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ORIGINAL RESEARCH ARTICLE

Prosocial Behaviour and Antibiotic Resistance: Evidence from a Discrete Choice Experiment

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Abstract

Introduction The health of a community depends on the health of its individuals; therefore, individual health behaviour can implicitly affect the health of the entire community. This is particularly evident in the case of infectious diseases. Because the level of prosociality in a community might determine the effectiveness of health programmes, prosocial behaviour may be a crucial disease-control resource. This study aimed to extend the literature on prosociality and investigate the role of altruism in antibiotic decision making.

Methods A discrete choice experiment was conducted to assess the influence of altruism on the general public's preferences regarding antibiotic treatment options. The survey was completed by 378 Swedes. Latent class analysis models were used to estimate antibiotic treatment characteristics and preference heterogeneity. A three-class model resulted in the best model fit, and altruism significantly impacted preference heterogeneity.

Results Our findings suggest that people with higher altruism levels had more pronounced preferences for treatment options with lower contributions to antibiotic resistance and a lower likelihood of treatment failure. Furthermore, altruism was statistically significantly associated with sex, education, and health literacy.

Conclusions Antibiotic awareness, trust in healthcare systems, and non-discriminatory priority setting appear to be structural elements conducive to judicious and prosocial antibiotic behaviour. This study suggests that prosocial messages could help to decrease the demand for antibiotic treatments.

Key Points for Decision Makers

- More altruistic people tend to care more about their contribution to antibiotic resistance.
- Antibiotic awareness, trust in healthcare, and non-discriminatory priority setting promote proper antibiotic use.
- Prosocial messages could be used to decrease the demand for antibiotic treatments.

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1 Introduction

People with prosocial attitudes tend to engage in healthier behaviours and positively contribute to public health, thus improving human well-being [1]. Prosociality is defined as 'all kinds of actions that benefit others, often at a personal cost to the actor' [2]. It plays a crucial role in health systems, especially in instances where the health of the community can be directly affected by the health and behaviours of the individual. A typical example includes infectious diseases. Cornerstones of infection control include hygiene, vaccines and antibiotics. All are characterised by a tension between the individual effort to follow medical and public health recommendations on the one hand and the community's gain on the other [3, 4].

The coronavirus disease 2019 (COVID-19) pandemic has shown that encouraging prosocial behaviours may be a critical measure of disease control because a community's degree of prosociality can influence the effectiveness of health policies [5, 6]. Prosociality is associated with willingness to vaccinate [7–9], and was shown to be a predictor of hygiene-related behaviours such as mask-wearing [5, 10]; yet, less is known about the link between prosociality and appropriate antibiotic use to control infectious diseases.

All misuse and overuse of antibiotics contribute to the abiding rise in antibiotic resistance (AR), a global public health challenge with staggering and escalating mortality. AR enables bacteria to survive and proliferate despite antibiotic exposure, thus making treatment of infections difficult or ineffective. Every year, about 1.3 million people die from infections caused by drug-resistant bacteria, viruses and fungi, which is predicted to increase to 10 million by 2050 [11, 12]. The use of antibiotics has been conceptualised as a social dilemma where the (short-term) interests of individuals are misaligned with the (long-term) interests of society [13]. Understanding factors that may influence antibiotic decision making is crucial. In contexts of clinical uncertainty, where the need for antibiotic treatment is unclear, most individual patients benefit from antibiotic prescribing because the adverse effects of antibiotics are typically small compared with the risks of missing an infection. It is therefore in their interest to receive unlimited access to antibiotics. In contrast, the societal consequences of antibiotic overuse in terms of the acceleration of AR and the loss of antibiotic efficacy are devastating. As individuals and communities are strongly interrelated, socially responsible behaviour is crucial to reduce AR.

The evidence about the potential role of prosociality in antibiotic decision making is mixed. Experimental research in the US and the UK on appeals to altruism to reduce the overuse of healthcare services, such as antibiotic use, resulted in little effect on participants' intention to reduce their requests for healthcare services [14, 15]. A recent Swiss study found no significant association between altruism and willingness to prevent antibiotic use [16]. This was instead associated with biospherism (valuing unity with nature), which, according to the authors, includes an important altruistic aspect, namely protecting the environment as a form of protecting others [16]. Evidence of lay people's sensitivity to prosocial messages is shown by a Chinese intervention study in which social-regarding health messages on AR had a higher impact than self-regarding health messages in reducing antibiotic consumption [17]. In a German behavioural game, the authors found that when participants were exposed to the social dilemma of AR, they showed egoistic preferences and thus tended to overuse antibiotics [18]. An experimental study involving UK and US participants, which used an adapted version of the German behavioural game [18], found that participants were more inclined to overuse antibiotics when the generation after them would face the consequences; however, when the researcher introduced elements to induce empathy toward the future generation, they observed a reduction of antibiotic overuse [19].

