

CZECH UNIVERSITY OF LIFE SCIENCES IN PRAGUE
Faculty of Tropical AgriSciences



Czech University of Life Sciences Prague
**Faculty of Tropical
AgriSciences**

**Overview of Food Safety Incidents in The Last 10
Years – An Exploration of Southern Asia**

BACHELOR THESIS

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Author: Barbora Kociánová Majzlíková

Supervisor: Helga Johana Hernandez Hernandez, Ph.D.

Declaration

I hereby declare that I have done this thesis entitled “Overview of Food Safety Incidents In The Last 10 Years – An Exploration of Southern Asia” independently, all texts in this thesis are original, and all the sources have been quoted and acknowledged by means of complete references and according to Citation rules of the FTA.

In Prague

.....
Barbora Kociánová Majzlíková

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Abstract

Food safety in developing countries is no longer simply about having enough – it is increasingly more and more also a question of whether or not the food available is safe to eat. Foodborne disease is a global issue which so far has not been successfully solved and continues to claim lives every year. Because of poor sanitation and hygiene standards, Southern Asia has been through more cases than can be fit into an entire book; especially because data on this matter are often missing or incomplete, and cases unreported. Salmonella, E. Coli, Norovirus and many more are a topic of interest discussed in this thesis, as well as how they are spread, to whom and what they cause. Perhaps the most notable is the pattern which has emerged here: sanitation is the key to beating the spreading of harmful bacteria to wide general public; street food is handled and stored so badly that it accounts for a major portion of disease outbreaks; children under 5 years of age are at most immediate risk; and poultry is often the most frequent source of dangerous bacteria.

Key words

Southern Asia, foodborne disease, food safety, sanitation, outbreak, zoonotic virus

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List of abbreviations

UN – United Nations

WHO – World Health Organization

FAO – Food and Agriculture Organization

ODF – Open Defecation Free

WASH – Water, Sanitation and Hygiene (UNICEF)

BSS – Bangladesh Bureau of Statistics

NHSL – National Hospital of Sri Lanka

HACCP – Hazard Analysis and Critical Control Points

PATS – Pakistan's Approach to Total Sanitatio

1. Introduction

Among all other world-shaking issues which we as a society face in this day and age, among wars and poverty and the pollution of Earth, it shouldn't come as a surprise that the question of food security is one of the things that currently plague us. And yet, the fact that many people don't have enough food is only the tip of the iceberg; because, as this thesis will discuss, having food is not enough.

The World Health Organization (WHO) and Food and Agriculture Organization (FAO) defines food safety as "*food that is free from all hazards, whether chronic or acute, that may make food injurious to the health of the consumer*". Nowadays the concept of food safety is a discussion trend on the rise because of the increasingly frequent outbreaks of foodborne diseases worldwide (Javed, 2016). Foodborne disease is a phenomena which has kept up with humanity during the course of all of its existence, and yet it seems to be much harsher, far more brutal, in the past several decades; specifically with the end of World War II and the coming of the new "modern era". Considering the obvious population boom which has come with it, it seems that the quality of food which we consume diminishes with every next bite.

The topic itself is not a secret. A new discussion on the matter arises with each passing day, each new virus outbreak, and each child buried because of poor hygiene practices and toxic food consumed. Countless studies have been written by large international stakeholders. However, this does not seem to affect the existence or the prevalence of this issue. The sheer fact that WHO has estimated that 125 000 children under the age of 5 die every year of foodborne disease should speak for itself and highlight just how severe the situation is.

It comes to mind what is the reason for this increase in foodborne disease occurrence? Why is the food we eat borderline poisonous? And what are the reasons behind all this?

The most frequently appearing reports are of raw meat, vegetables and water contamination by chemical and microbiological agents.

Food poisoning from Salmonella is usually caused by two main species of this genome - Salmonella enterica and Salmonella enteritidis. The infection usually manifests as diarrhoea, vomiting, and abdominal cramps, though it can be combined with confusion, disorientation, altered state of consciousness and even anxiety and depression (Dutta & Debnath, 2014). *Salmonella* is a major foodborne pathogen, both causing illness and impacting economies. It has been found to reside in a variety of foods in nearly all countries which have

been involved in research on this issue (Ahmed et al. 2014). It most typically spreads to humans through consumption of undercooked meat, poultry and dairy products and other cross-contaminated foods. Street food in this case is particularly risky business.

Norovirus is one of the leading causes of childhood diarrhoea, and that in turn remains the second leading cause of child mortality in Southern Asia (Platts-Mills et al. 2015). *Norovirus* is a genetically diverse RNA virus, the whole group comprising of about 25 genotypes (and more are being discovered as time goes on). However, it is especially GI through GV groups which are most commonly found in humans. Next to rotaviruses (which aren't discussed in this paper as much) they are the leading cause of human gastroenteritis (Chitambar et al. 2012).

Escherichia coli is a diverse group of numerous bacteria. Not all strands of it are harmful, however those that are are usually transmitted through human or animal faecal matter, especially through means of water consumption (USGS, 2017). In developing countries E. Coli poses a big danger, as sanitation tends to be poor and sewage often gets mixed with water sources. Symptoms of E. Coli contamination include diarrhoea, nausea, abdominal cramping and fever.

Other bacteria mentioned in the thesis are *Staphylococcus Aureus*, *Shigella* and *Aeromonas*. As such, this thesis will focus on delivering a comprehensive collection of some of the most interesting cases appearing in Southern Asia.

2. Aims of the thesis

This thesis seeks to describe the main issues occurring around food safety incidents. With a healthy dose of some investigative journalism, it should also explore the possible causes of this sad phenomenon, and recount some of the most interesting previous case studies carried out with the intention of finding out more about this global problem. The thesis will also attempt to hopefully offer a comprehensive review of the situation such as it is.

3. Methodology

This thesis is strictly a literature review; no primary data have been collected during its completion. However, it is a combination of an investigative and critical reading. The word “incident” points to a kind of scandal, something out of the ordinary. Therefore, during the research part, the author consulted newspaper articles, and even the author contacted a few willing citizens, usually residents of the affected countries. The literature review, however, aims to keep as unbiased as can be. The case studies selected were all carried out by respected researchers interested in either providing reliable data or provoking a debate on the issue. The databases used for the collecting of relevant information include: Web of Science, Science Direct, Scopus and Google Scholar. The websites consulted include: FAOSTAT, WHO, World Bank and UN.

4. Literature review

4.1. India

Also called Bhārat or Bhāratavarsha, India is the largest of the countries discussed in this thesis, and therefore it also has the most materials to discuss. It is an immensely diverse and actually quite incredible country; and ever since it broke out of the British patronage in 1947 (Schwartzberg, 2019), it's been systematically reclaiming its rich culture. Being as it is one-third coastline, it has six neighbouring countries, even though it itself is quite large. To the northwest of it is Pakistan; to the north it is bordered by China, Bhutan and Nepal; and to the east by Myanmar. The country of Bangladesh is entirely enveloped by India to the north, east, and west. Furthermore, the aforementioned coastline is washed by the Arabian Sea on the west and by the Bay of Bengal on the east (Allchin, 2019).

As of the 1st of April 2019, there are 1,364,515,009 people living in all of India. In fact, the UN estimates that by the year 2028 its population might grow higher than China. The World Bank reports that it is the world's largest democracy, as well as an important emerging global player. Despite having one of the largest, not to mention most diversified economies in the world, it is still considered, in terms of income and GNP per capita, a poor country (Allchin, 2019). This is caused by its steadily growing population, and the extreme economic division between the poor and the wealthy.

The country's fairly recent growth is almost miraculous; but it does not come without a price. A population as large as this is not easy to feed and maintain; 1.3 billion people to take care of, figuratively speaking, is no small feat. That is over one billion people at risk each day; over one billion lives that stand to be lost due to the challenges that this country is facing every day. The challenges range from lack of transparency and gender inequality, to the so-called more apparent problems, such as sanitation (Mehta, 2014).

