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From intentions to behaviour: a cross-sectional online study on the rational use of antibiotics in the treatment of urinary tract infections in Serbia

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Irrational antibiotic use is one of the significant contributors to antimicrobial resistance, with urinary tract infections being among the most common clinical presentations in which this problem is particularly pronounced. Understanding patients' attitudes, intentions, and behaviours regarding antibiotics is essential for developing effective educational strategies and public health policies to decrease inappropriate use. This study aimed to explore the relationships between sociodemographic and health factors and attitudes, intentions, and behaviours regarding the use

of antibiotics in the treatment of urinary tract infections, with a particular focus on predictors of self-medication and irrational antibiotic use. A cross-sectional survey was conducted in Serbia with 449 respondents using an anonymous online questionnaire distributed via the snowball method. Most respondents (96.9%) expressed their intention to follow doctors' advice; however, 25.8% planned to retain the remaining antibiotics, and 9.8% intended to share them with others. About 10% intended to use antibiotics without consulting a doctor, while 17% were open to this idea. The intention to self-medicate was significantly linked to age and employment status. Women, students, and those with medical education demonstrated a greater tendency towards rational antibiotic use. Binary logistic regression revealed that respondents intending to use antibiotics without prior consultation were 21 times more likely to self-medicate. These findings underscore the importance of raising public awareness about the risks of antibiotic self-medication and providing targeted education and counselling by healthcare professionals to reduce irrational use and combat antimicrobial resistance in Serbia.

Keywords: antibiotic use, urinary tract infections, patient behaviour, self-medication, public health

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Od namera do ponašanja: onlajn studija preseka o racionalnoj upotrebi antibiotika u lečenju infekcija urinarnog trakta u Srbiji

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Neracionalna upotreba antibiotika predstavlja jedan od značajnih uzročnika antimikrobne rezistencije, pri čemu se urinarne infekcije ubrajaju među najčešće kliničke slike u kojima je ovaj problem posebno izražen. Razumevanje stavova, namera i ponašanja pacijenata u vezi sa antibioticima ključno je za razvoj efikasnih obrazovnih strategija i politika javnog zdravlja koje mogu smanjiti neracionalnu upotrebu antibiotika. Cilj ove studije bio je da ispita povezanost sociodemografskih i zdravstvenih faktora sa stavovima, namerama i ponašanjem u vezi s upotrebom antibiotika u lečenju infekcija urinarnog trakta, sa fokusom na prediktore samolečenja i neracionalne upotrebe antibiotika. Studija preseka sprovedena je u Srbiji na 449 ispitanika korišćenjem anonimnog onlajn upitnika metodom snežne grudve. Većina ispitanika (96,9%) izrazila je nameru da se pridržava preporuka lekara, ali 25,8% je nameravalo da čuva preostale antibiotike, a 9,8% bi ih delilo sa drugima. Oko 10% namerava da koristi antibiotike bez konsultacije sa lekarom, a 17% je otvoreno za takvu mogućnost. Namera za samostalno korišćenje antibiotika bila je značajno povezana sa godinama i zapošljenjem. Žene, studenti i ispitanici sa medicinskim obrazovanjem pokazali su veću sklonost racionalnoj upotrebi antibiotika.

Binarna logistička regresija pokazala je da oni koji nameravaju da koriste antibiotike bez konsultacije sa lekarom imaju 21 puta veće šanse za samolečenje. Potrebno je podići svest javnosti o rizicima samolečenja antibioticima i obezbediti ciljane edukacije i savetovanje zdravstvenih radnika o racionalnoj upotrebi antibiotika kako bi se smanjila neracionalna upotreba i ograničila antimikrobna rezistencija u Srbiji.

Ključne reči: upotreba antibiotika, infekcije urinarnog trakta, ponašanje pacijenata, samolečenje, javno zdravlje

Introduction

Antimicrobial resistance is a global threat to health and development and is recognised as one of the top ten threats to global health in the 21st century (1). The World Health Organization has warned that the world is "running out of antibiotics," highlighting that the emergence and spread of resistant bacterial strains present a critical obstacle in managing infectious diseases (2). The rise of antimicrobial resistance has resulted in an increased incidence of hospital-acquired infections (3) and a higher risk of treatment failure (4). It significantly elevates healthcare costs due to prolonged hospital stays, the need for more expensive therapeutic alternatives, and increased morbidity and mortality rates (5-7). The main driver of antimicrobial resistance is the frequent and irrational use of antibiotics (8). These drugs are often prescribed without proper indication (9,10), given for insufficient or unnecessarily long treatment durations (11,12), or misused through self-medication (13,14)—all of which significantly accelerate the dissemination of resistant bacteria. Urinary tract infections (UTIs) exemplify this, with reports indicating that the rate of irrational antibiotic use in their treatment reach up to 70% (15-17).