Research conducted in Sweden consistently reported a positive association between prosociality and appropriate antibiotic use. A group interview study found that participants sharing altruistic values were keener to use antibiotics judiciously, whereas participants showing higher egoistic tendencies were less willing to withhold antibiotics [20]. A survey study showed that lay people with greater concern for the communal consequences of AR were more likely to abstain from antibiotic use and incur a personal cost of additional sick days [21]. Finally, a field experiment reported a relationship between altruism (measured by willingness to make charitable donations) and individual antibiotic use [22].

The role of prosociality was also discussed in a recent review of behavioural research related to AR [23]. While the review suggested the need for a nuanced understanding of prosociality in the context of prescriber choices, it confirmed the importance of cooperative and altruistic behaviour by patients and the general public to preserve the public good of antibiotic efficacy.

This study aimed to extend the initial literature on prosociality and antibiotic decision making through a discrete choice experiment that assessed the role of altruism in explaining different preferences for antibiotic treatment characteristics (including impact on AR) among members of the general public in Sweden.

2 Methods

2.1 Case Study, Recruitment and Ethics

Participants were recruited in April 2019 from the Swedish general public between 18 and 65 years of age. The sample was intended to be representative of Sweden regarding age, gender, and geographical region. Respondents were recruited online via Dynata, a commercial survey sample provider, and were compensated according to customary agreements between Dynata and the participant (approximately US$2).

Recruitment continued until 400 completed responses were collected. The sample size was chosen to allow the estimation of reliable models while considering the number of attributes, levels, and parameters to be estimated [24]. This study adhered to Swedish research regulations and was approved by the Uppsala Regional Ethical Review Board (Dnr 2018/293). The submission document included a high-level prespecification of the covariates to be included in the questionnaire as well as plans for the analyses conducted as part of this study (see Online Resource 1).

2.2 Experimental Design of the Discrete Choice Experiment

Respondents were repeatedly asked to trade-off alternative antibiotic treatment options that were described using a variety of attributes and levels. The DCE was conducted following Good Research Practice Guidelines [25]. The attributes and levels, which were selected to elicit the Swedish public's preferences on antibiotic treatment characteristics and the importance of AR in their treatment choices, followed a stepwise procedure: a review of the literature, focus groups ($n = 4$; 23 participants), an attribute features checklist, and stakeholder interviews (two general practitioners, a nurse, and a pharmacist). The literature review on key concepts in antibiotic use behaviour resulted in 26 documents and 12 potential attributes. In the focus groups with laypeople, nominal group techniques were employed to determine and rank features that would drive participants' decision making between different antibiotic treatment options. As a result, seven additional potential attributes were identified. The 19 potential attributes were reduced to 10 after being tested against a checklist of desirable attribute features: realistic, plausible, tradable, clear and unambiguous, distinctively different from others, comprehensive, not a proxy for utility, unlikely to dominate, and relevant to respondent's choice. Interviews with stakeholders and research team discussions led to the identification of five attributes and relative levels (see Table 1). More information about the work to determine the attributes and levels can be found in the study by Ancillotti et al. [26].

A Bayesian D-efficient heterogeneous forced choice DCE design was developed [27, 28]. This type of design allows for reducing the number of choice tasks per respondent and a reliable estimation of the parameters while accommodating respondent heterogeneity. The design was optimised for level balance. In total, 48 choice tasks were designed and divided over three blocks, so each respondent was shown 16 choice tasks (see Online Resource 2). Each choice task consisted of two alternatives: 'Antibiotic A' and 'Antibiotic B'. Given the presented hypothetical scenario (an ascertained bacterial infection and the recommendation of the doctor to take antibiotics) and based on the stakeholders' interviews and the pretesting and testing phases, it was decided not to include an opt-out alternative because it was deemed unrealistic in the DCE scenario. Priors for the initial design were based on the outcomes of the literature search, expert interviews, and best guesses. The priors (and full design) were adapted based on the results of the pilot test (see Sect. 2.4).

2.3 Questionnaire

The questionnaire had three sections. Before answering the DCE, the questionnaire contained sociodemographic and background questions about age, gender, education level, perceived health, financial vulnerability, health literacy, numeracy, and altruism. After the DCE, participants answered questions about their health-risk attitude.