4.1.1. Why is sanitation so challenging

According to the World Bank, one in ten deaths in India occurs due to poor sanitation practices and overall low hygiene standards. One of the most outstanding problems is open defecation. Between 2016 and 2017 a shocking 60% of world's open defecation took place in India – 450 million people relieved themselves in public places, and 157 million people from the country's urban population didn't have a working toilet. On top of that, much of the solid waste is emptied into improperly constructed drainage systems, and worse, into ponds, rivers and lakes.

One of the biggest Open Defecation Free (ODF) advocates and pioneers is India's Prime Minister Narendra Modi. Before his Independence Day speech in 2014, less than 50% of households had access to sanitation facilities, and even fewer had working toilets. Similarly, only 30% of sewage coming from urban areas was treated before being let into rivers and streams, which, combined with the fact that rural India at the time was still quite fond of open defecation, is truly horrifying. Every year, an estimated 0.4 million children died of water-borne diseases, not to mention suffering from stunted growth. And even though Modi's ODF programme did manage to reach some incredible numbers, like a 92% household toilet coverage in the year 2018, India still battles one of this causes biggest enemies – clinging to the old ways. India's Ministry of Drinking Water and Sanitation reports that even though 'only' 13 million households remain to be included in ODF efforts, many Indians, especially in the rural areas, actually prefer open defecation to using the lavatory (Sengupta & Verma, 2018).

Still, that barely scrapes the surface on which the foundation of this prevailing issue stands. The overall mindset and practice is only one of the causes – India has been seeing quite a dramatic increase of foodborne disease and food safety incidents. From street vendors and their lack of both interest and ability to sell properly treated and prepared food to large multinational companies like Nestle (Mehrotra & Obiko Pearson, 2015), disease outbreaks and poisoning reports keep piling up. Based on this, it is safe to assume there are quite a few cases to be examined.

4.1.2. The cases in India

Unfortunately, in India, many of the food safety incidents stay either unreported or without investigation. India remains as a country of rather poor hygiene practices and the zoonotic disease outbreaks remain without the attention they deserve, unless the case generates a direct impact on either, the economy or public standing of the whole area (Vernula et al. 2012). Sadly, these are conditions which make supervision and control over the outbreaks nearly impossible. The early and swift detection and the immediate removal of the causes, such as the contaminated food and the propagators, is unlikely. Most importantly, the prevention of future disastrous situations such as these become very hard to say the least. Furthermore, it is no small task to strengthen food safety policies without the recognition of the incidents, just like creation and upkeep of possible programmes targeted at improvement of the current standard (Samarajeewa, 2012).

Some of the most common sources of these food safety incidents in India occur due to food adulteration (Vemula et al. 2014), which is a process that decreases the quality of a given food through adding adulterants. These are certain chemical substances, such as nitrate, washing powder, ethyl acetate or tamarind seeds. Other common sources include excessive colouring of food, chemical contamination, pesticide residues, microorganisms present inside the food, and more.

Error! Reference source not found.. We can see an overview of some of the most common microorganisms which can contaminate food, as well as the type of food affected. *Salmonella enteritidis* has the lead and is believed to originate from kheer; a traditional rice pudding meal, made with boiled milk (which is the most likely source of the microorganism) (Vernula et al. 2012).

Table I - Bacteria most commonly found to be the source of outbreaks

Place	Incidents	Number of people affected	Microorganism	Food
Party	3	98	<i>Salmonella Paratyphi</i>	Vegetables
			<i>Staphylococcus Aureus</i>	
			Var durazoo	
Mess hall	1	76	<i>E.Coli</i>	Dinner food
Home	2	5	Salmonella - various	Stale rice
Army unit	1	78	<i>Salmonella enteritidis</i>	Frozen food
School	2	135	<i>E.Coli</i>	Soy milk, Bhalla
			<i>Staphylococcus Aureus</i>	
Hostel	1	34	Salmonella welteverden	Fish
School	1	150	<i>Salmonella enteritidis</i>	Kheer (milk)
Hospital	10	10	Salmonella wein	Poultry products

Adapted from: (Vernula et al. 2012)

Apparently, most of the cases of salmonellosis which occur in India come from the consumption of poultry. Every year, there are millions of cases of this disease reported worldwide. Generally, salmonellosis is considered to be one of the most prominent and most commonly encountered bacterial disease, as a wide variety of species can suffer from it (Maherchandani et al. 2015). Since poultry is a typical reservoir of many zoonotic pathogens, salmonellosis in the species should be an ever-growing area of study. Poultry is, by far, the most consumed type of meat, and whatever pathogen it happens to be carrying (in this case

Salmonella) can spread to humans by means of consumption of the contaminated meat and eggs.

Table II - Foods most commonly contaminated

Type of food	Bacteria
Milk	E.Coli, Listeria monocytogenes
Meat	E.Coli, Staphylococcus Aureus
Beef sample	E.Coli
Sweets	Salmonella enteritidis, Salmonella Newport
Samosa	Staphylococcus Aureus
Batatawada	Staphylococcus Aureus
Tamarind	Salmonella, Staphylococcus

However, salmonellosis can be contracted by consumption of many more foods than just poultry. In fact, the bacteria can be presented in most other

Adapted from (Vernula, et al., 2012) consumables – namely pork, beef (though that is not a concern in India), seafood, milk, fish and vegetables (Vernula et al. 2012). Table II - Foods most commonly contaminated describes which microorganisms are most associated with which source foods; furthermore, it should be mentioned that Samosa is savoury baked good (usually filled with vegetables) and Batatawada (or Batata Vada) is a fried potato dish.

Notably, a study carried out by (Maherchandani et al. 2015), points out that there is an apparent reason for the rise of salmonellosis cases, both in India and the rest of the world. The past few decades have been marked by the emergence of antibiotic resistance among certain species of bacteria. Unsurprisingly, this suggests the coming of a great threat to public health: the possible transmission of zoonotic bacteria from livestock and other food animals, in this case poultry. As was already mentioned, poultry tends to be prone to bacteria contamination, and therefore the threat of zoonotic diseases spreading through its consumption rises. The study concludes that the irrationally widespread and increasingly more common use of antibiotics as growth promoters in poultry is an important factor. The now evolved bacteria are passed to humans through the consumption of the affected meat, resulting in rapid outbreaks of resistant salmonellae.

Outbreaks of salmonellosis of surprising resistance to treatment have been occurring in Indian hospitals ever since the 1970s (Frost, 2010). Often in these outbreaks the common theme seems to be how quickly it spreads, affecting mostly new-borns or very young children, even though adults are involved as well. At the same time, this common pattern seems to be presented not only in salmonellosis victims, but in most of the food safety incident victims.

A study conducted by (Vemula et al. 2014) has shown that most cases in the past decade regarding food poisoning due to bacteria were caused by *Salmonella* and *Staphylococcus aureus*. Strangely enough and despite what most studies and statistical data shows, the distribution of the contracted diseases in different age groups was as follows: from 81 patients which were examined with interest to the study, 7% were between 5-9 years, 19% were aged 10-14 years, 17% were between 15-19 years, 24% were in the 20-29 age group, 11% of the participants were from 30-39 years, those between 40-49 years represented 9%, and finally, those aged 50 years and more represented 9%. It was also discovered that the most common 'setting' in which the diseases were contracted was a common household. The study collected 14 food samples, as well as 12 stool samples over time from each treated person and subjected each sample to a microbiological analysis. Both *Salmonella spp.* and *Staphylococcus aureus* were found in large colonies in all of the samples. Furthermore, this study observed that the types of food responsible for most cases of these outbreaks include, but are not limited to, 'kaddu ka kheer' (a type of dessert, or sweet dish, made from desiccated milk), milkshakes, chicken, various fruits, colostrum and jaggery rice. Again, we can note here that poultry is one of the mentioned sources of the bacteria contracted in these cases.

