

Community perceptions of infectious diseases, antibiotic use and antibiotic resistance in context of environmental changes: a study in Odisha, India

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Abstract

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Background The public health impact of environmental changes and the faceless threat of antibiotic resistance are currently among the top global health challenges. Community understanding of health, diseases and medicines in relation to the changing environment is necessary to mitigate the impact of these changes on health and for prudent use of antibiotics.

Objective The objective is to explore community perceptions of infectious diseases, antibiotic use and antibiotic resistance in the context of environmental changes.

Methods A qualitative study was conducted among community members with various backgrounds in education, gender, age and occupation of two districts of Odisha, India. Eight focus groups discussions and ten individual interviews were conducted. Data were analysed using content analysis.

Results Two themes emerged: 'Interpretation of infectious diseases and health hazards in the context of environmental changes', and 'Understanding of antibiotic use and its consequences for resistance development and the environment'. The participants perceived that nowadays there is irregularity in the occurrence of seasons, particularly an increase in average temperature, which is influencing health. Participants' perceptions of infectious diseases, antibiotic use and resistance varied according to their social environment. Furthermore, they perceived that improved sanitation, choice of alternative medicine and awareness and education on prudent use of antibiotics are probably some ways to prevent antibiotic resistance.

Conclusions The participants perceived that climate variability is increasing and that this has health consequences for the community. They also hypothesized an interrelationship between the environment, infectious diseases and medicine use, particularly antibiotics. This is helpful for further empirical studies.

Introduction

The public health impact of environmental changes¹ and the faceless threat of antibiotic resistance² are among the top global health challenges of the 21st century. The environment comprises of four major components: physical, natural, social and behavioural.³ The emergence and increase of infectious diseases, antibiotic use and increase of resistant bacteria interrelate with changes in any one or all of these components. Climate change, overcrowding, poor sanitation practices and behaviours relating to antibiotic use are examples of some of the changes.⁴

Antibiotic use is influenced by an interplay of knowledge, expectations and interactions of prescribers, dispensers and patients, along with the socioeconomic and regulatory environment.⁵ The emergence and re-emergence of infectious diseases and the increase of resistant bacteria require an understanding of how these changes impact on the infectious disease burden, use of medicines and public health⁴ and also how people perceive this issue. Community understanding of health, diseases and medicines in relation to the changing environment is necessary to mitigate the impact of these changes on health and for the prudent use of antibiotics. Furthermore this study is essential for a country like India, where environmental changes have vast impacts on public health.⁶

There are reports that the epidemiology of infectious diseases and use of antibiotics are associated with geographical regions, socioeconomic factors and climatic conditions.^{7–9} However, little is known about community perceptions of infectious diseases, antibiotic use and development of antibiotic resistance in context of environmental changes. Therefore, we explored the community perceptions of infectious diseases, antibiotic use and antibiotic resistance in the context of environmental changes in two environmentally different regions of Odisha, India. A qualitative study helps to explore unknown issues and gain insight into people's attitudes, behaviours and concerns about an underlying concept. Several articles have advocated for the need of conducting

qualitative studies in environmental health research.^{10,11} Thus we decided to use such a design as it facilitates the identification of knowledge gaps and generation of hypotheses for further research.¹²

Methods

Design, study setting and participants

A qualitative study was conducted among community members of two districts-Khurda and Malkangiri of Odisha, India. These districts together offer a large spectrum of environmental variability¹³ (Table 1). Eight Focus Groups Discussions (FGDs) and ten individual interviews were conducted. Based on the objective of the study, community members of different gender, age, educational background and occupation were purposively selected from two environmentally different districts to enhance variety. For the FGD the first author contacted about sixty persons, through prior contacts, as they were thought to be good informants. Among them 53 agreed to participate. Among the participants, 33 were from Khurda and 30 from Malkangiri district. A description of the participants is presented in Table 2. We selected participants from two different environmental contexts as we assumed that their perceptions might differ. Community members having any

