Research Article

Understanding on antibiotics and antibiotic resistance among a group of internet users in Sri Lanka and development of a simple online educational tool

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Abstract

Background: Cooperation of the general public is required to successfully combat the imminent threat of antibiotic resistance (ABR). This study was conducted in two parts; 1) to assess the understanding of internet users on antibiotics and ABR and 2) to develop a simple educational tool to improve the understanding on ABR among internet users.

Methods:
Part 1: A web-based self-administered questionnaire was used to gather data. Open ended questions were analyzed thematically. A knowledge score was calculated from the close-ended questions. 204 responses were analyzed.
Part 2: A web-based tool based on multiple choice questions with answers was developed targeting areas identified as deficient in knowledge through part 1. This was made available through the same social media platforms as part 1 from November 2019. At the time of writing the paper in May 2021, 102 participants had engaged with the developed web-based tool.

Results: Of the 204 respondents to part 1, the majority (183, 89.7%) were undergoing or had completed tertiary education. The average knowledge score out of 10 was 4.9 (SD 2.4) and median score 5 with 114 (55.9%) scoring ≥5 marks. Of the 204 participants, 51 (26.8%) defined antibiotics as a drug that acts against any microorganism and 166 (81.8%) did at least one wrong practice relating to antibiotic use sometimes or always. Only 147 (72.1%) had heard the term ABR. In part 2, among those who used the educational tool, 81 (79.4%) found it helpful while 66 (64.7%) thought the tool will help change their behavior towards antibiotic use.

Conclusion: Overall knowledge and awareness on antibiotics and antibiotic resistance has ample room for improvement among the study group despite their higher educational levels.

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The developed tool received favourable feedback from those who engaged with it but has room for improvement.

Keywords: *Antibiotic resistance, AMR, ABR, general public, online tool*

Introduction

Antibiotic resistance (ABR) is a global public health threat. However, its effects on developing countries are more pronounced.[1] While ABR is a natural phenomenon, inappropriate prescription of antibiotics, antibiotic misuse by patients, weak infection control in health care settings and poor hygiene and sanitation of people lead to increasing rates in emergence and spread of ABR.[2,3] Multidrug resistance and pan-drug resistance where bacteria become resistant to multiple classes of antibiotics or all available antibiotics are also increasingly recognized.[4]

The general public plays a key role in preventing and minimizing the impact of ABR.[2,3,5] The general public contributes to antibiotic misuse by demanding antibiotics, over the counter purchase of antibiotics and not following prescription advice.[2,3] Antibiotics are considered a quick-fix for diseases by many who use them and this behavior is driven by lack of knowledge.[6] While knowledge does not translate 100% to behavioral changes, knowledge on antibiotics and antibiotic resistance do promote appropriate use of antibiotics.[3]

It is therefore worthwhile to evaluate knowledge and practices of the public towards antibiotics, their use and ABR and to have simple tools to educate them. Social media has become very popular among the public. While used most often as a tool for social interactions, social media can be used to gather information from the public and to disseminate knowledge.[7,8] We therefore developed simple online tools for this study and disseminated them through social media.

This study was conducted in two parts.

Part 1 – survey of existing knowledge, attitudes and practices on antibiotics and ABR among internet savvy general public.

Part 2 – developing of a simple educational tool addressing the common misconceptions identified through Part 1.

Methods

Part 1

A self-administered questionnaire was developed in English, pretested among a group of internet users known to the researchers with similar demographics to the expected participants, and translated into Sinhala and Tamil. Content validity was established by two experts. The tool was administered through Google Forms and disseminated via social media platforms Facebook, Twitter and WhatsApp groups. Two hundred and twenty four (224) internet users answered the questionnaire and 20 of them were excluded as they were medical officers. Answers of the remaining 204 were analyzed.

The questionnaire consisted of 29 questions in three sections, 5 for socio-demographic data, 15 questions for knowledge on antibiotics and antibiotic resistance including 5 open ended

questions and another 9 questions for use of antibiotics. Of the 15 questions on knowledge, 10 were used to calculate the knowledge score.

Part 2

Part 2 of the study was designed based on the findings of part 1. A Google Form based educational tool was developed where the participants are able to answer a few questions and get feedback. This was developed in English and translated to Sinhala.

This was disseminated through the same social media platforms as part 1 for anyone interested in updating themselves on antibiotics and antibiotic resistance, from November 2019.