Education was classified as 'low (primary education)', 'medium (secondary education)', 'high (tertiary education)', and 'other'. Perceived health was measured through self-reported health status with a five-point Likert scale ranging from 'very poor' to 'very good'. Financial vulnerability, i.e., the capacity to recover from sudden financial shocks, was measured through two questions about respondents' experience of financial problems during the past year and their capacity to afford an unexpected expense. Answers were classified as 'low', 'medium', and 'high' financial vulnerability. Health literacy, defined as the ability to access, understand, appraise and apply health-related information, was measured through the Communicative and Critical Health Literacy Scale-Swedish version (S-CCHL) [29]. The S-CCHL consists of five items on a five-point Likert scale from 'never (1)' to 'always (5)'. Participants' overall levels were classified as 'sufficient' (consistently scoring 4–5), 'problematic' (at least scoring a 3), and 'inadequate' (consistently scoring 1–2). Numeracy, defined as the ability to apply and manipulate numerical concepts, was measured using the three-item version of the Subjective Numeracy Scale (SNS-3) [30]. The SNS-3 consists of three items on a six-point Likert scale from 'not good at all/never (1)' to 'extremely good/very often (6)'. Respondents' overall levels were classified as 'sufficient' (consistently scoring 5–6), 'problematic' (at least scoring a 3–4), and 'inadequate' (consistently scoring 1–2).

The DCE section comprised instructions and a set of 16 DCE choice tasks. Participants were asked to imagine that they had a bacterial infection and that their doctor prescribed antibiotics to avoid complications (see Online Resource 3).

Health-risk attitude, defined as a general attitude toward risk-taking in health and care, was measured using the 13-item Health-Risk Attitude Scale (HRAS-13) [31]. The items of the HRAS-13 were rated on a 7-point Likert scale from 'completely disagree' to 'completely agree'. Overall scores were obtained by reverse-scoring seven items expressed negatively and then summing all the scores.

Table 1 Attributes and levels as described in the survey

Contribution to antibiotic resistance:
Bacteria that can withstand an antibiotic treatment are antibiotic-resistant bacteria. The leading cause of resistance is treatment with antibiotics. AR is a serious and growing public health problem. It results in longer care times, higher care costs and an increased risk of complications in infection. The contribution to AR of the antibiotic treatments you choose is:
Low, 15,000 cases per year: In 10 years, the number of cases in Sweden would remain the same
Medium, 30,000 cases per year: In 10 years, the number of cases in Sweden would double
High, 70,000 cases per year: In 10 years, the number of cases in Sweden would more than quadruple
Treatment duration: You must take three tablets a day throughout the treatment period prescribed by your doctor
3 days
7 days
14 days
Adverse effects: All medicines have adverse effects, including antibiotics. Because they kill harmful and beneficial bacteria in the body, they can cause mild to moderate adverse effects such as nausea, stomach upset, headache and tiredness. In the choice situations, it is stated how likely the antibiotic treatment is to cause adverse effects
1% (1 in 100 people taking this antibiotic get adverse effects, 99 do not get adverse effects)
5% (5 in 100 people taking this antibiotic get adverse effects, 95 do not get adverse effects)
10% (10 in 100 people taking this antibiotic get adverse effects, 90 do not get adverse effects)
20% (20 in 100 people taking this antibiotic get adverse effects, 80 do not get adverse effects)
Treatment failure: An antibiotic treatment can fail to treat an infection for many reasons. If treatment fails, it means that you have to be treated with another course of antibiotics
5% (5 of 100 people need a further course of antibiotics)
10% (10 of 100 people need a further course of antibiotics)
15% (15 of 100 people need a further course of antibiotics)
20% (20 100 people need a further course of antibiotics)
Cost: Antibiotic treatments are not reimbursed and you have to pay out-of-pocket
100 Swedish Crowns[a]
250 Swedish Crowns
400 Swedish Crowns
1000 Swedish Crowns

AR antibiotic resistance

[a]April 2019: 1 US dollar = 9.34 Swedish Crowns

Possible overall scores ranged between 13 and 91. Lower scores indicated higher health risk aversion, whereas higher scores indicated higher health risk acceptance. Altruism was measured using the 14-item Adapted Self-Report Altruism Scale (ASRAS) [32]. The items of the ASRAS were rated on a 5-point Likert scale from 'never' to 'very often'. Possible overall scores ranged between 14 and 70. A higher score indicated greater altruism. With respect to the original version [33], which focused on explicit altruistic acts, the ASRAS emphasises individual self-perception of how one would act in future contexts (see Online Resource 4).

