International Baccalaureate

# Extended essay cover

Sample A

| *Candidates must complete this page and then give this cover and their final version of the extended essay to their supervisor.* | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Candidate session number | 0 | 0 | | | | | | | |
| Candidate name | | | | | | | | | |
| School number | | | | | 0 | 0 | | | |
| School name | | | | | | | | | |
| Examination session (May or November) | MAY | | | Year | 2009 | | | | |

Diploma Programme subject in which this extended essay is registered: Environmental systems and societies

(For an extended essay in the area of languages, state the language and whether it is group 1 or group 2.)

Title of the extended essay: An Investigation Into The Social and Environmental Causes of Cholera.

**Candidate's declaration**

*If this declaration is not signed by the candidate the extended essay will not be assessed.*

The extended essay I am submitting is my own work (apart from guidance allowed by the International Baccalaureate).

I have acknowledged each use of the words, graphics or ideas of another person, whether written, oral or visual.

I am aware that the word limit for all extended essays is 4000 words and that examiners are not required to read beyond this limit.

This is the final version of my extended essay.

Candidate's signature: _____ Date: 20/5/09

**IB Cardiff use only:** A: _____ B: _____

## Supervisor's report

*The supervisor must complete the report below and then give the final version of the extended essay, with this cover attached, to the Diploma Programme coordinator. The supervisor must sign this report; otherwise the extended essay will not be assessed and may be returned to the school.*

Name of supervisor (CAPITAL letters)

## Comments

*Please comment, as appropriate, on the candidate's performance, the context in which the candidate undertook the research for the extended essay, any difficulties encountered and how these were overcome (see page 13 of the extended essay guide). The concluding interview (viva voce) may provide useful information. These comments can help the examiner award a level for criterion K (holistic judgment). Do not comment on any adverse personal circumstances that may have affected the candidate. If the amount of time spent with the candidate was zero, you must explain this, in particular how it was then possible to authenticate the essay as the candidate's own work. You may attach an additional sheet if there is insufficient space here.*

The candidate suggested this topic as it is a concern relevant to the area in India from which she comes.
She researched the topic very methodically and spent time working on it when she was in India during the summer break. The practical investigation was carried out in India under the supervision of Mudhaji College, but she practised the psychological techniques used under my supervision prior to going to India.

✓

I have read the final version of the extended essay that will be submitted to the examiner.

To the best of my knowledge, the extended essay is the authentic work of the candidate.

I spent [ 4 ] hours with the candidate discussing the progress of the extended essay.

✓

Supervisor's signature:

Date: 13/02/09

# International Baccalaureate Diploma (2007-2009)

**Centre:**
**Centre number:**
**Candidate name:**
**Candidate number:**
**Date:** 24/01/2009

# Extended Essay

**Topic:** An Investigation into the Social and Environmental Causes of Cholera

**Research Question:** The impact of sanitation on the incidence of cholera in Satara district of India

**Subject area**: Environmental systems and societies

✓

Etary investigation / spread (human) of cholera.
Nice systems approach.
Weak sph + data as clear but techniques used more standard microbiological ones.
Small aged research. Better as a bio EE?

**Word Count:** 3669

# Acknowledgement

I acknowledge and thank , my supervisor, for his continuous support and helpful guidance during the development of this assignment.

I also thank Microbiology Department of Mudhoji College, Phaltan (India) for permitting me to carry out the experiment and Government Health Department of Satara district (India) for providing information. I thank all those individuals who contributed in this assignment and are not part of this acknowledgement.

Thank you very much!

# Abstract

This essay sought to explore the social and environmental causes of cholera incidents in the district of Satara, located in Maharashtra state of western India. Possible social and environmental causes are discussed in relation with the cholera incidences in the district over the past four years. The main aim was to investigate the relation between sanitation facilities in the villages and cholera cases. It was found after comparing the cholera cases and number of families using sanitation facilities in the years 2004-2007 that these had a negative correlation.

To examine it further, the coliform count of the tap water of two villages were compared. One village is a totally sanitized village with basic sanitation facilities and the other has problems of sanitation such as open defecation. It was found that the totally sanitized village had no coliform bacteria in the water whereas the other village had coliform in its water. It is suggested that the amount of coliform could be due to the open defecation and lack of sanitation facilities making non-sanitized villages vulnerable to cholera outbreaks. Environmental causes were also taken into account but they need to be investigated thoroughly by the experts.