Table 1 Description of the study areas with various environmental components

	Khurda	Malkangiri
Physical components		
Temperature (Maximum, Minimum)	41.4 °C, 9.5 °C	47.0 °C, 11.0 °C
Average rainfall in mm	1664	1465
Natural components		
Height from the sea level in metre	46	196
Forest coverage in %	13	38
Social components		
Population density per sq. km	649	77
Literacy rate in %	81	31
Infant mortality rate (SRS 2008)	57	151

<http://www.123orissa.com/exploreorissa/distinfo/default.asp>

Table 2 Background information of participants

Participants background	No of participants in Malkangiri				No of participants in Khurda			
	FGDs		Interviews		FGDs		Interviews	
	Female	Male	Female	Male	Female	Male	Female	Male
Gender								
Education								
Illiterate	7	6	1	1	7	8	–	1
Primary	2	–	–	1	1	–	–	–
Secondary	1	3	3	–	4	1	1	–
Higher	2	3	–	–	2	6	–	2
Occupation								
Employee/business	3	5	1	–	3	6	–	2
Daily labour	6	6	–	2	–	–	–	1
Farmer	–	–	–	–	–	8	–	–
Housewife	3	–	3	–	10	–	1	–
Student	–	1	–	–	1	1	–	–
Age								
18–25 years	4	2	1	1	2	1	–	–
26–59 years	7	9	3	1	9	11	1	2
> 60 years	1	1	–	–	3	3	–	1

Illiterate-someone who cannot, with understanding, both read and write a short, simple statement on his or her everyday life (United Nations Educational, Scientific and Cultural Organisation).

kind of health-care provider background were not included in the study as our intention was to bring out the views of laypeople.

Data collection procedures

Data were collected using a discussion/interview guide (Table 3). To bracket the researchers' pre-understanding and experiences open-ended questions were used during data collection. Four homogeneous FGDs with (i) illiterate women, (ii) illiterate men, (iii) literate women and (iv) literate men were conducted in each district. For each FGD eight to ten participants were contacted with the help of the local authority (village or ward head). Five to seven persons participated in each FGD as per their availability and willingness to participate.

Ten individual open-ended interviews, four in Khurda and six in Malkangiri district, were conducted to gather more in-depth information. The interviews were conducted after the preliminary analysis of the FGDs for more in-depth information. The interviewees were selected based on purposive snowball sampling.¹⁴ Participants of the FGDs were asked to suggest

Table 3 Interview/discussion guide, showing the introductory questions for each area of discussion

Introductory questions
What do you understand by infectious diseases?
What is your view on change in climate/weather?
What do you think of impact of change of environment or change in climate on infectious diseases?
Where and how do you take medicine/treatment?
Do you know what an antibiotic is? Can you describe more about it?
What is your view on non-functioning of some medicines?
Have you heard of antibiotic resistance?
Do you have any idea about how resistance problems can be controlled?

suitable informants for the individual interviews. After seven to eight interviews no new information emerged and thus saturation of data was reached. All the FGDs and interviews were carried out at a place convenient for both participants and the moderator/interviewer (residence of a participant, open ground or the school). The FGDs lasted for an average of 80 (range 60–110) min and the interviews for an average of 35 (range 20–60) min. All the FGDs and interviews were conducted in 2009 in the

local language, Odia, by the first author (KCS), who has an educational background in biological and environmental sciences; experience in social service and is a native of the study area. The FGDs were conducted in the presence of an observer, a sociologist who took notes during the discussions. One FGD and four interviews, held among indigenous tribal community members in Malkangiri district, were moderated, transcribed and translated by the sociologist who has command of the tribal language. The FGDs were audiotaped and video recorded to facilitate transcription, whereas the interviews were only audiotaped.