2.4 Pretesting and Pilot Testing

In the pretesting phase, peer debriefing (n = 12, researchers with different expertise areas) and think-aloud (n = 4, convenient sample of the general population) methods were used to test the survey for accurate and understandable explanatory materials, choice sets, questions and layout. Based on the pretests, minor edits were made in the survey related to wording and layout. Forty-four respondents from the general population participated in a pilot test run in February 2019. The aim of the pilot run was to retrieve input for the experimental design of the final DCE. Results were analysed using a conditional logit model. Data from the pilot were not included in the overall dataset.

2.5 Statistical Analysis

Analyses were conducted in R Core Team [34] and results were considered significant at $p < 0.05$. To enhance data quality, respondents who completed the survey 50% quicker than the average completion time were excluded.

Participant characteristics were analysed descriptively. Moreover, the association between altruism and other variables in this study were described using Pearson correlations for linear variables and analysis of variance (ANOVA) for categorical variables.

To identify and allow for unobserved heterogeneity in preferences between respondents, and as prespecified (see Online Resource 1), latent class analyses were used to analyse the DCE data [35–37]. This type of analysis can be used to investigate heterogeneity by distinguishing groups of respondents based on their preferences. The classes are not determined a priori (hence the term 'latent'), and class membership is expressed using class probabilities that may depend on respondents' characteristics.

Multinomial logit models served as an input for the optimal latent class model specification. Attributes were included as continuous variables if the t-test indicated linearity of the variable and if model fit significantly improved based on likelihood ratio (LR) tests. Two-way interaction terms were included if they significantly ($p < 0.05$) improved the model fit based on the LR test. If attributes were not linear, the levels were dummy-coded, with one being the reference level. Using this model specification, latent class analyses were performed for 2–5 classes. The optimal number of classes was based on model fit and with consideration for class size and interpretability of the main effects model.

The probability of class membership was specified as a function consisting of a constant term and respondent characteristics. The full class membership model included age, gender, education level, perceived health, financial vulnerability, health literacy, numeracy, health-risk attitude, and altruism. Age, health-risk attitude, and altruism were included in the class membership as linear variables. The other variables were included as categorical and dichotomised depending on the expected direction of the impact of these variables on class assignment: gender ('male' vs. 'other'), education ('high' vs. 'other'), perceived health ('very good' vs. 'other'), financial vulnerability ('low' vs. 'other'), health literacy ('sufficient' vs. 'other'), and numeracy ('sufficient' vs. 'other'). A statistically significant estimate for altruism indicates that altruism contributes to class membership and hence distinguishes respondents between classes. A positive estimate indicates that more altruistic respondents are more likely to be in a particular class than in the reference class. Vice versa, a negative estimate indicates that these respondents are less likely to be in that class than in the reference class. The same interpretation holds for the other variables. Variables that did not statistically significantly contribute to class membership were excluded from the final class membership model.

3 Results

3.1 Respondent Characteristics

In total, 415 individuals completed the survey, of which 37 (8.9%) were excluded as they were marked 'speeders' since they completed the survey in less than 6 min (average completing time was 12 min). The final sample consisted of 378 respondents, the majority of whom were women (55.0%). The mean age was 43 years and most respondents were highly educated (51.3%). Sufficient health literacy and numeracy were reported by 46.6% and 23.3% of respondents, respectively. About one-third of respondents were classified as being highly financially vulnerable (33.6%). Altruism mean and median scores were 48.2 and 48.0, respectively (Cronbach's alpha = 0.87). More detailed respondent characteristics can be found in Table 2.

Altruism was statistically significantly associated with gender ($p = 0.002$), education level ($p = 0.023$), and health literacy ($p = 0.004$). On average, women and highly

Table 2 Respondent characteristics

	N = 378 (100%)
Gender	
Men	169 (44.7)
Women	208 (55.0)
Other	1 (0.3)
Age, years [mean (SD)]	43.28 (13.6)
Education	
High	194 (51.3)
Middle	108 (28.6)
Low	70 (18.5)
Other	6 (1.6)
Health	
Very good	58 (15.3)
Good	163 (43.1)
Neutral	113 (29.9)
Poor	38 (10.1)
Very poor	6 (1.6)
Health literacy	
Inadequate	41 (10.8)
Problematic	161 (42.6)
Sufficient	176 (46.6)
Numeracy	
Inadequate	108 (28.6)
Problematic	182 (48.1)
Sufficient	88 (23.3)
Financial vulnerability	
High	127 (33.6)
Medium	105 (27.8)
Low	146 (38.6)
Health-risk attitude [mean (SD)]	60.2 (9.8)
Altruism [mean (SD)]	48.2 (9.4)
Altruism (median)	48
Altruism (minimum–maximum)	14–70

Data are expressed as *n* (%) unless otherwise specified

SD standard deviation

educated and more health-literate respondents had higher altruism scores (see Table 3).

