Self-medication with antibiotics: a national cross-sectional survey in Sri Lanka

Abstract

Background: Antibiotic self-medication is common in low- and middle-income countries. This study aimed to evaluate the Sri Lankan public's knowledge about and attitudes towards antibiotic use and self-medication, and factors associated with self-medication.

Methods: A national cross-sectional, interviewer-administered, survey of a random household sample (N=1100) was conducted. Factor analysis of the attitudinal items was conducted to investigate the factors associated with antibiotics self-medication.

Results: A response rate of 91% (n=998) was obtained. Knowledge about antibiotics was poor (mean=12.5; SD=3.5; (scale 0-27)). Half of the respondents had previously used an antibiotic once in the past three months. About 11% (108/998) had self-medicated the last time they took antibiotics; mostly obtained from a pharmacy (82%; 89/108). Three attitudinal factors were obtained, explaining 56.1% of the variance. Respondents were less likely to self-medicate if they did not support *ease of access to antibiotics from pharmacies* ($p<0.001$) and *situational use of antibiotics* ($p=0.001$); supported *appropriate use of antibiotics* ($p=0.003$); and had greater *knowledge about prescription requirements* for obtaining antibiotics ($p=0.004$).

Conclusion: There is limited knowledge about, and a high rate of self-medication with antibiotics in Sri Lanka. Factors contributing to self-medication could be addressed with appropriate public education, awareness campaigns, and policy changes.

Keywords: Antibiotics; Antibiotic resistance; Self-medication; General public; Knowledge; Attitudes; Quantitative study; Survey; Sri Lanka.

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1. Background

Self-medication refers to the use of medicines for the treatment of symptoms without advice from a healthcare practitioner [1]. Self-medication with antibiotics has become common practice in most parts of the world [2-4], particularly in low and middle-income countries (LMICs) [2-4]. In LMICs the prevalence of self-medication with antibiotics varies, with an overall estimate of 38.8% (95% CI: 29.5 – 48.1) [3]. Self-medication with antibiotics has been associated with a higher risk of inappropriate use [3], primarily for minor viral infections e.g. upper respiratory tract infections (URTIs) and acute diarrhoea [3,5]. Furthermore, self-medication with antibiotics is often linked to shorter duration of treatment, inadequate dose, stopping therapy when symptoms improve and sharing medicines with others [6]. All these factors are known to contribute to antibiotic resistance (ABR) [7,8].

ABR limits the choice of antibiotics in the treatment of common infections in LMICs and increases the risk of morbidity and mortality [7]. A substantial proportion of healthy people in developing countries are colonized with multi-drug resistant bacteria [9-11]. An antibiotic surveillance study in Sri Lankan hospital outpatient settings found that *Escherichia coli* (including 85% of the *E. coli* from urine samples of patients with suspected urinary tract infection (UTI)) were resistant to commonly used antibiotics [10]. It has been estimated that if no action is taken, by 2050, 10 million people globally will die due to ABR each year and the cost to the global economy would be US$100 trillion [12,13].

A meta-analysis revealed that patients' lack of knowledge and false beliefs about the effectiveness of antibiotics and their uses, and the public's experiences in receiving antibiotics for mild viral infections from healthcare professionals, were the widely discussed factors associated with inappropriate self-medication [3]. The unnecessary supply of antibiotics by health professionals (pharmacists and physicians) is also a key factor contributing to self-medication with antibiotics [5]. This unnecessary supply by physicians [14,15] and community pharmacists [16,17] appears to be treating self-limiting viral infections. In Sri Lanka, antibiotics can be purchased illegally without a prescription for common viral infections [16,18]. The Sri Lankan government provides free healthcare services, including medications, to the public throughout the country [19]. In

addition, Sri Lanka has a private sector which includes private hospitals and clinics, where patients are able to access healthcare services by directly paying for the services or using their private health insurance. Overall, private sector services are more easily accessible with shorter waiting times compared to the public healthcare system [19].

The prevalence of antibiotic use and self-medication patterns in LMICs varies between different communities, and may be based on their social determinants of health. These often differ from developed nations [3,20]. The reasons why the public self-medicate with antibiotics are unique to different settings and are reflective of the matrix of the health system, and social, economic and health factors [3,20]. Therefore, it is important to understand antibiotic use and factors influencing this use in each country in order to develop targeted and effective educational and behavioral interventions to promote appropriate use of antibiotics.

Despite self-medication with antibiotics being a global health concern, determinants such as knowledge of antibiotic use and attitudes towards self-medication have not been well-examined in LMICs [2,3]. Some studies have investigated antibiotic use, knowledge, attitudes, and behaviors of the general public in LMICs [3,21-24], however, no such studies exist from Sri Lanka. In this context, we conducted a national survey to determine the public's knowledge about, and attitudes to, antibiotic use; evaluate their self-medication with antibiotics; and identify factors associated with self-medication.

2. Methods

This was a cross-sectional study conducted among the public in Sri Lanka covering all nine provinces. Face-to-face interviews were conducted using an interviewer-administered structured questionnaire, between December 2016 and August 2017.

2.1. *Sample size*

The sample size of 861 was estimated using the standard error of proportions equation with a 95% confidence interval (CI) and a margin of random error of ±3%. This equation is recommended to calculate sample sizes for cross-sectional surveys conducted to estimate a population parameter like prevalence of a condition in a community, or finding the average value of a variable in a population [25].

The expected proportion for the sample size calculation was derived from a study conducted in India in which 28% of the parents in the study were knowledgeable about antibiotic use for bacterial infections [26]. The response rates in antibiotic related surveys conducted among the general public vary from 69% to 90% [26-28]. Therefore, an additional 25% was added to the estimated sample size to account for possible non-responses. Eventually, a total of 1100 adults were approached from a proportionate sample of rural (81%, n=890) and urban (19%, n=210) areas representing the country's rural (82%) and urban (18%) population ratio [29].