Urinary tract infections are among the most common bacterial infections in the general population and represent a significant cause of antibiotic use, especially in primary healthcare settings (18,19). Women are at a significantly higher risk of developing UTIs (20), and recurrent infections add to the burden on both the healthcare system and patients' quality of life (21,22). Evidence from various countries shows that patients often hold misconceptions and unfounded attitudes about antibiotic use. Moreover, their intentions and actual behaviours frequently do not align with the principles of rational pharmacotherapy (23-25). One of the main reasons for the irrational use of antibiotics in the treatment of UTIs is patients' poor adherence to proper antibiotic regimens. Some patients refuse antibiotic therapy due to concerns about side effects or because they perceive only short-term benefits compared to potential long-term risks (26-29). Others engage in self-medication, using antibiotics without prior consultation with a healthcare professional (30,31).

Understanding individuals' attitudes, intentions, and behaviours regarding antibiotic use, particularly in the treatment of UTIs, is essential for developing effective educational strategies and public health policies. Attitudes and intentions are key concepts often employed to understand and predict human responses, as well as to explain how these factors influence behaviour (32,33). In the context of health and illness, individuals' attitudes, intentions, and behaviours significantly impact the healthcare process, affecting lifestyle choices, symptom

recognition and response, interactions with health professionals, treatment decisions, and adherence to therapy. When a person becomes ill, their reactions can range from concern to denial, potentially leading to refusal to seek professional advice, self-medication, or non-adherence to recommended therapy. Such behaviours complicate treatment and can cause frustration for both patients and healthcare providers (34).

Patients' attitudes toward medications largely influence self-medication. Addressing the problem of antibiotic self-medication requires a thorough understanding and assessment of the general population's attitudes and experiences regarding antibiotic use within a specific region and for specific diseases. Studies indicate that attitudes toward antibiotics vary across countries and are shaped by factors such as culture, education, economic status, personal habits, and the organisation of healthcare systems (35,36).

Available data suggest that, in Serbia, there is limited understanding of the general population's attitudes and intentions regarding the rational use of antibiotics for UTIs. Accordingly, this study aimed to explore the relationships between sociodemographic and health factors and attitudes, intentions, and behaviours regarding the use of antibiotics in the treatment of UTIs, with a particular focus on predictors of self-medication and irrational antibiotic use.

Materials and Methods

This research was conducted as a cross-sectional study between February and April 2024. Before data collection, an anonymous online questionnaire was specifically designed as the instrument for data collection to assess respondents' attitudes, intentions, and behaviours regarding the use of antibiotics in the treatment of UTIs. The instrument was disseminated electronically, employing the snowball sampling technique to facilitate inclusion of a broader sample.

Instrument

The instrument was first developed and validated in three phases before being administered to the study sample. In the first phase, a thematic framework was established, and a set of items was constructed based on a narrative literature review (PubMed and Google Scholar). The initial version of the instrument comprised 28 items derived from selected publications.

In the second phase, content and face validity of the initial version of the instrument were assessed through two focus groups—one with respondents without medical education (n = 4) and another with respondents with medical education (n = 3). Discussions were facilitated by a moderator, assisted by an observer responsible for monitoring the discussion and taking detailed notes. This phase led to the reformulation or removal of certain items, resulting in an online version of the instrument containing 24 items, including items related to sociodemographic and health characteristics.

The third phase involved pre-testing with 10 respondents using a cognitive interview approach. Participants were instructed to read the items aloud and actively reflect on their responses. The principal investigator was present to provide assistance and resolve any issues encountered during completion. Following this phase, the final version of the instrument was produced.

The instrument, administered in Serbian, comprised four domains: Domain 1 with 11 questions on sociodemographic and health characteristics; Domain 2 with three items assessing attitudes toward antibiotic use for UTIs; Domain 3 with five items on intentions regarding antibiotic use; and Domain 4 with five items on actual antibiotic-related behaviour. Respondents' attitudes were measured using a five-point Likert scale (1 = strongly disagree, 2 = partly disagree, 3 = neither agree nor disagree, 4 = partly agree, 5 = strongly agree). At the same time, intentions were assessed by indicating either a positive (yes) or negative (no) response for each specified activity, except for the item regarding the intention to obtain antibiotics without consulting a physician, for which two additional options (maybe and don't know) were provided due to the high importance of this item.

Respondents

The sample size was calculated to include 385 respondents, based on the estimated population of approximately 6.6 million inhabitants in the Republic of Serbia in 2023, with a 95% confidence level and a 5% margin of error (37). To account for potential non-response and incomplete questionnaires, the target sample size was set approximately 20% higher, anticipating a low response rate. Inclusion criteria were voluntary participation, residence in the Republic of Serbia, and the ability to understand and use the Serbian language. Respondents who attempted to complete the questionnaire more than once or provided incomplete answers were excluded from the analysis.

Only respondents who had used antibiotics to treat UTIs in the past year answered items regarding real behaviour related to antibiotic use. These responses were included in the analysis of the association between intentions and real behaviour.

Data collection

The questionnaire was distributed using the snowball technique via email and social media platforms (*Facebook*, *Viber*, and *Instagram*), with respondents asked to forward it to friends and family. All participants provided informed consent before participation. At the outset, respondents were informed about the study's objectives, the estimated time required for completion, details regarding the principal investigator, and the study location. They were also told that participation was voluntary and that they could withdraw at any time without explanation or penalty. No material or other incentives were offered. This approach facilitated the collection of data from a heterogeneous sample while minimising potential bias associated with participation for personal gain.