3.2 Preferences and Impact of Altruism on Preference Heterogeneity

All attributes showed a significant estimate, indicating that each attribute contributed to the respondents' decision process regarding the choice of antibiotics. Participants generally preferred antibiotics with a lower contribution to AR compared with antibiotics with a greater contribution to AR. Participants also preferred medium-course treatment durations (7 days) over long-course (14 days) and short-course (3 days) treatment duration. Regarding adverse effects, the preferred option was the one posing the lowest risk (1%). The negative signs for failure rate and cost indicate that participants preferred treatments with a lower failure rate and price.

A three-class model resulted in the best model fit showing distinct preference heterogeneity among respondents for the use of antibiotics (Table 4). The class assignment model shows the variables significantly impacting class membership and thus preference heterogeneity. Among those is altruism; adding altruism significantly improved model fit (log-likelihood [LL] = −2946.1) as compared with the same model without altruism (LL = −2953.7, LR test statistic = 15.2, and $p < 0.001$). The estimates for altruism were positive and statistically significant in classes 1 and 2. Hence, more altruistic people were more likely to be in classes 1 and 2 than in class 3 ($p < 0.001$).

The relative importance of attributes differed across classes (Fig. 1). When more altruistic people consider taking an antibiotic, it is relatively most important that these antibiotics have a low contribution to AR (class 1) and a low likelihood of treatment failure (resulting in another round of antibiotics) [class 2]. Out-of-pocket costs were relatively most important in the class in which altruistic people are less likely to belong (class 3).

4 Discussion

This study provides new insights into the role of prosociality in health-related decision making, with a focus on antibiotic use. The findings highlighted that altruism was associated with public decision making about antibiotics. Indeed, participants with higher altruism scores demonstrated a greater concern about AR. This was evidenced by a preference pattern involving antibiotic treatment choices with low contributions to AR and attempts to minimise treatment failure

Table 3 Relationship altruism and other respondent characteristics

Variable	Category	Altruism (mean)	*p* value	Correlation	*p* value
Gender	Men	46.40	0.002	–	–
	Women	49.09	0.002	–	–
	Other	46.67	0.002	–	–
Education	High	49.14	0.023	–	–
	Middle	47.24	0.023	–	–
	Low	45.95	0.023	–	–
	Other	50.2	0.023	–	–
Health	Very good	48.83	0.236	–	–
	Good	47.98	0.236	–	–
	Neutral	46.69	0.236	–	–
	Poor	49.81	0.236	–	–
	Very poor	44.26	0.004	–	–
Health literacy	Inadequate	44.58	0.004	–	–
	Problematic	47.57	0.004	–	–
	Sufficient	49.67	0.067	–	–
Numeracy	Inadequate	46.69	0.067	–	–
	Problematic	48.37	0.067	–	–
	Sufficient	49.79	0.236	–	–
Financial vulnerability	High	47.68	0.196	–	–
	Medium	49.63	0.196	–	–
	Low	47.69	0.196	–	–
Age	–	–	–	0.00[a]	0.992
Health-risk attitude	–	–	–	0.08	0.106

[a]The actual correlation in the model was −0.001

Table 4 Preferences for antibiotics and preference heterogeneity based on the latent class analysis with altruism in the membership model