We did not account for design effects in our sample size calculation, as an individual dwelling was considered to be a single unit for randomization.

2.2 ***Recruitment strategy***

A stratified multistage random sampling technique was used to obtain a potentially representative sample of the public in Sri Lanka from all nine provinces. For each province, a proportion of the population was estimated based on the population density of the province. To maintain urban and rural equality, the quota of each stratum was further stratified in proportion to urban and rural populations of the stratum (secondary stratification). In the sampling frame, from each selected rural and urban areas, one to three Grama Niladari (GN) division(s) were randomly selected from the list of GN divisions of each urban or rural area of the stratum. A GN division is a sub administrative unit of a divisional secretariat department, under the Home Affairs Division of the Ministry of Home Affairs. There are a total of 14,022 GN divisions under 331 divisional secretariats in the country [30]. The final sampling unit was adults from randomly selected dwellings of these GN divisions. At each pre-selected GN division, researchers visited randomly selected dwellings. An adult from each household was approached to participate in the survey. If a dwelling contained more than one family, one unspecified adult from each family (chosen by the family) was invited to participate. If there was no response from the dwelling, then the researcher did not revisit the same dwellings again and moved on to a new adjacent dwelling to complete the quota. This process was continued until the province quota was filled. A similar approach was carried out throughout all nine provinces.

2.3 *Inclusion criteria*

Adults (18-70 years old), other than health professionals (e.g. doctors, pharmacists, nurses), and those employed in health-related professions (e.g. microbiologists and medical laboratory scientists), were included in the study.

2.4 *Data collection*

A trained group of recent pharmacy graduates (n=3) and pharmacy undergraduates (n=29) conducted the recruitment and interviews. They were trained on study methods, sampling procedure, obtaining informed consent, data collection, confidentiality and ethical behavior through an interactive two-day workshop led by one of the researchers. Several rehearsals and pilot testing were conducted before actual data collection commenced, to ensure consistency, reliability and validity of the data collected.

2.5 *Study instrument*

A structured questionnaire was developed in English, based on previous research [24,31-37]. The questionnaire underwent face and content validity testing with a panel of six experts from Australia and Sri Lanka, including two researchers, a pharmacologist, a clinical psychologist, a clinician and a pharmacist. The final questionnaire was translated into the two primary languages spoken in Sri Lanka (Sinhala and Tamil) using forward-backwards translation to ensure consistency [38]. To clarify possible problems of comprehension with any questionnaire item, a pilot study was conducted with a convenience sample of 30 people. The time to complete the questionnaire was recorded. Based on their feedback, the questionnaire was further modified to improve presentation and understanding. As most of the questions and statements were derived from other validated studies, the questionnaire was not repeated for test-retest reliability evaluation [39]. The pilot study respondents were excluded from the final survey analysis to avoid possible bias.

2.6 *Measures*

The questions and statements in the survey were arranged into six sections: 1) respondents' self-reported past antibiotic use and self-medication 2) antibiotic requests from pharmacies without prescriptions for common infections, 3) socio-demographic characteristics, 4) knowledge about

antibiotics 5) attitudes towards antibiotic use, 6) experience driven beliefs on usefulness of antibiotics for common infections.

2.6.1. *The dependent or outcome variables*

1) Antibiotic use and self-medication behavior

Antibiotic use was measured as an antibiotic taken at any point in time in the past three months, and the last time an antibiotic was used, which also included the last three months.

Self-medication with antibiotics was defined as obtaining antibiotics from any of the following sources; pharmacists, nurses, friends, family members, leftover antibiotics from previous use, or sources other than using a medical prescription from a registered physician [1]. A self-medication variable was created based on source of antibiotic supply for the last use (that is, source of antibiotic received the last time with a doctor's prescription (not self-medication) or from any other sources without a prescription (self-medication)).

2) Antibiotic requests from pharmacies without prescription for common infections

Antibiotic requests from a pharmacy without a prescription were measured using the statement "I request antibiotics for the following infections from a pharmacy without a prescription." The five common infections (sore throat, common cold and cough, wound infection, diarrhea, UTI) were used to assess requests for antibiotics without a prescription. The response options were "never", "sometimes", "often", "very often", "always", and "not applicable". The responses were recoded such that options "sometimes" to "always" became "antibiotic requested" and "never" remained as "no antibiotic requested".

2.6.2. Independent variables

1) Socio-demographic characteristics and past antibiotic use

The following socio-demographic characteristics were included in the regression model; age, gender, geographical location, ethnicity, highest level of education, monthly household income, marital status, number of children, family member(s) working at healthcare institution(s), and the respondent working at healthcare institution(s).

2) Knowledge

Twenty-seven statements categorized into six sub-domains, were used to evaluate the public's knowledge related to antibiotic use. The sub-domains were *Antibiotic prescribing requirements* (3 statements); *Effectiveness of antibiotics for minor infections* (5 statements); *What is an antibiotic?* (3 statements); *Appropriate use of antibiotics* (4 statements); *Knowledge about ABR* (8 statements); and *Adverse effects of antibiotics* (4 statements) (supplementary document A).

One knowledge statement was "paracetamol is an antibiotic." This statement was used to determine respondents' knowledge about common medicines and antibiotics; because, firstly, paracetamol (acetaminophen) is a well-known medicine, and secondly, fever and pain can be treated with paracetamol, and they are also symptoms of an infection.