It was concluded that there is a possibility of social reasons being responsible for the cholera incidences more than environmental causes. However, the need of investigating environmental reasons is stated. Some possible measures to control the disease are given, which should be carried out by the local government such as vaccination programs and awareness campaigns. Finally, limited source of information due to time and financial limitations is acknowledged while making the conclusions.


**Words:** 266

# INDEX

# Introduction

In my locality in India I see people suffering from diseases such as cholera every now and then and I wonder about the causal reasons of such outbreaks. As cholera is a waterborne disease, it was clear to me that water pollution should be the main reason for this; but as I looked at it more closely I discovered that there are other social reasons as well, such as open defecation which led in having frequent outbreaks of cholera in Satara district. When I came to the UK, seeing basic hygiene facilities and general cleanliness, I was assured that the reason for cholera in my locality was lack of hygiene and sanitation.

Satara is a district in a West Indian state called Maharashtra. It is located in the western part of Maharashtra. It has 1727 villages in it which are similar to thousands of other villages of India, with lack of facilities and affected by poverty. In Satara, average literacy rate is 78.52% of the total population: male literacy rate is 88.45% and female literacy rate is 68.71%.[1] This also plays a vital role in general health of the people.

I decided to look at this topic as I believe that there can be causes other than general assumptions whose roots may lie in social reasons. This topic has a practical importance in the area as it is affected by cholera very often, especially in the rainy season. If this question is answered, it will prove to be aid in controlling frequent outbreaks of the disease. This essay will be of special value for the people who suffer from the disease and to some extent to the people who are trying to control it in one way or the other. It is because this essay will look at environmental as well as social reasons behind the cholera spread. If some useful evidences and conclusions are made from the essay, they can be used to implement preventive measures for the disease in Satara district. It might also give an overview of cholera in Maharashtra on a broader level.

I think by the end of this essay I will have information about the causal reasons of this disease in Satara. I might be able to identify the measures for this disease in specific areas or propose further research options. This essay will deal with the hypothesis that the outbreak of these diseases is due to the lack of sanitation and proper hygiene habits among people in the particular area. It will show the statistics of the district in relation with cholera.

[1] : http://www.indianetzone.com/8/satara_district_maharashtra.htm

# Cholera: An Overview

Cholera is caused by the bacteria known as Vibrio cholerae which has two major biotypes: classical and EI Tor which was first isolated in Egypt in 1905. Currently EI Tor is the predominant cholera pathogen worldwide. The V.cholerae is comma shaped gram-negative aerobic bacillus whose size varies from 1-3 mm in length by 0.5-0.8mm in diameter. Its antigenic structure consists of a flagellar H antigen and a somatic O antigen. It is the differentiation of the latter that allows for separation into pathogenic and non-pathogenic strains.[2]

V.cholerae is a saltwater organism and it is primary habitat is the marine ecosystem.[3] Cholera has two main reservoirs, man and water. Animals do not play a role in the transmission. V.cholerae is unable to survive in an acid medium. Therefore, any condition that reduces gastric acid production increases the risk of acquisition.

The faecal-oral route through contaminated water and food and sometimes land, transmits cholera. The infectious dose of bacteria required causing clinical diseases varies with the source. If ingested with water the dose in the order of $10^3$ – $10^6$ organisms to spread infection. When ingested with food, fewer organisms are required to produce disease, namely $10^2$– $10^4$.[4]

Direct transmission is rare in this route; for humans at least. Most common are the indirect routes like contaminated foodstuffs or water. It may be caused by people not washing their hands before preparing food or untreated sewage being released into a drinking water supply. People who eat and drink it become infected. In developing countries, most sewage is discharged into the river or on cropland. This is the typical mode of transmission for the infectious agents of cholera. This is what happens in Satara but some of the sources are more responsible than others.

