaflet.

**Figure 11: Advice or information from a health professional when prescribed an antibiotic in the last 12 months (n=1,347)**



Among all survey respondents (regardless of recent illness), levels of trust in advice about antibiotics from health professionals was high and similar to 2014 (Figure 12). Higher proportions of respondents trusted their GP's advice compared to that given by nurses and pharmacists.

**Figure 12: Trust in advice about antibiotics given by healthcare professionals**



## Implications

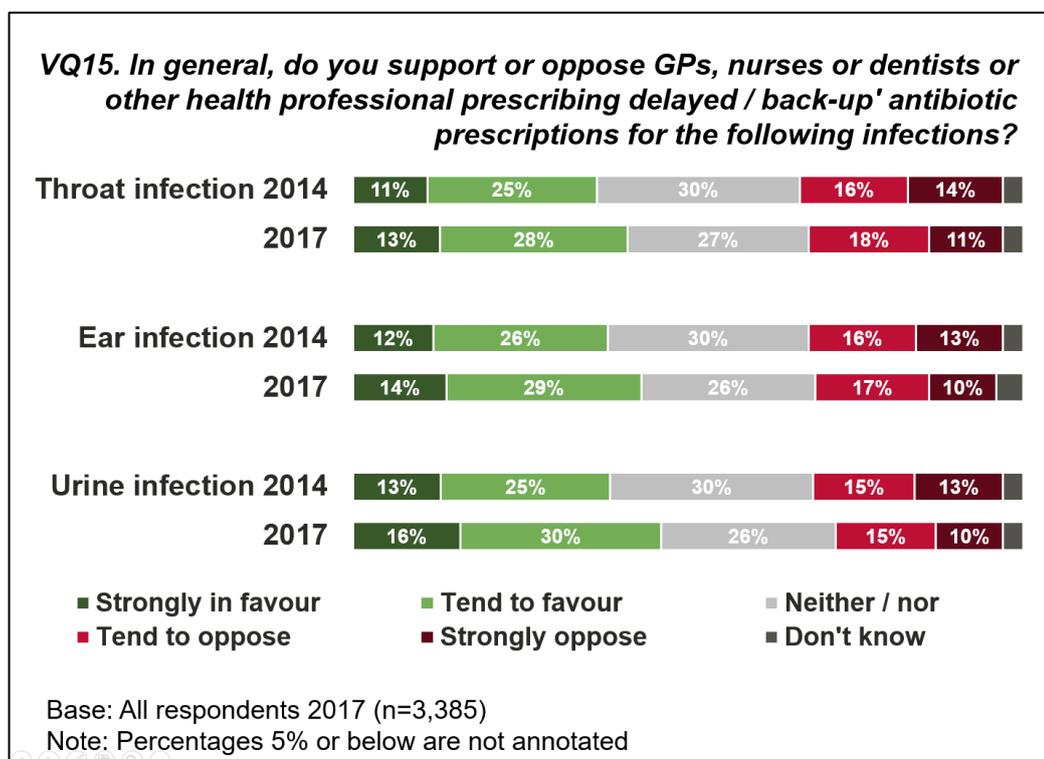
The implications are that:

- the public are still not receiving enough advice or information about antibiotics when they visit a health professional
- most people trust their GP's advice about antibiotics
- public trust of advice given by nurses and pharmacists is high but could be improved
- the verbal information given to patients in a consultation is probably insufficient to change behaviour as it is unlikely to be recalled; patients should be given written advice or signposted to information
- pharmacists are not reported as sources of advice about infections and antibiotics, and this could be increased

## Delayed antibiotics

Overall, 4% (64/1691) of respondents had been given a ‘delayed or back-up’ antibiotic prescription by a GP, nurse, dentist or other health professional in the past 12 months, the same proportion as in 2014. Fewer respondents in 2017 (23%) compared with 2014 (28%) were aware of delayed antibiotics (Appendix D). There is increased support in 2017 compared to 2014 for the use of ‘delayed/back-up’ antibiotic prescriptions, but there are still up to 29% who oppose their use. (Figure 14).

**Figure 14: Public support for delayed/back-up antibiotic prescribing**



## Implications

Though support for ‘delayed/back-up’ antibiotic prescriptions is slowly increasing, the continued opposition by nearly 30% suggests that the public need to be provided with more information and explanation.

## Parents of young children

A recent episode of respiratory (cough, throat, ear, chest infection) or flu symptoms in a child under 5 years old was reported by 265 parents, prompting 141 (52%) to visit or contact a doctor’s surgery or visit a NHS Walk-In Centre or GP out-of-hours service and 14 (5%) to attend A&E.

Among the 141 parents who accessed primary care, a similar number expected antibiotics for their child (27%) as expected treatment for symptoms (33%); 41% were prescribed antibiotics (Appendix C).