This tool has a few sections. The first section titled "Who are they and what do they do?" is on what micro-organisms are and what infectious diseases are. The second section titled "Bugs that we meet and do us harm" is on what a pathogen is, what an antibiotic is and on the use of antibiotics for the common cold, and the last section titled "When bugs start fighting back" is on antibiotic resistance. All questions were multiple choice in nature. At the end of each section, answers were provided for the participants to reflect upon.

Educational tool in English https://forms.gle/oAjs4XEcJSbhfjqp6 and Sinhala https://forms.gle/x7CJp86uA7MCJWep7 are available for dissemination.

Results

Part 1

Analysis was carried out on 204 responses. Among them, 120 (58.8%) were females and 84 (41.2%) were males. Respondents' ages ranged from 16-56 years (mean 29.4, SD±7 years, median 27 years). All participants had at least secondary education and 183 (89.7%) were either undergoing or had completed tertiary education. The majority (127, 62.3%) had studied in the science stream (Table 1).

Table 1- Socio-demographic information of the participants give n=

		Number	%
1. Gender	Male	84	41.2
	Female	120	58.8
2. Age	<30	145	71.1
	30-39	41	20.1
	40-49	11	5.4
	50-59	7	3.4
	60-69	-	-
3. Education	Never schooled	-	-
	Primary education	-	-
	Secondary education	21	10.3
	Tertiary education (undergoing or completed)	183	89.7
4. Occupation	Unemployed	9	4.4
	Employed	132	64.7
	Student	60	29.4
	Not mentioned	3	1.5
5. Stream of study	Science	127	62.3
	Commerce	11	5.4
	Management	9	4.4
	Arts	16	7.8
	Mathematics	21	10.3
	IT1	8	8.8
	Tourism	1	0.5
	Not mentioned	1	0.5

- No respondents in these groups

Fourteen of 204 (6.9%) participants stated that they did not know what an antibiotic was. The definitions given by the 190 (93.1%) participants who stated they knew what an antibiotic is were thematically analyzed (Table 2.1).

Table 2: Summary of the responses given – what is an antibiotic, what is antibiotic resistance

Category	No	%
2.1 What is an antibiotic? **(n=190)**		
Drugs that act against bacteria	93	48.9
Drugs that act against infections	5	2.6
Drugs that act against microorganisms	51	26.8
Drugs that act against pathogens	1	0.5
Drugs that act against viruses	1	0.5
Drugs that act against viruses and bacteria	2	1.1
Drug that speed recovery from diseases	2	1.1
Drug to prevent infectious diseases	1	0.5
Immune booster	1	0.5
No answer	18	9.5
Unclear/incorrect	15	7.9
2.2 What is antibiotic resistance? **(n=204)**		
Bacteria resist antibiotic	75	36.8
Body rejecting antibiotics	10	4.9
Fight against antibiotic	1	0.5
Humans become resistant	1	0.5
Ineffectiveness of antibiotics	32	15.7
New bacteria emerged against antibiotics	1	0.5
No answer	58	28.4
Resistance against the disease	1	0.5
"Resists antibiotics" not specified	9	4.4
Unclear	4	2.0
Wrong	12	5.9

Of the 169 participants who had given the names of antibiotics, 12 included drugs or substances other than antibiotics as examples. These included antiseptics with antibacterial properties such as povidone iodine and triclosan, a vaccine (anti-rabies vaccine), paracetamol, chlorpheniramine and cetirizine, domperidone, aspirin, insulin, saline, and plants (cannabis and "weniwelgeta"). 157 had stated names of antibiotics. The most frequently identified antibiotics were amoxicillin (n=106), and penicillin (n=70). Of those 32 had named both amoxicillin and penicillin. 89 participants had named additional antibiotics which included erythromycin (named by 24) co-amoxiclav (named by 20) and ciprofloxacin (named by 16). The spellings used by many were incorrect.

When asked if they had heard the term antibiotic resistance, 147 (72.1%) stated yes and 56 (27.5 %) stated no, while one person refrained from answering the question. Answers given to the open-ended question "What do you understand by the term antibiotic resistance?" were categorized into common themes and are given in Table 2.2

Ten questions were given to evaluate knowledge on antibiotics, antibiotic resistance, and antimicrobials. Each correct answer was given one mark and zero for a wrong answer. Neutral and not responded answers were taken as wrong answers.

