Knowledge about Antibiotics and Antibiotic Resistance among the Adult Population of Rural Areas in Tamil Nadu: A Cross-Sectional Study

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Abstract:

Background: Antibiotics are crucial in medicine, but rising resistance threatens their efficacy. Public awareness is vital. Globally, antibiotic resistance could cause 10 million deaths annually by 2050 if unchecked. India faces a significant burden, especially in drug-resistant tuberculosis. Varied awareness (5% to 70%) exists nationwide. Over-the-counter antibiotic access worsens misuse. Inappropriate prescriptions, even among professionals, compound the issue. With limited research on rural Tamil Nadu, this study assesses antibiotic knowledge and resistance, providing insights for targeted interventions to counter misuse and resistance.

Methods: This cross-sectional study, conducted by the Department of Community Medicine, assessed antibiotic knowledge and resistance awareness among rural adults (≥18) in Tamil Nadu, India. A sample of 384 was determined using estimated prevalence (50%), confidence level (95%), and margin of error (5%). Multistage random sampling selected 10 villages, followed by systematic random sampling of 39 households per village. Structured questionnaires with 10 questions scored as aware (2), don't know (1), or not aware (0) covered antibiotic-related knowledge, usage, and resistance awareness. Responses were scored for "adequate knowledge" (score ≥ 10) or "inadequate knowledge" (score < 10). SPSS 20.0 utilized descriptive and inferential statistics (Chi-squared, Student's t-test) for analysis.

Results: In present study a total of 384 participants were enrolled. Gender distribution shows that 54.7% are male, while 45.3% are female. A common misconception exists, with 64.1% believing antibiotics can be stopped when feeling better. Approximately 39.8% of respondents possess adequate knowledge, comprising 153 individuals. On the other hand, 60.2% of respondents have a perceived lack of adequate knowledge, totalling 231 individuals. Socioeconomic status highlights disparities, with 29.4% of the upper class having inadequate knowledge, compared to 70.6% of those with adequate knowledge (p < 0.0001).

Conclusion: The findings underscore the urgent need for targeted educational campaigns to rectify misconceptions and enhance awareness. These results mirror global concerns, highlighting the imperative of comprehensive initiatives to promote responsible antibiotic use.

Keywords: Antibiotics, Antibiotic Resistance, Knowledge, Awareness, Rural Population.

Introduction

Antibiotics, essential therapeutic agents in modern medicine, have revolutionized the treatment of bacterial infections [1]. However, the escalating global challenge of antibiotic resistance jeopardizes the efficacy of these medications and necessitates a comprehensive understanding of prudent antibiotic use [2]. A cornerstone of effective antibiotic stewardship lies in public awareness and education, aimed at curbing misuse and mitigating the rise of antibiotic-resistant pathogens [3].

Globally, antibiotic resistance presents an alarming crisis, with the World Health Organization (WHO)

emphasizing its potential to revert medicine to an era devoid of effective infection control [4]. A WHO report highlights that antibiotic resistance contributes to an estimated 700,000 deaths annually, and this toll could rise to 10 million deaths annually by 2050 if no effective interventions are enacted [4,5]. India, with its vast population and intricate healthcare landscape, faces a disproportionate burden of antibiotic resistance [6]. A recent study revealed that India has the highest burden of drug-resistant tuberculosis globally, exemplifying the gravity of this issue within the Indian context [7]. Within India, public awareness of antibiotics and resistance remains variable (5% to 70%), with studies illustrating substantial knowledge gaps and misconceptions [8,9,10]. A study conducted in urban India reported that a significant proportion of respondents were unaware of the meaning of antibiotic resistance, reflecting a pressing need for robust educational initiatives [9]. Furthermore, the practice of over-the-counter antibiotic dispensing, prevalent due to factors such as self-medication and inadequate regulation, exacerbates the issue of antibiotic misuse [10].