Parents of children who had a recent cold or runny nose and who accessed primary care for their child's illness (53/262) were less likely to expect antibiotics (13%) or treatment for these symptoms (22%) than were parents of children with respiratory or flu symptoms; 33% (17/53) were prescribed antibiotics.

## Discussion

This survey has shown that misunderstandings about antibiotics persist in the minds of a substantial minority of the general public, although most people do have a correct basic understanding of the purpose of antibiotics (to treat bacterial infections).

Given that less than half of people who had an infection or took antibiotics in the past year said that they received advice or information, and that most people trust GPs' advice, there is scope for providing more information about antibiotics and antimicrobial resistance during primary care consultations.

This is particularly important for groups identified as being less knowledgeable about antibiotics, namely adults under 24 or over 65 years old and black, Asian and minority ethnic adults.

### Strengths and limitations

This study's main strength is the use of a well-established survey methodology, which yields a representative sample of the population in England. Similar PHE surveys have been conducted several times since 2003, which have allowed us to refine the questions (although reliability and validity have not been evaluated formally).

Conversely, changes in the wording of questions mean that some results from earlier surveys are not directly comparable. Some Ipsos MORI interviewers can conduct interviews in other languages, but translation is not routinely offered. Some of the survey questions require respondents to recall events during the past 12 months. While this inevitably introduces a degree of inaccuracy, we have no reason to suspect systematic biases in responses. However, potentially sensitive questions, for example around the use of non-prescribed antibiotics, might underestimate such practices.

### Interpretation and implications

The results of this latest survey suggest a favourable change in the proportions of respondents who know that antibiotics are effective against bacteria but not against viruses. The proportions of households with 'forgotten' leftover or 'standby' leftover antibiotics in 2017 were lower than in 2003 (6) and 2014, but the 2003 survey was based on visual inspection of household drugs and the 2014 survey asked, 'What do you usually do [with leftover antibiotics]?' rather than 'What did you do...?' A repeat of the visual inspection survey would be needed to establish whether the practice of retaining leftover antibiotics is diminishing.

We are encouraged that 38% of patients accessing primary care with respiratory or flu symptoms expected to be prescribed antibiotics, representing a substantial reduction since 2011 (53%) (11). Less encouraging was the one third of respondents who

reported being prescribed antibiotics for their own or their child's cold or runny nose, and fewer respondents being aware of delayed antibiotics compared to 2014 (8).

People are still not receiving enough information about antibiotics when they attend primary care. Most of the 42% receiving information reported this was verbal which in a short consultation is probably insufficient to improve public knowledge and awareness.

Patient-facing leaflets for respiratory and urinary tract infections are included in the **TARGET Antibiotic Toolkit** (15) and are freely available to download. However, increased uptake requires health professionals to have ready access to these leaflets.

Our findings show that BAME respondents were less knowledgeable about antibiotics and support recommendations that ethnicity is explored in further detail in subsequent studies. There is a lack of qualitative and quantitative evidence on best approaches to tackling this issue, such as whether targeted education and information interventions accommodating social and cultural factors might be effective.

Adolescents and younger adults (16 to 24-year-olds) are a difficult group to reach (16) but a recent feasibility study showed that 72% of 16 to 18-year-olds who had participated in an **e-Bug** (17) lesson consented to receive follow-up text messages about antibiotic use (PHE data). Hence, alternative approaches such as social media messaging and games might be more effective than patient leaflets for this age group (18-20).

Our survey took place before the launch of PHE's '**Keep Antibiotics Working**' campaign, which included adverts on television, radio and social media. While national and international campaigns to raise public awareness of the threat posed by antimicrobial resistance are ongoing, a key element in optimising antibiotic use is to improve antibiotic prescribing practice through medical education, continuous professional development and dissemination of evidence and prescribing indicators, as outlined in the UK's **5-year national action plan** for tackling antimicrobial resistance (21).