For all knowledge questions the response options were "Yes," "No" and "Don't know." The knowledge score for each of the sub-domains was computed. A wrong answer resulted in a value of 0, and correct answer in a value of 1 and ''do not know'' in a value of 2 [40]. The score of each sub-domain was defined as the sum of the responses of all the correct answers. For example, the sub-domain *Antibiotic prescription requirement* was measured using 3 statements. If a respondent answered all three statements correctly, a maximum total score of 3 was computed.

3) Attitudes related to antibiotic use

The public's attitudes towards antibiotic use were assessed using 14 items (Table 1) on a 5-point Likert scale (from 1 = Strongly Disagree to 5 = Strongly Agree). These items were further subjected to exploratory factor analysis.

4) Experience driven beliefs on usefulness of antibiotics for common infections

Ten items were used to assess the public's beliefs about the usefulness of antibiotics for five common infections as a result of having received them from physicians (five items), or pharmacists without a prescription (five items), in the past. Each item was assessed using a 5-point Likert scale; from strongly disagree (1) to strongly agree (5), with an additional option of "not applicable." The responses to each item were recoded into a new variable, such that "not applicable" became "no

previous experience" and the remaining response options became "previously experienced" (Supplementary document B).

2.7. *Data analysis*

The responses were coded, reviewed for accuracy and entered into SPSS version 24. A research assistant validated 10% of the entered data. Data were analysed using descriptive and inferential statistical techniques. Basic demographic and other information, including prevalence of self-reported use of antibiotics, knowledge, attitudes and practice related items were presented either using mean ±SD or median (IQR) for continuous data, or frequencies and percentages for nominal data. The Kuder-Richardson formula 20 (KR-20) test was performed to assess the reliability or internal consistency of the sub-domains created using the dichotomous knowledge items [41]. Values of KR-20 range from 0.0 to 1.0, with higher values representing a more internally consistent sub-domain.

Construction of attitude scales

Exploratory factor analysis was conducted to determine the dimensionality reduction of the attitudinal variables in the dataset [42]. Eigenvalue greater than 1 was used as a criterion to select the number of components to be rotated. A cut-off value of 0.30 was set for factor loadings as inclusion criterion in a factor. The reliability of each factor was computed using Cronbach's alpha and average inter-item correlation. The regression mean scores were computed for each factor, after recoding items (if needed), i.e., changing scores of 1 to 5, 2 to 4 and vice versa, with neutral remaining unchanged. The reverse coding was done to ensure that higher scores for each scale represented positive attitudes.

Inferential analysis

Factors (attitudes, knowledge and socio-demographic characteristics) associated with self-medication with antibiotics, and factors (socio-demographic characteristics, knowledge, experiences, expectations, past antibiotic use and supply) associated with antibiotic requests from pharmacies without prescriptions for each of the common infections were investigated using multiple logistic regression. Adjusted regression models were developed using the backward elimination method provided in the SPSS. The regression outcome of self-medication with

antibiotics was reported by adjusted β and the corresponding 95% CI. The level of significance was set as $p < 0.05$.

Chi-square likelihood ratio test, pseudo R-square values, and the Hosmer-Lemeshow chi-square test were used as model fit statistics for binary multiple logistic regression models.

2.7 *Ethical considerations*

The study received ethical approval from the Ethics Review Committee, Faculty of Medicine, University of Ruhuna, Sri Lanka (Reference No: 16.11.2016: 3.1). Informed written consent or a thumb print (for those unable to read or write due to poor literacy) was obtained from each respondent prior to the survey. The respondents were informed about the purpose of the study, that participation was voluntary, and that all data collected would be confidential.

3. Results

3.1. *Respondents' characteristics*

Approximately 91% (998/1100) agreed to be interviewed. The mean age of the respondents was 40 (SD=14.7) years; 70% were female and 74% lived in rural areas (Table 1). The majority of respondents had secondary education or above (94%). Over two thirds were married with an average of two children. Over 80% of the respondents had a monthly household income of less than USD 400. The respondents' average annual visits to healthcare facilities was six.

3.2. *Antibiotic use and self-medication*

Nearly all respondents (98%, 974/998) had used an antibiotic in the past. Most had obtained their last antibiotic supply with a physician's prescription (87%) and the common conditions were for the common cold (62.7%), sore throat (12.8%) or both (9.5%). Half of the respondents claimed that they had taken antibiotics at least once in the three months prior to being surveyed.

Out of 998 respondents, 11% (108) reported to have self-medicated with an antibiotic the last time they took an antibiotic (inclusive of in the past three months). Most had obtained their antibiotics for self-medication from community pharmacies (82%; 89/108) by either reporting symptoms

(47%) or requesting antibiotics by name (35%). The major health conditions for the last antibiotic self-medication were upper respiratory tract infections (77%; 83/108) with common cold (64%; 69/108), sore throat (13%; 14/108), or both (7%; 8/108). The main reasons reported for self-medication were the illness was simple and straightforward (41%; 44/108), previous experience of using antibiotics for similar conditions (25%; 27/108), followed by time constraints to consult a physician (9%; 10/108) (Table 2). There were no significant differences observed between the respondents who used an antibiotic with a prescription and those who self-medicated, in respect to the conditions reported, including common cold (65% vs 66%, respectively), sore throat (13% vs 13%), wound infections (17% vs 20%), diarrhea (2% vs 3%) and UTI (2% vs 1%), except fever (25% vs 12%, $p<0.05$).

One in every four reported that they had requested an antibiotic for common cold and cough (n=258), 16.3% (n=163) for wound infection and 14.3% (n=143) for sore throat, from pharmacies without a prescription. Direct antibiotic requests for diarrhea 7.2% (72) and UTI 4.2% (42) were considerably lower than other conditions.