Data management and analysis

The recorded interviews were transcribed verbatim and the transcripts in Odia were translated into English. The first author (KCS) conducted the main analysis using content analysis.¹⁵ All authors further interpreted the transcripts. The co-authors have different professional backgrounds: agriculture, environmental medicine, nursing, pharmacy and qualitative research, all with a public health perspective. As the co-authors were from different professional and national backgrounds and also genders, each one brought a unique perspective to the study, which enhanced the conformability. During analysis this factor helped to broaden the interpretation and the final finding is a negotiated outcome of their deliberations. We did the analysis based on the participants' perceptions. During data collection and analysis pre-understanding by the researchers was bracketed. During the analysis, meaning units were identified, condensed and coded. The audiotaped and the video recorded versions, especially in case of the FGDs, were used to recognize the various participants. The Odia and English transcripts were used in parallel and crosschecked during the coding procedure to understand the full meaning. Similar codes were clustered together and collapsed into categories. Finally, the main themes that emerged during the analysis were articulated based on the categories. To avoid misinterpretation of the results, they were checked against both the Odia transcripts

and recorded versions by an independent researcher with a background in infection biology who had a command of the Odia language.

Ethical approval

The ethical committee of the Kalinga Institute of Medical Sciences, Odisha, India approved the study. Before the FGDs and interviews, permission was granted from the relevant local authorities, information about the purpose of the study was given to the participants, and they were informed about the video recording of FGDs and they accepted that. Participants were informed that they could withdraw from the study at any time and their names remained confidential.

Results

The results are presented under two major themes along with categories: (i) interpretation of infectious diseases and health hazards in the context of environmental changes (ii) understanding of antibiotic use and its consequences for resistance development and the environment. Quotes from the respondents within each category are presented to illustrate the findings. Explanations by the authors are put in square brackets.

Theme: Interpretation of infectious diseases and health hazards in the context of environmental changes

This theme emerged from two categories: (i) occurrence and way of transmission of infectious diseases and (ii) regional climate variation and its impact on health, diseases and medicines (Table 4).

Occurrence and way of transmission of infectious diseases

All the participants understood the meaning of infectious diseases, but their perceptions varied. The views of the illiterate participants of Khurda differed from the views of the illiterate participants of Malkangiri, whereas the literate participants of both the districts had a common viewpoint.

Table 4 Interpretation of infectious diseases and health hazards in the context of environmental changes

Theme	Interpretation of infectious diseases and health hazards in the context of environmental changes	
Categories	Occurrence and way of transmission of infectious diseases	Regional climate variation and its impact on health, diseases and medicines
Examples of codes	Common cold infection Tuberculosis, measles, small pox, chicken pox, diarrhoea, eye infection Transmitted from one to another Contaminated water and food Unhygienic surroundings, sharing clothes Overcrowding, open air defecation	Irregularity in seasonality, unpredictable cataclysmic events Water pollution, water and food borne diseases Scarcity of food, malnutrition Deforestation, urbanization, air pollution Agricultural intensification Temperature related health effects Emergence of skin diseases, previously suppressed infection Vectors survivorship, resistance to anti-malaria drugs

The illiterate participants of Malkangiri perceived that tuberculosis, leprosy, malaria, itching and scabies were infectious diseases. As per their view, sharing of clothes and droplet spray by sneezing were reasons for transmission of infectious diseases. Apart from this, according to other participants common cold, measles, small pox, chicken pox, diarrhoea, typhoid, filaria, swine flu and AIDS were viewed as examples of infectious diseases. All participants viewed that infectious diseases are transmitted from one point to another, i.e. from human to human, environment to human, animal to human and by physical contact with infected persons or animals. They perceived that most of the infectious diseases are either waterborne or airborne, and contaminated water and food were seen as major factors for the spread of infectious diseases. Some of the participants believed that in the case of eye infection, if somebody looked into the eyes of an infected person, there might be a chance of transmitting the infection. Literate participants said that overcrowding in urban areas and unhygienic surroundings due to poor sanitation practices such as faecal contamination as a result of open-air defecation in rural areas are main reasons behind the occurrence of most of the infectious diseases.

