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Knowledge, attitudes and practices regarding antimicrobial use and resistance among healthcare seekers in two tertiary hospitals in Ghana: a quasi-experimental study

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ABSTRACT

Objective To evaluate knowledge of antimicrobial resistance (AMR), to study how the judgement of health value (HVJ) and economic value (EVJ) affects antibiotic use, and to understand if access to information on AMR implications may influence perceived AMR mitigation strategies.

Design A quasi-experimental study with interviews performed before and after an intervention where hospital staff collected data and provided one group of participants with information about the health and economic implications of antibiotic use and resistance compared with a control group not receiving the intervention.

Setting Korle-Bu and Komfo Anokye Teaching Hospitals, Ghana.

Participants Adult patients aged 18 years and older seeking outpatient care.

Main outcome measures We measured three outcomes: (1) level of knowledge of the health and economic implications of AMR; (2) HVJ and EVJ behaviours influencing antibiotic use and (3) differences in perceived AMR mitigation strategy between participants exposed and not exposed to the intervention.

Results Most participants had a general knowledge of the health and economic implications of antibiotic use and AMR. Nonetheless, a sizeable proportion disagreed or disagreed to some extent that AMR may lead to reduced productivity/indirect costs (71% (95% CI 66% to 76%)), increased provider costs (87% (95% CI 84% to 91%)) and costs for carers of AMR patients/societal costs (59% (95% CI 53% to 64%)). Both HVJ-driven and EVJ-driven behaviours influenced antibiotic use, but the latter was a better predictor (reliability coefficient >0.87). Compared with the unexposed group, participants exposed to the intervention were more likely to recommend restrictive access to antibiotics ($p<0.01$) and pay slightly more for a health treatment strategy to reduce their risk of AMR ($p<0.01$).

Conclusion There is a knowledge gap about antibiotic use and the implications of AMR. Access to AMR information at the point of care could be a successful way to mitigate the prevalence and implications of AMR.

STRENGTHS AND LIMITATIONS OF THIS STUDY

- ⇒ This study included an intervention to evaluate how access to antimicrobial resistance (AMR) information may influence AMR mitigation strategies in Ghana.
- ⇒ The study involved 800 participants, and the data were collected using a validated instrument.
- ⇒ Reporting and methodological quality followed the Strengthening the Reporting of Observational Studies in Epidemiology checklist.
- ⇒ One limitation was that the intervention was administered to participants by the same person who performed the interview leading to a power imbalance in which participants may have felt a need to give an expected answer rather than their own opinion.
- ⇒ Another limitation was that though the intervention group received examples of antibiotics, we were unsure if they had a correct perception of drugs in mind when assessing statements about antibiotics.

INTRODUCTION

WHO has declared antimicrobial resistance (AMR) a top 10 public health emergency,[1] posing an aggravated threat to fighting infectious diseases.[2] Moreover, AMR has adverse health and economic consequences.[3 4]

Studies show that AMR is attributable to non-prescribed access to antibiotics, and WHO and others thus recommend restricting this access.[1 5 6] Consumers and providers are responsible for the inappropriate use of antibiotics.[7] Evidence shows an AMR knowledge gap among patients[8 9] and there may be a problem for providers due to information asymmetry between patients and providers, which results in inappropriate prescription or treatment.

We hypothesised that a person with ill health faces several decisions. Whether to: (1) self-treat with leftover medicine or over-the-counter medicine or consult a doctor[10–12]; (2) press for a prescription for antibiotics even if a doctor finds it unnecessary and[13] (3) comply with a prescription from a certified provider.[14 15]

From the theories of utility and demand, we assumed that an ill person makes choices that maximise utility for a given information and preference structure, considering income, price and health effects.[16 17] Behavioural economics principles[18–20] suggest utility expectations may explain decisions on antibiotic use. Notably, among other factors, the health benefits from previous use of the same antibiotic may influence the non-prescribed use of antibiotics. Likewise, the prices of antibiotics and the income of the patient could be determining factors for antibiotic use.[21–23] This explains why a patient is likely to use cheaper and more generic and accessible first-line antibiotics like penicillin, gentamicin, metronidazole and ciprofloxacin rather than second-line and third-line antibiotics like meropenem and vancomycin.[24]

Antibiotic use presents a typical public goods problem. Excessive unauthorised demand and access to antibiotics may cause a shortage for others in need.[24 25] Therefore, restricting antibiotic use is a preferred AMR mitigation strategy. We hypothesised that if people are made aware of the implications of AMR, they may decide to use antibiotics only when prescribed by a certified healthcare professional.

In this study, we equate health value judgement (HVJ) behaviours to situations where people consume antibiotics because of the health value they place on the drug. Thus, the expected effectiveness of a drug is based on peoples' own experience or perfect/imperfect information sources, whereas economic value judgement (EVJ) may refer to financial or productivity decisions for antibiotic use. A perfect information source for the decision to use antibiotics may be a certified provider, while imperfect information sources may encompass friends, family and other uncertified/unauthorised sources.

The study setting is Ghana, a lower-middle-income country (LMIC) challenged by inappropriate antibiotic use and an AMR knowledge gap.[26 27] A recent global study named Ghana as one of five countries where unauthorised antibiotic use may escalate disproportionately if actions are not taken to address inappropriate use.[11] The aim of this study was first to ascertain the knowledge gap of the implications of AMR; second, to evaluate the importance of HVJ and EVJ in decisions to use antibiotics and third, to understand if access to information on the health and economic implications of AMR may significantly influence perceived AMR mitigation strategies.

METHODS

Design

We conducted a quasi-experimental study where hospital staff collected data among patients on knowledge and attitudes regarding antibiotic use and AMR. An intervention group was provided with point-of-care information about the health and economic implications of antibiotic use and AMR, while a control group was not given the information. The hospital staff collecting data did not provide medical care to the study participants. This study followed the Strengthening the Reporting of Observational Studies in Epidemiology checklist.[28]

Setting

The study settings were four outpatient departments (OPDs) in each of the two participating hospitals. The OPDs included medical, surgical, child health and obstetrics/gynaecology. The KBTH is in the Greater Accra Region, the national capital and KATH is in Kumasi, the Ashanti Regional capital of Ghana. Both facilities have more than six decades of rendering specialist clinical and diagnostic services with a current hospital bed capacity of about 2000 and 1200, respectively, and attending to about 1500 outpatients daily before the COVID-19 outbreak.[29 30] Data collection lasted 3 months from July to September 2021.

