Infection Biology

An insight into global health

Photo sources: Oronna Anam, Sara Olofsson, and Google Images: refugee camps
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Written by the class of 2016 Masters of Infection Biology, in association with Uppsala University and icddr,b
We would like to express our gratitude to all involved who have enabled us the opportunity of coming to Bangladesh and sharing the knowledge of the staff at icddr,b. Our thanks go especially to Dr. Shakila Banu and Dr. Aftab Uddin who made great efforts to help us through our studies and give us a pleasant stay in Dhaka. We would also like to thank the staff at icddr,b for the informative lectures, lab rounds, and hospital visits. Not the least, we wish to show our appreciation for all the professors and researchers who answered our questions and contributed with their knowledge to this journal.

Finally, we thank the organizers of this trip from Uppsala University, Prof. Catharina Svensson and Dr. Susanne Tingsborg as well as Dr. Patrik Ellström and Evangelos Mourkas for accompanying us and being of great help during our stay in Bangladesh.
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A closer view on epidemics in refugee camps

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The idea of a refugee camp has been associated with a poverty-driven way of survival. From the scrap-made tents of Dollo Ado to the white, plastic tents of Dabaab, there is a very powerful link between living in a camp and not having access to water, food, or medication. Malnutrition and infectious diseases are just a few of the challenges that many refugees have to encounter on a daily basis. War-ravage countries, such as Afghanistan and Syria, are constantly confronting with outbreaks of bacterial and viral infections, while vaccines and medications are, in many instances either scarce or non-existent. The ongoing Syrian civil war has generated one of the largest refugee crises since World War II and its effects are felt throughout the Middle East and Europe. However, thanks to the efforts of many organizations such as the WHO and UNHCR, things have started to improve in some parts of the world. There are some extraordinary examples where the involvement of a whole country has turned the life around for thousands of refugees, offering them unprecedented living conditions, extensive child education and adequate medical care. In order to fully overcome these challenges however, more resources will need to be made available and the origins of the problem will need to be tackled and resolved.

A summary of current refugee crises

As of 2014, 60 million people are displaced worldwide due to regional or international conflicts, prosecution, and violation of human rights or simply due to generalized violence. This is a very large increase with 8 million more people compared to 2013. 14 million people were forced to become refugees or asylum seekers in 2014 alone (a significant increase from previous years). In average 42,500 people had to flee their home every day, and only a totally of 126,800 people could return. The majority of these people originate from developing countries¹.
The country which hosts the highest number of refugees is currently Turkey (1.6 million), followed by Pakistan and Lebanon, each with more than 1 million refugees within their borders. Lebanon is also hosting the highest number of refugees per its national population, with a total of 232 refugees per 1000 inhabitants. The top three refugee origins in the end of 2014 were Syrian Arab Republic with 3.9 million, Afghanistan with 2.6 and Somalia with 1.1 million.

All 3 countries being hotspots for civil wars, governmental instability and chaos-induced poverty.

An estimated number of people being displaced from their homes in Syria is at least 7.6 million people, with most of the refugees still in their homeland. However, three of the largest refugee camps in the world are located in Africa, namely in Kenya (Dabaab and Kakuma) and Ethiopia (Dollo Ado).

Dabaab, the largest of the three, is currently host for almost 500,000 refugees. Most of them live either in tents made out of plastic sheets, provided by the UNHCR (United Nations High Commissioner for Refugees), or in improvised tents, made from whatever materials were at hand.

UNHCR has a budget (2015) of approximately 6 billion US dollars and manage around 300 refugee camps over the whole world. This means that they have a very limited amount of money for the 13 million refugees which are under UNHCRs care. With a focus on the Middle East and Africa, UNHCR reported requirements for 2013 ending at 22 billion US dollars. But worldwide, the situation in refugee camps is much worse. Many encampments have very little access to water, food and shelter, since the UNHCR’s resources can only be stretched so far. There are many known long-term problems among the refugees living in camps. UNHCR has repeatedly reported the negative impacts that a life in a camp can have on a person’s way of living. Economics can also be disturbed by camps, which may cause detrimental effects on surrounding areas. However, for some refugee camps, other locals can take advantage of the humanitarian aid intended for the refugees. Due to a lack of law enforcement, the goods, including food, sanitation and medicine can be sold on black markets. UNHCR also reports increased protection risks such as sexual and gender-based violence, child protection concerns and human trafficking in large camps.