To ensure data reliability, the authenticity of responses was verified through the analysis of duplicate entries and monitoring of completion time. Responses that were duplicated or completed in an unusually short period were excluded from further analysis.

Data analysis

The collected data were analysed using IBM SPSS Statistics version 20. Sociodemographic and health characteristics, as well as respondents' attitudes and intentions, were summarised using descriptive statistics (frequencies and percentages for categorical variables, means and standard deviations for numerical variables). Inferential statistical methods were employed to examine group differences and to assess the impact of selected variables on attitudes and intentions. For ease of analysis, the original five-point Likert scale used to measure agreement with statements was collapsed into a three-point scale.

Data distribution was assessed using a standard probability plot and the Kolmogorov–Smirnov test with Lilliefors correction. Categorical variables were compared using the χ^2 test, with adjusted residuals calculated; values > 1.96 or < -1.96 were considered statistically significant. Numerical variables were compared using the Kruskal–Wallis test, followed by the Mann–Whitney U test for

pairwise comparisons. Associations between attitudes, intentions, and specific behavioural variables were further examined using binary logistic regression.

The level of statistical significance was set at $P < 0.05$ in all cases.

Ethical approval

The study protocol was approved by the Ethics Committee of the Faculty of Medicine, University of Niš (approval number 12-1760-1/2-2, issued on February 26, 2024). After collection, the data were kept anonymous and confidential. Data that could reveal the identity of the respondents was removed.

Results

The study included 449 respondents who fully completed the questionnaire. The sample mainly consists of females, mostly of a younger age. The majority of respondents lived in urban areas and had completed a university education. A significant proportion did not possess formal medical training. Most were either students or employed, while a smaller percentage were unemployed or retired. Most were single, and only a few reported chronic diseases (Table 1). A total of 149 respondents (33.2%) reported experiencing symptoms of UTIs in the previous year, of whom 71 (47.7%) used antibiotics as part of their treatment.

Table 1. Basic characteristics of the respondents

		Whole sample	Without prior antibiotic use for UTIs	With prior antibiotic use for UTIs	p value
Sample size, n (%)		449 (100.0)	378 (100.0)	71 (100.0)	
Age, Mean (SD), range; years		31.4 (12.6), 18-80	31.5 (12.7), 18-80	31.3 (11.7), 19-63	0.640*
Gender, n (%)	Female	397 (88.4)	382 (86.8)	69 (97.2)	**0.012****
	Male	52 (11.6)	50 (13.2)	2 (2.8)	
Residency, n (%)	Urban	354 (78.8)	303 (80.2)	51 (71.8)	0.115**
	Rural	95 (21.2)	75 (19.8)	20 (28.2)	
Education level, n (%)	Non-university	191 (42.5)	157 (41.5)	34 (47.9)	0.320**
	University	258 (57.5)	221 (58.5)	37 (52.1)	
Formal medical education, n (%)	Yes	180 (40.1)	156 (41.3)	24 (33.8)	0.239**
	No	269 (59.9)	222 (58.7)	47 (66.2)	
Employment status, n (%)	Employed	187 (41.6)	154 (70.7)	33 (46.5)	0.732**
	Unemployed	47 (10.5)	39 (10.3)	8 (11.3)	
	Retired	11 (2.4)	10 (2.6)	1 (1.4)	

	Student	204 (45.4)	175 (46.3)	29 (40.8)	
Marital status, n (%)	Single	315 (70.2)	270 (71.4)	45 (63.4)	0.174**
	Married	134 (29.8)	108 (28.6)	26 (36.6)	
Self-reported illness, n (%)	Yes	71 (15.8)	57 (15.1)	14 (19.7)	0.326**
	No	378 (84.2)	321 (84.9)	57 (80.3)	

* Mann–Whitney U test, ** χ^2 test, bold values are statistically significant

Attitudes and behavioural intentions regarding antibiotics and their rational use

Most respondents did not consider antibiotics safe for frequent use. This view was widespread among females and those with formal medical training (Table 2). Most also disagreed with the idea that antibiotics should only be used for the duration of symptoms, with notable differences based on gender, medical education, and employment status. Females, respondents with medical training, and students were more likely to support a rational approach to antibiotic use (Table 3). Furthermore, around two-thirds of respondents recognised that missing one or two doses of antibiotics could harm treatment outcomes, with those holding medical qualifications more aware of this risk than other groups (Table 4). Other socio-economic factors did not show statistically significant differences.

