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Young doctors' perspectives on antibiotic use and resistance: a multinational and inter-specialty cross-sectional European Society of Clinical Microbiology and Infectious Diseases (ESCMID) survey

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Background: Postgraduate training has the potential to shape the prescribing practices of young doctors.

Objectives: To investigate the practices, attitudes and beliefs on antibiotic use and resistance in young doctors of different specialties.

Methods: We performed an international web-based exploratory survey. Principal component analysis (PCA) and bivariate and multivariate [analysis of variance (ANOVA)] analyses were used to investigate differences between young doctors according to their country of specialization, specialty, year of training and gender.

Results: Of the 2366 participants from France, Greece, Italy, Portugal, Slovenia and Spain, 54.2% of young doctors prescribed antibiotics predominantly as instructed by a mentor. Associations between the variability of answers and the country of training were observed across most questions, followed by variability according to the specialty. Very few differences were associated with the year of training and gender. PCA revealed five dimensions of antibiotic prescribing culture: self-assessment of knowledge, consideration of side effects, perception of prescription patterns, consideration of patient sickness and perception of antibiotic resistance. Only the country of specialization (partial η^2 0.010–0.111) and the type of specialization (0.013–0.032) had a significant effect on all five identified dimensions ($P < 0.01$). The strongest effects were observed on self-assessed knowledge and in the perception of antibiotic resistance.

Conclusions: The country of specialization followed by the type of specialization are the most important determinants of young doctors' perspectives on antibiotic use and resistance. The inclusion of competencies in antibiotic use in all specialty curricula and international harmonization of training should be considered.

Introduction

Antibiotic resistance has been recognized as a major global health threat and optimizing prescribing is one of the most effective measures to preserve the effectiveness of antibiotics.[1] The quality of prescribing depends mostly on those prescribers belonging to clinical medical specialties having direct contact with patients.[2] These doctors, who comprise the majority of antibiotic prescribers, undergo long-term undergraduate and postgraduate training that shapes their professional knowledge and behaviour.

Several papers have shown that prudent antibiotic prescribing is not sufficiently covered in the undergraduate medical curricula,[3] or during specialty training.[4,5] Antibiotic prescribing is influenced not only by knowledge but also by the attitudes and beliefs of the prescribers.[6,7] A review of studies of the social and professional influences on antibiotic prescribing by young doctors in postgraduate

training showed that they operate in a challenging context dominated by hierarchical relationships, powerful prescribing norms, unclear roles and responsibilities, expectations about knowledge and many uncertainties.[8,9] Studies investigating the attitudes and perspectives of young doctors in training are mostly limited to single hospitals or countries; only a few of them have pointed to any international[10] and inter-specialty differences.[11]

Following existing studies on the influence of sociocultural characteristics of societies on human behaviour in various areas of life, such as education, health and profession,[12] we designed a cross-sectional survey of young doctors in training, from different specialties and countries, to inform the following research questions: (i) which factors influence the culture and habits of antibiotic prescribing? and (ii) can we support the hypothesis about socio-cultural environment influences related to the country of specialization or the effect of type of specialty on the antibiotic prescribing behaviour of young doctors in training?

Methods

Ethics

The study was approved by the National Medical Ethics Committee in Slovenia (22p/08/14).

Participants, research design and the questionnaire

The research was focused on young medical doctors after graduation from medical school and the start of specialty training, but before taking specialty board examinations (specialty assessment). We included participants (trainees) from all medical specialties having daily contact with patients. The research was designed as a survey based on a standardized online questionnaire.

The questionnaire was sent to the study coordinators, who were members of the ESCMID Study Group for Antibiotic Stewardship (ESGAP) in 12 countries (Austria, Bulgaria, Croatia, France, Greece, Italy, Portugal, Slovenia, Spain, Sweden, Turkey and the UK), who forwarded the survey to young trainee doctors in their own country using the available networks. French data were analysed separately.[13] Additionally, the survey was advertised via Facebook groups. The survey was open from September 2015 to March 2016 and 12 reminders were sent to country coordinators.