To prevent food poisoning outbreak, it is recommended that an appropriate education and preventive measures should be taken (Vemula et al. 2014). The health authorities should considerably strengthen the foodborne disease surveillance system and follow it with efficient education and extension activities in various aspects of food safety. Initiatives like epidemiological and laboratory components should be incorporated in countries to conduct appropriate surveillance programmes, so that the real burden of foodborne disease can be determined at different national levels.

Still, the source of dangerous food, food that is able to cause death or at least some nasty, long-term problems, is not always so easy to find. Through a mind-provoking article and preceding study conducted by (Mandala et al. 2019) shocking information was gained: in the region of West Bengal the villagers have been using water containing arsenic for cooking rice; one of the most important staple foods in India. Arsenic is also considered a Class I carcinogen. The study discovered that the use of arsenic-rich groundwater in the villager's daily cooking might potentially boost the arsenic concentration in cooked rice up to 129% compared to what it is before the rice is cooked. This fact dramatically increases the West Bengali villagers' rate of exposure to arsenic through rice consumption, something that they simply cannot stop

consuming. In addition, the tradition of drinking the stewed rice water does nothing to lessen the risk in the local communities.

The most astounding discovery is that arsenic exposure does not come only from water, but also from the rice itself. As it is grown mainly in a handful of Asian countries, including India, rice is often growing on arsenic-contaminated soils. In the West Bengal community, where rice is consumed on daily basis, the risk of arsenic poisoning is particularly high. In fact, even if the West Bengal community weren't already drinking arsenic-infused water, the arsenic intake from rice alone would be a hazard.

Finally, the study showed that from the 100 households evaluated, the majority of these households (about 86%) consumed the rice that they themselves grew in the fields, and the rest of those involved in the study bought their rice from local markets that sold locally grown rice. Despite the government-issued water supply provided by a central pipeline, the villages which were a part of the investigation showed that most of their inhabitants (up to 65%) used this water mostly for drinking purposes, and it was undeniably cleaner compared to the groundwater. Additionally, about 98% of households in the examined region preferred groundwater from wells for their cooking and other activities, such as bathing or dishwashing. All of this water was found to be severely arsenic-contaminated, and it can be assumed that many of the population's health problems derived from the consumption of arsenic-infused rice, cooked in arsenic-contaminated water (Mandala et al. 2019).

4.2. Nepal

Nepal is considered a small country and a land of many wonders and even more mountains. At 143,350km² it is a landlocked state that shares borders with Tibet Autonomous Region of the People's Republic of China in the North and India in the East, South and West. According to the UN estimates there are 29,861,471 people living in Nepal as of Monday, April 1st, 2019, and incredibly enough, only 20% of the Nepalese live in urban areas. Though squeezed in between the two powerful and prominent national powers like India and China, it successfully retains a culture that is distinct in every way, shape and form. Not to mention that it is the home to Earth's highest peak, Mt. Everest or Sagarmatha, in its local Nepali name.

Though Nepal has been through its share of troubles, from earthquakes to political tensions and upheavals, in the year 2015 it ranked 3rd in WaterAid’s list of countries making the biggest progress in sanitation (unicef, 2018). Similarly to India, 4 in 10 people do not have a decent toilet – that is nearly exactly half of the entire population – and over 700 children a year die from diarrhoea. Non-ideal sanitation practices are the leading cause of death for children under 5 years old. With how harsh the country can be, for example after an earthquake hits, many people’s lavatories are damaged, and there are simply not enough resources to repair them, which then leads to practicing of open defecation (WaterAid, 2018). Public health problems are usually related to hygiene and sanitation. However, through the efforts of UNICEF, the situation in the country is quickly and tirelessly being improved, and now 9 in 10 people have access to drinkable water, as shown in Figure I - Population with improved access to drinkable water and sanitation.

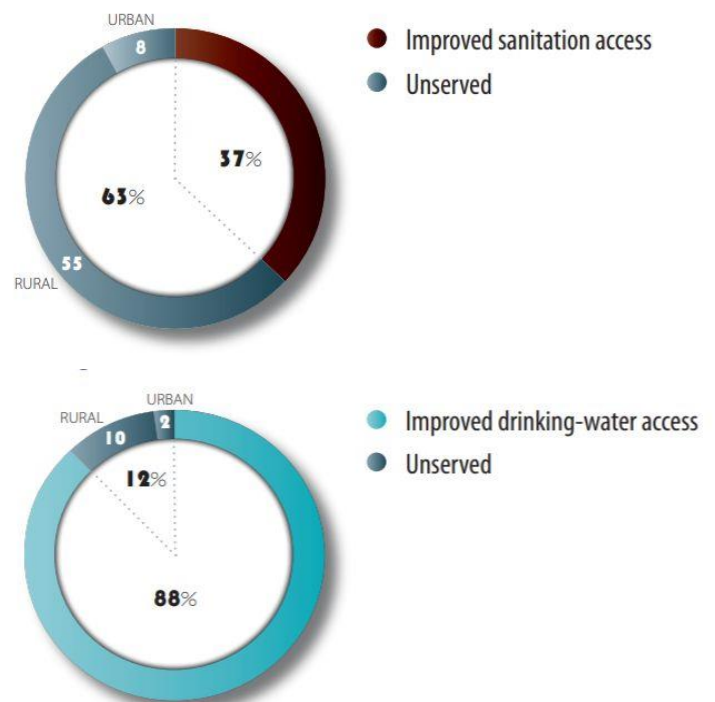


Figure I - Population with improved access to drinkable water and sanitation

Projects are being implemented to improve matters of sanitation. For instance UNICEF’s WASH (water, sanitation and hygiene) component has set an ambitious goal: to work with the Ministry of Water Supply to provide improved and equitable access and use of safe drinking water and sanitation services to all children, their families included (unicef, 2018).

Although the progress Nepal is making is admirable, there are still quite a few things to be discussed.

4.2.1. The cases in Nepal

As in many other Asian countries, street food is wildly popular in Nepal. However, it is exactly here where many products become contaminated, as they are seldom stored properly while waiting to be bought. Meats in particular are sensitive to this, as it provides suitable medium and near-ideal conditions for the growth and prospering of various microorganisms and bacteria. Indeed, the contamination of meat later being sold in Nepalese markets may occur

quite easily. It may come from external sources during bleeding, handling, and processing via knives and other tools, during exportation, and even simply by air (Bantawa et al. 2018). Not only simple and obvious hazards like flies and dust from the road threaten it. The biological, chemical, physical, and particularly microbial food hazards are the constant impending doom that hangs above it. The most prominent foodborne bacterial pathogens associated with meat are *Salmonella spp.*, *Staphylococcus aureus* and *Escherichia coli* (though there are, of course, many more) and they all pose a major health problem.

A study was conducted by (Bantawa et al. 2018) in the city of Dharan and has presented several interesting observations in the field. Most of the time, Nepal’s raw meat is obtainable only with questionable hygiene practices, sold simply out in an open area without any kind of acceptable temperature control.

Table III - Prevalence of pathogens in raw meat

Type of meat	Prevalence of pathogens (%)			
	S. Aureus	E.Coli	Salmonella spp.	Shigella spp.
Chicken (n=15)	53.33	66.6	60	4
Pork (n=15)	73.33	60	10	0
Buffalo (n=10)	80	40	20	2
Goat (n=10)	70	46.7	33.3	0
Total (n=50)	68	54	34	6

Adapted from (Bantawa et al. 2018)

The city chosen is also an interesting landmark; the study shows that the average consumption of meat is almost 4 kilos higher compared to the whole country, reaching 13 kilos per year per capita on average. Samples were collected from chicken, pork, buffalo and goat – reaching a total of 50 samples, 15 per each category, as we can see in Table III - Prevalence of pathogens in raw meat. After thorough microbiological analysis the researchers discovered that the ‘riskiest’ and ‘most troublesome’ meat was pork, the least problematic being buffalo. Still, the research led them to the conclusion that all marketed meat was under extreme risk of spreading foodborne disease, and all of it was contaminated from the improper storing and handing at the market stalls. It is especially *Salmonella* and *E. Coli* which is worrying, as these

bacteria can cause severe health problems, and even cause an epidemic. In addition, perhaps the most regrettable finding in the whole study was that most of the meat vendors were not even aware of the standards that should be fulfilled, and therefore unaware of the danger that they were spreading to their friends and neighbours.