Among healthcare professionals in India, a study assessing prescription practices demonstrated that nearly half of antibiotic prescriptions were deemed inappropriate, with broad-spectrum antibiotics often prescribed without due diligence [10]. This highlights the critical importance of enhancing knowledge and practice patterns among medical practitioners to address the complex challenge of antibiotic resistance [11,12,13].

In light of these pressing concerns and the dearth of literature exploring antibiotic knowledge and resistance within the rural populace of Tamil Nadu, this cross-sectional study aims to elucidate the levels of awareness, understanding, and practices concerning antibiotics and antibiotic resistance.

By delineating prevailing knowledge deficits and misperceptions, this study seeks to provide a foundational framework for targeted interventions and health education programs aimed at fostering responsible antibiotic utilization and mitigating the encroachment of antibiotic resistance in these underserved rural communities.

Materials and Methods

Study Design and setting

This cross-sectional study was conducted under the aegis of the Department of Community Medicine, which provided the scholarly foundation and research infrastructure for the meticulous exploration of antibiotic knowledge and antibiotic resistance awareness within the adult population (aged 18 years and above) of rural Tamil Nadu, India.

Sample Size Calculation and sampling technique

A meticulously calculated sample size was determined via a meticulous process, accounting for estimated prevalence rates (50%, as lack of studies in the rural areas in Tamilnadu), effect size, desired confidence level, and precision. Based on a confidence level of 95% and a margin of error of 5%, the final sample size was conservatively established at 384.The multistage random sampling technique entailed the random selection of villages(10 villages), followed by the systematic random sampling of households (39 households) within those villages. This approach facilitated an unbiased and representative participant selection, underpinning the robustness of the study's findings.

Data Collection

Data were meticulously gathered through structured questionnaires, purposefully designed to encompass a comprehensive spectrum of antibiotic-related knowledge, usage practices, and awareness of antibiotic resistance. This instrument was carefully constructed, taking into consideration established frameworks and validated measures. The questionnaire included 10 meticulously formulated questions, each focused on distinct facets of antibiotic resistance awareness.

Scoring Methodology

Each questionnaire item was meticulously assigned a numerical value based on response categories: aware (2), don't know (1), and not aware (0). Cumulative scores for each participant were computed, facilitating a quantitative categorization of "adequate knowledge" (score $\geq$ 10) and "inadequate knowledge" (score < 10).

Statistical Analysis

The amassed data underwent meticulous statistical scrutiny using SPSS 20.0. Descriptive statistics were employed to summarize socio-demographic characteristics, while inferential statistical methods, including Chi-squared test and Student's t-test, were applied to discern associations between variables.

Ethical Considerations

The study was conducted in strict adherence to ethical principles. Ethical approval was secured from the Institutional Review Board and Ethics Committee. Informed consent was garnered from each participant, safeguarding their autonomy and rights throughout the study.

Results

In present study a total of 384 participants were enrolled. Gender distribution shows that 54.7% are male, while 45.3% are female. Age distribution reveals that the majority falls within the 21-40 age

range (41.9%), followed by 28.1% in the 41-60 range, 16.9% below the age of 20, and 13.0% above 60, with a mean age of 39.21 ± 18.36 years. In terms of religion, 88.0% identify as Hindu, 7.6% as Muslim, and 3.9% as belonging to other religious categories. Socioeconomic status is distributed among the upper class (22.1%), upper and lower middle classes (43.8%), and upper lower and lower classes (33.9%). Education levels vary, with 18.2% being illiterate, 23.2% having completed primary or middle school, 25.5% attaining a high school or secondary school education, and 33.1% holding graduate degrees or higher (Table 1).

Table 1: Demographic characteristics of the study participants (N=384).

