Basic knowledge and misconceptions on antibiotic use: a comparative survey between Veterinary College and High School students in Bari (Italy)

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Antibiotic use, Antimicrobial resistance, Cross-sectional survey, Questionnaire, Students.

Summary
Misconceptions about the use and effectiveness of antibiotics contribute to the persistence of antimicrobial resistance. The aim of this study was to gather information on appropriate use of antibiotics in students from the Veterinary Medicine College (G1, n = 119) and from High School (G2, n = 220), from Bari (Italy) through a questionnaire. The response rate was 89% in G1 and 89.5% in G2. Fifty-five % of college students and 79% of high-school students had taken antibiotics in the last 12 months. Unsurprisingly, high-school students had more misconceptions about antibiotics than G1. The majority of misconceptions stated that i) antibiotics kill viruses (OR 8.4, CI 4.8-14.7, $p < 0.001$); ii) they are active against cold and flu (OR 4.6, CI 2.6-8.1, $p < 0.001$); iii) it is possible to purchase antibiotics without a medical prescription (OR 7.3, CI 4.3-12.5, $p < 0.001$). Information campaigns among young people are urgently needed to reduce misuse and to improve knowledge on antibiotics.

Introduction

Antimicrobial resistance (AMR) is a natural phenomenon in the context of bacterial homeostasis (Martínez 2012). In addition, the discovery of antibiotics and their use for therapeutic purposes have generated a selective pressure toward antimicrobial resistance (Hawkey 2008, Davies and Davies 2010). The inappropriate use of antibiotics in human and veterinary medicine has spread this phenomenon (Bronzwaer *et al.* 2002, WHO 2012, WHO 2014, Marshall and Levy 2011, ECDC 2014, Prestinaci *et al.* 2015). AMR is nowadays a threat to global public health since it is responsible for increased costs and mortality rates for bacterial diseases in humans (Cosgrove 2006, Michaelidis *et al.* 2016, Friedman *et al.* 2016) and animals (Bengtsson and Greko 2014). The inappropriate use of antibiotics in the community may result from a complex interaction between several factors, such as the patient's attitudes, beliefs, and knowledge about antibiotic use and effectiveness (Cockburn and Pit 1997, Davey *et al.* 2002, Baquero and Campos 2003, Vanden Eng *et al.* 2003, McNulty *et al.* 2007). The European Union has therefore identified a community strategy against AMR, in both human and veterinary medicine (EC Action Plan 2016). This Action Plan is intended to: i) prevent the spread of microbial infections, ii) ensure the appropriate use of antimicrobials, iii) undertake effective research programs to combat AMR. Communication, education and training of people represent a relevant part of this strategy. Since 2008, the European Centre for Disease Prevention and Control (ECDC) has launched the 'European Antibiotic Awareness Day' (EAAD), an initiative that provides a platform for national campaigns to raise

awareness on prudent use of antibiotics (ECDC/EAAD 2008).

As a part of this strategy, the Directorate-General for Health and Consumers of the European Union commissioned to Eurobarometer agency three wide surveys in 2010 (EC Eurobarometer Report 338, 2010), in 2013 (EC Eurobarometer Report 407) and, in 2016 (EC Eurobarometer Report 445), to test the level of public knowledge on antibiotics and the risks associated with their unnecessary use.

The overall picture emerging from those surveys is that the general public has many preconceived notions on antimicrobial substances and their effects. For instance, only 43% of Europeans know that antibiotics are ineffective against viruses, and just 56% know that they are ineffective against cold and flu (EC Eurobarometer Report 445, 2016). There is a substantial difference between Northern and Southern nations of Europe, regarding misconceptions, with Italy classified among the Nations with the highest personal consumption of antibiotics and lowest perception of the problem (EC Eurobarometer Report 445, 2016; ECDC 2017). The age of people interviewed and the level of education also influence the use of antibiotics and perception of AMR. Europeans aged from 15 to 24 years were found to have the worst perceptions on AMR and the consumption of antibiotics resulted higher among those with a low level of education (EC Eurobarometer 445, 2016).