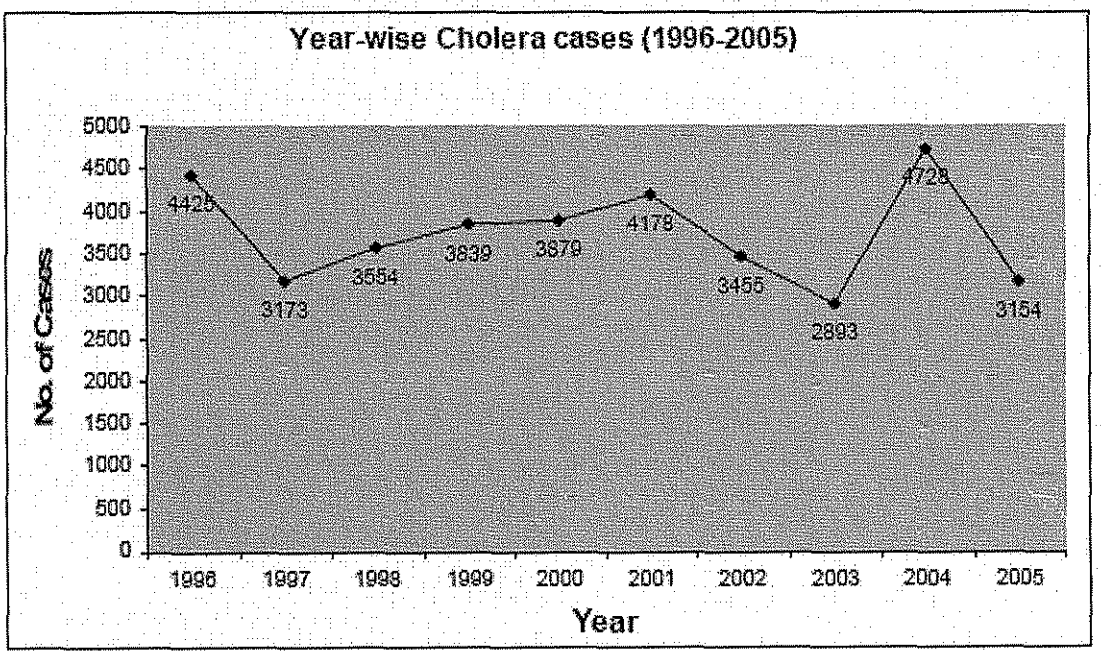
[2] : http://www.pitt.edu/~super1/lecture/lec19901/003.htm
[3] : http://www.pitt.edu/~super1/lecture/lec19901/011.htm
[4] : http://www.pitt.edu/~super1/lecture/lec19901/010.htm

# Cholera in India

Cholera has been an issue of concern for human beings all over the world for a long time. Now, considered to be eradicated in most of the developed countries, cholera still has its vicious effects in developing and undeveloped countries. India is one of them. Even though overall rate seems to have gone down; its severity in some areas is still enormous as population has increased as well.

The table below shows the cases of cholera in India during the year 1996 to 2005. This shows the consistency of the disease in the country.[5]

Figure and Table should be numbered




A study to show the burden of cholera in the area called Kolkata (West Bengal) of India is given below.[6] The experts from National Institute of Cholera and Enteric Diseases, Kolkata, India conducted it in the year 2003-04. This gives the general picture of the disease in India, even though it should be considered that the burden of the disease differs in different areas. Kolkata is a city situated on the coast of the Bay of Bengal.

- **Aims:** To conduct a prospective, community based study in an impoverished urban site in Kolkata (formerly Calcutta) in order to measure the burden of cholera, describe its epidemiology, and search for potential risk factors that could be addressed by public health strategies.

[5] : http://www.whoindia.org/linkfiles/health_&_environment_country_report_climate_change_kl_workshop.pdf
[6] : http://adc.bmj.com/cgi/content/abstract/90/11/1175