According to most of the illiterate and some literate participants there was a belief that measles and chicken pox manifested because of wrath of the 'Mata' (goddess). They viewed that if modern treatment was used to treat, 'Mata' would be angry and patients would not be cured,

so a worship ceremony is required for the cure. Some of the literate participants perceived that there is nothing wrong in a worship ceremony, which is based on traditional treatment methods.

The worship ceremony, which we perform to cure measles and chicken pox is logically correct. Mainly, we are using neem leaves and resin smoke, which kill the germs. The patient is sleeping on the neem leaves and away from the other family members; and patients eat in a separate bowl. We perform the ceremony for seven days, by that time the patient will be cured, so there is also some value in old traditional treatment, we cannot ignore it (FGD, literate females, Khurda).

Regional climate variation and its impact on health, diseases and medicines

Many participants perceived that nowadays there is an irregularity in seasons. For example, less cold and even sweating during the winter, and reduced rain, inconsistency in rain patterns and undue heat in the rainy season, as well as excessive heat in the summer. They perceived that deforestation, urbanization, air pollution and agricultural intensification are factors responsible for the change in climate. They also perceived that in general there is an increase in the average temperature, which has caused a decrease in the level of ground water, and dryness of ponds, wells, tube-wells and rivers, leading to water-crisis and health consequences.

Heat is increasing and cold is decreasing day by day. In our childhood, we were feeling severe cold in the winter. Nowadays no more cold, and also rain is not in time; during winter and the rainy

seasons, we feel like summer.... We destroyed lots of forests, so no rain and cold.... If all the three seasons [summer, winter and rainy] are in time, we feel happy and no more diseases will occur; there is no cold and more heat, that's why diseases are occurring (FGD, illiterate males, Malkangiri).

Most of the participants perceived that the changing environmental conditions cause unpredictable cataclysmic events like floods, droughts and cyclones as well as heat wave related mortality. These events also increase the number of environmental refugees and cause unhygienic surroundings and health consequences. The occurrences of such events were also viewed as a key factor for water and food borne diseases such as acute diarrhoeal disorders, malnutrition due to food crisis and air pollution related diseases. According to the participants, emergence of skin diseases, like pyoderma and measles among children, sunstroke, jaundice, malaria and dengue fever were the leading temperature related health effects. Some of the literate participants said that climate variability is responsible for re-emerging outbreaks of chicken pox and chikungunya. They also perceived that changes in the weather have caused alteration of the life cycle of some vectors i.e. vectors' survivorship, like tolerance of mosquitoes to insecticides and increases of vector population.

The chicken pox and measles were decreased, now these are again spreading. The environment is getting polluted which results in the rise of new diseases. The climate has a definite impact on diseases for example in coastal areas lots of filaria patients as coastal climate is suitable for survival of filaria mosquitoes and non-coastal for malaria mosquitoes (FGD, literate males, Khurda).

There is no rain in rainy season, that's why the mosquito population is rising. In heavy rains usually they die and their eggs are destroyed. Less rain is providing suitable surroundings for increase of their populations; heavy rain during rainy seasons is essential to decrease the Kita patanga [insect population] (Individual interview, literate female 45 years, Khurda).

The literate participants of Khurda perceived that climate variability is also responsible for non-functioning of some medicines, including

penicillins, spread of drug-resistant malaria and decreased immunity of humans.

Now penicillin injection is not working, malaria drugs are not functioning.... these medicines' power is not able to kill germ. Mosquitoes are also not dying by insecticides, this may be due to climate change (FGD, literate males, Khurda).

Theme: Understanding of antibiotic use and its consequences for resistance development and the environment

This theme evolved from four categories: (i) perceptions about antibiotics, (ii) use of antibiotics and resistance development, (iii) measures to reduce use of antibiotics and (iv) fate, effect and management of pharmaceutical wastes from the household (Table 5).