Participants

Inclusion criteria were patients aged 18 years and older seeking outpatient care at the four OPDs in each of the two hospitals during the study period. Patients were excluded if they had a medical condition requiring urgent intervention or if they declined participation. The selection of eligible participants was based on a first-come-first-select basis in consultation with the in-charge nurses and ward matrons. Ten participants from each OPD equal to 80 per week were selected from both hospitals for a total of 10 weeks. If a patient among the first 10 was eligible but declined participation, the next patient was selected. Consequently, we selected a total of 800 participants for 10 weeks spanning July to September 2021. The overall sample size of 800 (95% CI 786 to 814) was determined from a 95% confidence level (z score 1.96) and 3000 OPD attendances per week due to COVID-19. To assess the impact of the intervention on perceived AMR mitigation strategies, participants were divided into two groups, A and B. Group A, the control group, was enrolled in weeks 1, 3, 5, 7 and 9. Group B, the intervention group, was enrolled in weeks 2, 4, 6, 8 and 10.

The intervention: AMR knowledge dissemination package

In collaboration with staff at the OPDs and AMR stewards, we designed a simple intervention involving an AMR knowledge dissemination package. The choice of intervention was discussed and accepted, agreeing that it could be scaled up in LMIC settings if the intervention succeeds in changing participant attitudes about ways to mitigate the impact of AMR.

The intervention was presented midway into the interview after eliciting data on participants' knowledge and awareness of the health and economic consequences of antibiotic use and AMR. Illustrations and examples of the most used antibiotics in Ghana were given as examples of drugs that should be accessible as the first treatment and antibiotics that should be watched or reserved, including third-generation cephalosporins.[31] Refer online supplemental material 1 for a qualitative description of the intervention.

Variables and measurement

We analysed three primary outcomes: (1) knowledge of health and economic implications of antibiotic use and resistance; (2) stated HVJ and EVJ behaviours influencing antibiotic use and (3) differences in AMR mitigation strategies between the intervention and control groups.

We used numeric variables to capture responses to questions used to analyse objectives 1 and 2 and measured them on a 4-point Likert scale, where 1=agree, 2=agree to some extent, 3=disagree to some extent and 4=disagree. Knowledge was measured by five questions on perceived economic and health implications, respectively. If the correct answer to a question was 'agree', then responses 1 or 2 on the Likert scale indicated the participant has a degree of knowledge about the health and economic consequences of antibiotic use and resistance. If the correct answer to a question was 'disagree', then responses 3 or 4 showed some degree of awareness. Objective 2 was measured by seven HVJ questions and five EVJ questions. For objective 3, we used the simple 'yes' or 'no' categorical variables to capture responses, except for the question 'do you think a doctor's prescription for antibiotics should be more or less restrictive?'; this had three categorical responses, that is, more restrictive, unchanged and less restrictive.

Patient and public involvement

Patient and public involvement in this study were threefold. First, we conducted a week-long pilot of the data collection tool at the study sites between 24 May 2021 and 31 May 2021. The pilot involved 80 participants, equivalent to 10% of the study sample. The aim was to ensure that the target population understood the questions and that any difficulties translating the questions were documented and resolved. The aim was also to identify a smooth sequence in the arrangement of the questions. The term antimicrobial resistance and its acronym AMR were alien to about 73% of the participants who preferred the term antibiotic resistance. Also, about 61% of the participants validated a rewording of the Likert scale measures. For example, they were familiar with 'agree to some extent' and 'disagree to some extent' instead of 'strongly agree' and 'strongly disagree'. Similar experiences relating to translation and understanding of terminology and questions have been documented in another study.[32] These preferences led to changes in the Likert scale measures.

Data sources

Data were collected with a structured questionnaire and administered in person by trained hospital staff (intern nurses) using a computer-assisted personal interviewing tool embedded with CS Pro V.7.6.0 software. The tool comprises a list of 28 closed and open-ended questions classified into 6 modules (online supplemental material 2). Table 1 presents a summary of the number and category of questions contained in each module, the purpose of the questions and the data source for the inclusion of those questions. For instance, questions contained in modules 1, 2, 3 and 5 were drawn from the WHO protocol on antibiotic resistance multicountry public awareness survey[33] and supplemented with a few selected questions from a validated tool previously used to assess antibiotics knowledge.[8] Questions contained in modules 4 and 6 were developed by the authors for objectives 2

Table 1 Summary of data used in this study and the source

	No of questions	Data category	Participants	Purpose	Source
Module 1	11	Sociodemographic	All	Analyse the socio-demographic characteristics of respondents.	WHO,[33] plus the Authors
Module 2	3*	Antibiotics knowledge and implications of antibiotics use.	All†	Assess knowledge and implications of antibiotic use.	WHO,[33] Jairoun *et al*[8]
Module 3	5	Previous/current use of antibiotics	All†	Evaluate the use of antibiotics.	WHO[33]
Module 4	1‡	HVJ and EVJ determinants of antibiotics use.	All†	Examine if antibiotic use was influenced by either HVJ or EVJ or both and find out which socio-demographic variables relate to HVJ and EVJ.	Authors
Module 5	5§	AMR knowledge and implication tests.	All†	Assess participant's knowledge of AMR	WHO[33] plus Authors
Module 6	4	AMR mitigation attitude tests	Group A¶ and Group B**	Compare AMR mitigation attitudes between the intervention and control groups.	Authors

*Subdivided into 13 antibiotics knowledge test questions.
†Some subquestions do not apply to some respondents by design.
‡Subdivided into 12 HVJ and EVJ questions.
§Has 27 subquestions.
¶Group A—participants not exposed to the intervention.
**Group B—participants exposed to the intervention.
AMR, antimicrobial resistance; EVJ, economic value judgement; HVJ, health value judgement.