## References

1. PHE. English Surveillance Programme for Antimicrobial Utilisation and Resistance (ESPAUR). London, UK: Public Health England; 2018.
2. Ramanathan S. Multidrug-resistant gram-negative organisms and association with 1-year mortality, readmission, and length of stay in Veterans with spinal cord injuries and disorders. *Spinal Cord*. 2019.
3. Department of Health and Social Care. UK five year antimicrobial resistance strategy 2013 to 2018. London; 2013.
4. Global and Public Health Group EPaHPPD. Tackling antimicrobial resistance 2019–2024. The UK's five-year national action plan. 2019.
5. Butler CC, Hawking MK, Quigley A, McNulty CA. Incidence, severity, help seeking, and management of uncomplicated urinary tract infection: a population-based survey. *Br J Gen Pract*. 2015;65(639):e702-7.
6. McNulty CA, Boyle P, Nichols T, Clappison DP, Davey P. Antimicrobial drugs in the home, United Kingdom. *Emerg Infect Dis*. 2006;12(10):1523-6.
7. McNulty CA, Boyle P, Nichols T, Clappison P, Davey P. Don't wear me out--the public's knowledge of and attitudes to antibiotic use. *J Antimicrob Chemother*. 2007;59(4):727-38.
8. McNulty CA, Lecky DM, Hawking MK, Quigley A, Butler CC. Delayed/back up antibiotic prescriptions: what do the public think? *BMJ Open*. 2015;5(11):e009748.
9. McNulty CA, Lecky DM, Hawking MK, Roberts C, Quigley A, Butler CC. How much information about antibiotics do people recall after consulting in primary care? *Fam Pract*. 2016;33(4):395-400.
10. McNulty CA, Nichols T, Boyle PJ, Woodhead M, Davey P. The English antibiotic awareness campaigns: did they change the public's knowledge of and attitudes to antibiotic use? *J Antimicrob Chemother*. 2010;65(7):1526-33.
11. McNulty CA, Nichols T, French DP, Joshi P, Butler CC. Expectations for consultations and antibiotics for respiratory tract infection in primary care: the RTI clinical iceberg. *Br J Gen Pract*. 2013;63(612):e429-36.
12. National Institute for Health and Care Excellence (NICE). Antimicrobial prescribing guidelines. London, UK: NICE; 2018.
13. Crouch S, Housden M. *Marketing Research for Managers*: Butterworth-Heinemann; 2003.
14. Rao JNK, Scott AJ. On Chi-Squared Tests for Multiway Contingency Tables with Cell Proportions Estimated from Survey Data. *Ann Statist*. 1984;12(1):46-60.
15. McNulty CA, Cookson BD, Lewis MA. Education of healthcare professionals and the public. *J Antimicrob Chemother*. 2012;67 Suppl 1:i11-8.
16. Hawking MK, Lecky DM, Touboul Lundgren P, Aldigs E, Abdulmajed H, Ioannidou E, et al. Attitudes and behaviours of adolescents towards antibiotics and self-care for respiratory tract infections: a qualitative study. *BMJ Open*. 2017;7(5):e015308.
17. McNulty CA, Lecky DM, Farrell D, Kostkova P, Adriaenssens N, Koprivova Herotova T, et al. Overview of e-Bug: an antibiotic and hygiene educational resource for schools. *J Antimicrob Chemother*. 2011;66 Suppl 5:v3-12.
18. Santer M, Chandler D, Lown M, Francis NA, Muller I. Views of oral antibiotics and advice seeking about acne: a qualitative study of online discussion forums. *Br J Dermatol*. 2017;177(3):751-7.

19. Zucco R, Lavano F, Anfosso R, Bianco A, Pileggi C, Pavia M. Internet and social media use for antibiotic-related information seeking: Findings from a survey among adult population in Italy. *Int J Med Inform.* 2018;111:131-9.
20. Hale AR, Young VL, Grand A, McNulty CA. Can Gaming Increase Antibiotic Awareness in Children? A Mixed-Methods Approach. *JMIR Serious Games.* 2017;5(1):e5.
21. Department of Health and Social Care. Tackling antimicrobial resistance 2019–2024: The UK's five year national action plan. London; 2019.

## Appendices

### Appendix A: Factors associated with 7 or more correct responses to 9 questions exploring knowledge about antibiotic resistance and its relationship to antibiotic use