Table 2. Attitudes toward the safety of antibiotics by sociodemographic and health characteristics

		Antibiotics are safe medicines and can therefore be used frequently.			
		Disagree	Neutral	Agree	p value
Whole sample, n (%)		335 (74.6)	73 (16.3)	41 (9.1)	
Age, Mean (SD); years		30.7±11.8	33.9±13.9	33.5±15.3	0.245*
Gender, n (%)	Female	302 (76.1)	64 (16.1)	31 (7.8)	**0.022****
	Male	33 (63.5)	9 (17.3)	10 (24.4)	
Residency, n (%)	Urban	262 (74.0)	58 (16.4)	34 (9.6)	0.776**
	Rural	73 (76.8)	15 (15.8)	7 (7.4)	
Education level, n (%)	Non-university	141 (73.8)	35 (18.3)	15 (7.9)	0.474**
	University	194 (75.2)	38 (14.7)	26 (10.1)	
Formal medical education, n (%)	Yes	149 (82.8)	21 (11.7)	10 (5.6)	**0.005****
	No	186 (69.1)	52 (19.3)	31 (11.5)	
Employment status, n (%)	Employed	130 (69.5)	38 (20.3)	19 (10.2)	0.099**
	Unemployed	38 (80.9)	7 (14.9)	2 (4.3)	
	Retired	6 (54.5)	4 (36.4)	1 (9.1)	
	Student	161 (78.9)	24 (11.8)	19 (9.3)	
Marital status, n (%)	Single	238 (75.6)	49 (15.6)	28 (8.9)	0.773**
	Married	97 (72.4)	24 (17.9)	13 (9.7)	
Self-reported illness, n (%)	Yes	52 (73.2)	15 (21.1)	4 (5.6)	0.304**
	No	283 (74.9)	58 (15.3)	37 (9.8)	
UTI	Yes	110 (73.8)	30 (20.1)	9 (6.0)	0.110**
	No	225 (75.0)	43 (14.3)	32 (10.7)	

* Kruskal–Wallis test, ** χ^2 test, bold values are statistically significant

Table 3. Attitudes toward using antibiotics only while symptoms persist by sociodemographic and health characteristics

		Antibiotics should be used only as long as the symptoms last.			
		Disagree	Neutral	Agree	p value
Whole sample, n (%)		356 (79.3)	36 (8.0)	57 (12.7)	
Age, Mean (SD); years		30.7±11.8	31.4±13.6	35.8±15.4	0.162*
Gender, n (%)	Female	315 (79.3)	28 (7.1)	54 (13.6)	**0.045****
	Male	41 (78.8)	8 (15.4)	3 (5.8)	
Residency, n (%)	Urban	284 (80.2)	24 (6.8)	46 (13.0)	0.173**
	Rural	72 (75.8)	12 (12.6)	11 (11.6)	
Education level, n (%)	Non-university	142 (74.3)	16 (8.4)	33 (17.3)	**0.037****
	University	214 (82.9)	20 (7.8)	24 (9.3)	
Formal medical education, n (%)	Yes	162 (90.0)	7 (14.4)	11 (6.1)	**<0.001****
	No	194 (72.1)	29 (10.8)	46 (17.1)	
Employment status, n (%)	Employed	143 (76.5)	15 (8.0)	29 (15.5)	**0.033****
	Unemployed	38 (80.9)	2 (4.3)	7 (14.9)	
	Retired	5 (45.5)	2 (18.2)	4 (36.4)	
	Student	170 (83.3)	17 (8.3)	17 (8.3)	
Marital status, n (%)	Single	254 (80.6)	27 (8.6)	34 (10.8)	0.161**
	Married	102 (76.1)	9 (6.7)	23 (17.2)	
Self-reported illness, n (%)	Yes	57 (80.3)	6 (8.5)	8 (11.3)	0.921**
	No	299 (79.1)	30 (7.9)	49 (13.0)	
UTI	Yes	125 (83.9)	10 (6.7)	14 (9.4)	0.225**
	No	231 (77.0)	26 (8.7)	43 (14.3)	

* Kruskal–Wallis test, ** χ^2 test, bold values are statistically significant

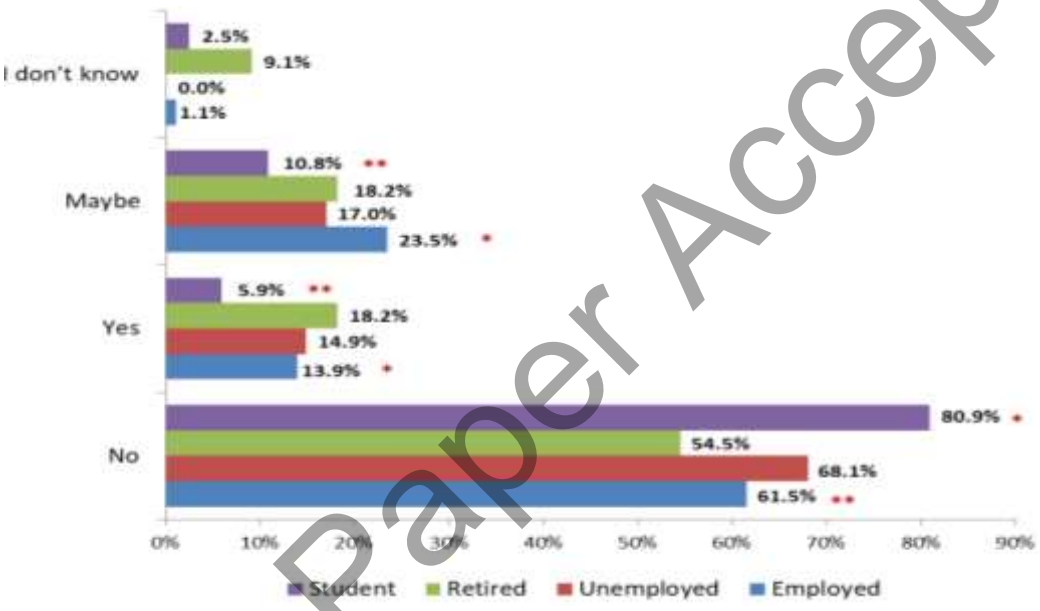
Table 4. Attitudes toward the impact of skipping one or two antibiotic doses on treatment outcomes by sociodemographic and health characteristics