Variables	Frequency	%
Gender		
Male	210	54.7
Female	174	45.3
Age group (in years)		
<20	65	16.9
21-40	161	41.9
41-60	108	28.1
>60	50	13.0
Mean age	39.21±18.36	
Religion		
Hindu	338	88.0
Muslim	29	7.6
Others	15	3.9
Socioeconomic status		
Upper class	85	22.1
Upper and Lower middle	168	43.8
Upper lower and Lower	130	33.9
Education		
Illiterate	70	18.2
Primary/Middle school	89	23.2
High school/Secondary school	98	25.5
Graduate and above	127	33.1

The data reveals varying levels of knowledge and beliefs about antibiotics and resistance within the surveyed population. While 33.6% understand the importance of avoiding antibiotics without a doctor's prescription, 45.1% recognize their ineffectiveness against viral infections. A common misconception exists, with 64.1% believing antibiotics can be stopped when feeling better. Concerns about antibiotic-resistant bacteria spreading between people are shared by 53.6%, and 46.6% grasp the challenges of treating resistant infections. A significant portion, 41.4%, acknowledges that unnecessary use can reduce future efficacy. Misunderstandings persist, as 37.2% think antibiotics eliminate normal body bacteria. Hospital and community reservoirs of resistant bacteria are acknowledged by 31.0%. Awareness about red-line marked medications is limited (24.0%). A global health concern is recognized by 21.1%, indicating the need for targeted education on antibiotic use and resistance(Table 2).

Table 2: Knowledge about antibiotics and its resistance among study participants (N=384).

Knowledge about antibiotics and its resistance	Frequency (%)		
Using antibiotics without a registered medical doctor's prescription is not recommended.	129 (33.6%)	171 (44.5%)	84 (21.9%)
Antibiotics are not suitable for treating viral infections like common cold, influenza, and dengue.	173 (45.1%)	124 (32.3%)	87 (22.7%)
Antibiotics can be stopped as one starts to feel better.	246 (64.1%)	57 (14.8%)	81 (21.1%)
Antibiotic resistant bacteria can spread from person to person, raising concerns.	206 (53.6%)	90 (23.4%)	88 (22.9%)
Antibiotic resistant infections are more difficult to treat and more expensive to treat than antibiotic-sensitive infections.	179 (46.6%)	74 (19.3%)	131 (34.1%)
Unnecessary use of antibiotics can reduce their efficacy for future treatment.	159 (41.4%)	97 (25.3%)	128 (33.3%)

Antibiotics can kill the bacteria that are usually present in our body.	143 (37.2%)	83 (21.6%)	158 (41.1%)
Hospitals and communities may harbor antibiotic resistant bacteria.	119 (31.0%)	100 (26.0%)	165 (43.0%)
Medications marked with a red line on their strip should only be consumed under a doctor's supervision.	92 (24.0%)	89 (23.2%)	203 (52.9%)
The declining effectiveness of antimicrobial drugs is a global health concern.	81 (21.1%)	131 (34.1%)	172 (44.8%)