The aim of this study was to gather information on antibiotic use and beliefs in students from the Veterinary Medicine College of the University of Bari and a High school in Bari, Italy. A questionnaire was administered to test their level of knowledge.

Materials and methods

Questionnaire design

The survey was developed based on the AMR Eurobarometer Surveys, report numbers 338, 407 and 445 (EC Eurobarometer Report 338, 2010; EC Eurobarometer Report 407, 2013; EC Eurobarometer Report 445, 2016), with some modifications. The questionnaire was reduced to 10 questions (Q) covering the personal use of antibiotics, the knowledge on the efficacy of antibiotics and the source of information about the topic (Q1-5). The final part of the questionnaire investigated the socio-demographic characteristics of respondents (age and sex) and the presence of health workers in the family. (Q6-9). All the questions were close-ended, except for the Q9 (age of the respondents), and Q10 (suggestions or comments to the questionnaire) (S1 Questionnaire).

Pilot study

To assure the accuracy and consistency of the questions, a pilot study was conducted. The questionnaire was given to a selected convenience sample of 20 young people from the Apulia region. The pilot study was successful and the questionnaire was not modified for the current study. Data from the pilot study were not included in the subsequent survey.

The survey

A cross-sectional survey was conducted. Two main population samples were selected: Group 1 (G1, n = 119) second-year students of the Veterinary Medicine College. The questionnaire was given at the beginning of the Microbiology course. Group 2 (G2, n = 220) students of the High School, Istituto Deviti Demarco, located in Valenzano (Bari, Italy). The survey was made within the project 'Percorso Alternanza Scuola Lavoro' in 2016-2017.

The questionnaire was given during the lessons, with a brief introduction on the aim of the survey made by the teachers.

This study did not require local ethics committee approval since it did not require the collection of biological samples or execution of medical treatments/investigations. All participants provided written consent to participate. The study was conducted in accordance with Italian and Institutional standards, with the principles set down in the Declaration of Helsinki and its revisions, and with local legislation. Following the guidelines of the Italian Data Protection Act, only limited data elements (including gender and year of birth) were collected from students, in order to analyse the data anonymously (D.Lgs. 196/2003).

Statistical analysis

The data were analysed with Excel 2010. Descriptive data analyses were undertaken including frequencies and percentages, calculated for the categorical data. The answers to Q3-Q4 were dichotomised, i.e. 'correct' versus 'incorrect/I don't know', while the answers to Q5 (source of the information other than school/university) were dichotomised as 'always/often' vs. 'never/sometimes'. Statistical analysis was performed for categorical data by using the Chi-square test with a significance level $p < 0.05$. The data were analysed using SAS software, version 8.2. Odds ratio (OR) with 95% Confidence Interval (CI) was calculated for measuring the risk.

Results

Table I summarizes the characteristics of the 2 sample populations.

Response rate

One hundred six out of 119 G1 students answered the questionnaire (response rate 89%). One hundred ninety-seven out of 220 G2 students completed the questionnaire (response rate 89.5%).

Demographic characteristics of the groups (Q 6-9)

G1: The mean age was 21 years (range 20-23 years). Sixty-two were females (58%), 44 males (42%). Thirty-seven out of 106 respondents lived with one or more health-workers (35%): 15 were nurses, 10 were physicians, 7 were veterinarians, 3 were pharmacists, 3 were biologists, 2 were lab workers.

G2: The mean age was 17 years (range 13-18 years). One hundred thirty-seven were males (69.5%), 60 females (30.5%). Fifty-four students lived with one or more health workers (27.4%). Thirty-two were nurses, 20 were physicians, 5 were pharmacists, 4 were veterinarians, 1 was a lab worker.

Antibiotic use (Q1-2)

G1: Fifty-eight students (55 %) had taken antibiotics in the last 12 months, for bronchitis (3), flu (18), sore throat (28), cough (10), fever (15) headache (5), diarrhoea (3), urinary tract infections (UTI) (5), or for other causes (15).

G2: One hundred fifty-six students (79%) had taken antibiotics in the last 12 months. In most cases, they had taken antibiotics for fever (68), flu (63), cold (52), sore throat (50) cough (42), headache (37), bronchitis (14), diarrhoea (11), skin infection (59), UTI (3), or for other causes (7) (Figure 1).