Table 2 Participants' sociodemographic characteristics

Category	Characteristics	Study sites			
		Overall N (%)	KATH N (%)	KBTH N (%)	Alpha*
Gender	Female	527 (65.88)	249 (62.25)	278 (69.50)	
	Male	273 (34.13)	151 (37.75)	122 (30.50)	
	Total	800 (100.00)	400 (100.00)	400 (100.00)	P<0.05†
Age group (years)	18–19	27 (3.38)	11 (2.75)	16 (4.00)	
	20–29	192 (24.00)	81 (20.25)	111 (27.75)	
	30–39	269 (33.63)	135 (33.75)	134 (33.50)	
	40–49	198 (24.75)	102 (25.50)	96 (24.00)	
	50–59	95 (11.88)	61 (15.25)	34 (8.50)	
	60+	19 (2.38)	10 (2.50)	9 (2.25)	
	Total	800 (100.00)	400 (100.00)	400 (100.00)	P<0.05†
Completed level of schooling	None	55 (6.88)	40 (10.00)	15 (3.75)	
	Basic	337 (42.13)	173 (43.25)	164 (41.00)	
	Secondary	246 (30.75)	124 (31.00)	122 (30.50)	
	Tertiary	162 (20.25)	63 (15.75)	99 (24.75)	
	Total	800 (100.00)	400 (100.00)	400 (100.00)	P<0.001†
Occupation type	Formal	122 (15.25)	55 (13.75)	67 (16.75)	
	Informal	557 (69.63)	287 (71.75)	270 (67.50)	
	Not working	121 (15.13)	58 (14.50)	63 (15.75)	P>0.05†
	Total	800 (100.00)	400 (100.00)	400 (100.00)	
Residential location	Rural	333 (41.63)	245 (61.25)	88 (22.00)	
	Urban	467 (58.38)	155 (38.75)	312 (78.00)	
	Total	800 (100.00)	400 (100.00)	400 (100.00)	P<0.001†
Ever registered for health insurance	Yes	573 (71.63)	260 (65.00)	313 (78.25)	
	No	227 (28.38)	140 (35.00)	87 (21.75)	
	Total	800 (100.00)	400 (100.00	400 (100.00)	P<0.001†
Currently have a valid health insurance	Yes	491 (85.69	205 (78.85)	286 (91.37)	
	No	82 (14.31)	55 (21.15)	27 (8.63)	
	Total	573 (100.00)	260 (100.00)	313 (100.00)	P<0.001†
Type of valid health insurance in possession	NHIS	436 (88.80)	186 (90.73)	250 (87.41)	
	PHIS	55 (11.20)	19 (9.27)	36 (12.59)	
	Total	491 (100.00)	205 (100.00)	286 (100.00)	P>0.05†
Economic status relative to others	Best	20 (2.50)	11 (2.75)	9 (2.25)	
	Better	249 (31.13)	150 (37.50)	99 (24.75)	
	Good	195 (24.38)	119 (29.75)	76 (19.00)	
	Worse	336 (42.00)	120 (30.00)	216 (54.00)	
	Total	800 (100.00)	400 (100.00)	400 (100.00)	P<0.001†
Household size	Mean (95% CI)	4.9 (4.7 to 5.0)	5.1 (4.8 to 5.4)	4.6 (4.4 to 4.8)	P<0.05‡
Years of schooling	Mean (95% CI)	10.8 (10.5 to 11.1)	10.2 (9.7 to 10.6)	11.4 (11.0 to 11.8)	P<0.05‡

*Comparing differences in observation between study sites.
†Derived from $\chi 2$ test for categorical variables.
‡Alpha derived from t-test for count variables.
KATH, Komfo Anokye Teaching Hospital; KBTH, Korle-Bu Teaching Hospital; NHIS, National health insurance scheme; PHIS, Private health insurance scheme.

and 3 (table 1). The questions were kept brief and administered in a preferred language, mainly English, Akan and Ga. The translation of the questionnaire into Akan or Ga language followed consensus by medical staff with the relevant language competencies. The questions considered the need to avoid technical language bias and no response bias.[34] All participants gave written informed consent and kept copies for reference.

Statistical analysis

Knowledge of the health and economic consequences of antibiotic use was evaluated using the proportionate

Otieku E, et al. BMJ Open 2023;13:e065233. doi:10.1136/bmjopen-2022-065233

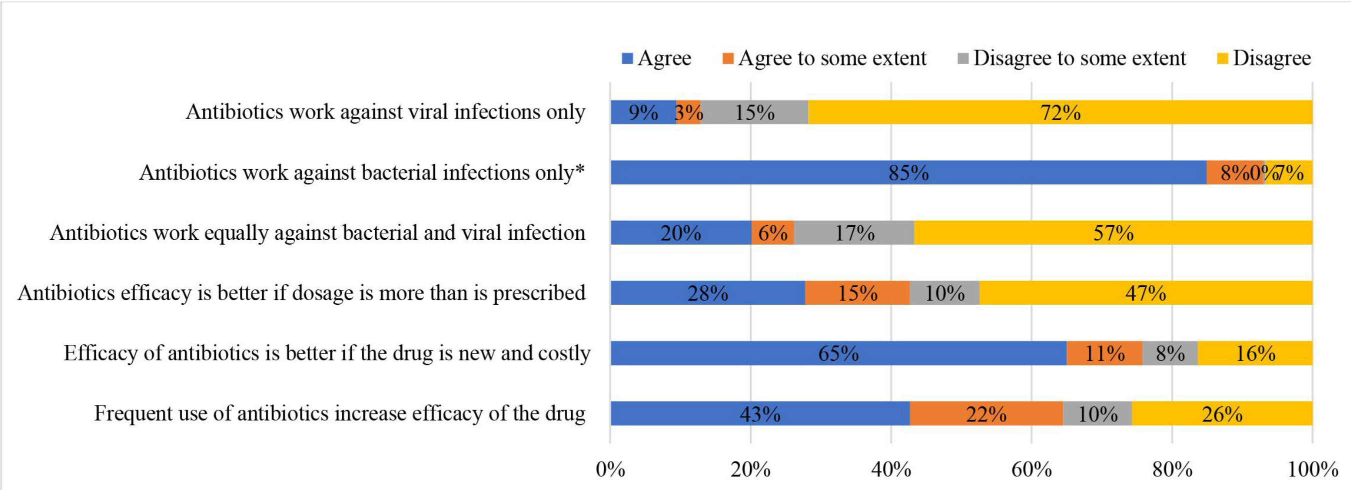

Figure 1 Participants' knowledge of how antibiotics affect health. *Only 0.29% disagree to some extent and is invisible due to the approximation.

ratings and their 95% CI for each category of response and presented the result in a 1%–100% stacked bar. Further analysis of mean knowledge scores and 95% CI for each response are presented in the online supplemental material.