The participants were labelled having adequate knowledge if a median score of 10 or more and a score of less than 10 was considered inadequate knowledge. Approximately 39.8% of respondents possess adequate knowledge, comprising 153 individuals. On the other hand, 60.2% of respondents have a perceived lack of adequate knowledge, totaling 231 individuals(Figure 1).
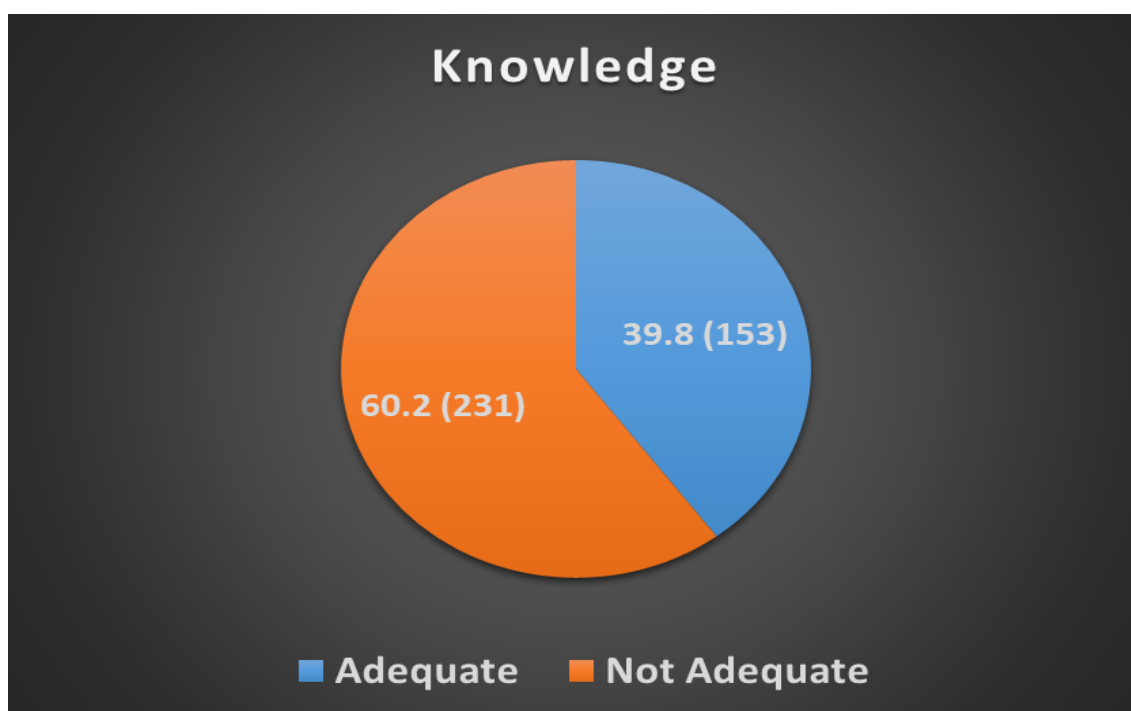

Figure 1: Participants knowledge status based on median score (N=384).

Gender differences are notable, with 49.5% of males and 73.0% of females having inadequate knowledge. Significant variations are seen across age groups (p = 0.147), religions (p = 0.096), and socioeconomic statuses (p < 0.0001). Hindus have 58.9% inadequate knowledge, while Muslims and Others have 79.3% and 60.0%, respectively. Socioeconomic status highlights disparities, with 29.4% of the upper class having inadequate knowledge, compared to 70.6% of those with adequate knowledge (p < 0.0001). Similar trends emerge in education, with illiterate individuals at 75.7% inadequate knowledge, primary/middle school at 73.0%, high school/secondary school at 56.1%, and graduates at 45.7% (all p < 0.0001).This analysis underscores significant knowledge gaps across demographics, emphasizing the need for targeted education to bridge these gaps and enhance overall understanding (Table 3).

Table 3: Association of demographic characteristics with the inadequate knowledge among study participants (N=384)

Variables	Knowledge Inadequate		Knowledge Adequate		P value
	Frequency	%	Frequency	%	
Gender					
Male	104	49.5	106	50.5	<0.0001
Female	127	73.0	47	27.0	
Mean age (in years)	41.43±20.62		38.56±17.76		0.147
Religion					
Hindu	199	58.9	139	41.1	0.096

Muslim	23	79.3	6	20.7	
Others	9	60.0	6	40.0	
Socioeconomic status					
Upper class	25	29.4	60	70.6	<0.0001
Upper and Lower middle	113	67.3	55	32.7	
Upper lower and Lower	92	70.8	38	29.2	
Education					
Illiterate	53	75.7	17	24.3	<0.0001
Primary/Middle school	65	73.0	24	27.0	
High school/Secondary school	55	56.1	43	43.9	
Graduate and above	58	45.7	69	54.3	

Discussion

In our study approximately 39.8% of respondents possess adequate knowledge, comprising 153 individuals. On the other hand, 60.2% of respondents have a perceived lack of adequate knowledge, totaling 231 individuals. A study conducted by Banerjee et al., observed that a mere 7.7% of participants exhibited satisfactory knowledge [14]. Similarly, study conducted among the general public by Awad et al., revealed a substantial 46% deficiency in knowledge [15].