As a result of the constant flux of people between states, it is estimated that more than 10 million people are left stateless, without any legal links to a particular nationality or state. Usually, this originates either from discrimination or discrepancies in one’s national legislation. However, such a status is further enforced by conflicts or a generalized breakdown of the society and has serious effects on a person’s ability to receive any kind of health treatments (due to the lack of means of identification, as well as the collapse of the healthcare system in affected countries).

This situation leads to the matter of asylum seeking. Because of the severe hardships which many families are forced to suffer in their native countries, many of them have fled either into neighboring states, or to western countries. According to official UNHCR statistics, Sweden has become one of the top five countries favored by asylum seekers and refugees. During last year
alone, it has received more than 75,000 asylum applications, making it one of the highest levels ever recorded (outclassed only by the 1992 Yugoslavian crisis). Half of these applications are made by Syrian nationals, as a result of the Civil War which started in 2011\(^1\).

Here, all asylum seekers and refugees which are granted residential permits receive temporary housing, health care, as well as monetary benefits.

Due to the war in the Middle East, Syria is facing a very big problem where at least 35% of the public hospitals are out of service and up to 70% of the health care workers have fled their homes, which results in a limited availability of health care for the people. At the same time, water and sanitation safety has been drastically disrupted leading to poor healthcare conditions for the locals. Vaccination programs have struggled to make vaccines available to people, with a general drop in vaccinations from 98% in 2010 to an estimated 45% in 2013. At the same time, the climate is suitable for various vectors of different infectious diseases and, according to DR Jaouad Mahjour, Director of the Department for Communicable Diseases at WHO’s Regional Office for the Eastern Mediterranean, the risk factors for the spread of public health diseases are present in all of Syria and its neighboring countries. Water-borne diseases and especially hepatitis, typhoid fever, cholera and dysentery are all expected to cause outbreaks.

In the beginning of 2013, Syria’s warning system reported a 172% increase (243 – 660) of acute watery diarrhea and a 219% increase (48 – 153) of hepatitis A. Due to the drop of vaccinations, laboratory-confirmed cases of measles increased from 0 cases in 2011 to 139 in 2013.

**Diseases and containment in refugee camps**

In 2005, WHO in conjunction with the UNHCR have released a step-by-step manual designed to provide containment guidance for countries which are dealing with epidemics in refugee camps. It covers several key aspects, which are essential for detecting, controlling and stopping an outbreak. Although these kind of outbreaks are similar to any other epidemic, there are many unique characteristics which make a refugee camp a much more volatile and unpredictable environment, such as poor sanitation, poor water quality and low availability, malnutrition/micronutrient deficiencies, a larger population density or pre-existing diseases in the affluent population\(^5\).

According to WHO, the most important communicable diseases in refugee camps are Hepatitis A/B, HIV, Measles, Leishmaniasis, MERS-CoV, Malaria, TB, Meningitis, Polio, Leptospirosis, Cryptosporidiosis\(^5\).

Important factors that contribute to the spreading of disease: lack of organized healthcare, resources and tools; lack of access to clean water and sanitation; contamination of water or food supplies; absence of herd immunization and lastly, intentional targeting of medical staff/facilities by insurgents\(^6-^9\).

**Leishmania – A plague for refugee camps**

When the Civil War started, millions of Syrians were displaced from their hometowns into various facilities. The
recent advances in healthcare which were reported throughout the country, such as the decrease of infant mortality rate and increase of child immunization rate, were lost when the war broke out. The breakdown of the government, and thus, of the healthcare system, along with the intentional targeting of healthcare facilities and workers by militants (as a warfare tactic) have ushered a new era for infectious diseases in the region. With almost no barriers left, many pathogens have spread with an unprecedented rate within the population. As such, Cutaneous Leishmaniasis has become one of the most prevalent infectious diseases in Syria. This condition is caused by several species of the genus Leishmania (such as L. major), an intracellular parasitic protozoan which is related to the genus Trypanosoma. This parasite is usually transmitted via sand fly bites (Phlebotominae subfamily), by blood transfusions or by infected animals (dogs, cats).