For objective 2, the analysis was in phases. Phase 1 followed the procedure used to analyse and report results for objective 1. Results of the mean scores and 95% CI of each of the 12 lists of HVJ and EVJ items/questions, disaggregated by study sites are presented in online supplemental file. In phase 2, we refined the measure for HVJ and EVJ behaviours. We anticipated that not all HVJ and EVJ items would influence the use of antibiotics. To that end, we performed an exploratory factor analysis (EFA) by first testing the assumption of collinearity between the 12 HVJ and EVJ items/questions. Results of the correlation matrix and the corresponding alpha values ($p<0.01$ and $p<0.05$) are presented in online supplemental table S1A. The analysis includes Bartlett's test for interrelatedness between items ($p<0.001$) and the Kaiser-Mayer-Olkin measure of sampling adequacy (KMO=0.85). A sampling adequacy of 0.8 or more is recommended for EFA.[35 36] Second, Eigenvalues generated from the EFA were assessed for their unique variance and communality. To preserve orthogonality, factor loadings from the EFA were subject to Varimax rotation and those with factor loadings >0.4 plus a scale reliability coefficient of 0.87 were extracted for inclusion in the multifactor regression analysis (online supplemental table S1B,C). Though arbitrary rule, studies recommend that factor loadings >0.4 is statistically significant/reliable and must be retained.[36 37] In phase 3, we analysed the factors affecting HVJ and EVJ behaviours through multifactor regression. We first undertook an analysis of the correlation between retained factor loading items from the EFA and numerically coded sociodemographic variables (independent/explanatory variables), that is, age, years of schooling, household size, gender (male=1, female=2), occupation type (formal=1, informal=2, not working=3), residential location (rural=1, urban=2), valid health insurance status (no=1, yes=2) and self-rated

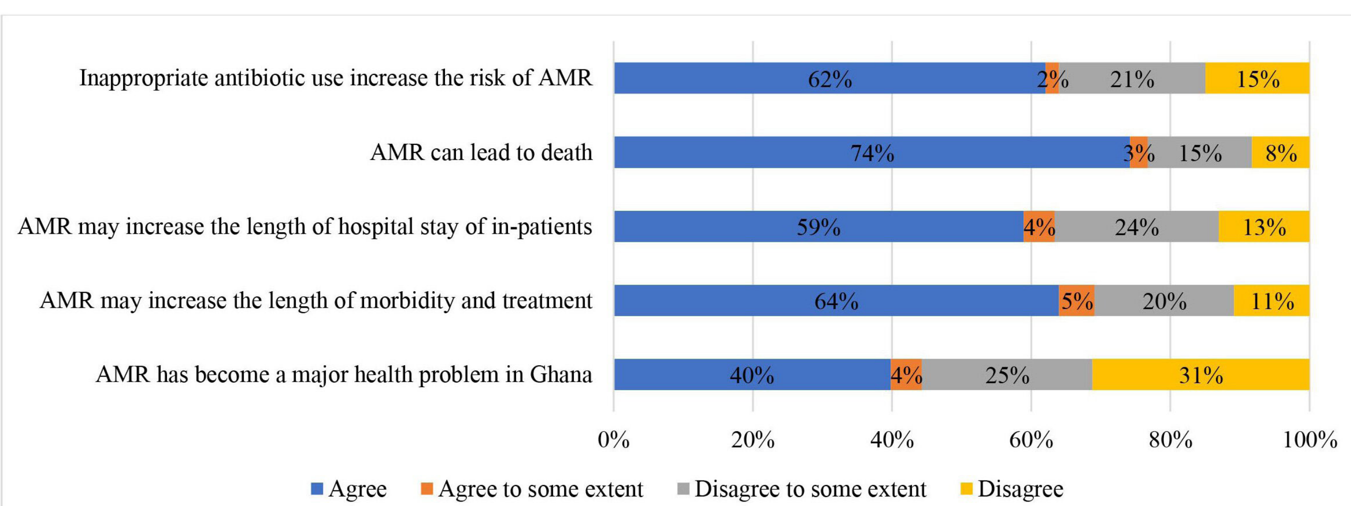

Figure 2 Participants' knowledge of the health implications of antibiotics resistance/AMR. Note: In the questionnaire, we used the synonym antibiotic resistance instead of AMR. AMR, antimicrobial resistance.