Table I. *Main characteristics of the two study populations.*

		G1 Undergraduate students (Frequency %)	G2 High school students (Frequency%)
Total		**119**	**220**
Total of respondents (%)		106 (89)	197 (89.5)
Gender	Female	62 (58)	60 (30.5)
	Male	44 (42)	137 (69.5)
Mean age (range)		21 (20-23)	17 (13-18)
A health care worker in the family			
Yes		37 (35)	54 (27.4)
	Nurse	15	32
	Physician	10	20
	Veterinarian	7	4
	Pharmacist	3	5
	Biologist	3	0
	Lab worker	2	1
	Other	0	0
No		69 (65)	143 (72.6)

Knowledge on antibiotic action (Q3, statements 3.1, 3.2, 3.3 and 3.4)

G1: Eighty-three respondents (78.3%) knew that antibiotics are not active against viruses and 45 of them (43%) were aware that antibiotics are not effective against cold and flu. Ninety-two respondents (86.8%) knew that antibiotics often produce side-effects and 78 (73.6%) knew that abuse of antibiotics makes them ineffective.

G2: 59 respondents (30%) knew that antibiotics are not active against viruses, while just 27 students (13.7%) knew that antibiotics are inactive against cold and flu. Eighty-three of the respondents (42.1%) knew that antibiotics often produce side-effects and 130 (66%) that unnecessary use of antibiotics makes them ineffective.

Use of antibiotics and compliance with the prescription (Q4, statements 4.1, 4.2, 4.3, 4.4)

G1: Seventy-four respondents (70%) said that it is necessary to not forget one or more doses, while 87 (82%) knew that it is not correct to stop taking antibiotics when feeling better and 64 (60%) that prescriptions are needed to purchase an antibiotic. Regarding the choice of a new generation antibiotic rather than an old one, 43 respondents (40.6%) were aware that this is not a correct practice.

G2: 105 respondents (53.3%) correctly answered 'false' to Q 4.1 (you may forget one or more doses). Seventy-three (37%) knew that it is not correct to stop taking antibiotics as soon as you feel better. Only 34 students (17.3%) knew that it is not possible to purchase an antibiotic without a

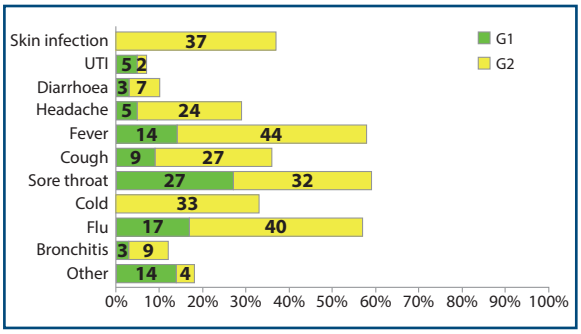

Figure 1. *Reasons for taking antibiotics in two study populations.* G1 = Undergraduate students; G2 = High school students; UTI = Urinary tract infection.

medical prescription. Regarding the choice of a new generation antibiotic rather than an old one, 68 respondents (34.5%) were aware that this is an incorrect practice.

Interestingly, within the G1 group just 2 students answered correctly to all Q3 questions, and 1 student to all Q4 questions. In the G2 group, 3 students gave 4 correct answers to all Q3 questions and 2 students to Q4 questions. In both groups, no one answered correctly to all questions.

Source of information (Q5)

When the G1students were asked where they obtained the information from (other than university courses), they answered either internet (82%) and television (62%) while only 36% consulted books or newspapers.

Students of the G2 group gathered information from the internet (63%) or television (54.4%) while 38% of them consulted books or newspapers.

Statistical analysis

Differences between G1 and G2

The comparison between the two groups is shown in Table II.