Individuals affected by this type of Leishmaniasis can become carriers for a long time without presenting any clinical signs. However, when the disease occurs, it usually presents itself as one or several severe ulcerations, smooth nodules or flat plaques on a patient’s skin. In most cases, the lesions are localized, but in more severe cases, the parasites can access the lymphatic system and spread throughout the body, causing secondary skin or mucosal lesions.

Most lesions are painless and can heal spontaneously. Exceptions occur in HIV-positive patients, where severe fibrotic tissue can form after healing. Preventive measures can be employed to decrease the abundance of sand flies in an area via insecticides or by means of personal protections (insect repellent skin lotions, bed nets). Additionally, large-scale screening and culling of infected dogs can decrease the prevalence in extreme situations.

As far as treatment goes, pentavalent antimonial are initially administered, however, due to resistance development, Amphotericin B may be used instead. The situation changes in immunocompromised individuals, where the disease can relapse after successful treatment, and there is an
increased risk of developing Visceral Leishmaniasis in the future.\textsuperscript{5,11}

In 2012, there were more than 53,000 individuals suffering from Cutaneous Leishmaniasis in Syria and Lebanon, with many regions having an endemic status for Leishmania.\textsuperscript{10}

Neighboring countries are now reporting cases of measles, tuberculosis and cutaneous leishmaniasis. WHO is trying to prevent the spread of these diseases by supplying safe drinking water and sanitation, distributing bed nets, pre-positioning medicines and medical supplies, together with vaccination campaigns within Syria and nearby states.

**Viral diseases**

Due to such a dramatic decrease in vaccinations in the Syrian Arab Republic (from 91\% to 45\% in 2013), viral diseases which were previously held at bay by herd immunity have seen a massive increase in prevalence. In 2014, more than 7000 cases of measles were reported throughout the country, as well as sporadic cases in adjacent countries.\textsuperscript{12,10}

Measles, or rubella, is a viral infectious disease caused by the Measles virus (MeV). It is a ssRNA virus belonging to the Paramyxoviridae family, which causes respiratory tract infections in humans. This virus is transmitted via aerosols or saliva droplets, and is one of the most contagious diseases known to man. It has an attack rate of 80\% and, without vaccination, an $R_0$ of \(\geq 11\), meaning that 1 person will infect at least 11 other individuals).\textsuperscript{13,14}

In the beginning, the disease is characterized by coughing, fever, difficulty breathing, diarrhea, mouth ulcers (Koplik spots) and rashes. But as the illness progresses, complications may occur, including pneumonia (due to superinfections caused by \textit{S. aureus} or \textit{H. influenza}), vitamin A deficiency, otitis media and encephalitis, the latter usually becoming fatal.\textsuperscript{5,15}

Although a measles-specific nonnucleoside inhibitor is in the pipeline,\textsuperscript{16} currently there is no focused treatment available. Nevertheless, there are many protocols established to ensure that patients do not suffer from complications after the disease passes. These include the administration of paracetamol for keeping the fever under control, making sure that patients are well hydrated, administering vitamin A as prophylaxis (to prevent xerophthalmia and subsequent blindness, especially in high risk groups), as well as maintaining breastfeeding for infants.\textsuperscript{5}

The highest risk groups are children between the ages of 9 months and 5 years and the largest number of reported cases are found in developing countries.\textsuperscript{17} As such, vaccination is essential in preventing measles outbreaks. In recent epidemics, it was observed that vaccination and herd immunity can lower the viral $R_0$ to values as low as 1.2\textsuperscript{14} and provide lifelong immunity to 95\% of vaccinated individuals. This situation changes during war conditions, where vaccination rates plummet, increasing the case-fatality rate to 30\%, from which almost 45\% are represented by children cases.\textsuperscript{18,5,19}

Finally, the immunization process in these regions is further hampered by the handling requirements of the vaccine. The vaccine must be kept at low temperatures and is administered via injections, as opposed to the polio vaccine, which is orally administered. As a result, medically trained
workers are needed to inoculate patients, a requirement which simply cannot be met in the Syrian state. Nevertheless, several vaccination campaigns were initiated in the country and in neighboring regions, which still manage to help millions of people.