Perceptions about antibiotics

Participants' perception of antibiotics varied according to their education and urbanization of the community. The educated informants were more familiar with the term antibiotics. According to some of the participants, antibiotics were powerful medicines, used for quick or instant relief of any kind of disease. Some of the participants said that antibiotics are prescribed in order to not make any disease serious. Some of the educated participants were able to tell names of some antibiotics such as penicillin, ciprofloxacin, cefixime, ofloxacin and erythromycin. One offered the information that norfloxacin was used for dysentery. Some educated participants of Khurda district said that antibiotics are used to kill bacteria or germs. Some educated informants also used the terms high antibiotic, high dose and side effect. As per their view, antibiotics cured some diseases and simultaneously generated some diseases. Although the illiterate participants of Khurda were not able to understand the term antibiotics, they had heard the term and knew penicillin as a wonder drug for infections and as 'fever injection'. The illiterate participants of Malkangiri were not at all able to understand the term antibiotics.

Table 5 Understanding of antibiotic use and its consequences for resistance development and the environment

Theme	Understanding of antibiotic use and its consequences for resistance development and the environment		
Categories	Perceptions about antibiotics	Use of antibiotics and resistance development	Measures to reduce use of antibiotics
Examples of codes	Quick relief of any kind of disease or instant relief Wonder drugs for infections Not to make any diseases serious or powerful medicine Fever injection Kill bacteria and germ Penicillin, Erythromycin Ciprofloxacin, Cefixime Norfloxacin, Ofloxacin	Sharing medicine Improper diagnosis Irrational prescription Untrained prescribers Lack of doctors Non-functioning of medicine Excessive use of chemicals in food production Change in food habit and climate Fake and low quality medicine Non-compliance behavior	Fate, effect and management pharmaceutical wastes from the household Unused medicine Chemicals harm environment Impact on water Affect aquatic organisms Dispose properly Policy needed No instruction for proper disposal Awareness needed

We have heard the word antibiotics from hospitals, when we feel fever, doctors prescribe antibiotics and another tablet...Penicillin injection is good for wounds (FGD, illiterate males, Khurda).

Use of antibiotics and resistance development

According to the educated participants of both the districts, antibiotics were the most commonly used medicines. Most of the participants, except illiterate participants of Malkangiri, viewed that an incomplete course of antibiotics (because of poverty and high cost), self-medication, medicine sharing and use of leftover medicines were common practices among the community members.

People are not taking medicines completely; poor people, no money for rice and salt, how will they buy full course of medicine; some people when cured a little, they think, they are well, no need to take full medication (FGD, illiterate females, Khurda).

Some educated participants said that improper diagnosis, irrational and frequent changes in prescriptions of some of prescribers, and the mercenary natures of some of the trained and untrained prescribers were other factors for irrational prescription. They also perceived that high load of patients in hospitals and lack of trained prescribers and in some remote areas even lack of untrained prescribers or 'quacks' are also contributing factors to irrational use of medicines. Some of the participants realized that although untrained prescribers or so called 'quacks' were giving irrational treatment they were still helping people in remote areas. They suggested that supportive training and orientation on appropriate treatment would be of benefit for 'quacks'. Some of the participants also suggested restricting the 'quacks' to carry out only primary treatment or first aid, followed by referral to local trained prescribers.

There is a need for rules and regulations of quacks. They should be permitted for only first aid. They are providing saline without knowing the diseases; that is wrong. They are injecting intravenously without justification, they should be limited in their treatment to first aid level, just take care of the patients until they reach a hospital. Anyhow, they

are helping people in emergencies; we should verify their knowledge and train them (FGD, literate males, Malkangiri).

None of the participants understood the concept of antibiotic resistance, but after a brief description of the term, certain individuals said that some of the previously used medicines were not prescribed nowadays. Most of the participants were of the view that excessive use of chemicals in cultivation, availability of fake and low quality medicines, irrational prescriptions and non-compliant behaviour of community (such as incomplete courses, medication sharing and use of leftover medicines) resulted in non-functioning of some medicines.

Previously, penicillin was working well, now doctors are not prescribing penicillin. It is not working as we are eating poisons, but without chemical fertilisers no food production (FGD, illiterate females, Khurda).