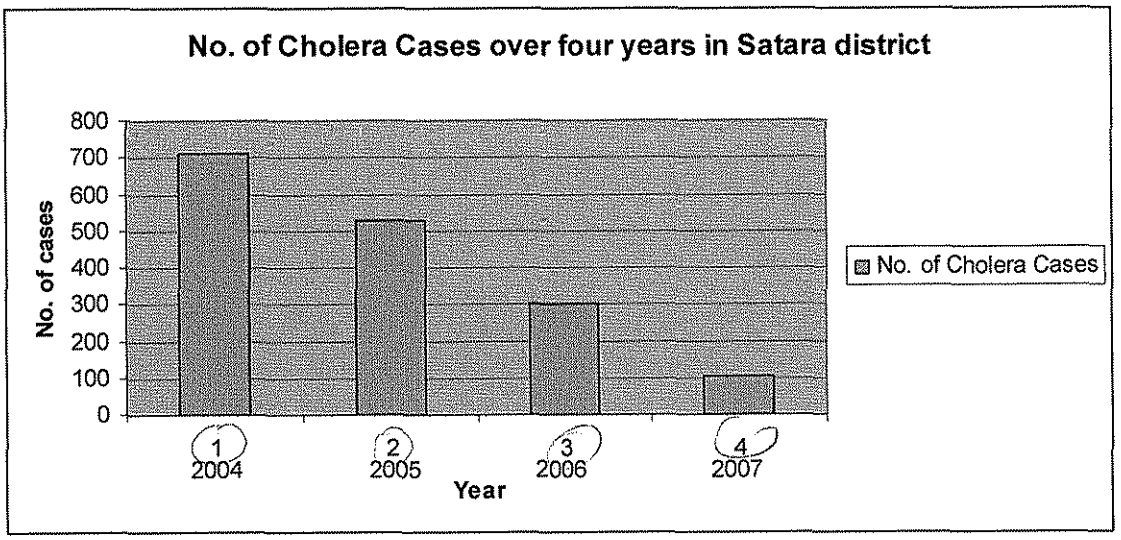
- **Methods:** The study population was enumerated at the beginning and end of the study period. Surveillance through five field outposts and two referral hospitals for acute, watery, non-bloody diarrhoea was conducted from 1 May 2003 to 30 April 2004. Data and a stool sample for culture of Vibrio cholerae were collected from each patient. Treatment was provided in accordance with national guidelines.
- **Results:** From 62 329 individuals under surveillance, 3284 diarrhoea episodes were detected, of which 3276 (99%) had a stool sample collected and 126 (4%) were culture confirmed cholera. Nineteen (15%) were children less than 2 years of age, 29 (23%) had severe dehydration, and 48 (38%) were hospitalised. Risk factors for cholera included a household member with cholera during the period of surveillance, young age, and lower educational level.
- **Conclusions:** There was a substantial burden of cholera in Kolkata with risk factors not easily amenable to intervention. Young children bear the brunt not only of diarrhoeal diseases in general, but of cholera as well. Mass vaccination could be a potentially useful tool to prevent and control seasonal cholera in this community.

After getting general information of the presence of this disease in India, now this essay will concentrate on the Satara district in particular. This background information will be helpful in looking at the individual district.

# Cholera in Satara

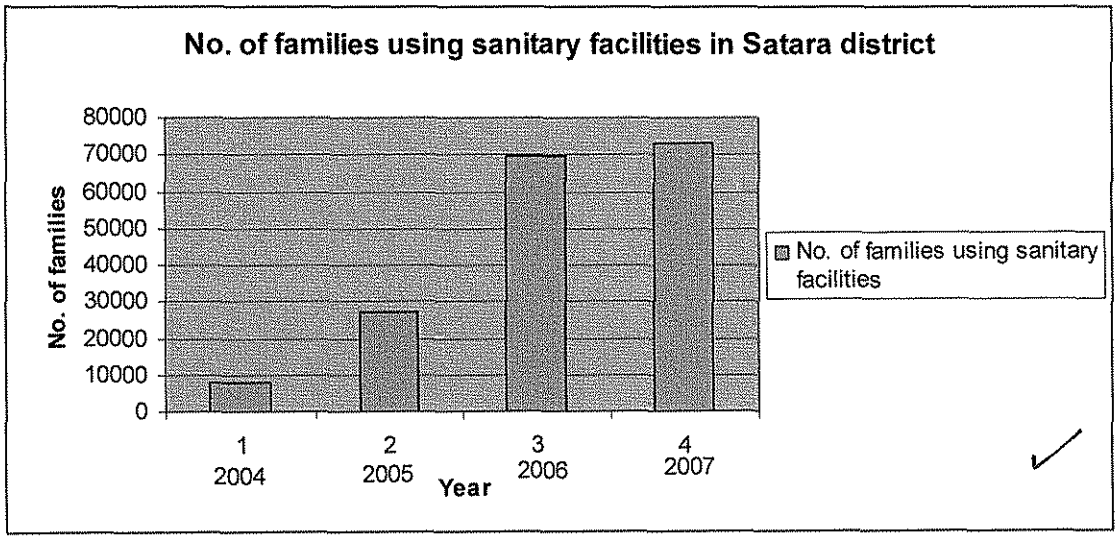
Satara as many other districts of India, suffers from frequent cholera outbreaks due to various reasons. In some villages people have adapted 'Total sanitation policy' which means learning sanitary habits and building toilets for every family. In totally sanitized villages open defecation does not occur. Significant differences are seen in such areas about frequency of the disease and risk of the outbreak. Following charts are presented to compare the number of cholera cases and use of the sanitation facilities from 2004 to 2007. The data about number of cases was collected from the district health department, where hospitals inform the detected cases of diseases. Numbers of people using toilets were collected from a government website.