A similar study showed that many butchers, despite playing a rather vital role in prevention of foodborne diseases, often lack the knowledge to do so. The meats involved were goat and poultry and, unfortunately, none of the butchers investigated during the research period of the study fell into a group deemed as having adequate knowledge and satisfactory practice during the handling and displaying of the sold meats (Poudel & Khanal, 2017).

Noroviruses, another common culprit in the group of causes of food safety incidents, are a common and prevalent agent of sporadic acute gastroenteritis in children worldwide (Parashar et al. 2009). Out of the 25 genogroups according to which *Noroviruses* are divided, five are known to be dangerous to humans, with three being the most seriously threatening (GI, GIII, GIV). As these particular viruses tend to evolve with time and changing circumstances, it is vital to continue to study them, if effective vaccines are to be developed. A study carried out by (Thi Nguyen et al. 2015) in Kanti Children's Hospital in Kathmandu has examined 350 patients (all of which were children under the age of 5, as that is the most vulnerable group when it comes to foodborne disease). The research team has collected 4437 samples between the years 2005 and 2011, all from those admitted into the care of Kanti Children's Hospital. Out of this number, *noroviruses* were detected in 356 samples – roughly 8%. During the time span, the researchers also examined the presence of *rotaviruses*. They have been detected for 1191 cases – accounting for 27%. Additionally, there were 27 samples found during the study, which contained both *rotavirus* and *norovirus*.

As was mentioned before, the examined group of patients were children of 5 years of age and less, and while *norovirus* infections were detected in all age groups up to that particular age, they were most often found in very small children, typically aged from 6 to 23 months. Sadly, the most typical finding was that the infections, which were detected in children less than 2 years old, made up a staggering 84% of the total *norovirus* gastroenteritis cases. Furthermore, it was found that although *norovirus* infection patients were admitted all year round, the occurrences peaked during the month of October.

An interesting, yet disturbing case presented itself in the year 2009 among Israeli travellers arriving from Nepal. They seemed to have brought *Salmonella Paratyphi* back with

them. They were suffering with enteric fever, which emerges from infection with *Salmonella Typhi* or *Paratyphi*. Most cases worldwide are attributed to *S. Typhi*, although Asia has recorded an increase in infection with *S. Paratyphi* in the past years. Indeed, during this reported outbreak, 37 travellers from Nepal were admitted to care in 7 hospitals around Israel, diagnosed with Enteric fever. 100% of the travellers were staying in Pokhara, Nepal, during the time of their probable infection, and 72% of these infected were orthodox Jews following kosher eating practices. What they all had in common was that they have visited 1 of 6 different food venues – most likely the places where they contracted *S. Paratyphi*. However, the case ended on a positive note: there were no fatalities, and all 37 patients were back to full health in about 2 weeks (Meltzer et al. 2014).

4.3. Bhutan

Much like Nepal, Bhutan is a small kingdom huddling in between the two giants known as India and China. Druk Yul, its Bhutanese name, means “Land of The Thunder Dragon”. The population tops out at 823,903 people, based on the latest United Nations estimates from Monday, April 1st, 2019. Out of this number about 41% people live in urban areas. Despite the country being so little, and the population not even at a million, the capital, Thimphu, is a vibrant city of its own cultural appeal, although interestingly enough, before 1960 Thimphu was just a few scattered hamlets in the hills.

Luckily, Bhutan is quite a pioneer of good practices when it comes to hygiene and sanitation. According to UNICEF and their annual reports, 63% of Bhutan’s population has access to sanitation services, which is a vast improvement over, for example, India. Plus, most of this percentage is made up by the rural population. Only 1 in every 5 schools lacks proper lavatories and water access for handwashing; although nearly a third of all schools lack separate toilets for female students. In the light of this, it is a common occurrence that girls currently menstruating miss school activities, both due to pain and discomfort and, at the same time, because of the lack of proper sanitation utilities. However, UNICEF has been working with nunneries and monasteries since 1990s to improve this. And although many positive things have come from this, many schools still need support (unicef, 2018). Still, even with 80% of toilets up and running, Bhutan has some room for improvement in their future.

4.3.1. The cases in Bhutan

Once more, we come back to the topic of poultry – Bhutan imports its supply of chicken meat from India, and as one might guess, it does not always come as a given that the meat is

handled and treated the way it should be. Be it as it may, chicken meat remains one of the main sources of *Salmonella*, which, as we have already established, is the source of many cases of foodborne diseases. Raw poultry is often contaminated with harmful bacteria, propagated through means such as already infected stock, cross contamination, improper handling and care, and inevitably also careless storage, as well as improper cooking.

A study by (Dahal, 2007) found an overall *Salmonella* prevalence to be a low 13% among the imported chicken carcasses, though this is restricted to the so-called consumer level; no large warehouses or other intermediaries were investigated. However, it remains a positive fact that the prevalence of *Salmonella* in these tested samples remains low compared to many other countries, and not only in Asia. For example, Malaysia has a score of 35.5%, Spain has 55%, and Thailand takes the lead with 57% of *Salmonella* prevalence. It should be noted that these are 2007 data, and in the year when this thesis is being finalized, they are no longer up-to-date. Still, it is an interesting and refreshing discovery that even in the past decade; Bhutan was fending fairly well for itself compared to others.

Another case of foodborne disease takes us back to *noroviruses*, the second most frequent cause of acute gastroenteritis in young children after rotavirus (Huhti et al. 2011). During the time between the years 2010 and 2012, a study was conducted on children aged less than 5 suffering from watery diarrhoea treated at the Department of Pediatrics, Jigme Dorji Wangchuk National Referral Hospital, Thimphu, Bhutan. (Again, we come back to the theme of very young children being the most susceptible to this type of disease). The research team has tested 270 samples for the treacherous bacteria, and indeed, they came to some unsettling conclusions. Out of the 270 children admitted to the Thimphu hospital, 64 were positive for norovirus; that means about 24%, which is still a large portion. Similar to the case from Nepal, the largest age group affected were children less than 23 months old, and, interestingly, the largest appearance of the *norovirus* infection was during winter. This seems eerily similar to the Bhutan case, during which the months with the largest number of patients admitted were October and November.

Unfortunately, the study never found out why and, most importantly, how the children of Thimphu were infected by the virus. *Norovirus*, also called the “vomiting bug” (National Health Service, 2017), more specifically the GII genotype (which is a genotype that is among the most common causes of *norovirus* illnesses worldwide – since it affects all age groups and resistance to it only lasts from a couple of months to a couple of years) (Centers For Disease Control and Prevention, 2018).

Despite the researches having detected the GII type in a water sample, it is not clear if the source was tap water or not, as it wasn't detected elsewhere in the water supply system (Yahiro et al. 2015). The outbreak could have been caused by the very same thing as most of these incidents; improper handling, transportation and storing of various market products, such as meat and fish and milk.

On May 25th, 2016, a case from more recent times has gained international interest, in a village called Deptsang a District Health Officer reported an outbreak of acute gastroenteritis. The initial report went on to hypothesize that the cause of the sudden and violent outbreak was the consumption of carcass meat as is quickly becoming the trend in these cases. Three days before the whole ordeal, the suspicious meat was served as lunch to labourers working on the construction of a community temple. Later that same day, the very same meat was also presented during dinner, and consumed by the workers as well as their families at home (Tsheten et al. 2016).