		Skipping one or two doses of antibiotics affects treatment outcomes.			
		Disagree	Neutral	Agree	p value
Whole sample, n (%)		73 (16.3)	73 (16.3)	303 (67.5)	
Age, Mean (SD); years		31.6±13.3	32.8±12.5	31.1±12.4	0.763*
Gender, n (%)	Female	66 (16.6)	59 (14.9)	272 (68.5)	0.085**
	Male	7 (13.5)	14 (26.9)	31 (59.6)	
Residency, n (%)	Urban	54 (15.3)	57 (16.1)	243 (68.6)	0.497**
	Rural	19 (20.0)	16 (16.8)	60 (63.2)	
Education level, n (%)	Non-university	31 (16.2)	34 (31.1)	126 (66.0)	0.741**
	University	42 (16.3)	39 (15.1)	177 (68.6)	
Formal medical education, n (%)	Yes	31 (17.2)	16 (8.9)	133 (73.9)	**0.002****
	No	42 (15.6)	57 (21.2)	170 (63.2)	
Employment status, n (%)	Employed	36 (19.3)	33 (17.6)	118 (63.1)	0.419**
	Unemployed	6 (12.8)	10 (21.3)	31 (66.0)	
	Retired	3 (27.3)	1 (9.1)	7 (63.6)	
	Student	28 (13.7)	29 (14.2)	147 (72.1)	
Marital status, n (%)	Single	54 (17.1)	45 (14.3)	216 (68.6)	0.200**
	Married	19 (14.2)	28 (20.9)	87 (64.9)	
Self-reported illness, n (%)	Yes	11 (15.5)	13 (18.3)	47 (66.2)	0.874**
	No	62 (16.4)	60 (15.9)	256 (67.7)	
UTI	Yes	27 (18.1)	20 (13.4)	102 (68.5)	0.447**
	No	46 (15.3)	53 (17.7)	201 (67.0)	

* Kruskal–Wallis test, ** χ^2 test, bold values are statistically significant

Approximately one in ten respondents (10.2%) expressed an intention to use antibiotics for UTIs without consulting a doctor beforehand. Meanwhile, 16.9% reported they might consider using

them, and the majority (71.1%) stated they would not. In addition, 1.8% of respondents were uncertain about whether they would use antibiotics without consulting a doctor. This intention was significantly linked to age (p = 0.001) and employment status (p = 0.001). Further analysis with the Mann–Whitney U test for pairwise comparisons showed a significant difference in the mean age of respondents who would not use antibiotics (30.1 years) compared to those who would (35.4 years) or might (35.1 years). There was also a notable difference between those who might consider using them (35.1 years) and those who did not know (28.6 years). The analysis of standardised residuals indicated that students were more inclined to express an intention not to use antibiotics without prior consultation for UTIs. In contrast, employed respondents more often expressed an intention to use or might consider using antibiotics (Figure 1).



* Adjusted Residuals > 1.96; ** Adjusted Residuals < -1.96

Figure 1. Intention to self-medicate with antibiotics by employment status

Most respondents (96.9%) indicated they would continue taking antibiotics as advised by their doctor, even after feeling better. However, about a quarter (25.8%) said they would save leftover antibiotics for potential future use if UTI symptoms reoccurred, while 17.1% stated they would dispose of the remaining medication after treatment. Only a small proportion (9.8%) expressed an intention to share antibiotics with friends or relatives. These intentions varied significantly with education level (Figure 2) and formal medical training (Figure 3).