The survey questionnaire was developed based on a literature review[9,10,14,15] and discussed by experts in medicine and survey methodology, who were authors of this study, through informal discussion. It was prepared in the Slovenian (for Slovenia) and English (for other countries) languages. In January 2016 the survey was translated into Spanish due to the interest of the coordinator and slow response of Spanish-speaking participants. The questionnaire was validated during a pilot phase that included 34 participants. After the pilot phase, minor changes (Table S1, available as Supplementary data at *JAC* Online) were made to the questionnaire and the final exploratory web survey consisted of 48 items covering different topics: the decision-making process in prescribing antibiotics; self-assessed knowledge; attitudes towards antibiotic resistance as a public health issue; the perception of the role of antibiotic prescribing in the development of resistance; the perception of prescribing patterns; the perceived role of education; and the demographics of the participants (the questionnaire is available as Supplementary data at *JAC* Online). Most items used four-point scales, with the exception of demographic variables and self-assessed knowledge, which used a five-point scale. Topics were operationalized as blocks of questions, arranged on separate pages of the survey questionnaire, which was then published as a customized 1KA survey.[16] To ensure only eligible respondents, two filter questions were included at the beginning of the questionnaire.

Data analysis

After the survey had closed, data were then exported from the 1KA survey file and the three language versions were harmonized and merged into an SPSS file, with which further analyses were conducted. For the sake of the consistency and representability of the individual countries, we decided to include only participants from countries with >100 respondents. This enabled us to interpret the attitudes as the reflection of the culture on the country level.

Based on expert classification, a new variable comprising seven categories of specialty groups was derived from the raw data on specialties (paediatrics; family medicine; internal medicine; surgery; anaesthesiology, intensive care and emergency medicine; infectious diseases, clinical microbiology and tropical medicine; others). The groupings of the specialties are presented in Table S2.

In order to answer our research questions, we used the following analytical procedures:

- In the first step, a general descriptive overview of results by individual survey questions was prepared. Frequency distributions or average values were used.
- In the second step, we checked the structural equivalence and consistency of the measuring instrument (the questionnaire). The main objective in this phase was to check whether the respondents from different demographic groups (by country of specialization, type of specialization, year of training and gender) had understood the questions in the same way and consistently responded to individual questions within each dimension (group of questions covering the same issue), which was a precondition for valid between-group comparisons. Principal component analysis (PCA) was used. A more detailed description of PCA can be found elsewhere.[17]
- Development of composite indices for measuring different dimensions of the use of antibiotics was undertaken in the next step.
- Bivariate analyses (cross-tabulations, comparison of means) and multivariate analyses [analysis of variance (ANOVA)] were used to investigate differences between different demographic groups of young doctors. To show the strength of associations, in the case of cross-tabulations Cramer's V was used, η^2 was used in the case of comparison of means and partial η^2 was used in the case of ANOVA. These indicators measure the strength of the association on a scale from 0 to 1 and are used in situations when at least one of the variables is categorical (Cramer's V) or where the independent variable is categorical (η^2). In social sciences we are talking about the existence of an association if Cramer's V exceeds the value of 0.1 or η^2 exceeds the value of 0.01.[18]

Results

Description of the data

The survey was completed by 2842 participants from 29 countries and 61 specialties. Further analysis was performed on 2366 (83.3%) participants from six countries with >100 respondents, presented in Table 1. In Greece the proportions of male and female respondents were the same; in all other countries the proportion of female respondents was higher. All years of training were included, with slightly fewer participants in the last 2 years of training. Excluding countries with a low number of respondents reduced the number of specialties to 56, which were later grouped into seven specialization groups (Table 1).

Practice and culture of antibiotic prescribing: results at the level of individual questions

Most respondents (52.1%) prescribed antibiotics at least once a day, 32.9% respondents prescribed antibiotics several times

Table 1. Characteristics of final sample of trainee doctors included in the analysis (N=2366).

Characteristic	n	%
Country		
Spain	818	34.6
France	653	27.6
Slovenia	444	18.8
Italy	187	7.9
Portugal	154	6.5
Greece	110	4.6
Year of training[a]		
first year	498	21.0
second year	536	22.7
third year	584	24.7
fourth year	447	18.9
fifth and sixth years	301	12.7
Gender		
male	883	37.3
female	1483	62.7
Specialty group		
family medicine	682	28.8
internal medicine	637	26.9
surgery	204	8.6
anaesthesiology, intensive care and emergency medicine	180	7.6
paediatrics	176	7.4
infectious diseases, clinical microbiology and tropical medicine	161	6.8
others	326	13.8

[a]Fifth and sixth years are combined due to different lengths of specializations.