Seven (3.4%) participants gave correct answers for all questions while 5 (2.5%) got zero total marks. The mean knowledge score out of 10 was 4.9 (SD2.4) while the median was 5 and 114 (55.9%) obtained ≥5 marks. Knowledge scores, categorized into gender, age and education levels are given in Table 3.

On individual questions, it was worth noting that over 50% thought that antibiotics can cure a cold or speed up recovery from a cold, and diarrhoea (Table 4).

Table 3: Summary of the knowledge scores of participants

	n	Score				Difference*	Mean (SD)	Median	Difference^
		=> 5		< 5					
		n	%	n	%				
Female	120	72	60	48	40.0	0.20	5.1 (2.3)	5	0.130
Male	84	42	50	42	50.0		4.6 (2.5)	4.5	
<30 yrs	145	76	52.4	69	47.6	0.08	4.7 (2.4)	5	0.035
>30y yrs	59	38	64.4	21	35.6		5.4 (2.4)	5	
Secondary education only	21	7	33.3	14	66.7	0.04	4.3 (2.5)	3	0.082
In or completed undergraduate education	183	107	58.5	76	41.5		5.0 (2.4)	5	
Total		114	55.9	90	44.1	NA	4.9	5	NA

*Chi-square test, ^ Mann Whitney U test.

Table 4: Summary of the correct and incorrect answers on knowledge about antibiotics and antibiotic resistance

	Correct answer Disagree or strongly disagree		Wrong answer Agree, strongly agree, or not responded	
	n	%	n	%
Antibiotics can cure a cold	87	42.6	117	57.4
Antibiotics can speed up recovery from a cold	57	27.9	147	72.1
Antibiotics can cure any diarrhoea	48	23.5	156	76.5
Antibiotics can speed up recovery from any diarrhoea	43	21.1	161	78.9
Antibiotics are active against viruses	130	63.7	74	36.3
Any antibiotic can cure any bacterial infections	123	60.3	81	39.7
Antibiotics are active against fungi	86	42.2	118	57.8
	Correct answer agree or strongly agree		Wrong answer disagree, strongly disagree, or not responded	
Antibiotics are active against bacteria	185	90.7	19	9.3
Inappropriate use of antibiotics promotes the emergence of antimicrobial resistance	162	79.4	42	20.6
	Correct answer bacteria exhibit resistance to antimicrobial agents		Wrong answer antibiotics show resistance to bacteria or not responded	
How do you understand antibiotic resistance?	154	75.5	50	24.0

Antibiotics had been taken by 86 (42.1%) participants in the 3 months preceding the questionnaire. Antibiotics were taken for respiratory tract infections by 55 participants. Prescriptions from a doctor were used by 67 participants, 18 (8.8% of total respondents) had taken on their own and one person did not give an answer. Of the 18 participants who had taken antibiotics on their own, 14 stated they chose the antibiotics, 2 stated the antibiotics were chosen by pharmacists, one stated it was chosen by a nursing officer and one person did not answer the question.

Considering good practices on antibiotic use, 85 (41.7%) participants stated they always completed the full course of antibiotics, 125 (61.3%) never used leftover antibiotics and 108 (52.9%) never volunteered to give antibiotics that were prescribed to someone else. Ninety nine (48.5%) participants had not requested for antibiotics over the counter (Table 5). However, 166 (81.8%) of the participants had done at least one wrong practice sometimes or always.

Table 5: Summary of the participant's behavior towards antibiotic usage

	Always		Sometimes		Never		Not responded	
Do you complete the full course of antibiotics when given?	85	41.7	97	47.5	21	10.3	1	0.5
? Do you use leftover antibiotics from a previous time	2	1	76	37.3	125	61.3	1	0.5
Do you volunteer to give antibiotics that you were prescribed to someone else?	4	2	91	44.6	108	52.9	1	0.5
Do you ask for over the counter antibiotics from pharmacists?	4	2	106	49	99	48.5	1	0.5
Are you told by the doctors that you are being given antibiotics?	58	28.4	115	56.4	30	14.7	1	0.5

Part 2

A hundred and two participants engaged with the educational tool from November 2019 to May 2021, fifty one participants with the English version and 51 participants with the Sinhala version. Summary of the answers is given in Table 6, along with the qualitative feedback given by the participants. Of the 101 participants, 72 (70.6%) identified antibiotics as drugs that are used to treat any infection while 78 (76.8%) identified antibiotic resistance to occur when bacteria become resistant to antibiotics. At the end of the activity, 81 (79.4%) stated they found the activity helpful and 66 (64.7%) stated that the tool will help them to change their practices.