Table IV - Overview of victim demographics

Characteristics	Victims (n=33)	
	n	%
Male	20	57.8
Female	13	42.2
Farmer	19	56.7
Hermit	10	30
Preschoolers	0	0
Students	2	6
Businessmen	2	6

Adapted from (Tsheten et al. 2016)

The big mystery behind the outbreak was a cow. A dead cow, which was carried by two villagers to the construction site, and then later processed by a cook from the village and served to nearly everybody there. After several simple questionnaires with the villagers, most of them admitted that the meat had a foul smell and was likely rotting by the time it was brought out. As for the results which are described in Table IV - Overview of victim demographics, 55 of the concerned villagers ate the faulty meat during lunch and several more consumed the same meat at dinner, resulting in a total of 33 cases. The respective victims displayed symptoms such as loose diarrhoea in 100% - the entirety of the village, nausea or vomiting represented by 67%, fever displayed by 40% of the villagers, and abdominal cramps found in 34% of the affected people. In the end, the research team assigned to the case found out that the bacteria at fault was *Aeromas hydrophila* – a previously unmentioned bacteria (Tsheten et al. 2016). In the last decades however, *Aeromonas* has become a more and more recognized type of etiological agent of gastrointestinal diseases – and in this particular case, it sent 15 people to hospital. Luckily, with no fatalities.

4.4. Bangladesh

With total land area of only 130,170 km² to its name, Bangladesh has a staggering population of 167,636,199 citizens (as to Monday, April 1st, 2019) according to United Nations estimation, meaning it has an incredible 1291 people per square kilometre population density. Out of this, over 62 million of the inhabitants live in urban areas. The country's capital city, Dhaka, is a testament to the diversity, which courses throughout its people. The country is bordered by India in the west, north and east and to the east also shares a short border with Myanmar.

UNICEF works dutifully in the country to continue improving its sanitation and hygiene practices. Even though Bangladesh has made some great progress throughout the years, there are still obstacles to be torn down. A modest, but still positive, 56% of the population has access to sanitation facilities, although a rather high proportion of lavatories are still shared, especially among dense urban populations, specifically in Dhaka's (and other large cities') slums. The government is continuously fighting open defecation as conventional sewerage systems are positively still absent in all urban areas except Dhaka. However, even there, in the capital city, only 1 in 5 people are connected to a sewer network; a ratio which needs to be improved in the near future, as this makes vast contributions to the sanitation problems. Similarly, safe disposal of faecal matter from both rural and, more importantly, urban areas, is thought of as a major challenge by the Bangladesh government. For instance, mostly in rural areas many parents with small children do not practice hygienic disposal of diapers and whatever goes in them, only 33% of households dispose of child faeces is done properly (unicef, 2018).

To add to the already bad situation tied to poor sanitation and overpopulation (which results in insufficient infrastructure), most government-based agencies lack the ability to coordinate their actions to further the progress towards better food safety (Noor & Feroz, 2016).

4.5. The cases in Bangladesh

Bangladesh encounters its fair share of hygienic problems, and due to this, about 30 million people in the country find themselves tackling one kind or another of a foodborne disease each year. Because of the density of Bangladesh's population, microbial attacks are more likely for the people, especially those living in less than ideal conditions; like, for example, the slums of Dhaka. Diarrheal diseases are among some of the most common types of food poisoning cases in Bangladesh – and in extreme cases, they can be deadly. As is a common theme now in all the cases so far presented, by far the most typical cause of these is improper handling of raw products. Meat left out in the open as flies feast upon it, vegetables sitting out in the sun, milk left to spoil and more – these are all a theme we've seen repeat over and over again. Combined with the use of adulterants, as seen in a case from India, this can be quite the dangerous game.

Being as Bangladesh falls into the developing country category, the information and awareness of proper treatment of raw products is scarce or missing entirely, as well as the cognizance of foodborne illness and what it means in the world, how it spreads and that it is one of the leading causes of death in their country. Foodborne disease fatality is, unfortunately, quite common in Bangladesh, as well as other Southern Asian countries (Noor & Feroz, 2016), and truly, the cases of foodborne illness both claiming lives or at the very least making lives harder are plentiful.

A large number of products, including food products from street vendors and, shockingly, even foods brought in to supply Bangladeshi hospitals, has been reported to be contaminated with a worrying wide variety of microorganisms. Reportedly, this was very likely caused by the handlers living and working in deprived hygienic conditions (Noor & Feroz, 2016). For instance, a news report from Bangladesh Bureau of Statistics (BSS) from January 2015 has informed that well over 50% of food and drinks sold in the bustling, busy city streets of Dhaka were found contaminated with various types of the *coliform* bacteria, and more than one third were found to be inhabited by the faecal pathogen also known as *E. Coli* (Rahman, 2015).

Even more shocking was the report presented by Miprohashi News on May 2015. Apparently, over 300 workers fell sick in a clothes factory in Dhaka after having been treated to a meal by their superiors in the company. The police have not released much, but apparently as many as 3000 workers were working at 'Starling Creation Limited' at the time of the incident. The foods served to the workers included eggs, bananas and bread, and it did not take long before workers began to lose consciousness. The aforementioned 300 victims of rather serious

food poisoning were admitted to Women and Children Health Complex, Nightingale Medical College Hospital and other medical centres for treatment (Rahman, 2015).

Another danger currently on the rise is the emergence of multidrug-resistant bacteria. In a particular case, researched by (Parvej et al. 2016), the team's investigation revealed that more than 70% of infecting bacteria in Bangladesh were resistant to at least one of the commonly used antibiotics. In fact, the amount of drug resistant pathogens has been rising somewhat steadily in the past several years, as observed in several other cases. This is a universal problem and comes mainly from overusing of adulterants and other chemicals, mainly in livestock and poultry (Rashed & Sakil, 2015). As the bacteria multiply, they transfer the resistant gene among the colony, and so pose a great threat to public health everywhere.

Keeping in tune with the previous cases (and the emerging pattern) (Parvej et al. 2016) note that poultry and the various products from this family are the main source of Salmonellosis in humans, as they are the most widespread, as well as the most common reservoirs of *Salmonella* bacteria. According to (Parvej et al. 2016), up to 7% of healthy chicken in Bangladesh are a source of multidrug resistant *Salmonella*. This is a statistic not to be taken lightly. The concept of multidrug resistant bacteria circulating in and out of its country of origin, for example through tourists, trade or simply by contaminated water, is simply horrifying, as it suggests a fast, nearly epidemic spreading. In the event of such a situation, the researches state that accurate identification of the source, as well as geographic origin of the *Salmonella* bacteria would be vital. As for the actual results of the whole study, they were nothing short of horrifying. After evaluating 170 samples from 4 different commercial Bangladeshi farms to thorough laboratory testing, *Salmonella enterica* was isolated and characterized in samples from not only in one, not even two, but all four of these commercial farms. The study proved that out of the 170 samples collected 4% (meaning 6 out of 150) apparently healthy layer chickens and 50% (10 out of 20) feed samples were found to be positive for *Salmonella serovars*.

Furthermore, a high level of resistance to ampicillin was observed; and this is especially reason for concern as ampicillin has, until 1980s, been a so-called first choice drug for the treatment of Salmonellosis. Again, the reason for this is already known; it is the overusing of antibiotics in the poultry business without the expertise that should be linked to it. Farmers often use antibiotics as growth promoters and thus spread the danger of drug resistant pathogens. Yet, the problem doesn't stop there; in Bangladesh, it isn't uncommon to be taking antibiotics without a doctor's prescription, thus creating a natural resistance to them (Rashed & Sakil, 2015).

Additionally, the majority of people in Bangladesh are unlucky and forced to maintain a poor quality of life, as well as lack of any substantial information on diseases associated with bad hygiene. Subsequently, increasing the general public's understanding of foodborne disease and the threats of poorly handled, non-sanitary food, is absolutely vital, if there is any improvement to be seen in the future. And perhaps one day, such day will come when better actions will be observed and regulated by governmental bodies and practicing professionals both.