No significant difference between the groups was observed on the use of antibiotics in the last 12 months. On the opposite, a significant difference in the level of general knowledge on antibiotics was found. Students belonging to the G2 group seemed to have more misconceptions about the use of the antibiotics. In particular, most G2 students believed that antibiotics kill viruses (OR 8.4, CI 4.8-14.7, $p < 0.001$) and that they are active against cold and flu (OR 4.6, CI 2.6-8.1, $p < 0.001$). Students of the G2 group had also a worse perception of antibiotic side effects (OR 9, CI 4.8-16.9, $p < 0.001$), when compared to the G1 students. Regarding the statement 'unnecessary use of antibiotics contributes to make them ineffective', the difference of knowledge between the groups was not statistically significant (OR 1.4, CI 0.8-2.4, $p > 0.05$). A higher number of G2 students gave incorrect answers to the statement: 'you may forget one or more doses' (OR 2, CI 1.2-3.3, $p < 0.01$) than G1 students. When asked if it is possible 'to stop taking antibiotics as soon as you feel better', a greater proportion of G2 respondents gave an incorrect answer (OR 7.8, CI 4.4-13.8, $p < 0.001$), than G1 students. A greater and significant number of G2 respondents believed that it is possible to purchase an antibiotic without a medical prescription (OR 7.3, CI 4.3-12.5, $p < 0.001$), while no significant difference was found regarding the answer to the statement 'a new antibiotic is preferable to an old one' (OR 1.3, CI 0.8-2.1, $p > 0.05$).

Table II. *Comparison between G1 (undergraduate students) and G2 (high school students) groups regarding the use and basic knowledge of antibiotics.*

Questions	Answer	G1 N=106 (%)	G2 N=197 (%)	OR (95% CI)	*p value*
Q.1 Have you taken any antibiotics in the last 12 months?	Yes	58 (55)	156 (79)	0.3 (0.2-0.5)	< 0.001
	No	48 (45)	41 (21)		
Q.3.1 Antibiotics kill viruses	False	83 (78.3)	59 (30)	**8.4 (4.8-14.7)**	**< 0.001**
	True	23 (21.7)	138 (70)		
Q.3.2 Antibiotics are effective against cold and flu	False	45 (43)	27 (13.7)	**4.6 (2.6-8.1)**	**< 0.001**
	True	61 (57%)	170 (86.3)		
Q.3.3 Taking antibiotics often causes side-effects	True	92 (86.8)	83 (42.1)	**9 (4.8-16.9)**	**< 0.001**
	False	14 (13.2)	114 (57.9)		
Q.3.4 Unnecessary use of antibiotics contributes to make them ineffective	True	78 (73.6)	130 (66)	1.4 (0.8-2.4)	> 0.05
	False	28 (22.4)	67 (34)		
Q.4.1 You may forget one or more doses	False	74 (70)	105 (53.3)	**2 (1.2-3.3)**	**< 0.01**
	True	32 (30)	92 (46.7)		
Q.4.2 You can stop to take it as soon as you feel better	False	87 (82)	73 (37)	**7.8 (4.4-13.8)**	**< 0.001**
	True	19 (18)	124 (63)		
Q.4.3 You can take it without a prescription from a pharmacy	False	64 (60)	34 (17.3)	**7.3 (4.3-12.5)**	**< 0.001**
	True	42 (40)	163 (82.7)		
Q.4.4 A new antibiotic is preferable to an old one	False	43 (40.6)	68 (34.5)	1.3 (0.8-2.1)	> 0.05
	True	63 (59.4)	129 (65.5)		

Does the presence of health workers in the family improve knowledge about the proper use of antibiotics?

To test if the presence of one or more health workers in the family was related to a better knowledge of the use of antibiotics, a statistical analysis was performed in both groups.

G1: Students living with health workers did not take more or fewer antibiotics than other students, neither seemed to have a better knowledge about the antibiotics (Table III).

G2: students living with health workers did not take fewer antibiotics, but knew more about the efficacy of antibiotics, than other students. In fact, they knew that antibiotics are not effective against cold and flu (OR 2.7, CI 1.2-6.1, $p < 0.05$), that they may cause side effects (OR 4, CI 2.1-7.9, $p < 0.001$) and that compliance with drug prescription is a relevant issue (OR 2.5, CI 1.3-4.7, $p < 0.01$) (Table IV).