3.3. *Knowledge about antibiotics, appropriate antibiotic use and resistance*

The findings of the public's knowledge are shown in Table 3 and supplementary document A. All six sub-domains assessing knowledge were reasonably reliable (KR-20 values >0.5), except "effectiveness of antibiotics for minor infections" (KR-20 value = 0.35). Knowing *what an antibiotic is* was poor, i.e., knowing correctly that antibiotics cannot be used for viral infections (11%; 109/998) or only for bacterial infections (37%; 369/998). Overall, about two thirds of the respondents did not know whether antibiotics could be used for bacterial or viral infections. About 41% (406/998) correctly reported paracetamol as not an antibiotic, while 29% (298/998) considered it as an antibiotic. Knowledge about *antibiotic prescription requirements* was good. The majority knew that antibiotics should only be prescribed by a physician (86%; 863/998) and should not be obtained from pharmacies without a prescription (73%; 728/998). However, most respondents reported it to be easy to obtain antibiotics from pharmacies without a prescription (77%; 776/998). The knowledge score for the *effectiveness of antibiotics for minor infections* was poor (mean = 1.1, SD = 0.9, possible score range = 0-5). The majority reported that antibiotics could cure common cold and cough (76.4%), and sore throat (53.4%). Most did not know whether

antibiotics could cure UTIs or acute diarrhoea. Though respondents' overall knowledge on *appropriate use of antibiotics* was poor (mean = 2.1, SD = 1.1, possible score range = 0-4), items included in the sub-domain such as completing the prescribed antibiotic course and refraining from self-medication with previously used antibiotics, were well understood by the majority (78%, (774/998) and 73% (734/998), respectively)). But about half incorrectly understood that a prescribed antibiotic course can be stopped if the symptoms improve (47%; 473/998). The vast majority had no knowledge about how to deal with side effects of antibiotics (92%; 914/998). Knowledge scores of *ABR and possible causes of ABR* were also low. Only a few respondents were aware of ABR (17%; 169/998) and over two thirds of them did not know about possible causes of ABR. Except allergic reactions (72%), most of the respondents did not know about *adverse effects* caused by antibiotics.

3.4. *Exploratory factor analysis*

The initial exploratory factor analysis revealed a three-factor solution, consistent with the prior conceptual basis of the factors, explaining 56.1% of the variance in the data. All items loaded onto the expected factors, with factor loadings greater than 0.37. Though two factors showed satisfactory reliability, factor 2 showed a low Cronbach's alpha (0.49). However, the factor was kept in the model as the variables in that factor had high loadings and the items conceptually fitted together within this factor (Table 4).

3.5. *Experience-driven beliefs on usefulness of antibiotics for common infections*

The respondents had an overall positive belief on the usefulness of antibiotics in treating common cold and cough, sore throat and wound infections due to receiving antibiotics from health professionals in the past. A large proportion had received antibiotics for common cold and cough (84%), sore throat (53%) and wound infections (50%) from physicians in the past. Of these, 88% (737/838), 83% (441/530) and 82% (411/503), respectively, believed that antibiotics were useful in treating these infections. About 49.3%, 35.3% and 30.2% had experienced receiving antibiotics without prescriptions for the common cold and cough, sore throat and wound infections, respectively, from pharmacies. Of these, 50.7% (250/493), 42.6% (150/352) and 22.7% (52/229), respectively, believed that antibiotics were useful to treat these infections (Supplementary document B).

3.6. *Antibiotic requests from pharmacies without a prescription for common infections*

One in every four (25.8%) had requested an antibiotic for the common cold and cough, 16.3% for wound infection and 14.3% for sore throat. Direct requisition of antibiotics for diarrhoea (7.2%) and UTI (4.2%) was considerably lower (Supplementary document B).

3.7 *Factors associated with self-medication with antibiotics*

The results from the multivariate logistic regression showed that respondents, who did not support *ease of access to antibiotics from pharmacies* (Adj. OR=0.38, 95% CI: 0.27 - 0.54; $p<0.001$) and *situational use of antibiotics* (Adj. OR=0.55, 95% CI: 0.38 - 0.79; $p=0.001$); and those who had positive attitudes towards *appropriate use of antibiotics* (Adj. OR=0.64, 95% CI: 0.47 - 0.86; $p=0.003$), were less likely to self-medicate with antibiotics (Table 5). Those respondents with greater knowledge about prescription requirements in Sri Lanka were less likely to self-medicate (Adj. OR=0.37, 95% CI: 0.19 - 0.72; $p=0.004$), whereas, respondents with greater knowledge about appropriate use of antibiotics were more likely to self-medicate with antibiotics (Adj. OR=1.62, 95% CI: 1.16 - 2.26; $p=0.004$). Respondents in the middle monthly household income group, were more likely to self-medicate (Adj. OR=3.09, 95% CI: 1.16 – 8.26; $p=0.024$) than the lower income group. Whilst married respondents were less likely to self-medicate than never married ones (Adj. OR=0.48, 95% CI: 0.23 - 0.99; $p=0.048$) (Table 5).