	Class 1			Class 2			Class 3		
	Coefficient	SE	*p* value	Coefficient	SE	*p* value	Coefficient	SE	*p* value
Contribution to resistance									
Low (Ref)	0	–	–	0	–	–	–	–	–
Medium	− 1.70	0.117	< 0.001	− 0.10	0.087	0.237	− 0.49	0.111	< 0.001
High	− 4.20	0.232	< 0.001	− 0.51	0.138	< 0.001	− 0.81	0.183	< 0.001
Number of days of treatments									
3 days (Ref)	0	–	–	0	–	–	0	–	–
7 days	0.11	0.106	0.298	0.05	0.078	0.517	0.15	0.098	0.114
14 days	− 0.24	0.105	0.022	− 0.17	0.077	0.028	− 0.39	0.101	< 0.001
Risk of adverse effects									
1% (Ref)	0	–	–	0	–	–	0	–	–
5%	− 0.24	0.128	0.062	− 0.33	0.094	< 0.001	− 0.14	0.117	0.229
20%	− 0.19	0.133	0.152	− 0.77	0.103	< 0.001	− 0.01	0.127	0.930
20%	− 0.70	0.159	< 0.001	− 1.59	0.129	< 0.001	− 0.23	0.160	0.149
Treatment failure	− 0.58	0.143	< 0.001	− 0.94	0.108	< 0.001	− 0.17	0.137	0.203
Cost	− 0.15	0.024	< 0.001	−0.05	0.017	0.003	−0.44	0.029	<0.001
Class allocation model									
Constant	− 2.15	0.860	0.012	− 3.12	0.934	0.001	0	–	–
Age	− 0.02	0.010	0.029	0.01	0.011	0.448	0	–	–
Gender (male)	0.51	0.287	0.075	0.74	0.304	0.015	0	–	–
Education (high)	0.67	0.279	0.016	0.34	0.299	0.256	0	–	–
Financial vulnerability (low)	0.81	0.299	0.007	0.74	0.313	0.018	0	–	–
Health literacy (sufficient)	− 0.77	0.282	0.006	− 1.05	0.307	0.001	0	–	–
Numeracy (sufficient)	0.55	0.354	0.122	0.87	0.366	0.017	0	–	–
Altruism	0.06	0.015	0.000	0.05	0.016	0.005	0	–	–
Average class probability		37.9%			29.1%			33.0%	
Log-likelihood								− 2946.0961	

SE standard error

risks, while other considerations, such as out-of-pocket costs, were relatively less important.

4.1 Prosociality in Healthcare: The Specificity of Antibiotic Use

Regarding the role of prosociality in infectious disease prevention, most research has focused on willingness to vaccinate and, more recently, on epidemic prevention. The available evidence suggests that prosocial behaviour is associated with increased vaccine uptake [7] and adherence to health recommendations for COVID-19 prevention [5, 6, 38]. However, vaccine uptake and epidemic prevention are influenced by various complex and multidimensional factors, and intersect with political and ideological views to an extent that does not pertain to the antibiotic use discourse [39, 40]. Individual decisions about vaccination or adherence to epidemic health recommendations have a public face and involve individuals positioning themselves within a broad societal debate. Indeed, besides altruism for the common good, other dimensions of prosociality, such as proactive and reactive forms, enter into play. Proactive prosocial behaviours reflect instrumental and self-benefiting functions [41]. For instance, when individuals expect others to hold them accountable, they adopt prosocial behaviour due to a motivation to preserve a positive self-image and gain a positive reputation among others [7, 42]. This notion of prosociality resembles that of ‘reciprocal altruism’, whereby people expect their altruism to be rewarded in the future [43, 44]. Reactive prosocial behaviours, on the other hand, reflect functions activated in response to someone in need [41]. These behaviours are a plausible reaction to situations such as the early stages of the COVID-19 pandemic, during which survival pressures (including social survival) were driving information processes, and a vast amount of new information and values were processed in a life-and-death frame [45, 46]. This entails that prosocial behaviour such as mask-wearing or other forms of adherence to public health recommendations under highly stressful circumstances may, in part, be triggered by short-term empathetic reactions to information