In our study, a common misconception exists, with 64.1% of participants believing antibiotics can be stopped when feeling better. Analogous trends have been documented in studies by from Kamata et al., Ding et al., Mason et al., and Raupach-Rosin et al, [16-19]. Notably, findings from the WHO multi-country survey underscored that merely 58% of individuals in India were aware that antibiotics should be continued until the prescribed course is completed [20]. This behaviour has the potential to foster the selection of resistant strains, bolstering antibiotic resistance and complicating future treatment efforts. These findings underscore the urgent need for enhanced awareness campaigns and the promotion of prudent antibiotic practices to counteract the rise and dissemination of antibiotic resistance.

In our study, 45.1% of participants recognize their ineffectiveness against viral infections. Nepal et al., conducted a study wherein 94.1% of respondents acknowledged the utility of antibiotics in killing germs [21]. Moreover, it was revealed that 30.8% of participants held the belief that antibiotics are universally effective against all types of germs. Study conducted by Agarwal et al., indicated that 45.9% of individuals believed antibiotics could be employed to combat any form of microbial infection [6]. Study by Al-Shibani et al., found that participant understanding regarding antibiotics' application against bacteria or viruses was unclear, as only 38% correctly recognized antibiotics' usage for bacterial infections [22]. Knowledge concerning antibiotics has been explored across diverse geographical areas yielding a congruent outcome as suggested in the studies by Broniatowski et al.,

Mazińska et al., and André et al., and have consistently reveal a shared challenge wherein individuals frequently conflate bacteria and viruses while remaining uninformed about antibiotics' inefficacy against viruses [13,23,24]. This confusion may stem from limited clarifications provided during medical consultations, wherein patients often receive inadequate information about the nature of their infection, whether bacterial or viral [25]. Concurrently, healthcare practitioners rarely communicate the presence of viral infections that do not warrant antibiotic intervention, thereby contributing to this knowledge gap.

Experts predict that around 10 million individuals could succumb annually by 2050 due to antimicrobial resistance (AMR). In 2010, India emerged as the globe's largest consumer of antibiotics for human illnesses, with a staggering consumption of 12.9 x 10^9 units (equivalent to 10.7 units per person) [26].

In our study, antibiotic resistance as a global health concern was recognized by 21.1% of participants, indicating the need for targeted education on antibiotic use and resistance.In a similar study by Agarwal et al., a lack of knowledge concerning antibiotic resistance was observed, with only 15.5% of participants recognizing the term antimicrobial resistance [6]. Regarding awareness of antibiotic resistance, our findings align with studies conducted in André et al., and Kim et al, [13,27]. A research study conducted by Princeton University indicated a 36% surge in antibiotic consumption between 2000 and 2010, with BRICS countries—Brazil, Russia, India, China, and South Africa, contributing to 76% of this escalation [28].

In our study, 75.7% of illiterate participants had inadequate knowledge while 45.7% of graduates at had inadequate knowledge (all p < 0.0001). Similar trends for education emerge in the study by Banerjee et al., where graduates displayed commendable knowledge levels for antibiotics as compared to illiterate ones [14]. Importantly, studies by Nepal et al., Mazińskaet al., and Vallin et al., reinforce the association between higher educational attainment and improved attitudes towards antibiotics [21,24,29]. Similarly, studies by

Napolitano et al., and Kamata et al., suggests a correlation between lower educational levels and reduced knowledge about antimicrobial resistance [16,30]. This underscores the positive relationship between higher education and a more positive disposition towards responsible antibiotic use. By 2010, the per capita usage of carbapenem, a crucial antibiotic for treating severe infections like sepsis, urinary tract infections, ventilator-associated pneumonia, and post-surgical infections, had surged to over 10 million standard units. Notably, over-the-counter sales of carbapenems in India are among the highest globally, contributing to the rise in carbapenem resistance among Gram-negative bacteria such as E. coli, Klebsiella, Pseudomonas aeruginosa, and Acinetobacter spp. [28,31]

Limitations

The study's design prevents establishing causality, self-reported data might introduce biases, and the findings may not be generalizable beyond rural areas. Reliance on structured questionnaires might not capture nuances, and potential selection bias from the sampling method could affect outcomes. These limitations should be considered when interpreting the results and planning future research.