3.8. Factors predicting the request of antibiotics without a prescription from pharmacies

Self-medication with an antibiotic for the common cold (Adj. OR=8.65, 95% CI: 4.54 – 16.48), sore throat (Adj. OR=6.87, 95% CI: 3.52 – 13.42), diarrhoea (Adj. OR=2.77, 95% CI: 1.12 – 6.87), wound infection (Adj. OR=5.22, 95% CI: 2.72 – 10.04) and UTI (Adj. OR=7.23, 95% CI: 2.66 – 19.61); previous experience of receiving antibiotics from physicians for sore throat (Adj. OR=3.44, 95% CI: 1.83 – 6.47), diarrhoea (Adj. OR=2.71, 95% CI: 1.29 – 5.70), wound infection (Adj. OR=2.21, 95% CI: 1.28 – 3.79) and UTI (Adj. OR=2.43, 95% CI: 1.10 – 5.36), and expectations of obtaining antibiotics without a prescription for a similar infection from a pharmacy for the common cold (Adj. OR=12.86, 95% CI: 8.10 - 20.42) sore throat (Adj. OR=10.20, 95% CI: 6.11 – 17.03), diarrhoea (Adj. OR=13.70, 95% CI: 6.33 – 29.67), wound infection (Adj. OR=7.42, 95% CI: 4.35 – 12.64) and UTI (Adj. OR=6.16, 95% CI: 2.58 – 14.71) were the strongest predictors of

requesting antibiotics from pharmacies for the common infections. Other significant predictors were ethnicity and current expectation to be prescribed antibiotics from physicians (Table 6).

4. Discussion

This is the first national survey providing insights about knowledge, attitudes and behavior regarding antibiotic use and self-medication among Sri Lankans, including antibiotic requests from pharmacies without a prescription, and factors associated with self-medication.

We found that a high proportion of the public in Sri Lanka had used antibiotics previously. The majority had obtained their last antibiotic supply with a physician's prescription and where it had, in most cases, been prescribed for the common cold, cough and sore throat. These are all minor ailments most likely caused by viruses indicating that inappropriate prescribing may exist. However, the absence of information on the actual diagnosis precludes us from discussing inappropriate or appropriate antibiotic prescribing in this given setting. Further research is needed to evaluate appropriate antibiotic prescribing practices among physicians in the Sri Lankan community.

Another important finding was that 11% of the respondents had self-medicated with antibiotics the last time they had taken an antibiotic, without consulting a physician. They had mostly obtained antibiotics from community pharmacies without prescriptions. Moreover, knowledge about antibiotics was poor, however respondents with knowledge about appropriate use of antibiotics were more likely to self-medicate with antibiotics. Positive attitudes towards having easy access to antibiotics from pharmacies was strongly associated with self-medication with antibiotics and experiences of receiving antibiotics from physicians and pharmacies predicting antibiotic request from pharmacies without a prescription.

Self-medication behavior reflects the wish of individuals to take responsibility for their own health and treat minor ailments. Some of the benefits of appropriate self-medication include decreased health care costs, decreased physician consultations and therefore, increased availability of health care workers for people with more urgent needs [43]. However, inappropriate behavior, especially with antibiotics, could result in potential individual harm, such as, worsening of health condition

due to incorrect self-diagnosis and wrong choice of therapy. However, even more importantly, such unwanted behavior could promote the development of ABR [7,8]. A substantial proportion of the respondents in our study inappropriately self-medicated with antibiotics, which is comparable with studies conducted in other developed and developing countries [3,4].

The major source of obtaining antibiotics for self-medication was community pharmacies. Despite the fact that this is against the law, antibiotics are widely available over the counter in Sri Lankan pharmacies [16,18,44] and this has been identified as common practice in many developing countries [3]. However, there is no evidence that supports this behavior as clinically appropriate. In fact, this behavior may be contributing to the global problem of ABR [16,45], and is an obvious target in the challenge for reducing inappropriate antibiotic provision and use, and therefore mitigating ABR.

Further, studies have revealed that in countries where antibiotics are widely available without a prescription from pharmacies, there is a high level of misconception among the public about antibiotic use and resistance [46,47]. It is evident from our study that the public had poor knowledge about antibiotics, their effectiveness and use, and ABR, findings consistent with other studies [37,46,48]. Poor knowledge together with easy access to antibiotics from pharmacies are supported by earlier research associating availability of antibiotics from pharmacies with misconceptions about antibiotics and ABR [16,18]. This also supports a positive feedback loop. That is, people have poor understanding of antibiotics, their use and effectiveness, and ABR, and they request antibiotics from pharmacies or present with symptoms of an infection to a pharmacy. They are readily provided with antibiotics without a prescription, and their belief about the effectiveness and use of antibiotics is reinforced, motivating future requests for antibiotics and self-medication [3,37]. Current findings have also revealed that people who believed antibiotics should be easily accessible to the public from pharmacies, were more likely to self-medicate with antibiotics. The easy access to antibiotics is evident from previous studies in Sri Lankan community pharmacies [16,18].

This study revealed that those with more knowledge of appropriate use of antibiotics were more likely to self-medicate. This may be because those who have knowledge, believe that self-medication is appropriate. They may believe that they know what they are doing when self-

medicating with antibiotics, and their actions may be reinforced by their previous use of antibiotics without harm (e.g. no side effects experienced).

We found that the strongest predictors for requesting antibiotics from pharmacies for common ailments were previous experiences in receiving antibiotics without a prescription from pharmacies, and with prescriptions from physicians. This may be due to people's false beliefs resulting from their positive past experiences of receiving antibiotics from health professionals for minor ailments.

We also found that physicians had prescribed antibiotics in the past for the majority of the respondents for their common cold and sore throats. These findings are also supported by other studies conducted elsewhere demonstrating that the previous experience of taking antibiotics are the strongest predictors for patients expecting and demanding antibiotics in the future from health professionals [49-51].