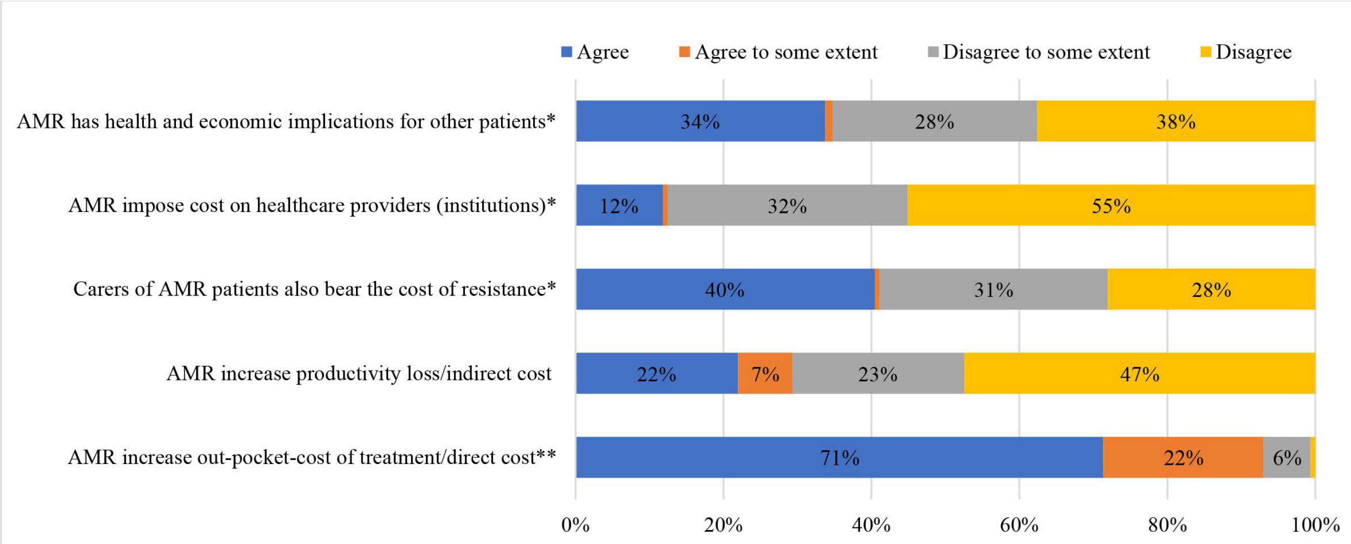

Figure 3 Participants' knowledge of the economic implications of antibiotics resistance/AMR. *Approximately 1.0% of the participants agree to some extent; **About 6% of the participants disagree. Note: In the questionnaire, we used the synonym antibiotic resistance instead of AMR. AMR, antimicrobial resistance.

economic status relative to others (best=1, better=2, good=3, worse=4) (online supplemental table S2). The retained factor loading items of HVJ and EVJ constituted the dependent variables for the regression analysis. To identify the best model fit with the least Akaike information and the error term, we performed a forward, backwards and bidirectional selection of variables. For each regression model, we included a test of heteroscedasticity-consistent SEs to rule out biases in residual values,[38] and a check for omitted variable bias using the Ramsey test of powers of the fitted values (p>0.1).

Finally, we computed a χ^2 test for non-parametric categorical variables (p<0.05) in module 6 questions for objective 3 and reported alpha values for statistical differences in reported AMR mitigation strategies between participants with and without exposure to the intervention.

All the analyses were performed with STATA analytical software V.14.0 (STATA) and Microsoft Excel to generate graphs.

RESULTS

Descriptive

A total of 800 adult outpatients from two hospitals (KBTH: N=400, KATH: N=400) participated in this study. Female participants accounted for 65.9%. The mean years of schooling, less the years spent in preschool, was 10.8 years (95% CI 10.5 to 11.1) and subjects with no formal education accounted for 6.9%. Approximately 42% of the participants lived in rural communities and about 89% had active health insurance to access healthcare when

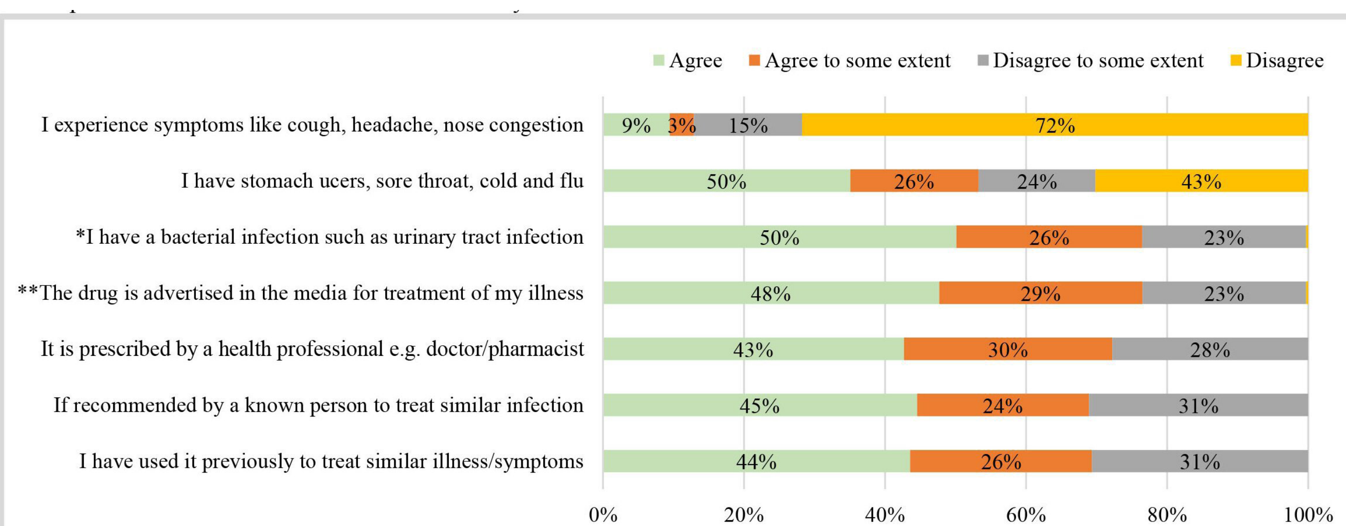

Figure 4 (Stated) influence of health value judgements on participant use of antibiotics. The response denotes 'I use antibiotics if/when or anytime…'. *About 1% disagree, **Less than 0.5% disagree.