Conclusion

In summary, this cross-sectional study illuminates the concerning gaps in knowledge surrounding antibiotics and antibiotic resistance within rural Tamil Nadu. The findings underscore the urgent need for targeted educational campaigns to rectify misconceptions and enhance awareness. These results mirror global concerns, highlighting the imperative of comprehensive initiatives to promote responsible antibiotic use. Collaborative efforts among stakeholders, including healthcare professionals and policymakers, are vital to address this escalating public health threat. The study contributes to the foundation for future interventions and emphasizes the ongoing importance of preserving antibiotic efficacy through informed practices and sustained vigilance.

References

1. Davis M, Whittaker A, Lindgren M, Djerf-Pierre M, Manderson L, Flowers P. Understanding media publics and the antimicrobial resistance crisis. Glob Public Health.2018;13:1158-68.
2. Zajmi D, Berisha M, Begolli I, et al. Public knowledge, attitudes and practices regarding antibiotic use in Kosovo. Pharm Pract (Granada).2017;15:827.
3. Jose J, Jimmy B, Alsabahi AG, Al Sabei GA. A study assessing public knowledge, belief and behavior of antibiotic use in an Omani population. Oman Med J.2013;28:324-30.
4. WHO Global Strategy for Containment of Antimicrobial Resistance. Available from: https://www.who.int. [Last accessed on 2023 Oct 26].
5. Nair M, Tripathi S, Mazumdar S, et al. Knowledge, attitudes, and practices related to antibiotic use in PaschimBardhaman District: A survey of healthcare providers in West Bengal, India. PLoS One. 2019;14:e0217818.
6. Agarwal S, Yewale VN, Dharmapalan D. Antibiotics use and misuse in children: A knowledge, attitude and practice survey of parents in India. J ClinDiagn Res. 2015;9:C21-4.
7. Parkunan T, Ashutosh M, Sukumar B, et al. Antibiotic resistance: A cross-sectional study on knowledge, attitude, and practices among veterinarians of Haryana state in India. Vet World.2019;12:258-65.
8. Desai AJ, Gayathri GV, Mehta DS. Public's perception, knowledge, attitude and behavior on antibiotic resistance – A survey in Davangere city, India. J Prev Med Holistic Health.2016;2:17-23.
9. Gupta MK, Vohra C, Raghav P. Assessment of knowledge, attitudes, and practices about antibiotic resistance among medical students in India. J Family Med Prim Care.2019;8:2864-9.
10. Chinnasami B, Sadasivam K, Ramraj B, Pasupathy S. Knowledge, attitude and practice of parents towards antibiotic usage and its resistance. Int J ContempPediatr.2016;1:256-61.
11. Islahudin F, Tamezi AM, Shah NM. Knowledge, attitudes and practices about antibiotic use among the general public in Malaysia. Southeast Asian J Trop Med Public Health 2014;45:1474-82.
12. Effah CY, Amoah AN, Liu H, et al. A population-base survey on knowledge, attitude and awareness of the general public on antibiotic use and resistance. Antimicrob Resist Infect Control.2020;9:105.
13. André M, Vernby A, Berg J, Lundborg CS. A survey of public knowledge and awareness related to antibiotic use and resistance in Sweden. J AntimicrobChemother.2010;65:1292-6.
14. Banerjee D, Raghunathan A. Knowledge, attitude and practice of antibiotic use and antimicrobial resistance: a study post the 'Red Line' initiative. Curr Sci. 2018;114(9):1866-77.
15. Awad AI, Aboud EA. Knowledge, attitude and practice towards antibiotic use among the public in Kuwait. PLoS One. 2015;10(2):e0117910.
16. Kamata K, Tokuda Y, Gu Y, Ohmagari N, Yanagihara K. Public knowledge and perception about antimicrobials and

antimicrobial resistance in Japan: a national questionnaire survey in 2017. PLoS One. 2018;13(11):e0207017.