The following chart is showing the number of total cholera cases that were detected in Satara district during the years 2004 to 2007.[7]




[7]: Source: Satara District Health Department

The following chart shows the total number of families in Satara district that are using at least basic sanitary facilities such as toilets during the years 2004-2007:[8]




It can be seen from comparing these charts that as the number of people and families using sanitary facilities has increased, the number of cholera cases has decreased significantly. There is a negative correlation between the number of cholera cases and the number of families using sanitary facilities in Satara. It is because when people do not defecate on the open land or near water resources, the water does not get contaminated making possibilities of the disease less.

[8] : http://nirmalgrampuraskar.nic.in-NirmalGramPuraskarFinalResults

# Coliform test

It has been said that due to total sanitation of the villages and increase in the number of people using sanitation facilities, there has been decrease in cholera cases. This suggests that non-sanitized villages are prone to the disease. To show that non-sanitized villages were more likely to have contaminated water and hence, the possibilities of the Cholera outbreak, Coliform tests were conducted to show the difference between Coliform count from the water samples from a sanitized village and a non-sanitized village. Presence of the Coliform bacteria suggests that the water which is being tested is contaminated and may have other pathogenic bacteria. Coliform is relatively harmless and hence was chosen for the test. Details of the experiment are given below. ? how?

As water gets polluted mostly in the villages because of the open defecation, cities having better sanitation facilities, villages were chosen for taking samples. These two villages were chosen to compare the results because Asgaon is totally sanitized village now and in Khed only 60% people use toilets and bathrooms. These two villages are nearly equally populated, so they could be compared with each other. Both of these villages are situated on the banks of rivers. Being in the same district, they have nearly equal climate and geography.

The water that was collected for the testing was tap water. This water is collected from the local resources like rivers and is then distributed in the villages after cleaning it on a truly basic level e.g. adding chlorine to it. It was assumed to have more coliform level in the water of Khed as people defecate on the open land and near the water resources. As a result water should have been getting polluted in that place more than Asgaon as there is not such a case. ✓

**Title:** An investigation of the total coliform count in the water of Khed and Asgaon. ✓

**Aim:** To count the number of total coliform bacteria per 100ml sample water taken from water sources of Asgaon and Khed.

**Hypothesis:** Total coliform level in the drinking water of Khed is more than that of in Asgaon on the days of sample collection. ✓

**Apparatus required:** sterile bottles, sterile pipettes, burette, sterile water, nutrient agar plates containing nutrient agar, refrigerator, incubator, container, marker pen, organic tape, clean table and tissue paper.

**Procedure:**

1. Sample of water was taken into sterile bottles. It was taken from tap water, in both of the villages.
2. 9 ml water was poured in 6 bottles using a 10ml pipette which made 6 tenfold dilution series. Bottles were labeled as $10^{-1}$, $10^{-2}$, $10^{-3}$, $10^{-4}$, $10^{-5}$ and $10^{-6}$. 1 ml water was transferred to the bottle with label $10^{-1}$ using 1ml pipette. The total amount of liquid in the bottle $10^{-1}$ was now 10ml. the bottle was shaken properly to mix the contents.
3. With a new pipette 1ml water was removed from the $10^{-1}$ bottle and transferred to the $10^{-2}$ bottle and the contents were mixed by shaking. In the same way, the dilution process was done up to $10^{-6}$ bottle.
4. 6 nutrient agar plates were taken and labeled as $10^{-1}$, $10^{-2}$, $10^{-3}$, $10^{-4}$, $10^{-5}$ and $10^{-6}$. These were called Set I agar plates. 1ml of the dilution sample was removed from the $10^{-1}$ bottle and transferred to $10^{-1}$ agar plate using 1ml pipette.
5. The dilution was spread in agar plates carefully so that the medium is not splashed on the lid and outside of the dish. In the same way dilution samples were transferred to rest of the agar plates from the bottle of their correspondent name.
6. Agar plates were then sealed with the organic tape and stored in the incubator at 37°C. Two sets of agar plates were created for every sample to increase the accuracy of the experiment.

**Variables and controls:**

1. Tenfold dilution series, as at each dilution point the dilution is tenfold.
2. Temperature of the incubator was 37°C for all the plates.