Otieku E, et al. BMJ Open 2023;13:e065233. doi:10.1136/bmjopen-2022-065233

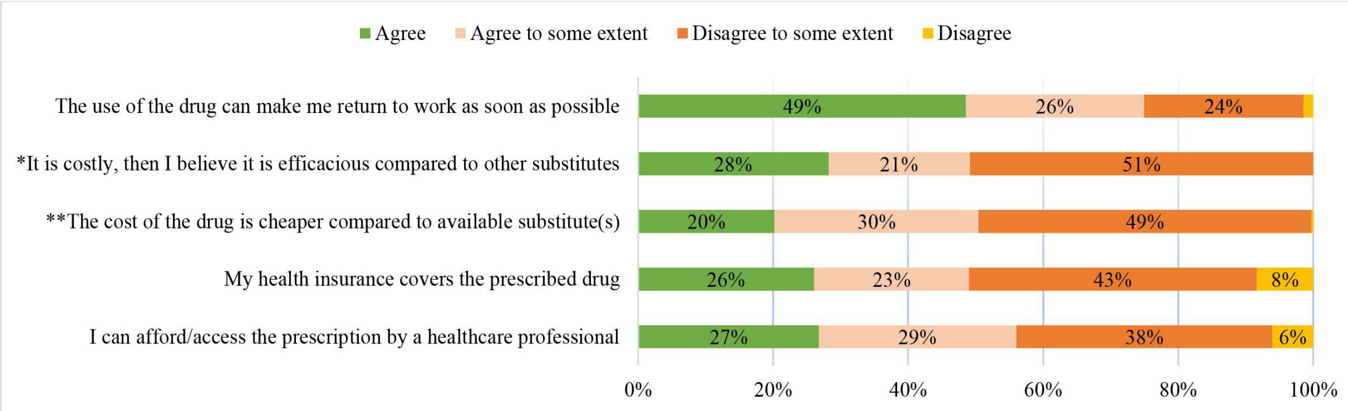

Figure 5 (Stated) influence of economic value judgement (EVJ) on participant use of antibiotics The response denotes 'I use antibiotics if/when or anytime…'. *About 1% disagree, **Less than 0.5% disagree.

ill. Participants' average household size was 4.9 people (95% CI 4.7 to 5.0). Participants from Kumasi were more rural with less schooling and lower insurance coverage but considered themselves better off than others (table 2).

Knowledge of how antibiotic use affects health

A total of 698 (87.3%) participants had heard/knew about antibiotics and could self-indicate the health implications of antibiotic use. We gave them six simple-framed standard statements on how antibiotics affect health and asked them to indicate whether they agree or disagree. The result showed that participants had varying degrees of knowledge on how antibiotic use affects human health. When asked if antibiotics work against viral infections and whether antibiotics efficacy is better if the dosage is more than is prescribed, the proportion of participants who correctly disagreed was 72% (95% CI 68% to 75%) and 47% (95% CI 44 to 51%), respectively (figure 1).

Knowledge of the health and economic implications of AMR

Less than 40% (39.3%, n=314) of the participants said they knew about antibiotics resistance or AMR, and we gave them 10 statements about the health and economic implications of AMR and asked them to indicate whether they agreed or disagreed. The first five questions related to knowledge of the health burden of AMR. We found that most of the participants correctly indicated that AMR could affect the length of morbidity and treatment (64% (95% CI 59% to 69%)), hospital length of stay (59% (95% CI 53% to 64%)) and mortality (74% (95% CI 72% to 77%)) and that inappropriate use of antibiotics increased the risk of AMR (62% (95% CI 57% to 67%)). However, a large minority—a quarter to one-third of respondents had incorrect perceptions about the effect of AMR on health. Finally, we found that 56% (95% CI 50% to 61%) of the participants either disagreed or disagreed to some extent that AMR is a major health problem in Ghana (figure 2).

Regarding the economic implications of AMR (figure 3), we asked the participants whether they agreed that AMR increases the following: (1) out-of-pocket cost of treatment, (2) productivity loss/cost due to absence from work occasioned by AMR, (3) costs to carers of AMR patients, (4) healthcare provider costs and (5) healthcare-related costs for other patients. The result showed that more than half of the participants could not relate to how AMR affects provider costs (87% (95% CI 84% to 91%)), productivity loss/indirect cost (71% (95% CI 66% to 76%)), the cost to carers of AMR patients/societal cost (59% (95% CI 53% to 64%)), but knew that AMR could increase the out-of-pocket costs of treatment (93% (95% CI 90% to 96%)).

In addition, we found statistically significant differences in AMR knowledge between participants with and without formal education regarding how AMR affects the duration of illness and treatment ($p<0.01$), death ($p<0.01$), 3), length of hospital stays ($p<0.05$) and how inappropriate use of antibiotics increase the risk of AMR ($p<0.05$) (online supplemental table S3A). However, there was no statistical difference in AMR knowledge between males and females and between rural and urban residents (online supplemental table S3B,C). Further, in all categories of AMR knowledge questions, the proportion of the participants who responded wrongly was much similar across gender and residence, but slightly different between participants with and without formal education (online supplemental table S3D).

How HVJ and EVJ influence antibiotic use

Figure 4 shows the list of items used to assess the influence of HVJ on antibiotic use. We posed seven HVJ questions to participants and found that they were more likely to use antibiotics if (1) they had used the drug previously to treat similar health conditions (70% (95% CI 67% to 73%)); (2) the drug had been recommended by a known person for the treatment of similar infection(s) (69% (95% CI 66% to 72%)); (3) the antibiotic was prescribed by a health professional such as a doctor or pharmacist (73% (95% CI 70% to 76%)); (4) the drug was advertised in the media for treatment of same illness (77% (95% CI 74% to 80%)) and (5) they have a bacterial infection such as a urinary tract infection (76% (95% CI 73% to 79%)).

Table 3 Regression results identifying sociodemographic factors influencing HVJ and EVJ items for antibiotic use

	Overall				KATH				KBTH			
	HVJ		EVJ		HVJ		EVJ		HVJ		EVJ	
	β	SE	β	SE	β	SE	β	SE	β	SE	β	SE
Age	0.05	0.04	0.04	0.04	0.04	0.06	0.02	0.06	0.02	0.04	0.01	0.05
Female sex	−0.21*	0.08	−0.16	0.08	−0.03	0.12	0.01	0.13	−0.36*	0.10	−0.30*	0.10
Years of schooling	−0.05*	0.01	−0.04*	0.01	−0.06*	0.01	−0.05*	0.01	−0.04*	0.01	−0.04*	0.01
Occupation:												
Informal	0.10	0.08	0.08	0.11	0.08	0.15	0.04	0.17	0.13	0.10	0.07	0.15
Not working	0.06	0.12	−0.08	0.12	0.09	0.19	−0.14	0.19	0.06	0.16	−0.04	0.18
Residential location (Urban)	−0.15	0.08	−0.22†	0.09	0.05	0.13	−0.06	0.14	−0.27†	0.13	−0.27†	0.13
Household size	0.02	0.01	0.01	0.02	0.01	0.02	−0.01	0.02	0.04	0.03	−0.04	0.03
Ever registered for HS (yes)	–											
Currently have a valid HS (yes)	–											
Type of valid HS in possession: NHIS	0.05	0.09	−0.64	0.13	0.05	0.23	0.08	0.22	0.06	0.11	−0.16	0.17
Economic status relative to others	0.09†	0.04	0.06	0.04	0.11	0.07	0.06	0.07	0.10	0.05	0.09	0.05
Model fit (%)	22.7		18.1		20.7		17.4		26.9		20.0	