Some participants perceived that some of the medicines were not working due to variation in climate. In addition to this, some of them thought that an increase of germs in the body due to pollution and overcrowding might be one reason for this. While few of them suggested that medicine losing its effect (due to drug resistance) is the major cause behind the non-functioning of some drugs, others claimed that decreasing body immunity is the major reason behind it. However, they suggested research on new medicines, which will help in increasing body immunity.

Gradually, immunity power of our body is decreasing; for that reason we are requiring high doses of medicines i.e. instead of one dose there is requirement of two doses. We are applying more chemicals in our foods. Our food habits and climate, both are changing. Due to these reasons body immunity is decreasing and medicines are not working (Individual interview, literate male 32 years, Khurda).

Measures to reduce use of antibiotics

Some of the educated participants understood the consequences of antibiotic resistance and the need for reduction in antibiotic use. They perceived that, to reduce the use of antibiotics, there is a need for improved hygiene, medication by

herbal treatment instead of unnecessary antibiotic treatment, rational antibiotic use practices and awareness among the public.

According to the participants, by improving personal hygiene (through cleanliness, hand hygiene and sanitation practices), one can avoid use of antibiotics. Some educated participants suggested that sanitation (such as disposal of garbage far from potable water source, and use of toilets for defecation), high quality water supply, education and awareness about hygiene (for example infection control practices) are essential in the community. Some informants highlighted yoga (exercise, breathing and meditation) and pranayam (breathing exercises) as the best preventive methods to improve health and reduce the need for medicines.

By practising yoga, we can avoid common diseases without taking medicines. My mother had suffered burning sensations in her legs and joints; we visited a skin specialist, a bone specialist and also a physiotherapist. Nothing happened, but after practising yoga and pranayam, she got cured. For common cold we are not taking medicines, we are doing pranayam...By practising yoga and pranayam; we can prevent misuse of medicines (FGD, literate females, Malkangiri).

Some participants from both the districts emphasized the need for traditional herbal treatment for infection control, so as to reduce antibiotic use. Although some participants emphasized antibiotic treatment for the common cold, some disagreed and suggested traditional treatment, such as basil (*Ocimum sanctum*) leaf with honey for treatment of common cold. Many participants informed about the anti-infective properties of neem (*Azadirachta indica*), and some of them emphasized the use of jasmine (*Nyctanthes arbor-tristis*) for malaria fever.

The educated participants realized that by avoiding unnecessary use of antibiotics (such as in treatment of common cold), through self-medication with antibiotics, and by taking the complete course of antibiotic treatment, resistance development might be prevented. Most of the participants viewed that by creating proper awareness among the community members, misuse of antibiotics can be prevented. They

suggested that awareness can be created through health missions by doctors, health workers, paramedical staff, teachers, village heads, NGOs and neighbours. The awareness can also be propagated by mass media.

Fate, effect and management of pharmaceutical wastes from the households

Some of the participants were concerned about the fate and effect of pharmaceutical waste of the households. Some of them were of the view that improperly disposed, unused medicines got mixed in ponds or rivers through rain water, and that chemicals present in these medicines polluted the environment with effects on aquatic organisms. Almost all literate informants suggested the need for proper management and disposal of unwanted pharmaceuticals. The participants mentioned that they were not aware of any instructions or environmental law for the proper disposal of pharmaceuticals. They suggested that there is a need for policy and awareness for disposal of household pharmaceutical wastes in a specific garbage dump in the community.

Discussion

This is, to our knowledge, the first study exploring community perceptions on health, infectious diseases, antibiotic use and antibiotic resistance in relation to the changing environment. All participants perceived that nowadays there is irregularity in the occurrence of seasons, associated with an increase in temperature and that these changing environmental conditions are influencing health. The participants also perceived an interrelationship between the environment, infectious diseases and medicines. While all participants understood the term infectious diseases, many literate and urban illiterate participants had heard of antibiotics. None of the participants understood the concept of antibiotic resistance, but after a brief description of the term, some of them considered it as a possible cause of non-functioning of some of the previously effective medicines. It was perceived that reducing the need for and use of antibiotics could prevent antibiotic resistance.