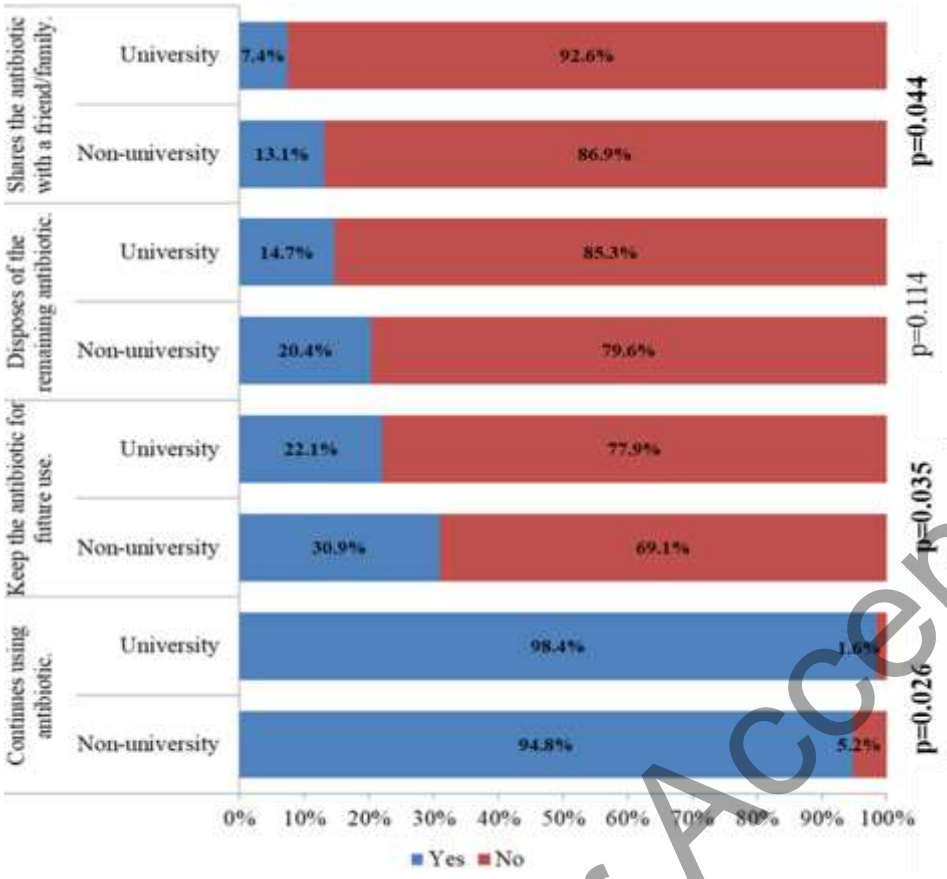


Figure 2. Intentions regarding antibiotic use according to education level

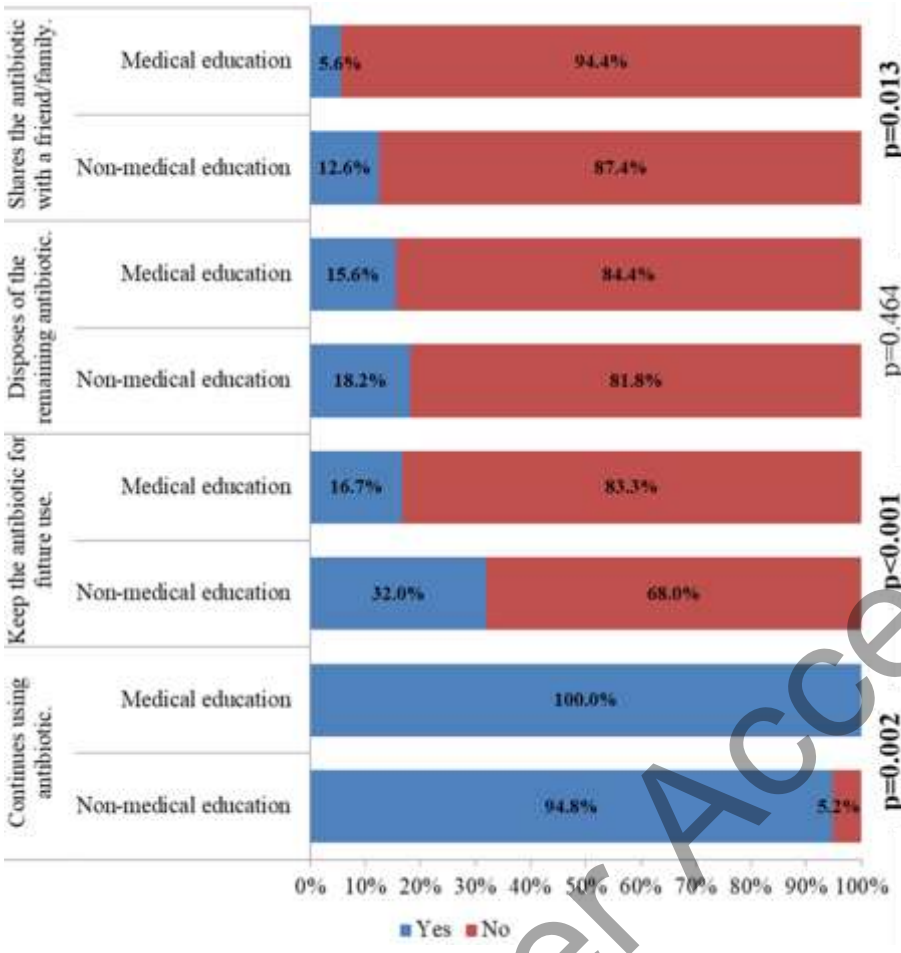


Figure 3. Intentions regarding antibiotic use according to formal medical education