a week and only a minority (15%) less frequently (n=2366). Young doctors from Italy reported most frequent prescribing and those from Slovenia the least (η^2=0.021 and Cramer's V=0.12). Trainees in infectious diseases and related specialties were more frequent prescribers than colleagues from surgery or internal medicine (η^2=0.047 and Cramer's V=0.155). More than half of the surveyed young doctors prescribed antibiotics completely (14.6%) or mainly (39.6%) as instructed by the mentor (n=2348). The results varied according to the country of training [young doctors from Slovenia were the least autonomous (η^2=0.024, Cramer's V=0.124)] and by type of specialization [surgeons and family medicine trainees being the most and anaesthesiologists the least independent prescribers (η^2=0.014, Cramer's V=0.095)]. There was some increase in independent prescribing from the first to the fourth year of training (η^2=0.053, Cramer's V=0.142). Fifty-eight percent of young doctors perceived that their supervisors used the guidelines when prescribing antibiotics, while others (42%) claimed that personal experience prevailed. The answers did not differ significantly or systematically according to gender, country, specialty or year of specialization.

The answers to other individual questions and their association with the four demographic variables are presented in Table 2 and more detailed results are in Table S3. In general, we found that all variables (questions) were associated (Cramer's V>0.1 or η^2>0.01) with the country of specialization (41 variables), followed by specialty groupings (23 variables), the year of training (8 variables) and gender (only 3 variables).

Main dimensions of practice and culture of antibiotic prescribing: results of PCA

In order to determine whether answers fitted the aspects of prescribing antibiotics that were included in the survey, we conducted a PCA. In a stepwise procedure (details in Table S4) the following five dimensions of antibiotic prescribing culture were clearly identified (explaining 63.84% of variance): (i) self-assessed knowledge of prescribing antibiotics (SA_KNW); (ii) consideration of side effects when deciding to prescribe antibiotics (DM_SEFF); (iii) perception of different *prescription patterns* (PATTRN); (iv) consideration of patient's sickness (degree of illness) when deciding to prescribe antibiotics (DM_SICK); and (v) perception of the problem of antibiotic resistance (RESIST) (Table S4).

This structure of dimensions fitted quite well with the structure of antibiotic prescribing culture that we operationalized in the questionnaire. The same structure could also be identified for each individual demographic group of respondents. We were able to conclude that the questionnaire was understood in the same way among respondents.

Five composite indexes, representing the five dimensions resulting from the PCA referred to above, were developed for further analyses. Values for all dimensions were fairly high; mean values are above the middle of the scale in all five indices (Table S4).

Influence of demographic factors on the culture of antibiotic prescribing: results of multivariate analyses of the level of composite indices

We performed multivariate analysis (ANOVA) separately for each of the five dimensions of antibiotic prescribing culture. Thus, we prepared five models with composite indices SA_KNW, DM_SEFF, PATTRN, DM_SICK and RESIST as the dependent variables. We did not include interactions in the models, but only the main effects of four factors (independent variables): country, specialization group, year of specialization and gender. We were therefore able to observe the 'direct' effect of each individual factor controlled for the other three factors included in the model.

The results confirmed the findings of the bivariate analyses at the level of individual survey questions. Country of specialization had the strongest influence (partial η^2=0.010–0.111), followed by specialization group (0.013–0.32), while, on the other hand, year of specialization and gender had little or no influence (Figure 1 and Table S5). The year of specialization had the strongest effect on self-assessed knowledge (0.071). Some relevant influence of gender on self-assessed knowledge was also found (0.013). Looking from the perspective of dependent variables, demographic variables best explained the scores for self-assessment of knowledge (R^2=0.153) (with the strongest effect being year of specialization) and the perception of bacterial resistance (R^2=0.142) (with country having the strongest effect by far). For the other three variables, the explanatory power of the model was much weaker (Table S5).

Table 2. Summary results for all individual variables on the culture of antibiotic prescription (mean values, bivariate associations with key demographic variables).