**Safety measures (Aseptic technique):**

- Gloves and lab coat were worn.
- Hands were washed before and after the experiment.
- Sterile bottles and pipettes were used.
- Experiment board and incubator were cleaned properly.
- Used material was disposed to sterilize again.
- The colonies cultured in agar plates were not exposed to the environment.

**Data collection:** Sample from Asgaon was collected on 01/08/08 and experiment was carried out on the same day. Second sample from Khed was collected on 02/08/08 and experiment was carried out on the same day. Experiments were started within 2 hrs from the time of collecting samples.

After two days, colonies were observed which could be seen with naked eyes as they were big enough. In the plates, each coliform reproduced several times to form colonies. The colonies were nearly round shaped, grey and were oily. Collected numerical data is attached in the appendices.[9]

**Data Analysis:** Number of colonies shows the number of coliform present in amount of sample water used for culture. Using appropriate dilution factor, number of bacteria per 100 ml of sample water was calculated.[10] Unitary method was used for the calculation. (Explained in the appendices)

**Conclusion of the experiment:** Total coliform found in Asgaon's water was 0 and in Khed's water it was 1000. The number of coliform found in Khed's water was found to be more than in Asgaon's water and thus hypothesis assumed for this experiment was true.

**Evaluation:**

- Some of the agar plates did not have any colony; it shows that aseptic technique used was effective.
- Other types of bacteria could also have grown in the agar plates along with coliform which could also have been counted with them.
- The time when water was collected was a rainy season; number of bacteria might get affected by this as well as in this season there are more chances of water resources getting polluted.
- Experiment was done within two hours of the sample collection and samples were stored with ice to prevent bacteria death. But there are chances that some bacteria might have died because I didn't have proper storage facilities.

**Results:** Although the results suggest that Khed's water is contaminated, it cannot be asserted that the reason behind it is open defecation. There might be other factors which are causing this. Asgaon's water didn't have any colonies as they have better sanitation and waste disposal system. This might provide hint for the causal reasons of cholera in this area however, it needs to be studied thoroughly to consider as true.

[9] : Appendix 1
[10] : Appendix 2

## Social reasons behind cholera spread in Satara

People as a society are generally responsible for the cholera spread. These social reasons also cause lack of control over disease spread in the district. Some prominent reasons are presented below:

**Poverty:** This leads to problems such as lack of facilities. Poor people cannot afford to build toilets and therefore defecate openly. They generally tend to defecate near water resources i.e. rivers, which in turn cause contamination of drinking water. These people mainly live in slums and other backward areas of the cities and villages where drinking water is polluted. Generally there is more possibility of cholera spreading in slums than other areas. A case study about cholera burden in Kolkata which is given above is an example of this. Even after the outbreak, poor people cannot afford to go to hospitals and drugs which do not allow controlling the disease spread. They tend to take homemade medicines which are not effective.

Satara being always hit by droughts has 43% of the total population Below Poverty Line (BPL).[11] Due to above listed reasons; it might be difficult to eradicate cholera from the district.

**Lack of awareness:** The main reason behind lack of awareness is illiteracy. Satara district has literacy rate of 78.52% of the total population.[12] People cannot realize the severity of open defecation and drinking contaminated water. If they become aware, they may not want to defecate openly or at least near water resources.

Some people, due to blind beliefs, prefer to take home-made medicines rather than going to a doctor. This does not help and cholera spreads on a greater level. The government arranges vaccinations for the people but due to ignorance, people do not take it. If not all, some people genuinely contribute in spreading cholera in the district in this way.

**Hygiene Habits:** In this feacal-oral route of transmission, bad hygiene habits of the people in the district contribute on a great level. People in India do not generally use spoons and forks, especially in rural area, they eat with hands. If they do not wash hands properly after defecation, it may cause transmission. Women specially are not educated and do not know and may not care about small things like washing hands before cooking, after changing nappy of a baby etc. such practices can have significant input in passing diseases like cholera.

[11] : http://dacnet.nic.in/cipmcnagpur/SATARA.htm
[12] : http://www.indianetzone.com/8/satara_district_maharashtra.htm

**Availability of drugs and medical services:** Being a developing country, India does not have infrastructure to provide all the medical facilities. Government has some vaccination programs to prevent such diseases but they can not be carried on a larger area due to limited availability.

Other than this fact, there is one more reason for lack of drugs and medical services, and that is remote areas. Some villages in this district are very remote and cannot easily have contact with cities. In such cases, cholera outbreaks may not be controlled quickly.