HVJ and EVJ are the health and economic value judgement items (dependent variables) with the best model fit in the regression analysis. For HVJ, the item used denotes whether participants agree to use antibiotics if/when they have a bacterial infection such as a urinary tract infection. The EVJ item denotes whether participants agree to use antibiotics if the drug can make him/her return to work as soon as possible. In both instances, the responses were coded as 1=agree, 2=agree to some extent, 3=disagree to some extent and 4=disagree.
*P<0.01.
†P<0.05.
EVJ, economic value judgment; HS, health insurance; HVJ, health value judgement; KATH, Komfo Anokye Teaching Hospital; KBTH, Korle-Bu Teaching Hospital; NHIS, national health insurance scheme.

Interestingly, we found some AMR knowledge gaps. For instance, participants would not use antibiotics anytime they experienced symptoms like nasal congestion and headache (87% (95% CI 84% to 90%)) but would use them anytime if they had a sore throat, stomach ulcers and infections like a cold and the influenza (76% (95% CI 73% to 79%)), which may be inappropriate without proper diagnosis and prescription. Between study sites, the trend in how HVJ and EVJ influenced the use of antibiotics was similar (online supplemental table S4).

From a scale reliability coefficient >0.87, we found two out of five EVJ items may strongly influence participants to use antibiotics (figure 5). For example, 75% (95% CI 72% to 78%) of the participants indicated they would use antibiotics anytime if the drug could make them recover quickly and resume productive work, and if they could afford the prescription by a certified healthcare professional (56% (95% CI 52% to 60%)). Again, possession of health insurance was a determining factor for antibiotic use for less than half of the participants (49% (95% CI 45% to 53%)).

Factors predicting HVJ and EVJ for antibiotic use

Factor loadings extracted from the EFA were regressed with the demographic characteristics of participants to find out which of the demographics influenced how HVJ and EVJ affected the use of antibiotics among our study participants. The HVJ item with the best model fit was whether participants agreed to use antibiotics if they had a bacterial infection such as a urinary tract infection, whereas the EVJ item was whether they agreed to use antibiotics if the drug would make them return to work as soon as possible. In the overall sample, we found the factors predicting HVJ for antibiotic use to include female sex (Co-eff. −0.21; p<0.01), years of schooling (Co-eff. −0.05; p<0.01) and economic status of participants relative to others (Co-eff. 0.09; p<0.05), all accounting for about 20% of the model fit. Regarding EVJ, significant predictors in descending order of magnitude to the model fit include years of schooling (Co-eff. −0.04; p<0.01) and urban residence (Co-eff. −0.22; p<0.05), suggesting that, for example, a unit decrease in participant years of schooling may cause a 4% increase in the chances that they would press to get antibiotics if they believed the drug would heal them quickly and make them able to resume productive work fast.

In the stratified model, the only predictor of HVJ and EVJ for antibiotic use in the KATH sample was years of schooling (Co-eff. −0.06; p<0.01), whereas female sex, years spent in school and urban residence emerged as significant predictors of both HVJ and EVJ in the KBTH strata (table 3).

AMR mitigation strategy

We posed four questions related to AMR mitigation strategy to all study participants. For the control group (group A), less than half (42.5% (95% CI. 36.9% to 46.6%)) indicated that antibiotic prescription should be more restrictive, and 49.5% (95% CI. 44.6% to 54.4%) suggested they would be willing to pay slightly more for a health treatment strategy that reduced their risk of AMR (table 4). Among participants in the intervention group

Table 4 Patient attitudes towards AMR mitigation, stratified by level of information

	The patient was provided with additional information on the health and economic consequences of AMR (N, %)			
	No (group A)	Yes (group B)	Total	Alpha*
Antibiotic prescription should be:				
Less restrictive	63	35	98	
	15.75	8.75	12.25	
Unchanged	170	81	251	
	42.50	20.25	31.37	
More restrictive	167	284	451	P<0.01
	41.75	71.00	56.38	
Total	400	400	800	
	100.00	100.00	100.00	
Willingness to pay more for health treatment that reduced the risk of AMR				
Yes	198	322	280	
	49.50	80.50	35.00	
No	202	78	520	P<0.01
	50.50	19.50	65.00	
Total	400	400	800	
	100.00	100.00	100.00	

Note. Group A—participants not exposed to the intervention (n=400); group B—participants exposed to the intervention (n=400).
*Indicate alpha for statistically significant difference between groups.
AMR, antimicrobial resistance.

(group B), a considerably higher proportion of 71% (95% CI 66.6% to 75.4%) suggested more restrictive antibiotic prescription and 80.5% (95% CI 78.5% to 82.5%) were willing to pay slightly more for a health treatment strategy that reduced their risk of AMR in the short term to medium term.

Eight possible sources of acquiring AMR information were presented to the intervention and control group to keep updated with and improve their knowledge of the health and economic implications of antibiotic use and we asked them to indicate their preference for each. The result suggested that most participants without exposure to the intervention preferred to receive AMR information at the point of care, that is, in a clinic/hospital (73.5%) or licensed pharmacy/drug stores (83.5%) or via television broadcast (91.8%). Compared with the control group, a higher proportion of the participants in the intervention group preferred point of care access to AMR information (93% (95% CI 90.5% to 95.5%)), while a lower proportion (84.3% (95% CI 82.5% to 86.1%)) preferred the same information via television broadcast.

Between groups, we observed a statistically significant difference in all measurements, that is, antibiotic prescription (p<0.01), willingness to pay slightly more for health treatment to reduce the risk of AMR (p<0.01) (online supplemental tables S5,6) and preference for AMR information sources (p<0.01; p<0.05) (table 5).

DISCUSSION

The study showed that providing participants with point-of-care information about the health and economic implications of inappropriate antibiotic use may yield positive attitudinal changes for better use of antibiotics and acceptance of restrictive access to antimicrobials. Participants in the intervention group were willing to pay slightly more for health treatment to avert the risk of AMR in the medium to long term than those in the control group. Thus, if patients have more information regarding their safety and do value their health, they may be likely to protect their health, provided they have the means.