4.6. Sri Lanka

Formerly called Ceylon, Sri Lanka is an island country located in the Indian ocean and separated from the Indian subcontinent by Palk Strait. Sri Lanka dates its roots all the way back to 6th century B.C. and has a rich cultural landscape. The population is estimated by UN to be 21,002,558 inhabitants (Monday, April 1st, 2019) with only about 20% people living in the island's urban areas. Subsequently, most people live in rural areas, are somehow poor and depend on agriculture as their source of income. Still, Sri Lanka remains a beautiful country of great potential. Colombo is the main urban centre, and serves as a judicial, executive and legislative capital (Peiris & Arasaratnam , 2019).

Sanitation in Sri Lanka is actually considered to be among the best in all of Southern Asia. The coverage reached in sanitation facilities is 92% and rising. The areas which still seek improvement include rural school sanitation, sanitation facilities for inconvenienced groups, such as the disabled, and the standing problem of ground water contamination in towns.

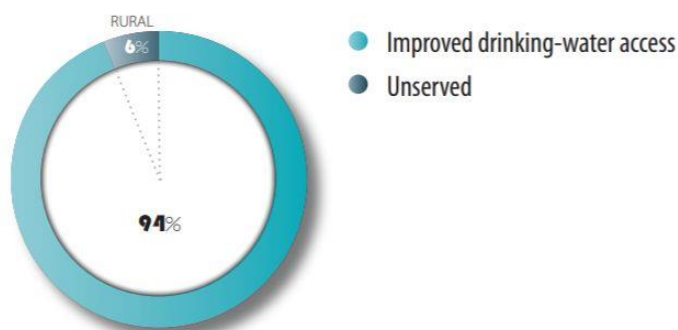


Figure II - Population with access to drinking water

According to data you can see in Figure II from UNICEF, drinking-water coverage is at an outstanding 94%. The remaining 6% of the population are communities which obtain water by purchasing it. However, this is not ideal solution, since not only is it unnecessarily pricy and unsustainable, but the vendors also transport the water in unsanitary conditions, in plastic containers, or by diverting the flow from rivers, streams or unprotected wells. The key to the country's amazing improvement and victories in the field of sanitation has been undoubtedly, the education. Urban areas struggle less and less with hygiene, and rural communities are being

educated on proper hygienic practices, as often as, it is possible by the means of public health inspectors, medical officers and even midwives. Whenever a water supply and distribution project is implemented in rural areas and for the communities living there, the organization working on it makes a point of incorporating a health and hygiene education. And, perhaps most importantly, Sri Lanka's school curriculum contains health education and environmental studies; a step in the right direction, and a tactic which more countries struggling with hygiene and sanitation should consider (WHO, 2014).

4.6.1. Cases in Sri Lanka

A common emerging theme in the field of foodborne disease is poultry as a source of the contamination. Chicken meat, as well as eggs, account for most of animal protein intake for Sri Lankans; however, the attention that is paid to their quality assurance is often insufficient (Utrachkij et al. 2012). Again, we come back to the theme of bad storage and sanitation practices: except for several packaged eggs (that belong to a certain brand and are sold for higher prices), practices such as cleaning or cooling before sale are usually omitted. This creates microbiological health hazard to the general public.

A 2015 study carried out by (Kalupahana et al. 2016) took it upon itself to identify the presence of *Salmonella* in raw table eggs available at retail outlets in one selected district of Sri Lanka. Based on the current practices in egg production and retail in Kandy district (which is further divided into 20 administrative regions), the primary hypothesis was that a considerable number of consumers might be exposed to potentially dangerous *Salmonella* through the retail of raw eggs. The study tested various kinds of table eggs available at a 100 randomly selected shops and market stands, ultimately looking for the presence of *Salmonella*. The study then tested the purchased eggs (including six pre-packaged eggs belonging to different brands as well as loose eggs) for *Salmonella*, searching for its presence both in the egg shell and the egg contents. From the number of samples, 15 were discovered to be positive for *Salmonella*. Out of these 15 samples, 12 yielded *Salmonella* from shell washings and 3 from egg contents; a positive finding, as least.

We have already established that salmonellosis is the most common disease contracted both by and from poultry in Sri Lanka. In 2013 there were 35 to 40 poultry breeders in the country, however only very few were maintained by the government; most of the large farms are in private ownership. However, it is compulsory to register before getting new stock, and the registration itself is only allowed if the percentage of *Salmonella*-positive specimen is less

than 1%. This regulation exists to encourage poultry breeder farmers to control or eradicate salmonellosis so they can only distribute *Salmonella*-free products, thus sparing the public from zoonotic disease. The other reason for this regulation is limiting the use of adulterants and various other chemical enhancers by minimizing the number of outbreaks in which the source is poultry (Priyantha et al. 2013).

Food safety is truly crucial when the food is served to patients in a hospital. Though Sri Lankan government is taking action in favour of better sanitation and less zoonotic disease outbreaks, namely through education on the matter (WHO, 2014), a study conducted by (Adikaria et al. 2016) showed that a number of food handlers still have a lot to learn and improve regarding their practices. This study was carried out with workers in National Hospital of Sri Lanka (NHSL) and was meant to assess the status of food hygiene and food safety practices in the hospital, while also examining the knowledge of the staff that came into direct contact with food before it was served to patients. 31 staff members that are involved in handling of food were included. From these, 52% of the staff was male and 48% female in the age range from 21 to 59. Over 50% of those involved had reached secondary education. The study, which was carried out through a series of interviews and questionnaires, showed that 54.8% of workers weren't familiar with the correct refrigerator temperature, while 51.6% of them thought that freezing food items kills all harmful bacteria. A concerning 19.4% of workers claimed that "fresh milk does not need to be stored in a refrigerator", which could not be more wrong, especially in tropical conditions. Furthermore, only 12.9 % of the included workers knew what Hazard Analysis and Critical Control Points (HACCP) are. However, the hospital employees working in food preparation had good knowledge concerning personal hygiene. Almost all the workers consider washing their hands after using the lavatory of importance. Still, the study has concluded that the workers' education on handling food was inadequate, and suggested the hospital provide proper clothing items (such as gloves and masks) and continue to educate their employees on both food hygiene and personal hygiene.

Colombo North Teaching Hospital was the setting of a 2009-2010 study on the causes and spreading of human *bocavirus*, which is a serious infection which, in developing countries, is often largely unrecognized (in 60%–85% cases) (Granerod et al. 2010). The study itself dealt with 233 patients with the following criteria: any combination of fever, headache, vomiting, along with altered level of consciousness and/or seizures. The age range was 2 months to 90 years, and, unlike in similar studies in other Southern Asian countries, the disease occurred in both malnourished and well-nourished patients. However, none of the cases ended in fatality.

The study's detection rate of viruses as a cause of encephalitis was 10% out of all the samples; however, that does not solve the mystery of how 233 patients got sick (Mori et al. 2013).

4.7. Pakistan

Formally Islamic Republic of Pakistan is a multicultural country that has struggled with political stability since gaining its independence in 1947, and in fact, what used to be West Pakistan is since 1971 Bangladesh. As per United Nations estimates, its population is 203,791,312 as of Wednesday, April 1st, 2019. 38% of the population resides in urban areas, mainly in Karachi, which is Pakistan's biggest city; although the capital is Islamabad, but this city serves mostly as administrative centre. The total land area of Pakistan is 770,880 km², and it is undoubtedly one of the most diverse countries when it comes to landscapes; it has the great Pamir mountains, as well as a maze of valleys and plateaus, all leading down to the Indus River plain and the coast of Arabian Sea (Ziring & Burki, 2019).

Pakistan, much like the rest of its neighbours, is also considered a challenged country when it comes to sanitation. According to UNICEF, 53,000 children die annually due to diarrhoea (which we know is most commonly the cause of poor sanitation, contaminated water and bad hygienic practices resulting in zoonotic disease). Additionally, Pakistan often suffers from disasters such as earthquakes, floods, droughts, and, perhaps most importantly, internal displacement due to this country's volatile political environment. Because of this, hundreds of thousands of households can be left in dire need of emergency water supplies and sanitation support.