Climate variability and health consequences

Many participants in this study thought that changes in the climate had health consequences. There was a variation in the perceptions amongst study participants and this differed according to their education; educated participants were more aware of changes and the impact of climate. A study on climate and health consequences conducted in the USA showed that there it was the income level, rather than educational level, that governed the behaviour among respondents.¹⁶ The findings of our study suggest that the participants are concerned about the health consequences of both direct and indirect impact of climatic variations. The direct impacts are lives lost due to extreme weather events such as heat waves, floods and cyclones. The indirect impacts are climate variability, resulting in acute diarrhoeal disorders, vector borne diseases and malnutrition. Our findings are largely consistent with studies on public perceptions on climate change from Africa, the United States of America and Europe.^{17–19}

Interrelationship between climate, infectious diseases and medicines

The climate influences the incidence of infectious diseases. In particular, it can increase water-borne and insect-transmitted infectious diseases.^{20–22} The participants in our study perceived that climate variability is altering the life cycle of the vectors, which might increase the burden of infectious diseases. They had noticed that change in climate is coinciding with re-emergence and outbreaks of chickenpox and chikungunya infections.

According to Xun *et al.*²³, the association between climate and health is complex; hence change in climate brings new challenges to epidemiology. In general, there is a lack of empirical studies on the relationship between climate, infectious diseases, and antibiotic use and resistance. Our study has attempted to explore the community perceptions on this issue. The participants perceived that the extreme weather events result in spread of infectious diseases and

increased use of medicines, which might result in non-functioning of some medicines, particularly antibiotics. A relationship between social and climatological factors, and antibiotic resistance was reported in Spain.²⁴ Their study was however more focused on social and natural environment rather than climate. Our previous study among health-care professionals in India revealed the perception that changes in the physical and natural environment influences the development of antibiotic resistance.²⁵

The present study brought out the perception that the climate, infectious diseases and medicine use are interrelated. This is however a dynamic and complex relationship, which is difficult to prove scientifically.

Knowledge of infectious diseases, antibiotics use and resistance

The participants' knowledge of infectious diseases and antibiotics varied according to their educational level and urbanization of the community. There were however no gender differences in perceptions. Community members were not aware of modern treatment of measles and chickenpox infections, and reported that they performed traditional worship ceremonies for cure. It is a common practice among many communities from low- and middle-income countries which also embraces hygienic practices.²⁶ There is a paucity of scientific studies on such traditional beliefs.

A prior study on community perceptions by Hawkins *et al.*²⁷ in the United Kingdom showed that participants were confident in the effectiveness and safety of antibiotics, but unfamiliar with their disadvantages and side effects. According to their participants, antibiotics were 'quick', 'effective', 'strong', 'safe' and a 'life saver' medicine. They also perceived that a non-compliant behaviour of the community towards antibiotic use was one of the reasons behind development of antibiotic resistance. Our findings were similar, except that many participants in our study appreciated that use of antibiotics could produce side effects. According to our participants, antibiotics were useful for the common cold, which

indicates the poor knowledge of the participants towards appropriate use of antibiotics.

A previous study in the United Kingdom²⁸ showed that community members do not see bacterial resistance as a personal threat but something that occurs in hospitals. Although the participants in our study were unaware of what antibiotic resistance is and how resistance develops, they were aware of non-functioning of some medicines. They perceived that irrational prescriptions by trained prescribers and quacks, and availability of fake and low quality medicines might be reasons for non-functioning of medicines, which is similar to other findings from developing countries.²⁹ In a previous qualitative study from India, participants perceived that if the same medicine is used again and again, it might become ineffective after some time and use of antibiotics in farm animals could thus influence antibiotic resistance in humans.³⁰ The participants in our study perceived that excessive use of chemicals in cultivation and change in climate might be contributing factors for non-functioning of medicines.