17. Ding L, Sun Q, Sun W, et al. Antibiotic use in rural China: a cross-sectional survey of knowledge, attitudes and self-reported practices among caregivers in Shandong province. BMC Infect Dis. 2015:1–9.

18. Mason T, Trochez C, Thomas R, Babar M, Hesso I, Kayyali R. Knowledge and awareness of the general public and perception of pharmacists about antibiotic resistance. BMC Publ Health. 2018;18(1):711.

19. Raupach-Rosin H, Rübsamen N, Schütte G, Raschpichler G, Chaw PS, Mikolajczyk R. Knowledge on antibiotic use, self-reported adherence to antibiotic intake, and knowledge on multi-drug resistant pathogens - results of a population-based survey in lower saxony, Germany. Front Microbiol. 2019;10:776.

20. World Health Organization (WHO). Antibiotic Resistance: Multi-Country Public Awareness Survey. Geneva: WHO; 2015.

21. Nepal A, Hendrie D, Robinson S, Selvey LA. Knowledge, attitudes and practices relating to antibiotic use among community members of the Rupandehi district in Nepal. BMC Public Health. 2019;19(1):1558.

22. Al-Shibani N, Hamed A, Labban N, Al-Kattan R, Al-Otaibi H, Alfadda S. Knowledge, attitude and practice of antibiotic use and misuse among adults in Riyadh, Saudi Arabia. Saudi Med J. 2017;38(10):1038-44.

23. Broniatowski DA, Klein EY, Reyna VF. Germs are germs, and why not take a risk? Patients' expectations for prescribing antibiotics in an inner-city emergency department. Med Decis Making. 2015;35(1):60–7.

24. Mazińska B, Strużycka I, Hryniewicz W. Surveys of public knowledge and attitudes with regard to antibiotics in Poland: did the European Antibiotic Awareness Day campaigns change attitudes? PLoS One. 2017;12(2):e0172146.

25. World Health Organization (WHO). Antibiotic Resistance: Multi-Country Public Awareness Survey. Geneva: WHO; 2021.

26. Neni WS, Subrain G, Shamshir Khan MSN, et al. Awareness, knowledge, and attitude (AKA) of government secondary school students on the use of antibiotics in Shah Alam, Malaysia. J Public Health. 2020;28:347–55.

27. Kim SS, Moon S, Kim EJ. Public knowledge and attitudes regarding antibiotic use in South Korea. J Korean AcadNurs. 2011;41(6):742–9.

28. Van Boeckel TP, Gandra S, Ashok A, et al. Global antibiotic consumption 2000 to 2010: An analysis of national pharmaceutical sales data. Lancet Infect Dis. 2014;14:742-50.

29. Vallin M, Polyzoi M, Marrone G, Rosales-Klintz S, TegmarkWisell K, StålsbyLundborg C. Knowledge and attitudes towards antibiotic use and resistance - a latent class analysis of a Swedish population-based sample. PLoS One. 2016;11(4):e0152160.

30. Napolitano F, Izzo MT, Di Giuseppe G, Angelillo IF. Public knowledge, attitudes, and experience regarding the use of antibiotics in Italy. PLoS One. 2013;8(12):e84177.

31. Laxminarayan R, Chaudhury RR. Antibiotic resistance in India: Drivers and opportunities for action. PLoS Med. 2016;13:e1001974.