Overall (N=1,691)		≤6 correct responses	≥7 correct responses	Unadjusted odds ratio (95% CI)	Adjusted odds ratio (95% CI)
Overall		58% (970)	42% (721)		
Age (years)	15-24	60% (141)	40% (102)	1.00 (ref)	1.00 (ref)
	25-34	55% (135)	45% (114)	1.18 (0.81, 1.73)	1.18 (0.76, 1.83)
	35-44	55% (124)	45% (98)	1.22 (0.83, 1.81)	1.17 (0.75, 1.84)
	45-54	54% (127)	46% (108)	1.23 (0.84, 1.81)	1.17 (0.76, 1.80)
	55-64	49% (141)	51% (140)	1.52 (1.05, 2.20)	1.44 (0.95, 2.19)
	65+	67% (302)	33% (159)	0.71 (0.50, 1.00)	0.64 (0.43, 0.96)
Sex	Male	59% (497)	41% (338)	1.00 (ref)	1.00 (ref)
	Female	57% (473)	43% (383)	1.08 (0.88, 1.33)	1.12 (0.89, 1.41)
Social Grade	AB	40% (173)	60% (250)	1.00 (ref)	1.00 (ref)
	C1	52% (311)	48% (276)	0.61 (0.46, 0.80)	0.65 (0.49, 0.88)
	C2	66% (215)	34% (108)	0.34 (0.24, 0.46)	0.45 (0.31, 0.65)
	DE	74% (271)	26% (87)	0.23 (0.17, 0.32)	0.36 (0.25, 0.52)
Education	Degree or equivalent	40% (206)	60% (288)	1.00 (ref)	1.00 (ref)
	A-level or equivalent	51% (155)	49% (163)	0.64 (0.47, 0.87)	0.86 (0.61, 1.21)
	GCSE or equivalent	64% (314)	36% (189)	0.37 (0.29, 0.49)	0.55 (0.40, 0.75)
	No formal education	81% (190)	19% (45)	0.16 (0.10, 0.24)	0.29 (0.18, 0.46)
	Other	74% (105)	26% (36)	0.23 (0.15, 0.36)	0.34 (0.21, 0.55)
Has children age under 15 years in household	Yes	57% (708)	43% (543)	1.00 (ref)	1.00 (ref)
	No	60% (262)	40% (178)	0.87 (0.69, 1.10)	0.72 (0.54, 0.97)
Been to doctor or pharmacy in past 12 months	Yes	52% (622)	48% (570)	1.00 (ref)	1.00 (ref)
	No	69% (348)	31% (151)	0.48 (0.38, 0.61)	0.44 (0.34, 0.57)
Ethnic grouping	White	55% (796)	45% (650)	1.00 (ref)	1.00 (ref)
	BAME	70% (163)	30% (68)	0.53 (0.38, 0.73)	0.53 (0.37, 0.76)

## Appendix B: Reported antibiotic use for infections in the past 12 months

How many courses of antibiotics have you taken for...	...a throat infection	...a cold or a runny nose	...an ear infection	...a cough	...flu symptoms	...a sinus infection	...a chest infection	...a skin infection	...a urine infection
	n=246	n=853	n=104	n=626	n=350	n=129	n=255	n=49	n=95
None	71% (179)	96% (816)	54% (59)	90% (561)	88% (310)	75% (97)	44% (107)	69% (34)	22% (21)
1	20% (44)	3% (25)	41% (39)	7% (45)	9% (35)	22% (28)	42% (109)	21% (10)	48% (45)
2+	10% (23)	1% (12)	5% (6)	3% (20)	2% (5)	3% (4)	14% (39)	10% (5)	30% (29)

## Appendix C: Expectations, advice and antibiotic prescriptions reported by respondents who accessed primary care for their own or their child's respiratory or flu symptoms or a cold/runny nose in the past 12 months

	Respiratory or flu symptoms		Cold/runny nose	
	n=242	n=141	n=61	n=53
<b>What did you EXPECT from your contact/visit for this most recent illness?</b>	<b>Self</b>	<b>Child</b>	<b>Self</b>	<b>Child</b>
To be prescribed antibiotics	38% (93)	27% (39)	29% (18)	13% (6)
To be prescribed treatment for symptoms	34% (85)	33% (46)	25% (15)	22% (10)
Advice about whether antibiotics were needed	19% (47)	23% (32)	24% (14)	21% (11)
<b>What HAPPENED?</b>				
Antibiotics were prescribed	57% (136)	41% (57)	31% (20)	33% (17)
Treatment to relieve/reduce symptoms was prescribed	30% (72)	24% (36)	26% (16)	16% (9)
Advice was given about whether antibiotics were needed	15% (36)	25% (35)	16% (11)	12% (5)

## Appendix D: Responses in favour of, ambivalent about or opposed to prescribing of delayed antibiotics

Type of infection		Fully aware of term and practice			Aware of term OR practice but not both			Unaware of term or practice		
		Urine	Ear	Throat	Urine	Ear	Throat	Urine	Ear	Throat
	2014	274 (17%)			167 (11%)			1,181 (72%)		
	2017 <sup>‡</sup>	238 (14%)			146 (9%)			1,307 (77%)		
<b>In favour or strongly in favour</b>	2014	51%	50%	49%	43%	47%	42%	35%	34%	32%
	2017	60%	51%	48%	50%	43%	42%	40%	38%	35%
<b>Neither in favour nor opposed</b>	2014	23%	23%	24%	37%	32%	33%	30%	31%	31%
	2017	14%	16%	18%	29%	25%	27%	28%	29%	30%
<b>Opposed or strongly opposed</b>	2014	25%	26%	27%	18%	21%	24%	30%	31%	32%
	2017	26%	32%	34%	20%	31%	30%	26%	28%	29%
<b>Don't know</b>	2014	1%	<1%	1%	1%	1%	1%	5%	4%	5%
	2017	1%	1%	0%	1%	1%	1%	5%	6%	6%

<sup>‡</sup> Overall change in awareness comparing 2017 with 2014, Pearson's chi-squared p=0.004