Prevention of antibiotic resistance

The participants perceived that sanitation, herbal treatment, and practice of yoga and pranayam are essential to reduce antibiotic use and prevent resistance. Domestic and personal hygiene introduces a sanitary barrier and helps to prevent infectious diseases thereby reducing the need for antibiotics.^{31,32} Some participants in our study also voiced this opinion. Our participants also perceived that the choice of herbal treatment as alternative to antibiotics might help to reduce antibiotic use and thereby prevent resistance. Antimicrobial activities of several plants have been found by previous studies.^{33,34}

Our participants believed that regular practice of yoga and pranayam can help in strengthening immunity and thus can help in fighting diseases. A similar conclusion was drawn in a review.³⁵ The participants also suggested the need of orientation programmes on rational use of antibiotics for trained and untrained prescribers. The findings of our study suggested the need of

education and awareness among communities on hygiene practice, and use of herbal treatment as an alternative to antibiotics in non-severe infections such as the common cold to reduce antibiotic use and to prevent resistance.

Methodological considerations

We used triangulation of data sources, methods and analysis to improve trustworthiness of the study. Information was collected from various groups of community members, i.e. different gender, age, occupation, socioeconomic, education and urbanization levels. Both FGDs and key informants interviews were used for data collection. We divided the FGD groups according to gender, but we did not find any difference in views according to gender in any of the themes. However, in a male dominant society it is essential to divide the groups according to gender, to make it easier for women to express their opinions freely. As the authors have various different educational backgrounds, and are from different countries and cultural settings, we interpreted the findings with both insider and outsider perspectives. We followed crosschecking methods during analysis of transcripts. Formal member check was not carried out but informal discussions with the study participants (on a revisit after finishing the analysis) suggest that they felt that their perceptions were interpreted correctly. Although we conducted the study in Odisha, the findings might be useful in other similar settings. We conducted FGDs among male indigenous community members, but due to practical reasons, we could not conduct FGDs among female indigenous community members. Instead we conducted some individual interviews among them.

Implications

This is a qualitative study; therefore, inferences from this study are not directly applicable to other situations. However, taking guidance from this study, suggestions in relation to health and health-related behaviour can be made to the policy makers and NGOs working on improving

the public health situation in Odisha and elsewhere. Most participants in our study talked about and experienced health consequences due to climate variability. They considered that deforestation is the main cause for this and that scarcity of good quality water is the reason for most of the climate sensitive health consequences. Thus, there is a need for reforestation and increased access to potable water. This is already an item on the agenda of policymakers and NGOs, but it appears to need further strengthening. It emerged from our study that there is a need for education and awareness campaigns among community members on hygiene practices, proper disposal of household pharmaceutical waste and understanding of the natural progress of diseases. For example, community members need to know that common cold is a self-limiting disease where the person will not benefit from treatment with antibiotics. Increased awareness amongst community members in this regard, and orientation programmes on rational use of antibiotics amongst trained prescribers will reduce antibiotic (mis)use and hence will also reduce prospects of resistance. Another lesson that can be drawn from this study is that there is a need for supportive training and orientation for 'quacks' on appropriate treatment practices for common diseases. This is essential as quacks are continuing to treat people in remote areas, where there is a lack of trained health-care providers.

Conclusions

The participants perceived that climate variability is increasing and that this has health consequences for the community members. They also perceived an interrelationship between environment, infectious diseases, antibiotic use and resistance. This can be used as a basis for empirical studies on how environmental factors influence antibiotic use and resistance development. The views on meaning and occurrence of infectious diseases, as well as on antibiotic use and consequences of resistance, varied according to the social environment of the participants. The participants suggested that improved

sanitation, choice of herbal treatment and practice of yoga and pranayam could prevent unnecessary use of antibiotics. Furthermore, it was perceived that orientation programmes among the prescribers along with community awareness on rational use of antibiotics could reduce unnecessary use of antibiotics, thereby helping to minimize resistance development.

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Conflict of interest

The authors declare that they have no competing interests.

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