Question		Mean (SD)	Country of specialization η^2 Cramer's V^a	Specialty group η^2 Cramer's V^a	Year of specialization η^2 Cramer's V^a	Gender η^2 Cramer's V^a
I. My decision for treatment is based on . . . *1—disagree strongly, 4—agree strongly*	. . . my concern that I might miss/overlook something	2.67 (0.953)	0.166 0.254	no	no	no
	. . . how sick the patient is	3.25 (0.800)	0.074 0.189	0.021 0.105	no	no
	. . . the patient's immunodeficiency	3.59 (0.612)	no[a]	0.022 0.103	no	no
	. . . the patient's expectations	1.77 (0.818)	0.018 0.140	no	no	no
	. . . local policy/guidance	3.18 (0.776)	0.264 0.335	0.010 0.122	no	no
	. . . my senior's expectations	2.66 (0.830)	0.043 0.180	no	0.013 0.077	no
	. . . clinical picture, laboratory results, imaging techniques	3.76 (0.482)	0.057 0.169	no	no	no
	. . . the potential emergence of bacterial resistance to antibiotics	3.41 (0.676)	0.019 0.118	0.023 0.104	no	no
	. . . the potential occurrence of *C. difficile* as a consequence of my antibiotic choice	2.84 (0.869)	0.048 0.166	0.055 0.142	no	no
	. . . the potential side effects of the antibiotic treatment	3.17 (0.673)	0.012 0.117	no	no	no
II. Do I have the necessary knowledge to . . . *1—not sufficient, 5—excellent*	. . . decide whether or not a patient needs antibiotic treatment	3.83 (0.681)	0.016 0.095	no	0.037 0.109	no
	. . . choose the most appropriate antibiotic	3.40 (0.831)	0.027 0.095	0.026 0.101	0.034 0.107	0.012 0.126
	. . . decide on the proper dosage and dosing intervals of antibiotics	3.49 (0.952)	0.067 0.132	0.012 0.073	0.078 0.152	no
	. . . decide on the proper duration of antibiotic treatment	3.41 (0.874)	0.041 0.110	0.018 0.090	0.034 0.104	no
	. . . properly choose between parenteral and oral antibiotic treatment	3.64 (0.890)	0.016 0.069	no	0.029 0.093	no
	. . . to appropriately interpret microbiology results	3.73 (0.858)	0.035 0.106	no	no	0.012 0.125
III. De-escalation *1—disagree strongly, 4—agree strongly*	In the case of positive microbiology results I tend to de-escalate antibiotic treatment if possible (changing to narrow spectrum)	3.54 (0.674)	0.032 0.141	0.050 0.140	no	no
	For patients receiving parenteral treatment, I use every opportunity to switch to oral therapy	3.23 (0.728)	0.036 0.131	no	no	no
IV. Bacterial resistance to antibiotics is . . . *1—not a problem, 5—major problem*	. . . a global problem	3.81 (0.428)	0.011 0.074	no	no	no
	. . . a problem in your country	3.56 (0.591)	0.092 0.180	0.012 0.081	no	no
	. . . a problem in your workplace	3.26 (0.756)	0.106 0.194	0.043 0.128	no	no