Much like in for example India, one of the biggest problems is open defecation; and one of the projects currently running that aims to eradicate it is PATS, or Pakistan's Approach to Total Sanitation. This project in partnership with UNICEF aims to end open defecation by 2025 (unicef, 2017).

4.7.1. Cases in Pakistan

The situation in Pakistan is similar to all the other countries of Southern Asia; evidence suggests that the current food safety status in this region is highly inadequate and distressing. The theme continues: it is Pakistani street-vended foods that have been found so hazardous, to a point where it is clear that they are a clear-cut threat to the general public. Most have been found to be chemically and microbiologically contaminated, and several locally produced milk products were discovered to be contaminated with foodborne pathogens (like *Staphylococcus Aureus*, *norovirus* and *Escherichia coli*) (Randhawa et al. 2014). And that's not even

mentioning unsatisfactory storage, transportation and handling processes, which seems to be a problem in all of Southern Asia as well as in Pakistan. Notedly, among all kinds of reported foodborne illnesses, it is found that those originating from microbial sources are more common than chemical ones (Javed, 2016). Data from 2011 shows that 58% of infections are caused by *norovirus*, followed by nontyphoidal *Salmonella spp.* (11%) (Scallan et al. 2011). However, chemical contamination is no less dangerous. In another case mentioned in a study by (Javed, 2016) methanol ingestion was reported in a Pakistani town near the coast of Arabian Sea. Reportedly, after 3 to 5 minutes after the victim consumed the infected meal, methanol intoxication symptoms started to show: these included, but were not limited to confusion, depression, dizziness, headache, as well as nausea and upset balance. After about 2 hours, the subject suffered death.

As a developing country, Pakistan is mostly concerned with maximizing its profits; most producers and vendors use low-grade and harmful food additives and adulterants. An interesting point was made in a study focused on colouring additives. The addition of food colouring is common practice not only in the developed world, but in Pakistan as well. Many food products, especially those available in close proximity to various educational institutes in big cities (such as Karachi), are an example of this. In the study carried out by (Saleem et al. 2013), different types of food items were analysed for identification of the added synthetics typically found in food colouring. As one might expect, the majority of food items sold under a brand name were found to contain permitted colouring additives; however, some locally produced food items contained non-permitted colouring. According to (Saleem et al. 2013) 11% of branded and 44% of unbranded food items were filled with colouring deemed unsuitable for human consumption. As for beverages, 4% branded and 30% unbranded products were deemed unhealthy and containing non-ideal colouring additives. Local products had significantly higher presence of harmful additives, presumably due to lack of awareness of the producers, and low education in the matter of chemical enhancers.

In 2010, Pakistan was hit by severe floods. It affected 78 districts and over 21 million people; only about 10% of the whole population, which may not seem like much, but the consequences were no less terrible for it. As reported by WHO, this was the biggest natural disaster since the 2005 earthquake. Unsurprisingly, those left behind in the affected areas were put into a horrible situation. Because of Pakistan's tendency to practice open defecation, as well as the ever-present poor sanitation practices, faecal matters got mixed into various bodies of water by different contaminated sources: for example, untreated (or poorly treated) sewage

water. During and after the incident, 5.3 million medical consultations were given, and out of these 708,891 (about 13%) were due to acute diarrhoea. High mortality rates due to diarrhoeal infection were recorded both during and after the flooding season. The study used 200 samples from various water sources, including ponds, streams, rivers and lakes. Out of these 200 samples, 61% were contaminated by *E.Coli*, a bacteria most typically distributed through faecal matter (Shah et al. 2016). As was already stated before, floods might potentially lead to an increased transmission of microbial pathogens (such as *E.Coli*) through mixing of the flood runoff with bodies of water and solid waste which is present due to poor hygienic practices.

The last case presented for Pakistan brings us back to our origins, and the pattern which we have discovered so far; poultry as the origin of *Salmonella*. Thanks to their ability to have many kinds of hosts, including mammals and birds in addition to humans, it isn't an easy bacteria to fight; furthermore, many types of *Salmonella* have, in the recent years, become resistant to commonly used antibiotics (due to the extensive use of adulterants during production) (Foley & Lynne, 2008). Salmonellosis has a wide range of symptoms, from mild to severe. It can even be fatal if not treated properly. The study carried out in Quetta's shops and markets in 2016 focused on 200 randomly selected samples, and once again proved the dangers of street food. The samples were divided half by half into frozen and fresh, and the results were as follows: *Salmonella* prevalence was found to be 30% in processed frozen poultry, and 36% in fresh poultry. This is further explained in Table V - Detection of Salmonella in frozen and fresh chicken; *S. typhi* had a presence of 3.3% and *S. enteritidis* 43.3% in frozen meat, and in fresh meat *S. typhi* was completely missing at 0%, while *S. enteritidis* had a presence of 44.4% (Samad et al. 2018).

Table V - Detection of Salmonella in frozen and fresh chicken

Samples	Salmonella detected	S. typhi	S. entretidis
Frozen (100)	30 samples	1 (3.3%)	13 (43.3%)
Fresh (100)	36 samples	0 (0%)	16 (44.4%)
Overall (200)	66 samples	1 (1.5%)	29 (43.9%)

Adapted from (Samad et al. 2018)

4.8. Afghanistan

Afghanistan is a landlocked, historically incredibly important country – as it is in the heart of south-central Asia, it lies along trade routes that used to connect eastern and southern Asia with Europe. As of April 1st, the population of Afghanistan is 37,029,766, as reported by United Nations. 26.7% inhabitants live in urban areas, and the total land area of the country is 652,860 km². Though it is historically beautiful and rich country, by 21st century many Afghani people grew up knowing nothing but war. Kabul is the biggest city as well as the capital of Afghanistan, and most other urban settlements trail along the road from it, with the rural population scattered in valleys and along rivers (Hatch-Dupree et al. 2018).

In Afghanistan, diarrhoeal disease is the second leading cause of death for children under the age of 5, and 2 out of 5 children are stunted due to bad sanitation. To improve this statistic, UNICEF is working to spread awareness of hygienic practices and to end open defecation, which is the main challenge for sanitary, safe-to-drink water. At this point over 65% of Afghans have clean drinking water, however only 40% have improved lavatory access (meaning a toilet where the risk of coming into contact with human waste is effectively eradicated). UNICEF is also working with the Ministry of Rural Rehabilitation and Development on a rural water supply and sanitation programme that should provide clean drinking water to communities that rely on natural water sources (rivers, ponds, streams etc.) as well as to those communities whose water systems have been destroyed or fallen into disrepair due to conflict or natural causes. In 2017, 300,00 people gained new access to safe drinking water (unicef, 2018).

4.8.1. Cases in Afghanistan

In the light of Afghanistan's troubled past and present, the crisis has become the perfect breeding ground for infectious diseases: the inflow of Western military personnel, humanitarians, peacekeepers as well as journalists, combined with huge amounts of internally displaced persons is overwhelming for the country's already non-ideal infrastructure, and threatens to destroy what the country is trying to build in terms of safe sanitation facilities and healthy hygienic practices (Gessner, 1994). The Amu Darya river, which serves as a source of water for thousands upon thousands of people, has been contaminated many times over due to the unrest and constant movement of people (WHO, 2001). The upheaval present all throughout Afghanistan's history, and especially in the last two decades, is a leading cause of the increasing

the threat of disease outbreaks among Western military and humanitarian aid workers as well as local populations (Wallace et al. 2009).

As a consequence of continuous arrival of war refugees, the city of Kabul keeps growing, it's infrastructure straining under the stream of newcomers. Since until fairly recently (2017), collection and disposal of waste was in no way capable of handling the rise in urban population, leading to 70% of Kabul's solid waste being accumulated next to roads, in slums, in people's backyards, drains, rivers and other publicly accessible places. At present day, waste is still disposed of in fairly shallow sewage channels running through streets, thus risking a contamination of food and water by faecal matter and bacteria residing within (Houben et al. 2009).