To achieve appropriate use of antibiotics, the WHO has suggested interventions on several levels [52]. For instance, individuals should only follow advice from health care professionals and should not buy antibiotics without a prescription. Furthermore, pharmacies should not sell antibiotics to individuals without a prescription and should preferably assess prescriptions according to current clinical guidelines before dispensing, and physicians should follow antibiotics guidelines in prescribing antibiotics. Additionally, policymakers should promote the appropriate use of antibiotics through regulations and funding schemes [52]. These suggestions seem to be both timely and relevant in the fight against ABR in Sri Lanka. Continuous educational programs and treatment guides for pharmacists for viral infections could improve appropriate antibiotic dispensing practice. Community awareness programs could be conducted in the rural settings by engaging community leaders and influencers in the village and school settings. Our findings have indicated gaps in knowledge as well as poor behaviour in relation to antibiotic use amongst the general public, which need to be addressed at the local level in community pharmacies and physicians, and be supported by strategies at the national level. Future intervention efforts, therefore, need to be multifaceted to improve both antibiotic supply by health professionals and appropriate use by people. Although there are limited studies conducted in LMICs to evaluate educational interventions to improve appropriate antibiotic use in the community setting, a

systematic review showed promising effects of multifaceted educational interventions in LMICs [53].

5. Strengths and Limitations

Our study has a number of strengths that may inform how the public could contribute to optimizing appropriate antibiotic use in Sri Lanka and areas for improving appropriate use of antibiotics in the community. Firstly, we performed a large study across Sri Lanka including all provinces, covering significant regional and ethnic variations, to understand self-medication with antibiotics in the country. Secondly, we randomly selected dwellings and therefore respondents, minimizing selection bias that may influence reporting. Thirdly, we had a high response rate which avoided non-response bias in reporting.

The study has some limitations. Self-reported measures are susceptible to recall bias and social desirability effects. To address this latter limitation and ensure the validity of the study, respondents were informed about confidentiality of the data collected including any personal information while obtaining informed written consent. Events that are salient and recent are more likely to be remembered and reported than those that are less salient and more distant. To address recall bias, we recorded antibiotic use practice from two different time points one within the last three months (most recent) and last time (any time the respondent could recall). The survey was approximately 20–30 minutes long, which could have impacted the responses through survey fatigue. To minimize survey time, we included closed-ended questions, kept the response options to a minimum, and used well-trained interviewers who also ensured that respondents had up to 20 to 30 minutes time for survey completion. The use of cross-sectional data also precludes any inferences about the directionality of effects. The respondents self-reported their common infections and the antibiotics used, and this self-reporting has limitations with regards to recall, as well as under or over reporting bias. Furthermore, it is possible that they may have had other common infections for which they sought antibiotics, but which were not specifically asked in the survey, such as pharyngitis. These findings and recommendations may only be applicable in environments where the cultural notions of illness, health and healthcare infrastructure are comparable with the Sri Lankan context.

6. Conclusions

Self-medication with antibiotics commonly occurs in Sri Lanka. This may be linked to poor knowledge about antibiotics, history of self-medicating practice, expectations of receiving antibiotics without a prescription, and experiences of receiving antibiotics from physicians and using them in the past. Community pharmacies were the main source of antibiotics purchased for self-medication without a prescription. Overall, self-medication was more likely in people who supported ease of access to antibiotics from pharmacies without a prescription, supported the use of antibiotics without a prescription in special circumstances (i.e. when they felt that they needed to be well), those who were more knowledgeable about appropriate use of antibiotics, and those who were less aware of the prescription requirements for antibiotic supply.

Our findings support the need for multifaceted intervention programs targeting the public, healthcare professionals and policymakers to reduce the practice of self-medication among Sri Lankans. These interventions should be focused on raising awareness of appropriate antibiotic use, and reinforce national regulations on antibiotic sales.

Competing interests

The authors have declared that no competing interests exist.

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Table 1

Socio-demographic characteristics of the respondents

Demographic Characteristics	Sample (N=998) Frequency (%)
Age (Years)	
Mean [SD]	40 [14.67]
Gender	
Male	301 (30.2)
Female	697 (69.8)
Geographical location	
Urban	257 (25.8)
Rural	741 (74.2)
Ethnicity	
Sinhalese	667 (66.8)
Tamil	180 (18.0)
Moors	149 (14.9)
Other	2 (0.2)
Highest level of education	
No formal education	14 (1.4)
Primary (5 years of school education)	45 (4.5)
Secondary (11 years of education)	677 (67.8)
Upper secondary 12-13 (13 years of school education)	215 (21.5)
Tertiary (college or university)	46 (4.6)
Missing data	1 (0.1)
Monthly household income*	
<LKR.10,000	77 (7.7)
LKR10,001- 20,000	136 (13.6)
LKR20,001- 30,000	220 (22.0)
LKR30,001- 40,000	199 (19.9)
LKR40,001- 50,000	130 (13.0)
LKR50,001- 60,000	90 (9.0)
> LKR 60,001	129 (12.9)
Missing Data	17 (1.7)
Working in a healthcare related institution	
No	974 (97.6)
Yes	22 (2.2)
Missing Data	2 (0.2)
Any immediate family member/s work/s in a healthcare field	
No	751 (75.3)
Yes	246 (24.6)
Missing Data	1 (0.1)
Number of visits participants made to a clinic or pharmacy (government/private) in the past 12 months?	
Mean [SD]	6.36 [5.59]
Marital status	
Never married	247 (24.7)
Married	733 (73.4)
Divorced	3 (0.3)
Widow/widower	13 (1.3)
Missing Data	2 (0.2)
Number children	
Mean [SD]	2.12 [1.38]

*LKR – Sri Lankan Rupees (100LKR = 0.55 US dollars)