Table 6: Responses received to the educational tool

Stem	Answers (n=102)	No	%
What is an infectious disease	Diseases caused by microorganism	99	97.1
	Diseases caused due to allergy	2	2.0
What is a micro-organism	Small trees that are nearly invisible	2	2.0
	Organisms that are found in small animas	1	1.0
	Organisms that cannot be seen by the un-aided eye	98	96.1
What are the different types of microorganisms causing infectious diseases	Bacteria	98	96.1
	Viruses	95	93.1
	Fungi	97	95.1
	Protozoa	69	67.6
	Chemicals	4	3.9
	Toxins	8	7.8
What group of micro-organisms causes common cold?	Bacteria	19	18.6
	Viruses	77	75.5
	Fungi	4	3.9
	Don't know/Not sure	2	2.0
What is an antibiotic?	A drug that can be used to treat any infection	20	19.6
	A drug that is used to treat bacterial infections-	72 9	70.6
	A drug that is used to treat viral infections-	1	8.8
	Don't know		1.0
What is meant by "antibiotic resistance"?	Antibiotics become resistant to humans-	2	2.0
	Bacteria become resistant to humans-	6	5.9
	Bacteria become resistant to the antibiotic-	78	76.5
	Humans become resistant to antibiotics -	12	11.8
	Humans become resistant to the bacteria-	4	3.9
Was this activity useful	Yes	81	79.4
	May be	6	5.9
	No answer	4	3.9
Do you think this activity will help you to change your behavior in taking antibiotics	Yes	66	64.7
	May be	18	17.6
	No	3	2.9
	No answer	15	14.7
Qualitative feedback received	" This is so informative. Thanks for giving chance to take part in your questionnaire as well as giving me knowledge. Hope this will do a good to society", "Why are we prescribed antibiotics for fungal infections?" "What are the treatments to other general non-bacterial infections?" "Can't use Amoxilline due to allergy reactions." "Are there anti-viral drugs for viral infections?" "This is useful for many people" "What indicates physicians to prescribe antibiotics for a simple cold?"		

Discussion

This study was designed to evaluate knowledge and practices regarding antibiotics and antibiotic resistance among internet users in Sri Lanka and to develop a simple educational tool based on the findings of the study.

In the first part of this study, we identified that many who believed they knew what an antibiotic was, in fact did not understand the term correctly. They were asked in two instances what is meant by an antibiotic, first through an open-ended question and second in a question with a Likert scale answer. One hundred and ninety (93.1%) stated that they knew what an antibiotic was. In the open-ended question, with thematic analysis, 93 (48.9%) defined antibiotics as drugs that act against bacteria while 51 (26.8%) stated they act against

micro-organisms. In the second question, 185 (90.7%) participants stated that they agreed or strongly agreed with the statement that antibiotics are active against bacteria. However, 74 (36.3%) agreed, strongly agreed or were neutral to the statement that antibiotics are active against viruses. These results indicate that the understanding about the term antibiotic was not comprehensive among the participants. While the term antibiotic is technically used to denote antibacterial agents, for a lay-person, it is not specific like the terms antivirals or antifungals. This linguistic issue may create a misunderstanding among the general public about the term, which can lead to a false belief that antibiotics are active against all micro-organisms. Tracing the origin of the term 'antibiotic', it is evident that the same confusion has been prevalent for a long time.[9]

Similar to many previous studies done in Sri Lanka and elsewhere, among the general public as well as health care workers, the current study identified that many believed antibiotics are active against viruses and that they can cure or speed up recovery from a cold, or other predominantly viral infections. [10,11,12,13]

Reflections on these findings led us to develop an educational tool commencing at the level of a microorganism, infectious disease and an antibiotic rather than starting at the level of antibiotic resistance. Many previous studies and tools which have been developed are aiming at the level of antibiotic resistance than at a more basic level (*https://www.e-bug.eu/, http://www.imperial.ac.uk/medicine/hpru-amr/applications-and-tools/antibiotic-prescribing-game/).*