Real behaviour and its association with attitudes and intentions

Only respondents who reported using antibiotics to treat UTIs (n = 71) answered questions concerning actual behaviour related to antibiotic use and were included in the analysis of the association between intentions and actual behaviour. The majority of respondents (90.1%) reported taking antibiotics on time. One-quarter of respondents (25.4%) continued taking antibiotics until the entire pack was finished, and 69.0% adhered to the duration prescribed by their doctor. In comparison, 5.6% took antibiotics only for the duration of their symptoms. The majority of respondents who had used antibiotics (83.1%) reported doing so based on a doctor's recommendation, while 16.9% practised self-medication. Binary logistic regression revealed that respondents who expressed an intention to use antibiotics without consulting a doctor (those who answered "yes" or "maybe") had 21.45 times higher odds (C.I. = 2.58–178.15, p = 0.005) of engaging in self-medication compared to those who reported they would not use antibiotics without consultation or who did not know whether they would use them. No statistically significant differences were observed between patients' attitudes that antibiotics should be used only while

symptoms last and their actual duration of use (p = 0.481), nor between patients' intentions if they felt better and their actual use duration (p = 0.081-0.796). Similarly, no significant differences were found between attitudes regarding missed doses and their impact on treatment outcomes and adherence to the antibiotic schedule (p = 0.431).

Discussions

Respondents in our study generally did not consider antibiotics safe for frequent use, nor did they support their use limited only to the duration of symptoms. A significant proportion also recognised that skipping prescribed doses could compromise treatment outcomes. These attitudes were more pronounced among women, respondents with university education or students, and people with medical education, while other socio-economic factors did not show a significant impact. Similar patterns have been observed in previous studies: women (38,39) and healthcare workers (40) expressed more critical attitudes and demonstrated better knowledge regarding antibiotics. A study from Tanzania showed that the average knowledge score of medical students was significantly higher than that of non-medical students, indicating a better understanding of antibiotics and self-medication among medical students (41). Conversely, socioeconomic status has not been shown to consistently exert an effect on attitudes and behaviours regarding antibiotic use. These results, consistent with the literature, suggest that education and gender play a more critical role than broader socio-economic factors, which requires targeted educational interventions tailored to the general population, as well as to non-health sciences and health sciences professionals.

Respondents' intention to use antibiotics for UTIs without prior consultation reflects a clear tendency toward self-medication in the general population. Similar patterns have been observed internationally. For example, Widayati et al. reported that 58% of respondents declared an intention to self-medicate with antibiotics (42). Another study found that the overall frequency of having such an intention was 54.1% (43). In contrast, a third study indicated that nearly two-thirds (63.3%) of participants expressed an intention to self-medicate with antibiotics in the future (44). Our findings suggest that employed respondents are more likely to intend to self-medicate, which may be related to their age group and the demands of multiple work commitments, as well as long waiting times at medical offices. Supporting this, another study confirmed that individuals younger than 40 years are more prone to self-medication with

antibiotics (45). Consistent with this, a study from China reported that adults aged 30–44 years had a significantly higher likelihood of inappropriate antibiotic use without medical consultation, further emphasising the role of working-age adults as a particularly vulnerable group (46). Conversely, students and younger respondents in our sample showed a greater tendency to avoid antibiotic use without consultation, likely reflecting better access to education and fewer professional responsibilities. It is important to note, however, that some of these students may have a medical background, which could contribute to their more cautious approach. This is supported by a study from Tanzania, which reported a significantly higher incidence of self-medication among non-medical students compared to medical students, highlighting the role of medical knowledge in rational antibiotic use (41). Since we did not specifically assess the field of study, the influence of medical education on self-medication behaviour in this subgroup remains unclear and warrants further investigation.

Most respondents expressed their intention to complete the full course of antibiotics as prescribed by a doctor, demonstrating responsible antibiotic use. This behaviour varied with education level and medical training, with those possessing higher education or formal medical training showing better adherence. Similar findings have been reported in other studies, indicating that higher education is often linked to greater awareness of proper antibiotic use and improved compliance (47). Notably, our respondents seemed more capable of articulating correct intentions regarding antibiotic use compared to findings from Albania (48), where 69.0% of participants followed prescription instructions, and Romania (38), where only 57.3% of respondents recognised that antibiotic treatment should not be discontinued once symptoms subside, and 83.32% of respondents agreed with the statement that they use antibiotics according to the instructions for use.