Discussion

The present study aimed at investigating both personal consumption of antibiotics in young people and their level of knowledge about antibiotic action and proper use. Two age groups of students were compared by administering a questionnaire. The survey was based on previous Eurobarometer surveys on AMR (published in 2010, 2013 and 2016) (EC Eurobarometer Report 338, 2010; EC Eurobarometer Report 407, 2013; EC Eurobarometer Report 445, 2016). Thus, it was possible to compare our results with those from the Eurobarometer surveys. The administration of the questionnaire during the lessons allowed us to obtain a high response rate. The study populations were composed of two age groups, both studying scientific topics although specific information on the use of antimicrobials was not included yet in their curricula.

Regarding the personal consumption of antibiotics, the number of students that had taken antibiotics in the last 12 months was high, 55% in G1 and 79% in G2.

These numbers appear very high, especially when compared with the frequencies reported in the last Eurobarometer survey (2016), i.e. 34%. In Italy, in 2016 this proportion was already high (43%) (EC Eurobarometer Report 445, 2016) and an increasing trend was noted when considering the percentage reported in 2013 (36%) (EC Eurobarometer Report 407, 2013).

The 2016 Eurosurvey report showed that respondents, whose education ended at or before the age of 15 were more likely to have taken antibiotics (39%) than those who ended studying at 16 (33%) or later (32%) (EC Eurobarometer Report 445, 2016). Regarding the G1 students, the high number of antibiotic consumers could be explained by several factors, such as the influence

Table III. *Presence of health workers in the family and different knowledge on the use of antibiotics: G1 (undergraduate students).*

Questions	Answer	Students with health workers	Students without health workers	OR (95%CI)	*p value*
Q.1 Have you taken any antibiotics in the last 12 months?	Yes	23	36	1.05 (0.7-3.4)	> 0.05
	No	14	33		
Q.3.1 Antibiotics kill viruses	False	30	52	1.4 (0.5-3.8)	> 0.05
	True	7	17		
Q.3.2 Antibiotics are effective against cold and flu	False	11	31	0.5 (0.2-1.2)	> 0.05
	True	26	38		
Q.3.3 Taking antibiotics often causes side-effects	True	26	51	0.8 (0.3-2)	> 0.05
	False	11	18		
Q.3.4 Unnecessary use of antibiotics contributes to make them ineffective	True	33	56	1.9 (0.6-6.4)	> 0.05
	False	4	13		
Q.4.1 You may forget one or more doses	False	24	52	0.6 (0.25-1.4)	> 0.05
	True	13	17		
Q.4.2 You can stop to take it as soon as you feel better	False	31	56	1.2 (0.4-3.5)	> 0.05
	True	6	13		
Q.4.3 You can take it without a prescription from a pharmacy	False	23	45	0.9 (0.4-2)	> 0.05
	True	14	24		
Q.4.4 A new antibiotic is preferable to an old one	False	17	24	1.6 (0.7-3.5)	> 0.05
	True	20	45		

Table IV. *Presence of health workers in the family and different knowledge on the use of antibiotics: G2 (high school students).*

Questions	Answer	Students with health workers	Students without health workers	OR (95%CI)	*p value*
Q.1 Have you taken any antibiotics in the last 12 months?	Yes	42	114	0.9 (0.4-1.9)	> 0.05
	No	12	29		
Q.3.1 Antibiotics kill viruses	False	21	37	1.8 (0.93-3.6)	> 0.05
	True	33	106		
Q.3.2 Antibiotics are effective against cold and flu	False	13	15	**2.7 (1.2-6.1)**	**< 0.05**
	True	41	128		
Q.3.3 Taking antibiotics often causes side-effects	True	37	50	**4 (2.1-7.9)**	**< 0.001**
	False	17	93		
Q.3.4 Unnecessary use of antibiotics contributes to make them ineffective	True	33	91	0.9 (0.5-1.7)	> 0.05
	False	21	52		
Q.4.1 You may forget one or more doses	False	23	80	0.6 (0.3-1.1)	> 0.05
	True	31	63		
Q.4.2 You can stop to take it as soon as you feel better	False	30	48	**2.5 (1.3-4.7)**	**< 0.01**
	True	24	95		
Q.4.3 You can take it without a prescription from a pharmacy	False	7	27	0.6 (0.3-1.6)	> 0.05
	True	47	116		
Q.4.4 A new antibiotic is preferable to an old one	False	18	51	0.9 (0.5-1.7)	> 0.05
	True	36	92		