Continued

Table 2. *Continued*

Question		Mean (SD)	Country of specialization η^2 Cramer's V^a	Specialty group η^2 Cramer's V^a	Year of specialization η^2 Cramer's V^a	Gender η^2 Cramer's V^a
V. Importance of appropriate prescription *1—disagree strongly, 4—agree strongly*	Inappropriate use of antibiotics is an important reason for the development of bacterial resistance to antibiotics	3.86 (0.354)	0.063 0.156	no	no	no
	Unnecessary antibiotic treatment can be (directly) harmful for individual patients	3.64 (0.552)	0.080 0.172	no	no	no
	Doctors prescribe antibiotics more often than necessary	3.46 (0.603)	0.031 0.197	no	no	no
	I (myself) prescribe antibiotics more often than necessary	2.39 (0.714)	0.019 0.125	0.017 0.084	no	no
VI. Limiting antibiotic use *1—disagree strongly, 4—agree strongly*	Limiting the use of antibiotics is harmful for the patient	1.97 (0.763)	0.086 0.203	no	no	no
	I try to avoid antibiotics that need approval	2.04 (0.794)	0.081 0.213	0.033 0.124	no	no
	Limiting the use of antibiotics will help reduce bacterial resistance	3.50 (0.620)	0.026 0.145	no	no	no
	Limiting the duration of antibiotic treatment will help reduce bacterial resistance	2.73 (0.975)	0.035 0.150	0.051 0.139	0.014 0.079	no
VII. Prescribing patterns *1—disagree strongly, 4—agree strongly*	When rotating through different departments, I notice that they each have their own 'prescribing habits' in antibiotic use	3.36 (0.654)	0.045 0.143	no	no	no
	I notice that certain departments consider their patients 'different' and they do not follow guidelines	2.82 (0.842)	0.006 0.128	0.012 0.078	no	no
	If I think that another doctor's decision about antibiotic treatment is inappropriate, I tend to share my opinion with him/her	2.88 (0.737)	0.022 0.149	0.024 0.106	no	no
VIIc. When choosing an antibiotic, I prescribe antibiotic . . . *1—completely on my own, 4—as told by my mentor*		2.56 (0.887)	0.024 0.124	0.014 0.095	0.053 0.142	no
VIId. When prescribing antibiotics, supervising specialists/senior colleagues prescribe . . . *1—adhere to the guidelines, 4—according to personal experience*		2.35 (0.901)	no	no	no	no
When choosing an antibiotic, I tend to . . . *1—disagree strongest, 4—agree strongly*	. . . adhere to the guidelines	3.43 (0.561)	0.017 0.109	0.012 0.079	no	no
	. . . choose an antibiotic according to prescribing patterns (habits) of the department or hospital where I work	2.88 (0.692)	0.089 0.206	no	no	no
	. . . choose an antibiotic that I feel comfortable with	2.82 (0.710)	0.027 0.149	0.018 0.103	no	no
VIII. Education *1—disagree strongly, 4—agree strongly*	I believe that good knowledge of antibiotics is important for my work	3.84 (0.404)	0.012 0.087	0.016 0.092	no	no
	I am aware of the guidelines and recommendations for antibiotic use in the hospital where I work	3.15 (0.719)	0.036 0.139	0.011 0.078	no	no
	I wish to get more training/education on antibiotics	3.67 (0.530)	0.032 0.116	0.016 0.078	no	0.011 0.109
	I get a lot of information on antibiotics and their potential use from representatives of pharmaceutical companies	1.93 (0.789)	0.024 0.119	no	no	no

[a]We are talking about the existence of an association if Cramer's V exceeds the value of 0.1 or η^2 exceeds the value of 0.01.[18]

Discussion

The key finding of our study is the impact of the country of specialization on antibiotic prescribing.

This was also identified as the most important variable associated with the five dimensions of antibiotic prescribing culture. However, we cannot state a single pattern of influence for all dimensions of prescribing culture (dependent variables) since we detected a slightly different 'pattern' of influence and dimensions of culture of prescribing among countries of specialization. Indeed, international differences in perception of antibiotic resistance in the workplace were found in a study that compared Scottish and French trainee doctors, and they also differed in attitudes to seeking advice from seniors and other professionals.[10]

In respect of antibiotic prescribing, specialty training was the second most important demographic factor identified in our study. For example, we found trainees in family medicine and surgery to be the most autonomous prescribers and, as expected, trainees in infectious diseases, clinical microbiology and tropical medicine were the most confident about their level of knowledge related to antibiotic prescribing, were more concerned about *Clostridioides* (*Clostridium*) *difficile* infection, were more likely to de-escalate and were more aware of the impact of limitation of treatment duration on antibiotic resistance. Some other studies have also shown associations between self-assessed knowledge and specialty training.[19,20]

Perception of resistance in the different specialties was only marginally different. The association between the type of specialty and the five dimensions identified by PCA was modest. The differences seem to be attributable mostly to the familiarity with topics that are expected to be better covered in infectious diseases and related specialties, less than to any inter-specialty cultural differences.[21] A few studies have addressed the differences in specialties for antibiotic prescribing and resistance. For example, Cortoos *et al.*[11] found lower use of guidelines but higher acceptance of consultations by surgeons than by internal medicine residents, and surgeons sought advice more often in a study by Srinivasan *et al.*[22]

In our study, trainee doctors with more years of training were more autonomous prescribers, a finding in line with the changing relationship between decision making and prescribing in advancing grades of doctor observed in a recent study.[23] The number of years of training was only associated with self-perceived knowledge. Gender appeared to have very little influence in our study, although there was significantly higher self-perceived knowledge in male trainees, with female trainees expressing greater need for additional training in this area; these differences had already been observed in a recent study on preparedness for antibiotic prescribing in students.[24]

The majority of the respondents claimed that clinical presentation and the issue of antibiotic resistance dominated their decisions on antibiotic treatment, as opposed to patient and senior expectations and concerns not to miss anything. This is different from a US trainee study where decisions were mostly based on the fear of missing an infection and severity of illness or immunocompromised state of the patient. However, in keeping with our results patient expectation did not play a significant role.[15]