Table 2: Antibiotic use and self-medication

	Frequency (%)
In the **past three months**, have you ever taken any antibiotics? **(n = 998)**	
No	494 (49.5)
Yes	502 (50.3)
Missing Data	2 (0.2)
The condition(s) for which the antibiotic was used last time (with multiple responses), (n=998)	
Common cold and cough	626 (62.7)
Sore throat	128 (12.8)
Fever	226 (22.6)
Wound infection	171 (17.1)
Diarrhea or other gastro-intestinal problems	21 (2.1)
UTI	21 (2.1)
Others	34 (3.4)
Common cold and sore throat	95 (9.5)
Common cold and fever	115 (11.5)
Sore throat and Fever	49 (4.9)
Common cold, sore throat and fever	45 (4.5)
Fever and UTI	4 (0.4)
Missing data	32 (3.2)
Where did you get the supply of antibiotics that you took **last time**? **(n = 998)**	
I had some at home	9 (0.9)
I bought some from a pharmacy, telling them my symptoms	51 (5.1)
I bought some from a pharmacy, asking for the antibiotic by name	38 (3.8)
I got some from my friend	6 (0.6)
I got some from my relatives	4 (0.4)
I got some with a prescription from the doctor	859 (86.1)
Other source	7 (0.7)
Missing Data	24 (2.4)
Self-medication with antibiotics last time (n = 998)	
Yes	108 (10.8)
No	866 (86.8)
Missing Data	24 (2.4)
The condition(s) for which the antibiotic was used as self-medication (with multiple responses), (n=108)	
Common cold and cough	69 (63.9)
Sore throat	14 (13.0)
Fever	13 (12.0)
Wound infection	21 (19.4)
Diarrhea or other gastro-intestinal problems	3 (2.8)
UTI	1 (0.9)
Common cold and sore throat	8 (7.4)
Common cold and fever	5 (4.6)
Sore throat and Fever	2 (1.9)
Common cold, sore throat and fever	2 (1.9)
Fever and UTI	3 (2.8)
Others	2 (1.9)
Source of antibiotic obtained for self-medication last time (n=108)	
I had some at home	9 (8.3)
I bought some from a pharmacy telling them my symptom	51 (47.2)
I bought some from a pharmacy, asking for the antibiotic by name	38 (35.2)
I got some from my friend	6 (5.6)
I got some from my relatives	4 (3.7)
Reason for obtaining antibiotics without a prescription for self-medication last time (n=108)	
Medical condition was simple and straightforward	44 (40.7)
Charges for consulting a physician is high	8 (7.4)
Previous experience of using antibiotics for similar condition(s)	27 (25.0)
Familiarity with antibiotics	7 (6.5)
There is no public hospital close to me	1 (0.9)
No time to see a physician	10 (9.3)
Other	2 (1.9)
Missing Data	9 (8.3)

Table 3
Knowledge scores about antibiotic use

Predictors	n	Mean (SD)	Median (IQR)	K20R
Antibiotic prescription requirements (Possible score range - 0-3)[a]	998	2.4 (0.9)	3 (2, 3)	0.594
Effectiveness of antibiotics for minor infections (Possible score range - 0-5)[a]	998	1.1 (0.9)	1.0 (0, 2)	0.346
What is an antibiotic (Possible score range - 0-3)[a]	998	0.9 (0.9)	1.0 (0, 1)	0.509
Appropriate use of antibiotics (Possible score range - 0-4)[a]	998	2.1 (1.1)	2.0 (1, 3)	0.491
Knowledge about ABR (Possible score range - 0-8)[a]	998	2.0 (2.3)	1.0 (0, 4)	0.856
Adverse effects of antibiotics (Possible score range - 0-4)[a]	997	1.8 (1.2)	2 (1, 3)	0.525
Overall knowledge (Possible score range - 0-27)[a]	998	12.5 (3.5)	12.0 (10.0, 14.2)	

[a]See Appendix A for details of items; SD – standard deviation; IQR – inter quartile range.

Table 4

Exploratory factor analysis- attitudes towards antibiotics use

Items	n	Mean (SD)	Median (IQR)	Factor loading 1	2	3
Factor 1- Ease of access to antibiotics from pharmacies						
[a]I tend to obtain antibiotic without a prescription, if I don't have enough money to see a physician	975	3.8 (1.2)	4 (3, 5)	0.88		
[a]I tend to obtain antibiotic without a prescription, if I don't have enough time to see a physician	977	3.8 (1.2)	4 (3, 5)	0.87		
[a]I prefer to obtain antibiotic without a prescription from a pharmacy where staff knows me	998	3.9 (1.2)	4 (4, 5)	0.67		
[a]If I need antibiotics, I tend to obtain them from pharmacy without a prescription	998	4.0 (1.2)	4 (4, 5)	0.62		
[a]Antibiotics should be available for purchase without prescription by the public from any pharmacy	998	4.0 (1.1)	4 (4, 5)	0.53		
Factor 2- Appropriate use of antibiotics						
I should only take antibiotics, if a physician has prescribed them for me	998	4.0 (0.9)	4 (4, 4)		0.71	
I believe that it is important to take antibiotics according to the instructions provided by physicians	996	4.2 (0.8)	4(4, 5)		0.64	
I should stop self-medicating with antibiotics to prevent antibiotics not working in the future	983	3.6 (0.9)	4 (3, 4)		0.63	
Factor 3- Situational use of antibiotics						
[a]I tend to use antibiotic when I get sick at the time of an important event (exam, funeral, wedding)	996	3.4 (1.3)	4 (2, 5)			0.88
[a]I tend to use antibiotics, when I am sick so I can remain active for work, family or study	997	3.4 (1.3)	4 (2, 5)			0.87
[a]I know when I need antibiotics	993	2.9 (1.1)	2 (2, 4)			0.57
[a]Left over antibiotics can be used for the similar condition in the future	994	3.9 (1.1)	4 (3, 5)			0.37
Cronbach's alpha				0.81	0.49	0.70

Note: Two items were not included because of low loading on all factors. The absolute value of >0.30 only reported in the table.

[a]For these items coding was reversed.

Table 5

Multiple logistic regression analyses relating public knowledge, attitudes and socio-demographic characteristics to self-medication with antibiotics

Predictors	Self-medication n=707
	Adjusted OR (95% CI)
Attitudes	
Ease of access to antibiotics from pharmacies	0.38 (0.27 – 0.54)***
Appropriate use of antibiotics	0.64 (0.47 – 0.86)**
Situational use of antibiotics	0.55 (0.38 – 0.79)**
Knowledge	
Appropriate use of antibiotics	1.62 (1.16 – 2.26)**
Antibiotic prescription requirements	0.37 (0.19 - 0.72)**
Socio-demographic characteristics	
Gender	
Male	1
Female	0.57 (0.31 – 1.08)NS
Monthly Household income (LKR)	
>20, 000	1
20, 001 – 40, 000	1.54 (0.63 – 3.79)NS
40, 001 – 60, 000	3.09 (1.16 – 8.26)*
>60, 000	2.95 (0.98 – 3.69)NS
Marital status	
Never married	1
Married/Divorced/ Widow/ Widower	0.48 (0.23 - 0.99)*

Model accuracy and fit: Percentage accuracy in classification (PAC) = 91.5%; Omnibus chi-square test for the model <0.001 and Hosmer and Lemeshow chi-square test for the model = 0.534. All of these values indicate that the model fits well.

NSNot significant; Significant at *<0.05; **<0.01; ***<0.001.

Not predicted in the dimension of final model produced using backward deletion method.

Other predictors adjusted in the model:

Knowledge about: effectiveness of antibiotics for minor infections, what is an antibiotic, adverse effects of antibiotics and ABR

Socio-demographic characteristics: age, highest level of education, geographical area, family member works at healthcare institution and working at healthcare related institution, marital status and number of children.

Table 6 Multiple logistic regression analyses of the factors that predict the likelihood of non-prescription antibiotics requesting from pharmacies

Outcomes / Predictors	Requesting antibiotics from pharmacies without a prescription for common infections									
	Common cold; N=690		Sore throat; N=606		[d]Diarrhea; N=509		Wound infection; N=566		[a]UTI; n=486	
	Adj. OR	CI (95%)	Adj. OR	CI (95%)	Adj. OR	CI (95%)	Adj.OR	CI (95%)	Adj.OR	CI (95%)
Age	0.98*	0.97 - 0.99	-	-	-	-	-	-	-	-
Gender										
Male	1		-		-		-		-	
Female	0.68NS	0.44 - 1.07	-	-	-	-	-	-	-	-
Ethnicity										
Sinhalese	1		1		1		1		-	
Tamils	1.73*	1.00 - 2.97	1.22NS	0.65 - 2.30	1.43NS	0.63 - 3.27	2.63**	1.48 - 4.66	-	-
Muslims	2.93*	1.06 - 3.53	2.33*	1.20 - 4.54	3.56*	1.35 - 9.387	2.71**	1.36 - 5.40	-	-
Area										
Urban	1		-		-		-		-	
Rural	0.65NS	0.41 - 1.03	-	-	-	-	-	-	-	-
Education										
Primary	-		-		-		-		1	
Secondary	-	-	-	-	-	-	-	-	0.26NS	0.06 - 1.07
Tertiary	-	-	-	-	-	-	-	-	0.89NS	0.15 - 5.42
Knowledge about the common infections										
Wrong/Don't know	1		-		-		-		-	
Correct	2.52*	1.12 - 5.67	-	-	-	-	-	-	-	-
Previous experience of receiving from physician for common infections										
No			1		1		1		1	
Yes			3.44***	1.83 - 6.47	2.71**	1.29 - 5.70	2.21**	1.28 - 3.79	2.43*	1.10 - 5.36
Expect from physician for common infections										
Disagree	1		-		1		1		-	
Neutral	0.61NS	0.28 - 1.33	-	-	0.13*	0.03 - 0.67	0.33*	0.13 - 0.85	-	-
Agree	1.75*	1.07 - 2.85	-	-	1.58NS	0.73 - 3.41	1.48NS	0.81 - 2.69	-	-
Expect from pharmacist for common infections										
Disagree	1		1		1		1		1	
Neutral	2.63*	1.22 - 5.69	0.83NS	0.25 - 2.70	1.28NS	0.31 - 5.32	4.12**	1.76 - 9.65	0.00	0.00
Agree	12.86***	8.10 - 20.42	10.20***	6.11 - 17.03	13.70***	6.33 - 29.67	7.42***	4.35 - 12.64	6.16***	2.58 - 14.71
Antibiotic used past three months										
No	1		1		-		-		-	
Yes	1.42NS	0.94 - 2.15	1.63NS	0.99 - 2.71	-	-	-	-	-	-
Last time antibiotic used for the similar infection										
No	1		-		-		-		-	
Yes	1.72*	1.08 - 2.74	-	-	-	-	-	-	-	-
Last antibiotic supply										

Obtained with physician's prescription	1		1		1		1		1	
Self-medicated via other sources	8.65***	4.54 - 16.48	6.87***	3.52 - 13.42	2.77	1.12 - 6.87	5.22***	2.72 - 10.04	7.23***	2.66 - 19.61

Note: Other variables adjusted in the models: Working at healthcare, family members working at healthcare and age. Adj.OR = Adjusted odds ratio; CI = 95% confidence interval. NSNot significant; *<0.05; **<0.01; ***<0.001. Not predicted in the dimension of final model produced using backward deletion method. [a] These models do not include variable called "last time antibiotic used for the similar infection" due to few numbers of cases. N – number of responded included in the analysis.
Did not show up in the final logistic regression model of the backward deletion method.