Nevertheless, this isn't the only threat for the Afghani. Contamination of water, soil and vegetables by heavy metals is an increasing concern in the country. In a study carried out by (Safi & Buerkert, 2011), 5 gardens with water sources in Kabul were tested for the presence of heavy metals (Cd, Pb, Cu, Zn) and microbes (*Coliforms*, *Salmonella*, *Shigella*, *Entamoeba*). Despite the soil remaining within the norms when it came to heavy metals, the concentrations of heavy metals in the edible parts of the vegetable plants were undeniably over the safety threshold. All samples proved heavily contaminated by Pb (lead). Cu (copper) exceeded only Indian and EU standards, however 50% of all samples were contaminated by Zn (zinc). The amount of microbes and parasites in irrigation water was several times higher than what WHO has set as a safety threshold. *Salmonella* was detected in irrigation water of 2 gardens, and *Shigella* in 4. Most notably, *Coliforms* were found to be transferred into agricultural produce of all gardens. The data from this study combined with high number of incidents of intestinal diseases and diarrhoea in Kabul's population only further confirms the need for more surveys and, most importantly, proper solutions.

4.9. The Maldives

The Republic of Maldives is an island country in the Indian Ocean, and rightfully so a wildly popular tourist destination. In total there are about 1200 islands, out of which about 200 are inhabited. It's capital, Male, is somewhere in the central area of the islands, and about 650 kilometres away from Sri Lanka. As of April 1st, 2019, the population of Maldives is 450,152 according to United Nations estimates. 41.7%, a near half, of the inhabitants live in urban areas (The Editors at Encyclopedia Britannica, 2018).

Perhaps because of the “westernization” of the country and the inflow of tourism, 98% of the whole population has access to sanitation services, and the country managed to completely eradicate open defecation; a feat proved not so easy by the rest of Southern Asia. Furthermore, only 1% of inhabitants don't have access to improved water services – otherwise, 46% use piped water and 53% have access to potable water (unicef, 2018).

4.9.1. Cases in Maldives

WHO now considers Maldives a middle-income country in the Southern Asia Region, however diarrhoea remains an important, though not very widely researched public health issue. In a study conducted by (Yoosuf et al. 2015) children and adults with acute diarrhoea at three different hospitals in Maldives were investigated with particular interest in the prevalence of diarrhoea causative agents. A total of 73 children and 57 adults with acute diarrhoea were enrolled into the study; more specifically, children in the age range between 3 months and 5 years, and adults aged from 18 to 70 years. Stool samples were collected from each subject, then taken into laboratory for further testing, and the study focused on the presence of *Shigella*, *Salmonella*, *Vibrio* and *Aeromonas*. As for the results, the study showed that 55% of the children included were male and 78% of the children's guardians reported a history vomiting. The most common organisms identified in the stool samples provided were *Norovirus* (43%), *Rotavirus* (18%) and *E.Coli* (13%). As for adults, 67% were male. The subjects mostly reported fever and abdominal pain, with the leading organisms being *Aeromonas* (11%), *Salmonella* (9%) and *Norovirus* (8%). As can be observed here, this is the first case thus far where the infectious diseases played a bigger role for adults rather than children. However, *norovirus* and *rotavirus* infections in children are consistent with previous cases from other countries.

As mentioned before, Maldives are increasingly more and more popular destination for holidays. However, it's not always the dreamland that many foreigners imagine; in 2008, a couple from the United Kingdom visiting one of the islands have contracted Salmonellosis due

to poor accommodation conditions, including undercooked meats, cut-off water supply and malfunctioning toilets. Leane Beasant was unable to work for the next 3 months after being diagnosed (due to diarrhoea and abdominal pain), while Scott Beasant lost 10 kilos in 5 days due to the illness. The couple reportedly then sued the travel company, and won a £10,000 settlement for the trouble they has to go through during their vacation (Robinson, 2012).

5. Discussion

Perhaps the best outcome from the research of these many cases of food contamination is the fairly clear pattern that has emerged: because developing countries are often missing comprehensive food safety agenda, the food supply chain tends to suffer from start to finish (Allchin, 2019). Be it at the production level, where proper sanitary practices are not observed, or at the consumer level, undoubtedly the receiving end of all the trouble, the lack of awareness and poor hygienic practices make life harder for everyone. Microbiological and chemical contamination of food and foodborne illnesses are, as of now, a somewhat common occurrence in the developing world, in this case Southern Asia, but it should be noted that organizations like UNICEF, WHO and WaterAid are working continuously and putting a lot of effort into the advancement of this region's sanitation quality. Often times it is in collaboration with local governments, and that is undoubtedly the best way to do it; people need to see positive leadership before they are able to change their views and traditional practices.

Furthermore, the situation as it is now should not be accepted as a standard for Southern Asia, as the conditions are often less than human and hardly acceptable. Despite the improvements made in the last decade, many of the foodborne illness cases and outbreaks go unreported and unrecognized, unless they are of greater economic or political significance. *Botulism*, *E.Coli* infection, *Staphylococcus Aureus* infection, *Salmonellosis*, and many more previously discussed are of great importance in the quest to ensure food safety for these developing countries (Javed, 2016).

In many of the countries discussed in this paper, food safety is somewhat of a new concept. A diverse food chain consisting of producers, middlemen, hotels and restaurants and finally consumers themselves is hard to keep in line, and overseeing of all the activities involved is definitely a challenge for the future. However, governments should be held reliable and to a higher standard than thus far.

Moreover, street vended foods simply need to be focused on more (Frost, 2010). It is no coincidence that all the discussed countries had at least one case caused by improper handling, storage or transportation of the food item in question. Better education for vendors and other workers that come into contact with raw foods will be absolutely critical if there are changes to be made in the future (as shown in the case of hospital workers in Sri Lanka) (Adikaria et al. 2016).

Assessment of foodborne infections and identification of foodborne illness outbreaks play an important role in better data analysis and more accurate information. They, however, aren't possible without proper monitoring, surveillance, and disease control. Again, this cannot be accomplished without the commitment of governments, engagement of international agencies, and a more strict legislation regarding food safety in the countries in question.

6. Conclusion

After my research on the topic, I am convinced more than ever that education is the only way the world may ever change. In many cases, the reason for bad conditions wasn't simply bad sanitation – it was the people's disregard of proper behaviour, their unwillingness to change what they have been doing for generations. Even though it may be hard to imagine for westerners, or those from developed countries, in many cases in India, Bangladesh and Pakistan, we see that despite being given the tools to succeed, many refuse to use them, seemingly out of sheer stubbornness. Specifically in India there are communities which, although having been provided with sanitation facilities, simply decide not to use them because they prefer their own way of life, even though it is much less hygienic.

Education also comes into play in the matter of street food. All of Southern Asia is very fond of it, however most of the food sold is under acute risk of microbiological contamination. Food vendors are not aware of proper cooling techniques, they seldom wash their hands during handling of raw products, and the food suffers while laid out on display in the beating sun. The vendors and butchers are often not willing to accept new practices, as very few others do things differently, and it is cheaper to stick to the old, simple ways. Unless that mindset changes, the future of street food is uncertain at best.

Additionally, bad sanitation practices seem more prevalent in countries with less outside influence, and lower GDP. Notably Bangladesh with its high population density faces a big challenge in organization and management of its people and their waste. The more people are crammed into one small space, the more waste accumulates, and it is especially in Bangladeshi slums where people have simply resigned on any attempts at improvement.

On a lighter note, I see a positive future overall. The active and upbeat engagement of international humanitarian groups and NGOs has so far been priceless, and of immense help. The fact that they are also keen to work with local governments points to a better future, as majority of correctional actions should be taken by government and its organs in order for the many already running sanitation projects to be sustainable in the long run. Furthermore, the continuous survey and study efforts promise more accurate information, which has always played a critical role in being prepared.

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