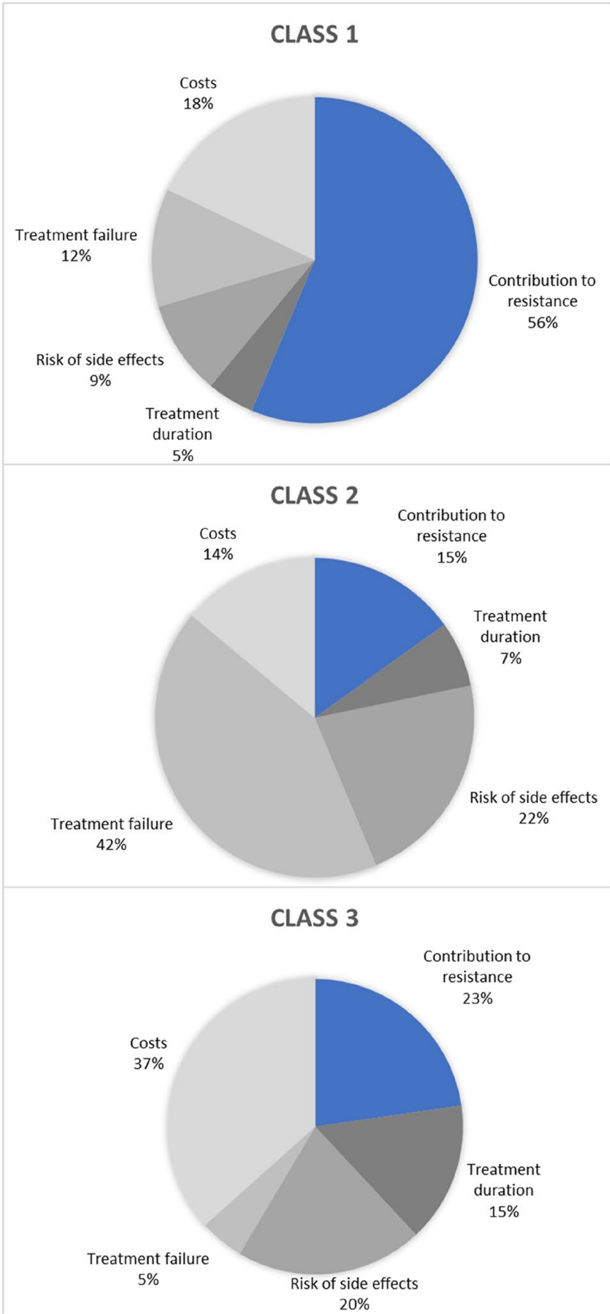

Fig. 1 Relative importance of attributes across the three classes on the latent class model, with more altruistic people being likely to belong to classes 1 and 2

quantity and framing, and not be reflective of deeply rooted individual characteristics and internalised moral and social norms. The appropriate use of antibiotics appears to be more closely related to altruism in its purest form. This involves placing other people's interests above one's own and helping others at a personal expense [47], because personal accountability, public image, or compassion have limited applicability to the context of antibiotic consumption in healthcare.

4.2 Structural Conditions: The Swedish Case

Considering the mixed evidence from research in other countries, the consistency of the Swedish results, albeit conducted by different groups with different methods, is noteworthy. Swedish prosociality in the context of antibiotic use could be explained in terms of local norms and sociocultural values [3], as well as structural elements facilitating judicious antibiotic use, such as comparatively high public awareness of AR, high trust in healthcare institutions, and non-discriminatory priority setting in healthcare.

In Sweden, outpatient antibiotic consumption is comparatively low, and Swedes demonstrate good knowledge of antibiotic use and AR [48]. Due to early commitment, the use of antibiotics began to decline as early as the 1990s [49]. A key element of the Swedish strategy is the focus on continuous communication and bottom-up initiatives to raise awareness, educate, and induce behavioural change [50]. It seems a sensible idea that engaging in antibiotic prosocial behaviour presupposes an adequate grasp of the AR problem. Individuals need to understand the relationship between their own potential contribution to the problem and the decrease in antibiotic effectiveness to act for the common good.

Trust in healthcare is often considered a valid instrument for evaluating healthcare performance [51, 52]. Sweden has been described as a high-trust country, both in terms of general social trust and concerning healthcare [53, 54]. Trust as a determinant of AR has been linked, in previous Swedish studies, with willingness to contribute to antibiotic stewardship, for instance, by postponing antibiotic treatment and accepting doctors' decisions not to prescribe antibiotics [21, 55]. Conversely, a lack of trust was regarded as a hindering factor for engaging in judicious antibiotic behaviour [56, 57]. Supposedly, there is a connection between trust and prosociality because trust involves positive expectations for others' behaviour [58].

Finally, it can be hypothesised that an influence on Swedes' prosocial antibiotic attitudes is exerted by core values embedded in the healthcare system. The Swedish healthcare system is universal, and priority setting follows three ethical principles: human dignity, need and solidarity, and cost effectiveness [59, 60]. The relatively low individual risk involved in postponing or withholding antibiotic treatment for the sake of others is arguably more acceptable within a universal and overtly non-discriminatory healthcare system.

4.3 Individual Characteristics: Gender, Education, and Health Literacy

This study showed that altruism was statistically significantly associated with gender, education, and health literacy. Women, highly educated respondents, and more health-literate respondents had higher altruism scores, on average.