## Environmental reasons and effects on Cholera spread

Besides the social reasons that are discussed above, there are chances of having environmental impact on the disease spread and outbreak. Environmental factors can affect directly, or indirectly, pathogen's survival, persistence and ability to produce disease. These possible factors are discussed below:

**Seasonal effect:** As Vibrio Cholerae is a water-born bacterium, there is higher possibility of cholera outbreak in the rainy season because bacteria get mixed into rain water which then mixes with drinking water. As mentioned earlier, drinking water provided by the government in this district is generally from local water resources like rivers and wells. These sources can easily get contaminated with pathogens. If water is not well-processed, it can obviously cause disease spread. In addition, some people who do not have drinking water provided by the government drink water directly from the rivers and wells; in such cases the probability of outbreak is even greater.

**Temperature:** In aquatic environments, higher temperature means more evaporation, causing increased humidity, an increased concentration of nutrients and a general change in ecology. A study of Bangladeshi medical records has found that Climate change can increase the spread of cholera by creating patterns of rainfall that favor the disease's transmission.[13] It might be worth considering as a factor in cholera spread in Satara as well because climate change is affecting all parts of the world.

**Aquatic environment:** The association of V. cholerae and its host, copepod, has been under study for more than 25 years. It is now well established that V. cholerae is autochthonous to the aquatic environment and closely associated with crustacea. Cockburn and Cassanos in 1960 first addressed the association of V. cholerae with plankton, observing a correlation between the incidence of cholera and presence of increased numbers of blue-green algae in the water. This correlation was explained as resulting from photosynthesis of the algae, resulting in increased dissolved oxygen in the water and an elevated pH, supporting growth of V. cholerae.[14]

Although these environmental reasons seem to be affecting cholera spread, it should be investigated further to see their actual effects in Satara district. However, due to limited nature it cannot be carried out as a part of this assignment.

[13] : http://www.scidev.net/en/news/climate-change-increases-cholera-spread.html
[14] : http://www.emro.who.int/Publications/emhj/0201/05.htm

# Conclusion

After looking at possible social and environmental reasons of cholera spread in Satara district, it seems that social reasons play vital role in causing disease. Although, it should be taken into account that possible environmental reasons are not fully investigated in the particular area. The coliform count test suggests that villages with less sanitation facilities may have contaminated water hence increasing the possibility of cholera outbreak. Hygiene habits of the people are another concern to be dealt with.

Even though due to limited sources and information it is difficult to make any conclusions, the reasons discussed in this essay cannot be ignored. So to control cholera in this district they should be taken into account on the first place. The following steps can be taken by the government to deal with this:

- **Vaccination:** Government can arrange mass vaccination programme, especially before the rainy season as in rainy season there are more chances of cholera outbreak.

- **Awareness:** Campaigns can be carried out to spread awareness about the disease such as awareness about water contamination sources, ways to detect cholera, prevention of the disease.

- **Hygiene habits:** People should be encouraged, especially in the rural area, to adopt some hygiene habits such as washing hands before eating and keeping cooking area clean.

- **Total sanitation programme:** Government is already running this and totally sanitized villages are getting prizes. This should encourage other villages to do the same. If not, compulsions from the government should be made to build toilets and sanitation facilities.

- **Further research:** As mentioned earlier, due to limited nature of this assignment, some aspects behind the presence of this disease in Satara district cannot be investigated. Health department can carry out further research such as seasonal affects on the disease spread, presence of aquatic plants and growth of V. Cholerae, effect of climate change specifically in this district, comparison studies of frequency of cholera in slums and other areas.

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- http://ddws.gov.in/TSC/crsp/main.htm (accessed on 10/08/08)
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- http://www.emro.who.int/Publications/emhj/0201/05.htm (accessed on 18/01/09)


18 no authors or titles.

- http://www.scidev.net/en/news/climate-change-increases-cholera-spread.html (accessed on 18/01/09)

- http://dacnet.nic.in/cipmcnagpur/SATARA.htm (accessed on 18/01/09)

Book:

- C. H. Collins, C.E.D. Taylor, 'Microbiological Methods' In: Applied Microbiology 2nd Edition (1967) London Butterworths.