The overall knowledge score obtained by the study participants as shown in part 1 was also poor. The proportion of participants with ≥5 marks was significantly higher among those who had or were undergoing tertiary education compared to those with only secondary education. However, the distribution of marks as compared through the Mann-Whitney U test was not significantly different between the two groups. This is an expected finding and the differences in the statistics could be due to the relatively low sample sizes. Marks were higher among those aged ≥30 years than the group who were <30 years in age. The proportion obtaining ≥5 marks, while not statistically significantly different, was higher among the older age group too. Overall knowledge on antibiotics and resistance has been almost universally found to be not satisfactory.[10,12,13,14] Given that the majority of our study participants were undergoing or had been through university education, this situation is of concern. The older group who were self-motivated to take this questionnaire are likely to be ones who are keener about the issue, as reflected in the higher knowledge score.

Thematic analysis of the open-ended question stems on antibiotic resistance (Table 2.2), of questions used for the knowledge score (Table 4) and the findings of part 2 highlights that understanding of antibiotic resistance also has room for improvement. The misconceptions on ABR ranged from antibiotics becoming ineffective, body resisting antibiotics to antibiotics resisting bacteria. This shows that overall understanding on antibiotic resistance also needs to be improved among the study participants.

Despite the low overall knowledge, 190 (93.1%) participants stated they knew what an antibiotic was and 147 (72.1%) had heard about antibiotic resistance. However, a number of them named un-related drugs as antibiotics, in addition to giving incorrect definitions of the terms 'antibiotic' and 'antibiotic resistance'. Over confidence about their knowledge of antibiotics motivates frequent use of antibiotics even for self-limiting disease.[15,16]

Inappropriate antibiotic prescription for acute respiratory tract infections is a major problem[17] aggravated by self-administration of antibiotics even for mild respiratory symptom.[18] Consequently, antibiotic resistance has become a challenging issue in the Sri Lankan health sector. Self-medication of antibiotics is known to be a prevalent practice in Sri Lanka.[18] One of the commonest antibiotics listed by the study participants is amoxicillin, which is commonly used for respiratory tract infections in Sri Lanka.[17] Of our study group, most believed that antibiotic use in cold-like illnesses either cures the disease or speeds up recovery, reflecting this trend (Table 4).

In the current study, the majority (166, 81.8%) misused antibiotics at least sometimes or always. While knowledge is not always reflected in practice, lack of knowledge on antibiotics or antibiotic resistance is a probable contributory cause of such misuse.[19] However, our study also identified that prescribers need to improve their communication with patients when antibiotics are prescribed as more than half the participants (n=115:56.4%) stated they are not told of the drugs being prescribed.

While there are some existing tools aimed at improving understanding on antibiotics, it is important to tailor-make educational tools to target gaps in knowledge and understanding of the target population.[20] We therefore developed a tool aimed at the key deficits identified by part 1 of the study. Among those who used the tool, 81 (79.4%) found it helpful while a lesser percentage thought the tool will help them to change their behavior towards antibiotic use. As this was meant to be an educational tool, we did not capture the demographic details of the participants and are unable to comment if the population reached through the tool is similar to the participants of part 1 of the study. The authors hope to develop the tool to be more attractive and to incorporate cultural aspects to make it more interesting to the local community. We aim to translate it to Tamil in the near future.

Conclusion

The results of this preliminary study show that there is room for improvement in knowledge and awareness on antibiotics and antibiotic resistance among internet users in Sri Lanka. Knowledge scores indicate a significant difference in education level and age groups. Lack of awareness of antibiotic usage was highlighted in the study, showing the need for taking appropriate measures to discourage misuse of antibiotics and minimize antibiotic resistance among the Sri Lankan population. The tool developed garnered favourable feedback from those who used it so far and could be developed further as a tool to provide basic education on antibiotics and infections.

Declarations

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Author contributions - RA – tool design for both parts, data collection, analysis and drafting part 2
NE – data analysis and drafting the part 1
PI – tool design for part 1, data collection of part 1 and analysis
OA – tool design for part 2, data collection, approval of final paper
SA - tool design for part 2, data collection, approval of final paper
KRA - tool design for part 2, data collection, approval of final paper
ALT - tool design for part 2, data collection, approval of final paper
VL – study concept, data analysis, editing and approval of paper

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