Our findings are consistent with others such as a WHO multicountry study on antibiotic resistance awareness in 12 countries, including Russia, South Africa, Nigeria and Indonesia. In that study, 87% of the participants knew when to use antibiotics and 72% understood that inappropriate antibiotic use expedites AMR in humans and prolongs morbidity and treatment of AMR patients.[33] A

Table 5 Preferred sources of AMR information by participants with and without exposure to the intervention

		The patient was provided with additional information on the health and economic consequences of AMR		
Description	Overall N (%)	No (group A)	Yes (group B)	Alpha
Point of healthcare delivery, that is, clinic and hospital (yes)	667 (83.4)	294 (73.5)	373 (93.3)	P<0.01
Licensed pharmacy and drug store (yes)	706 (88.3)	334 (83.5)	372 (93.0)	P<0.01
Community information system (yes)	224 (28.0)	141 (35.3)	83 (20.8)	P<0.01
Print media* (yes)	128 (16.0)	52 (13.0)	76 (19.0)	P<0.05
Digital/social media platforms† (yes)	426 (53.3)	230 (57.5)	196 (49.0)	P<0.05
Television broadcast and information sharing (yes)	704 (88.0)	367 (91.8)	337 (84.3)	P<0.01
Radio broadcast (yes)	255 (31.9)	206 (51.5)	49 (12.3)	P<0.01
School textbooks (should be taught in school) (yes)	619 (77.4)	289 (72.3)	330 (82.5)	P<0.01

Note: Group A—participants not exposed to the intervention (n=400); group B—participants exposed to the intervention (n=400).
*Book covers, newspapers, fliers, etc.
†Voice messages, short message service, Facebook, Twitter.
AMR, antimicrobial resistance.

study in China found substantial evidence of misguided knowledge regarding the use of antibiotics for viral infections such as colds and influenza[39]; these results are comparable to ours. It is possible these misconceptions can explain inappropriate antibiotic use in Ghana and elsewhere.[6] In addition to the similarities, we observed some differences compared with other studies.[8 40] We found that the proportion of our participants with the misconception that antibiotics efficacy is better if the drug is new and costly was about two-thirds and higher than in the UAE and Italy.[8]

One interesting observation concerned inconsistency in antibiotic use knowledge responses. Ideally, the same proportion of participants agreeing that antibiotics work against bacterial infection only would also disagree that antibiotics only work against viral infections. However, that was not the case in our study, indicating some confusion about when to use antibiotics appropriately.

We found commonalities in HVJ behaviours influencing antibiotic use in other LMIC settings. For example, a systematic review in LMIC showed that most people, including the educated, used antibiotics based on experience using the same drug[41] or recommendations by family/friends.[12 33 42] Our data suggested that antibiotic consumption among patients in Ghana was not only influenced by HVJ but also by EVJ. The multifactor and stratified regression analyses showed that HVJ and EVJ behaviours that may predict appropriate antibiotic use were influenced predominantly by participants' years of schooling. Thus, the more educated they were, the easier it was for them to assimilate information regarding antibiotic use. Our finding is congruent with a recently published study on the drivers of antibiotic use and misuse in Australia, which reached a similar conclusion that knowledge gained through formal education has a moderating effect on behaviours for antibiotic use.[42]

To a large extent, the results of this study are in line with our hypotheses. For example, we hypothesised that demand for antibiotics was influenced by EVJ, like pricing, co-payments and the need to resume productive work. Of the 11 factors extracted from the EFA, 6 were HVJ and 5 were EVJ, suggesting a wide range of health and economic value factors influenced antibiotic use. However, EVJ was a better predictor for antibiotic use.

We argue that although our study participants seemed to have a general knowledge about antibiotic use and resistance, this knowledge did not seem to matter much for some participants when considering the use of antibiotics when ill. Therefore, we agree with prior studies[6 10 43] suggesting the need for an intervention to promote attitudinal changes in antibiotic use. A solution may be to provide more persuasive information which in addition to the health consequences of AMR must include the economic implications of inappropriate antibiotic use. We demonstrated that information at the point of care has an immediate effect on attitude, but we cannot conclude whether this is sustained over time and to what extent it changes actual behaviour. Patients indicated they wanted more information and stated their preferences regarding various information channels. Some of these channels may be costly, but the benefit of AMR information interventions may outweigh the costs.

The strength of our study is the use of a validated instrument for data gathering, a reliable data source and a rigorous methodology that rules out several sources of bias and supports external validity and generalisability of the result. Again, the study involves a simple intervention that yielded the expected results and can encourage the appropriate use of antibiotics in the population.

One limitation of this study was the possibility of bias caused by a perceived need to please the health staff performing both the interviews and the intervention. This bias would have been strong if the same person that interviewed the patients was the one who treated them. A second limitation is the possibility of selection bias caused by the need to adhere to COVID-19 safety protocol and ethics approval guidelines. As a result, we replaced 11 participants and postponed 8 interviews to minimise the risk of physical contact. When necessary, patients unsure about the difference between antibiotics and other drugs were given examples of antibiotics as illustrations. However, we cannot be completely sure that patients when assessing statements about antibiotics, actually have the right group of drugs in mind. Even if they have a broader group of drugs in mind, it would still be problematic if they thought antibiotics could cure both bacterial and viral infections. In any case, we have no reason to believe that any misconceptions about antibiotics versus other drugs would differ between the intervention and control groups, so this is unlikely to bias the comparison between the two groups. Also, we detected a few missing data for six participants. However, a check for omitted variable bias using the Ramsey test of powers of the fitted values and heteroscedasticity-consistent standard errors showed no significant effect of missing values on study outcomes.

CONCLUSION

Among study participants, there was a general understanding of when and why to use antibiotics, as well as the implications of AMR. Nonetheless, there was no attributable change in attitude towards antibiotic use among study subjects. Our data showed that both HVJ and EVJ influenced antibiotic use, but the latter was a better predictor among participants when deciding which antibiotic to use. Creating public awareness of the health and economic implications of AMR at the point of care may lead to a behavioural change towards more appropriate antibiotic use to mitigate AMR.

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