of the parents. Some self-limiting diseases may be a cause of concern for parents and prescription of antibiotics may be influenced by their pressure to medical practitioners, or could be an autonomous decision (Bauchner *et al.* 1999, Cabral *et al.* 2015). For instance, in a survey conducted in Italy on parents of public schools' students, a third of them declared to use antibiotics for self-medication, and they either purchased them without prescription or used those available at home (Napolitano *et al.* 2013). Another possible explanation of this high percentage could be the lack of specific knowledge of antibiotics. In fact, most of the respondents indicated they had taken antibiotics for treating viral infections or non-infectious diseases, such as headache. In general, as Eurobarometer surveys highlight, most of Europeans use antibiotics for reasons other than bacterial diseases (EC Eurobarometer Report 338, 2010; EC Eurobarometer Report 407, 2013; EC Eurobarometer Report 445, 2016). Flu and sore throat are the commonest examples. Also, bronchitis, that it is not always caused by bacteria, was indicated among the reasons for taking antibiotics. An additional problem in South Europe Countries is the use of antibiotics without a specific diagnosis made by medical practitioners (Grigoryan *et al.* 2006, Morgan *et al.* 2011). A discrepancy of knowledge between the two groups was found about the activity against viruses, with a lower level of knowledge in the G2 group. Frequencies of students that incorrectly stated that antibiotics are active against cold and flu were high in both G1 and G2 groups. In 2013, 60% of European people thought that antibiotics are active against viruses, and 52% that are active against cold and flu, in 2016 the proportions were 57% and 56%, respectively (EC Eurobarometer Report 407, 2013; EC Eurobarometer Report 445, 2016). Italy is reported among the Countries with lower percentages of correct answers. Other surveys conducted in Italy show similar results (Napolitano *et al.* 2013, Prigitano *et al.* 2018), suggesting that information campaigns should be planned to inform people about viruses and that they are a common cause for cold and flu (McNulty *et al.* 2011).

Regarding the compliance to the antibiotic therapy, altogether a good knowledge in the G1 group was found. However, few persons (40.6%) correctly answered the question: a new antibiotic is preferable to an old one. Another issue was the possibility to purchase an antibiotic without a medical prescription. Students from both groups were not aware that a medical prescription is necessary, even if prescriptions in Italy are mandatory (D.Lgs. 219/2006). Eurosurvey reports that the proportion of people that were not aware of a medical prescription was very low (EC Eurobarometer Report 445, 2016).

The percentage of G2 students giving a correct answer was in general lower than that of G1 students. Young people use social networks as information source (Wong *et al.* 2014), in fact, in this survey, both groups declared to use the internet as a main

source of information, while books or newspapers were poorly consulted. The consequences of using unofficial sources of information are obvious and may explain some of the statements reported here. Despite the use of the same sources of information, misconceptions in G1 may be compensated by scientific studies. Regarding the presence of a health worker in the family, it was interesting to note that G1 students having a health worker in the family did not use fewer antibiotics, nor knew more about antibiotics in general. On the opposite, in the G2 group some differences were noted. In fact, students living with a health worker were found to be 3-4 times better informed on antibiotic activity, side effects and compliance. A cross-sectional survey represents a snapshot of participants' view at a particular time (Kelley *et al.* 2003). Moreover, when data are collected by questionnaire, respondents may misinterpret some questions or may report distorted information. Future studies employing other methods of data collection, and with a larger sample size may be useful to expand the results reported here.

In conclusion, despite scientific studies, students interviewed were not aware of the exact function of antibiotics. Including specific topics in school curricula may provide a better understanding of the use of antibiotics (Avezedo *et al.* 2009). As far as concern for veterinary students, the perception on AMR in different phases of their education is critical in guiding them for their future profession (Hardefeldt *et al.* 2018).

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