# Appendix1

**Coliform Count: Data collection**

**The number of colonies found in agar plates:**

In the water of Asgaon:

| Dilution | Date of experiment | Date of Observation | No. of colony Set I | No. of colony Set II |
|---|---|---|---|---|
| $10^{-1}$- 1ml | 01/08/08 | 03/08/08 | 0 | 0 |
| $10^{-2}$- 1ml | 01/08/08 | 03/08/08 | 0 | 0 |
| $10^{-3}$- 1ml | 01/08/08 | 03/08/08 | 0 | 0 |
| $10^{-4}$- 1ml | 01/08/08 | 03/08/08 | 0 | 0 |
| $10^{-5}$- 1ml | 01/08/08 | 03/08/08 | 0 | 0 |
| $10^{-6}$- 1ml | 01/08/08 | 03/08/08 | 0 | 0 |

In the water of Khed:

| Dilution | Date of experiment | Date of Observation | No. of colony Set I | No. of colony Set II |
|---|---|---|---|---|
| $10^{-1}$- 1ml | 02/08/08 | 04/08/08 | 1 | 1 |
| $10^{-2}$- 1ml | 02/08/08 | 04/08/08 | 0 | 0 |
| $10^{-3}$- 1ml | 02/08/08 | 04/08/08 | 0 | 0 |
| $10^{-4}$- 1ml | 02/08/08 | 04/08/08 | 0 | 0 |
| $10^{-5}$- 1ml | 02/08/08 | 04/08/08 | 0 | 0 |
| $10^{-6}$- 1ml | 02/08/08 | 04/08/08 | 0 | 0 |

**Total number of coliform in the water:**

**For Asgaon:**

| Dilution | No. of colony | | No. of coliform per 100ml of sample water | | Average no. of coliform per 100ml of sample water |
|---|---|---|---|---|---|
| | Set I | Set II | Set I | Set II | |
| $10^{-1}$- 1ml | 0 | 0 | 0 | | 0 |
| $10^{-2}$- 1ml | 0 | 0 | 0 | 0 | |
| $10^{-3}$- 1ml | 0 | 0 | 0 | 0 | |
| $10^{-4}$- 1ml | 0 | 0 | 0 | 0 | |
| $10^{-5}$- 1ml | 0 | 0 | 0 | 0 | |
| $10^{-6}$- 1ml | 0 | 0 | 0 | 0 | |

**For Khed:**

| Dilution | No. of colony | | No. of coliform per 100ml of sample water | | Average no. of coliform per 100ml of sample water |
|---|---|---|---|---|---|
| | Set I | Set II | Set I | Set II | |
| $10^{-1}$- 1ml | 1 | 1 | 1000 | 1000 | $\frac{2000}{2} = 1000$ |
| $10^{-2}$- 1ml | 0 | 0 | 0 | 0 | |
| $10^{-3}$- 1ml | 0 | 0 | 0 | 0 | |
| $10^{-4}$- 1ml | 0 | 0 | 0 | 0 | |
| $10^{-5}$- 1ml | 0 | 0 | 0 | 0 | |
| $10^{-6}$- 1ml | 0 | 0 | 0 | 0 | |

## Appendix 2: Calculation for Coliform count experiment

If 100ml inoculation contains 1 colony which developed from one coliform:

$10^{-1}$-1ml is $\frac{1}{10}$th of sample water.

1ml of $\frac{1}{10}$th contains 1 coliform.

10ml of $\frac{1}{10}$th should contain $1 \times 10 = 10$ coliform which is same as 1ml of 1.

So, 1ml of sample water contains 10 and 100ml contains $10 \times 100 = 1000$ coliform.

## Assessment form (for examiner use only)

| Candidate session number | 0 | 0 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|

| | | Achievement level | | |
|---|---|---|---|---|
| | | First examiner | maximum | Second examiner |
| **Assessment criteria** | **A** research question | 1 | 2 | 1 |
| | **B** introduction | 2 | 2 | 2 |
| | **C** investigation | 2 | 4 | 2 |
| | **D** knowledge and understanding | 2 | 4 | 2 |
| | **E** reasoned argument | 3 | 4 | 3 |
| | **F** analysis and evaluation | 1 | 4 | 1 |
| | **G** use of subject language | 2 | 4 | 2 |
| | **H** conclusion | 1 | 2 | 1 |
| | **I** formal presentation | 2 | 4 | 2 |
| | **J** abstract | 2 | 2 | 2 |
| | **K** holistic judgment | 2 | 4 | 2 |
| | Total out of 36 | 20 | | 20 |

Name of first examiner:
(CAPITAL letters)

Examiner number:

Name of second examiner:
(CAPITAL letters)

Examiner number: