Poor health literacy and behavior is a risk for the spread of antibiotic resistance: survey of high school students in Goa, India

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ABSTRACT

Aims. We assessed antibiotic knowledge and practice amongst youth in India, where antibiotics are widely available without prescription.

Methods. Randomly selected school questionnaire survey representing four regions in Goa, India, with students (N=773) aged 16-17.

Results. Most students (67%) were unaware of the problem of antibiotic resistance, with around half (49%) mistakenly thinking that bacteria cause colds or flu. Around one fifth (19%) said they frequently self-medicate with antibiotics, 57% would discontinue antibiotics when symptoms alleviated, and 24% stored unused antibiotics at home. Generalised Linear Mixed Models (GLMM) showed that females consistently had poorer antibiotic knowledge than males. Especially notable were the higher odds in females for reporting incorrectly that antibiotics kill harmful viruses (OR=1.93; 99.5% CI=1.09-3.41) and for reporting incorrectly that antibiotics do not kill harmless bacteria (OR=2.02; 99.5% CI=1.16-3.51). Poor antibiotic practice was not clearly differentiated between males and females. In terms of poor antibiotic practice, one model showed notable results for educational stream: both arts and commerce students were more likely than science students to say they would discontinue antibiotics when symptoms alleviated and before the antibiotic course of treatment was finished (arts: OR=2.76; 99.5% CI=1.58-4.82, commerce: OR=1.79; 99.5% CI=1.06-3.04). **Conclusions.** Young adults in India had poor antibiotic knowledge and practice. Efforts to improve antibiotic health knowledge and safe practice are required to help prevent the spread of antibiotic resistance.

INTRODUCTION

Since they first appeared in 1928 antibiotics have revolutionised healthcare [1, 2]. Their contribution to improved longevity, quality of life and reduction in premature death from infectious disease makes them indispensable to modern medicine [3]. However, widespread availability and use of antibiotics has resulted in an increasing number of resistant organisms, including multi-drug resistant (MDR) or pan resistant organisms [4].

Although inevitable in the natural ecosystem [5, 6], the rate of development and spread of resistance is amplified by human activity such as over-use and misuse, which are major contributors to the prevalence of antibiotic resistance within a community [6-9]. Factors that influence misuse include therapeutic and nontherapeutic use (curative or prophylactic), fear of poor clinical outcomes, medical norms and culture, perceived patient demand, gender, socio-economic, regulatory, knowledge or educational, environmental and global factors [6, 10-12]. Studies [13 14] also suggest that poor knowledge and awareness is an important cause of inappropriate use.

Reports have indicated that public awareness of antibiotics and antibiotic resistance has been found to be typically poor and lowest amongst young adults, women, poorly educated and non-whites [8, 9, 15, 16]. More specifically, medication knowledge and practices have been shown to be significant factors in the misuse of antibiotics among college students and young adults in Taiwan [13]. In a study by [17], although respondents were aware that viruses caused common colds, 73% of adults and 50% of students said that they treated flu and cold with antibiotics.

Self-medication is one of the most common concerns in studies that have examined safe/prudent use of antibiotics and is more common amongst women, youth and students [13, 18]. It contributes to antibiotic resistance through inappropriate use for viral infections and use of sub-optimal-quality or counterfeit drugs [19]. In one college study [13], more than a third of participating college students self-medicated in higher than recommended doses, and consultation with a doctor or pharmacist was found to be uncommon when individuals self-medicated. Hoarding antibiotics has also been found to be a common malpractice and often resulted in storage in uncontrolled environments and inappropriate use [9]. In Pakistan, 64% of college students consumed antibiotics from stock hoarded at home [18].

Non-compliance is also a concern, and can be a more serious issue than self-medication [13]. Typically, more than half of the respondents in survey studies reported that they deliberately altered or discontinued their antibiotics on relief of symptoms [9, 13]. Moreover, relying on participant self-report may considerably underestimate true rates, as one study [9] found that a 90% self-reported compliance rate was later discovered to be as low as 16% actual compliance.

India is witnessing increasing drug resistance to a number of life threatening pathogens, once thought to be under control, such as *Escherichia coli Streptococcus pneumoniae* which is now the leading cause of mortality among Indian infants, and including multi-drug resistance to pathogens of Tuberculosis [20, 21]. Where antibiotic resistance to serious pathogens is involved, there are two undesirable outcomes: increased cost in patient care for those who can afford it, or loss of life. The purpose of this study was to assess the prevalence of poor antibiotic knowledge and practice amongst higher secondary school students in Goa, India.

METHODS

Study participants were youth aged 16-17 from five schools from the North, South, East and West zones of Goa. Schools were selected at random within each zone. Each zone varies according to beliefs, affluency, customs, social background and literacy levels. Inclusion criteria for schools were:

1. All Public (government or government aided, non-private) schools.
2. Should provide Higher Secondary Education, (ie XI and XII standard; equivalent to A levels for 16-17 year-olds in the United Kingdom).
3. Should have at least the three main streams ie Science, Arts and Commerce.
4. Should be co-educational (mixed gender) schools.

Within a school, one class from each stream in each year was selected at random. The questionnaire used in this study was adapted a previous study in Taiwan [13] that assessed study medication knowledge and attitudes amongst first year college students. Designed by a group of faculty members and students from the school of pharmacy at Taipei University, this questionnaire was adapted from one previously use with the general public in Taiwan. Additional questions were included that were of relevance to Goan youth sample based on existing literature concerning youth medication behaviours and knowledge and on our personal experience of youth in the state of Goa, India. The questionnaire was also checked for readability with a small sample of students. Questionnaires were administered in the classrooms during lesson time by a researcher. Completion took from 15-30 minutes. The methods used in this study assured a high response rate and are consistent with other studies conducted in educational settings with a student population [13, 18]. Five questions concerned antibiotic knowledge and five questions concerned antibiotic practice. Assistance and clarification was given to a very small number of students, and responses solely reflect the opinion/knowledge of students. Questionnaire completion was voluntary, and complete anonymity of participants' identity was maintained, as no form of personal identification was recorded. University Research Ethics Committee approval was obtained before the study commenced, and questionnaire completion was specified as informed consent.

Analyses included summary percentages and ten general linear mixed models (GLMM in the R statistical programming language) with school as the random effect and gender, academic stream, and location as fixed effects [22], five models for antibiotic knowledge variables, and five for antibiotic practice variables. In logistic regression analyses correct responses to the questions in the survey were coded as 0 and incorrect (or uncertain) responses were coded as 1. Model estimates are reported as odds ratios (OR) and 99.5% confidence intervals (99.5% CI), conservatively adjusted for multiple models.

RESULTS

N=832 students were present and eligible for participation, and n=824 provided completed questionnaires, giving a response rate of 99%. Questionnaires where student age was not stated or stated as other than 16 or 17 (N=51) were not selected for data analysis, leaving N=773 eligible for analysis. There were no age or gender imbalances by geographic location.

Overall, antibiotic knowledge was poor, with 49% of students either wrongly thinking or unclear that bacteria cause colds/flu. Most (82%) students thought that antibiotics killed harmful viruses, 35% thought that antibiotics do not kill harmful bacteria, and 79% thought that antibiotics do not kill harmless bacteria. Most (67%) were unaware of the problem of antibiotic resistance. Table 1.

[TABLE 1 ABOUT HERE]

Similarly, respondents also reported poor antibiotic practice, with 19% reporting they frequently self-medicate with antibiotics, 57% said they would discontinue antibiotics when symptoms alleviated, and 24% admitted storing unused antibiotics at home. Most (73%) also said they expected doctors to prescribe antibiotics if they were sick with a flu/cold. Table 1.

GLMM showed that females consistently had poorer antibiotic knowledge than males. Especially notable were the higher odds in females for reporting incorrectly that antibiotics kill harmful viruses (OR=1.93; 99.5% CI=1.09-3.41) and for reporting incorrectly that antibiotics do not kill harmless bacteria (OR=2.02; 99.5% CI=1.16-3.51). Poor antibiotic practice was not clearly differentiated between males and females. Table 1.

The GLMM results also showed a tendency for students in arts or commerce educational streams, as opposed to a science stream, to have poorer antibiotic knowledge and to report poorer antibiotic practice. Both arts and commerce stream students were more likely than science stream students to think that bacteria are responsible for colds or flu (arts OR=3.56; 99.5% CI=1.98-6.41, commerce OR=2.78; 99.5% CI=1.56-4.96). Similarly, both arts and commerce students were more likely than science students to be unaware of the problem of antibiotic resistance (arts: OR=5.48; 99.5% CI=2.93-10.25, commerce: OR=2.85; 99.5% CI=1.64-4.94). In terms of poor antibiotic practice, one model showed notable results for educational stream: both arts and commerce students were more likely than science students to say they would discontinue antibiotics when symptoms alleviated and before the antibiotic course of treatment was finished (arts: OR=2.76; 99.5% CI=1.58-4.82, commerce: OR=1.79; 99.5% CI=1.06-3.04). Table 1.

Respondents from rural, as opposed to urban, areas tended to have poorer antibiotic knowledge, notably for being unaware of the problem of antibiotic resistance (OR=1.99; 99.5% CI=1.23-3.22). Rural students were also more likely than urban students to expect their doctor to prescribe antibiotics for a cold or the flu (OR=1.74; 99.5% CI=1.08-2.79). Table 1.

DISCUSSION

Bacterial resistance to antibiotics was unknown to a large proportion of student respondents. Although antibiotics do not kill viruses, whether harmful or harmless, most students thought that antibiotics kill ‘bad’ but not ‘good’ microorganisms, regardless of whether they are viruses or bacteria. This was especially evident for females, which is in line with other studies that have reported that women have poorer antibiotic knowledge [17]. Cultural factors within Goan society may help explain this finding, for example gender expectations regarding female roles mean that young women are entrusted with managing households and caring for families at a young age. This is also consistent with earlier research findings that self-medication is more common amongst women [13, 17]. There was also a clear tendency for poor antibiotic knowledge and practice to be more pronounced in arts and commerce students, rather than science students. It is likely that science students are more familiar with scientific and medical knowledge than arts or commerce students, which could help explain this finding. The results also showed that rural students had poorer knowledge and expectations than urban students for some aspects, but not others. It is possible that any differences between rural and urban settings reflect differences in the economic context for respondents: poverty has been linked to poorer antibiotic knowledge and practice [19].

Strengths of this study include the use of a previously validated questionnaire, a good sample size and high response rate, a robust statistical analysis, and overall the study, results and conclusions present a much needed perspective on antimicrobial use in an understudied population in a country with well documented antimicrobial challenges. There is a potential risk of reporting bias given that data was collected with a slef-completed questionnaire, although anonymity of responses should have protected against this risk. A limitation of the study is that it is limited to one state in India (Goa) and one population group (young adults still in education) so it is unclear to what extent the results are applicable to other population groups and settings.

One reason why some individuals reported misusing antibiotics could be a perception that the threat of antibiotic resistance is unknown or not taken seriously [2] and, consequently, the threat is not fully appreciated and often ignored both by concerned authorities and the public [6]. Antibiotics are ‘Societal drugs’ [2] and hence increased health knowledge and awareness could impact individuals and their immediate community. The WHO strategy [23] to control antibiotic resistance lists education as its primary intervention.

From the two types of non-compliance established in other literature [11], that is A) shorter than prescribed courses and B) reduced daily doses, this study identified a significant amount of type A non-compliance. Type B non-compliance was not directly examined, and should be further investigated in further studies of antibiotic practice. Just over half the respondents reported premature discontinuation of antibiotics, and this is an important finding in terms of the knock-on effect within communities and populations: apart from inadequately treating bacterial infections, non-compliance also results in 'left-over' antibiotics that, in turn, encourage self-medication [19].

In Europe additional health-care costs and productivity losses due to antibiotic resistance have been estimated to amount to €1.5 billion [6]. However it is difficult to estimate such economic burdens in India since surveillance systems are not in place to monitor such issues [20], though one study [24] found that out-of-pocket health expenditures were strongly correlated with anti-microbial resistance in low-income and middle-income countries. Verified epidemiological data only exists for major diseases that have had a long history with India such as Tuberculosis. Poor community awareness along with little legislation to control use, over the counter sales, primitive infection control and most importantly the lack of a central antibiotic resistance-monitoring agency clearly identifies the urgency of the situation in India if the global public health crisis of antibiotic resistance is to be curbed [7, 20]. What worsens this situation is the rapid decrease in the production of new antibiotics by pharmaceuticals that have shifted their focus to chronic diseases. The danger lies in not being able to cure simple but highly infectious and fatal diseases due to the loss of the efficacy of these compounds [6, 25, 26].

Importantly, one study [20] has identified that due to the lack of any national monitoring system, resistance issues are not raised as much as they are in the developed countries. This therefore prolongs a state of general unawareness or ignorance among the general population, including young adults.

Increasing population awareness appears to be the most efficient strategy given India's economic status and the apparent obstacles. No doubt regulation is vital, but education may serve as a better option than increasing the financial burden through enforcing regulation. Antibiotics are 'Societal drugs' [2] and hence awareness could instigate effects at an individual level and impact their immediate community [19]. The WHO strategy [23] to control antibiotic resistance lists education as its primary intervention. This accords with results from studies showing that an interest in medication knowledge existed among school students and 88% adults perceived education on antibiotics in school to be essential [7, 17, 18].

The level of knowledge that matters is that which promotes practice as close to safe/appropriate as possible. Hence the apparent lack of transference of knowledge into practice must be addressed. If patients are expected to be responsible for their health, it is imperative that they are made aware of all relevant information.

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Table 1: Prevalence estimates (and confidence intervals) of poor antibiotic knowledge and practice in high school students from Goa, India; alongside odds ratios (ORs, and confidence intervals) estimated from generalized linear mixed models (glmm) [22] for females vs. males, arts and commerce vs. science students, and rural vs. urban locations, with school as random effect. Confidence intervals are 99.5%, adjusted for 10 separate knowledge/practice analyses; results where OR confidence intervals do not include 1.00 are emboldened.

	All Students, Prevalence (%) (N=773)	**Gender ORs** *Females vs. Males*[a]	**Educational Stream ORs** *Arts vs. Science*[a]	*Commerce vs. Science*[a]	**Location ORs** *Rural vs. Urban*[a]
Poor Antibiotic Knowledge					
Bacteria causes colds / flu	49 (44-54)	1.28 (0.79-2.05)	**3.56 (1.98-6.41)**	**2.78 (1.56-4.96)**	1.98 (0.63-6.22)
Antibiotics kill harmful viruses	82 (78-86)	**1.93 (1.09-3.41)**	0.94 (0.47-1.87)	1.36 (0.68-2.72)	1.41 (0.60-3.28)
Antibiotics do not kill harmful bacteria	35 (30-40)	1.22 (0.75-1.97)	1.63 (0.91-2.93)	1.12 (0.62-1.99)	1.46 (0.76-2.81)
Antibiotics do not kill harmless bacteria	79 (74-83)	**2.02 (1.16-3.51)**	0.88 (0.45-1.75)	1.08 (0.55-2.11)	1.18 (0.69-2.03)
Not aware of bacterial resistance to antibiotics	67 (62-72)	1.13 (0.69-1.85)	**5.48 (2.93-10.25)**	**2.85 (1.64- 4.94)**	**1.99 (1.23- 3.22)**
Poor Antibiotic Practice					
Frequently self-medicate with antibiotics	19 (15-23)	0.81 (0.46-1.42)	1.24 (0.61-2.50)	1.29 (0.66-2.53)	0.77 (0.45-1.33)
Would stop antibiotics when symptoms alleviated	57 (52-62)	0.83 (0.53-1.31)	**2.76 (1.58-4.82)**	**1.79 (1.06-3.04)**	1.15 (0.74-1.78)
Admitted storing unused antibiotics at home	24 (20-29)	0.65 (0.39-1.08)	1.26 (0.67-2.36)	0.99 (0.53-1.84)	0.61 (0.38-1.01)
Expect doctor to give antibiotics for cold / flu	73 (68-77)	1.41 (0.86-2.30)	0.89 (0.49-1.60)	1.26 (0.70-2.29)	**1.74 (1.08-2.79)**
Would take antibiotics at friend's suggestion	25 (21-29)	0.98 (0.58-1.64)	1.67 (0.88-3.18)	1.36 (0.72-2.58)	0.79 (0.48-1.30)

[a] *reference category in multilevel logistic regression analyses*