Our study also found that antibiotic prescribing was mostly influenced by guidelines, in contrast with an Irish study where the influence of seniors was a more important determinant,[25] and a French study that revealed the influence of the trainees' own experiences.[26]

In line with the findings of several previous studies, our study observed that antibiotic resistance was the least recognized as a problem at the doctor's workplace. Repeatedly, young and senior doctors claimed that resistance is more a problem on the national or global level.[27] Overprescribing of antibiotics by other doctors as opposed to the surveyed doctors seemed to predominate, consistent with the findings reported by May and co-workers.[28] The weakest parts of self-assessed knowledge in our study were the choice of antibiotic and treatment duration. Treatment duration was also recognized as one of most difficult decisions by French and Scottish trainees.[10,26] Additional training in antibiotic use was requested by most of the respondents in our study as well in other studies.[15,29,30] In our study, the role of the pharmaceutical industry in education on antibiotics was rated as low, consistent with findings from several other studies.[10,21,30,31]

Due to the importance of the country of specialization in explaining the differences regarding prescribing culture, we assume that factors should also be investigated at a macro level. At least two types of phenomena may be relevant: (i) facts about prescribing antibiotics and antibiotic resistance; and (ii) norms and prevailing values in a country.

Looking at some of the statistical data about antibiotic use and resistance[32,33] supports our thesis about the importance of macro (country level) phenomena. Antibiotic overuse was perceived to be least problematic by Slovenian trainees. At the same time the use of antibiotics in Slovenia according to the European Surveillance of Antibiotic Consumption Network[32] was lower than in other participating countries. This suggests that the respondents correctly perceive the situation in their country or working environment. A systematic analysis of such relationships between the results of our study and antibiotic use and resistance is warranted.

When we consider prescribing culture, we cannot overlook the findings of various international comparative social studies on human values. For example, Hofstede *et al.*[12] spoke about the importance of values for understanding the behaviour of individuals in health and education. Several studies have found interesting relationships between the attitudes towards antibiotic use and antibiotic prescribing practices. The differences in outpatient antibiotic use can be explained by power distance, uncertainty avoidance, hierarchy, masculinity and religion,[6] and the frequency of prolonging antibiotic surgical prophylaxis beyond 24 h is concordant with uncertainty avoidance.[7] In our study, for example, self-assessed knowledge was lowest in more individualist countries (in our case, France and Italy), which ties in with Hofstede's interpretation that the main purpose of education in individualist societies is learning 'how to learn'.[12] Again, a more systematic analysis of the relationship between the results of the study and sociocultural dimensions is needed.

Given the fact that lists of all young medical doctors were not available to the researchers in the majority of countries used in this study, the sample is non-probabilistic. When we investigated the relations between phenomena (variables), especially with multivariate methods, this was less of an issue. Some poor understanding of the questions may be anticipated due to the language barrier. Because of different organization of postgraduate training we were not able to make the distribution of the questionnaire in the participating countries uniform, and we also did not focus on