In the prosociality literature, a strong association in experimental and empirical research was found between gender and altruism, and education and altruism. Women are, on average, more altruistic than men [61–63], and more highly educated individuals also show a tendency to be more altruistic [64–66]. Therefore, the present findings are aligned with the evidence from previous research. The association between gender and altruism, and education and altruism in antibiotic use and AR-related decision making was not found in other studies and is considered novel. Interestingly, relatively less research has investigated the relationship between altruism and health literacy, and the present study findings diverge from the available evidence. While this study demonstrated a positive correlation between altruism and health literacy, a US qualitative study investigating what factors were important to eligible volunteering participants in choosing among different trials reported that low health literacy participants (13%) were more likely than high health literacy respondents (< 4%) to resort to the concept of altruism to describe their selection criteria [67]. A survey study with Danish and UK participants exploring individual differences associated with consumer stockpiling during the early COVID-19 phases reported a statistically significant association between low altruism and low health literacy [68]. As for gender and education differences, the association between health literacy and altruism in antibiotic use and AR-related decision making was not found in other studies and is considered novel.

The novelty of the findings on gender, education, and health literacy is arguably connected to the relative paucity of research on altruism, but the consideration can be extended to prosociality in general, as an antecedent of judicious antibiotic behaviour.

4.4 Limitations

Our findings supported the model's theoretical internal validity because they followed the anticipated directions of the estimates. Nevertheless, this study had some limitations. There is a risk of selection bias as a commercial survey sample provider was used. For the same reason, there is also the potential for compromised data quality, as panel respondents may be less invested in completing a survey compared with samples recruited from clinical sites. This is sometimes reflected in the overly fast response times. To test reliability, an assessment of dominant decision making was carried out to identify participants using non-compensatory decision-making techniques. Tests for left-right bias—always selecting the option on the left or right—were conducted and gave negative results. We did not test respondents' understanding of training material on the attributes and levels nor the time spent reading these instructions. However, feedback questions about the length and difficulty of the questionnaire (only 4.5% of respondents found it long or very long and difficult or very difficult) did not flag any data quality issues. The questionnaire included several self-report measures, which, as with all methods, have advantages, such as easy interpretability and richness of information, but also disadvantages. One major critique of self-report methods concerns their credibility; yet, although inaccuracies in respondents' answers can never be ruled out, self-report methods are abundantly used in scientific research and are most troublesome in face-to-face interviews rather than in written or online questionnaires [69]. Additionally, all central self-report measures used in this study are validated (S-CCHL, SNS-3, HRAS-13, ASRAS). Finally, as with other DCEs, there is a chance of hypothetical bias about external validity, meaning that the outcomes might not accurately reflect actual behaviour. However, recent studies show that a good-practice DCE can predict up to 91% of individual choices [70].

5 Conclusion

The results of the present study reinforce the idea that a community's degree of prosociality can influence the effectiveness of health policies and, more specifically, contribute to judicious antibiotic use. The significant association between altruism and education and health literacy suggests that citizens' schooling should be a priority to foster prosocial behaviour conducive to public health within society. The mixed evidence in the literature about the association between prosociality and antibiotic use contrasts with the homogeneity of Swedish studies, which consistently demonstrate it. The promotion of prosocial behaviours among citizens requires governments, policy makers, and institutions to be oriented toward society [71]. Structural conditions, such as strengthening health systems and widening universal health coverage, are needed to promote judicious antibiotic behaviour and facilitate prosocial behaviours. A constant communication effort to raise awareness of AR is also required to achieve long-lasting results. The findings of this study suggest that health communication could use prosocial framing to encourage the responsible use of antibiotics and discourage overuse and misuse.

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Declarations

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Conflict of interest Mirko Ancillotti, Samare P. I. Huls, Eva M. Krockow, and Jorien Veldwijk have no conflicts of interest to declare that are directly relevant to the contents of this article.

Availability of data and material The data that support the findings of this study are digitally stored in a secure archive at Uppsala University. The datasets generated and/or analysed during the current study are available from the corresponding author on reasonable request.

Ethics approval This study adhered to Swedish research regulations and was approved by the Uppsala Regional Ethical Review Board (Dnr 2018/293).

Consent to participate and consent for publication Participants' consent to participate in the research and for their de-identified data to be used in publications was acquired through an online survey consent.

Code availability Not applicable.

Author contributions All authors contributed to the study conception and design. Material preparation and analysis were performed by Samare Huls, and data collection was performed by Mirko Ancillotti. The first draft of the manuscript was written by Mirko Ancillotti and Samare Huls, and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

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