Although most respondents indicated an intention to complete the prescribed course of antibiotics, approximately one-quarter indicated that they would save leftover antibiotics for future use or take them based on symptoms, and a tiny number would share medication with friends or relatives. These findings align with previous studies: three studies (two from Australia and one from Sweden, totalling 1,680 participants) found that 13% of respondents retained leftover antibiotics, with the percentage being lower in Sweden (6%) than in Australia (17%) (49). In our study, however, the proportion of respondents intending to save antibiotics for future use was notably higher (25.8%), suggesting that the practice of storing antibiotics is relatively more common in our population. In Romania, as many as 52.7% of respondents reported that

they always try to have antibiotics at home, reflecting widespread irrational use and storage of these medications (38). Such intentions may stem from a lack of awareness regarding the risks of improper antibiotic use and antimicrobial resistance. Additionally, long waiting times for medical consultations and high workload, particularly among employed individuals, may encourage keeping antibiotics "just in case" as a practical solution. Overall, these results indicate that medical education positively influences responsible antibiotic use, particularly regarding adherence to initial treatment. However, improper practices such as storing or sharing antibiotics still occur, especially among those without formal medical training. These findings indicate that although there is a high level of accountability, the risk of inappropriate antibiotic use still exists, especially among groups with lower levels of education.

The proportion of respondents who reported that they would discard leftover antibiotics after completing therapy reflects awareness of the potential risks associated with improper disposal. Conversely, only a small number indicated a willingness to share antibiotics with friends or relatives, which represents a positive indicator of responsible behaviour and a preventive factor against antimicrobial resistance. These findings align with previous studies, which show that most individuals are not inclined to share antibiotics (38). However, a segment of the population still engages in this practice, posing a potential risk.

The analysis indicates that individuals who consider self-medicating with antibiotics are much more likely to follow through. This finding suggests that intentions and attitudes may serve as reliable predictors of risky behaviour. In contrast, other factors, such as treatment duration and adherence to doctor recommendations, were not significantly associated with these attitudes. This suggests that while intention is a strong predictor of the decision to initiate self-medication, it does not necessarily influence how individuals manage antibiotic therapy once it has been started. In other words, a person may intend to self-medicate but still follow proper treatment duration or adhere to prescribed guidelines when using antibiotics. This finding highlights the complexity of antibiotic use behaviours. It indicates that interventions aimed at improving rational antibiotic use should not only target intentions or general attitudes but also provide practical guidance on correct administration, adherence, and completion of prescribed courses. Additionally, external factors such as access to healthcare, previous experiences with antibiotics, and trust in healthcare professionals may mediate adherence behaviours independently of expressed attitudes or intentions.

Recommendations for Practice

Based on our findings, measures should be introduced to promote responsible antibiotic use and reduce the risks of self-medication and improper storage, particularly in the context of UTIs. Patient education must be intensified, with pharmacies and healthcare facilities providing clear guidance on completing therapy, the risks of storing or reusing antibiotics, and the dangers of sharing medications. Educational materials, such as brochures, posters, or digital content, should target groups at higher risk, including employed adults and individuals with lower levels of education. For employed respondents, short video tutorials or online advice tailored to work schedules may be practical. At the same time, students and younger individuals can be reached through university programmes emphasising proper storage and avoiding the sharing of antibiotics.

Pharmacies should enhance patient counselling on dosage, therapy duration, and the safe disposal of unused medications, including providing collection points for proper disposal. Access to over-the-counter antibiotics should be limited through stricter sales controls and enforcement of prescription drug regulations. Combining education with behavioural monitoring helps identify at-risk groups and allows targeted support. Increasing awareness of antimicrobial resistance and the long-term effects of improper antibiotic use is vital for a systemic approach to encouraging responsible antibiotic use.

Limitations and Strengths

This study has several limitations. Self-reported data may be affected by recall or social desirability bias, especially regarding antibiotic use. The online survey format could have excluded individuals with limited internet access or digital skills, reducing sample heterogeneity. Recruitment through specific networks may have introduced selection bias, and the low number of elderly participants may reflect the difficulties they face in completing online questionnaires. Finally, online surveys tend to attract respondents with higher education, consistent with the findings of this study.

Despite these limitations, the study also has notable strengths. The survey was developed through multiple stages, including topic development, focus groups, and cognitive pretesting, which enhanced the validity and reliability of the instrument. Inclusion of a large and diverse group of participants provided data across different demographic and educational profiles, increasing the informative value of the results. Finally, the study offers valuable insights into

attitudes, intentions, and behaviours related to antibiotic use in Serbia, providing a foundation for future public health interventions and patient education initiatives.

Conclusion

The findings revealed that while most respondents followed doctor recommendations and recognised the risks of incorrect antibiotic use, a significant proportion engaged in self-medication or intended to store leftovers for future use. Such intentions and behaviours were more common among younger respondents, those who were employed, had a non-university education, and lacked formal medical education. Notably, respondents who expressed an intention to use antibiotics without consulting a doctor were over 20 times more likely to engage in self-medication.

These results emphasise a persistent gap between attitudes, intentions and practice, highlighting the need for targeted interventions. Stronger public education campaigns are advised to raise awareness about the risks of self-medication, the importance of completing prescribed antibiotic courses, and the dangers of sharing or storing leftover medications. Moreover, healthcare professionals, especially pharmacists and primary care doctors, should actively counsel patients on rational antibiotic use. Policies enforcing prescription-only access to antibiotics and incorporating educational programmes into community health initiatives could further reduce inappropriate antibiotic use and help limit antimicrobial resistance in Serbia.

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