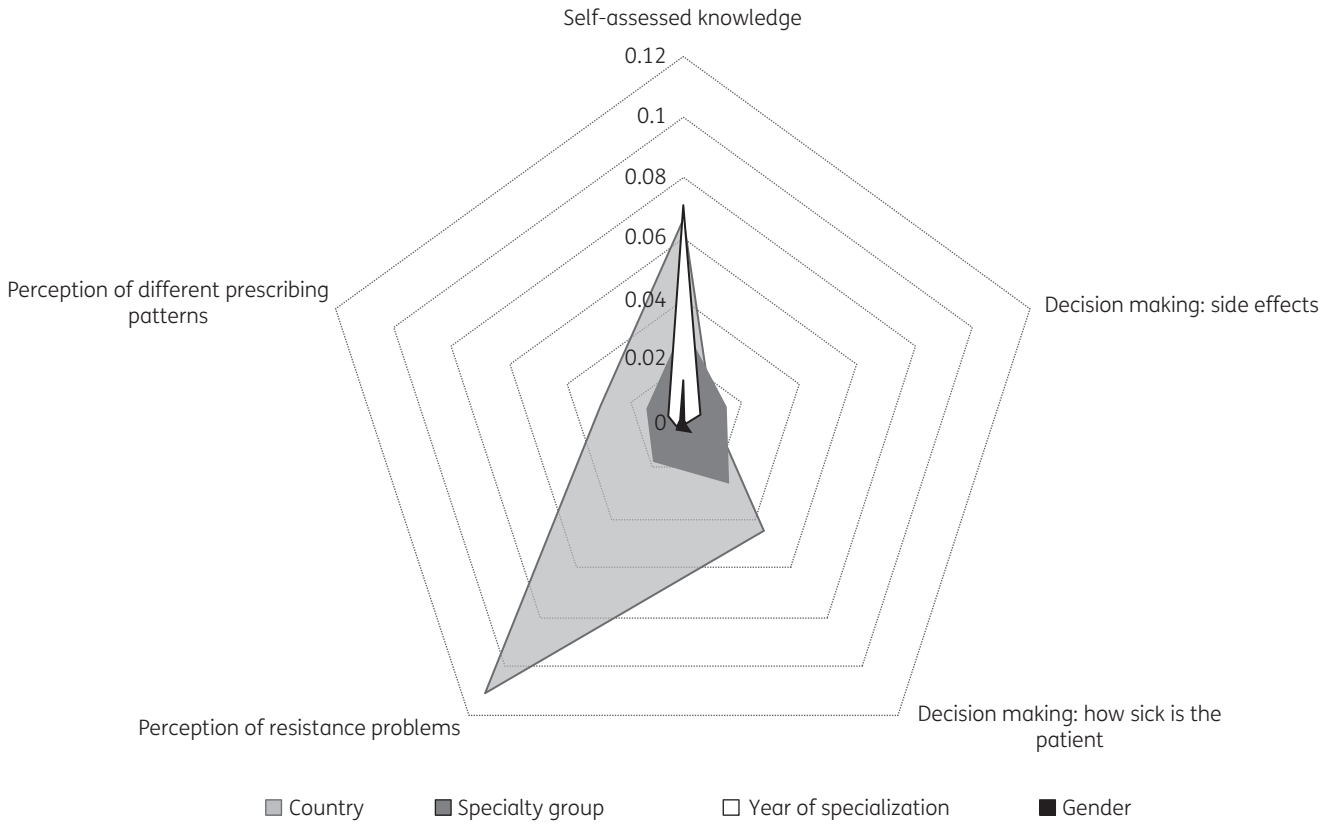

Figure 1. Association between four demographic variables (gender, country, year of specialization and specialty group) and five dimensions of antibiotic prescription culture (composite indices) (effect size of demographic variables is presented with partial η^2).

specific specialties. We must also draw attention to limitations due to only six countries, mainly southern and continental European countries, being involved in the study and an uneven number of participants per country. Inclusion of other countries, such as the UK or Scandinavian countries, may give different results related to different educational system and sociocultural aspects. However, the findings can be a good starting point for new research involving more countries with a large enough sample of surveyed trainees.

In conclusion, this is the first study to explore the differences in antibiotic prescribing practices, attitudes and beliefs in young doctors with regard to their specialty and country of training. The results clearly showed that the culture formed within the national context (national culture) prevails over the occupational and organizational culture related to the specialties. The differences between specialties in our study call for education in responsible antibiotic prescribing at an international level and in all specialty curricula. Internationally defined specialty curricula (UEMS) and antibiotic prescribing competencies[34,35] that should be included in all specialty training would provide a good starting point.

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Transparency declarations

None to declare.

Author contributions

B. B. designed the study, oversaw the survey, contributed to the analysis of the results and drafted the manuscript. M. D. led the survey, analysed the results and contributed to the manuscript. C. P. contributed to the questionnaire, distributed the survey and revised the manuscript. G. B. distributed the survey and revised the manuscript. J. R. P. P. distributed the survey and translated it into Spanish. D. S.-F. distributed the survey and helped with the translation into Spanish. D. K. distributed the survey. J. C. distributed the survey. L. P. distributed the survey. M. K. helped with the design of the questionnaire. K. N. helped with the distribution of the survey. M. H. F. designed the analysis and contributed to the manuscript. D. N. revised the questionnaire and revised the manuscript. S. U. revised the questionnaire, overlooked the analysis of the data and revised the manuscript.

Supplementary data

Tables S1 to S5 and the questionnaire are available as Supplementary data at *JAC* Online.

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