**Going back to the basics – Rebuilding a healthcare system in camps**

The integration of a centralized healthcare system within a refugee camp, coupled with a health information system (HIS) have proven to be essential for maintaining and monitoring the well-being of the inhabitants. There are many integral parts of a healthcare system which must be ensured and safeguarded, such as: water availability and sanitation, food availability, adequate shelter, emergency services and treatment availability, as well as health education and awareness. All these factors are vital for welfare, in addition to preventing and treating diseases.

**Better water, better health**

Ensuring environmental sustainability, where safe drinking water and basic sanitation are included, is one of the Millemium Development goals. Higher water quality and sanitation would improve the quality of life of millions of people. Managing water resources to lower the vector-borne diseases burden and to make water safe would save these lives.

Bad water quality can lead to diarrhea and malnutrition, which are the main causes for more than 2.2 million child deaths each year. Diarrhea is mainly caused by contaminated drinking-water, contaminated food or a lack of hygiene. Cholera, typhoid and dysentery are all included in diarrheal problems and 88% of all cases are related to contaminated water, inadequate sanitation or bad hygiene. Diarrheal problems can lead to underweight, a condition which causes 35% of all deaths of children under the age of five every year and makes children more vulnerable to almost all infectious diseases.

There are several examples where water sanitation has lowered the cholera rate in refugee camps, through effective chlorination at untreated water sources.

To make sure all refugees in camps have access to clean water, UNHCR has put up the following criteria:

- Availability of water should not be able to become a source of power
- Provision of water containers to ensure good water storage
- Access and distance to collection point should not exceed a specific time
- There should be enough water for agriculture and livestock
- Water points should be managed the same to ensure safe access and to minimize the potential for gender-based violence and minimize conflicts at water points

Most refugees are women and children and this fact can have a negative impact on the children’s education in refugee camps. Many children need to help collecting water and thereby cannot go to school. In the Ugandan refugee camp Kyangwali, it was believed that 42% of the school-going children regularly helped their mothers with water-collection instead of going to school. However, education should not suffer due to poor water availability.
Sanitation

Sanitation has the fundamental aim of providing a physical barrier between the inhabitants of a settlement and the rest of the environment. It is regarded as one of the vanguards of healthcare and a lack of sanitation can transform a safe settlement into an ideal background for disease\(^5\).

UNHCR has minimum standards for water and excreta disposal provisions and most of the refugee camps have a higher standard than UNHCR's minimum criteria. However there are still a large number (40 \%) of camps that has lower water availability than 20 liters per person per day and over 25 \% have too few latrines where there are more than 20 people per latrine\(^21\).

Food security

Both food shortages and malnutrition are commonly found in refugee camps. Malnutrition can lead to energy, protein and micronutrient deficiencies, all of which have been linked with an increased risk in contracting infectious diseases. This risk is further increased in high-risk groups, like infants, children and other immunocompromised individuals\(^22\). The WHO recommends that, for adults, the mean daily intake per capita should be no less than 2100 kcal and the average protein intake no less than 46g, originating from a mixed diet, if possible\(^5\). While a 2013 nutrition assessment of Syrian refugees situated in Jordan has shown that malnutrition can be almost as high as 10\% in young children (under the age of 5)\(^23\), a more recent UNHCR report, which looked at population profiles in regard to nutrient availability in the same region, shows a more positive situation where only 1.2\% of young children are regarded as malnourished. Additionally, undernourishment in young women with children was also shown to be decreasing, reaching a 5\% value within a two-year period\(^24\).

Rapid short-term support

A country which experiences a crisis has the option to ask the United Nations (UN) for help. However, it is up to the UN members to choose if they want to contribute with help or not. Sweden has a history of contributing with peacekeeping military around the world. At the moment, late 2015, the Swedish Military has soldiers stationed in eleven countries including Mali and North-West Africa, where about 250 Swedish peacekeeping soldiers are stationed\(^25,26\).

According to Ida Nezel (Soldier), there are many similarities between military and refugee settlements. For example, the fact that many people live close together in small areas may be a contributable factor to the spread of infectious diseases. Additionally, she also states that Swedish Military camps can also experience outbreaks, similar to refugee camps, where diarrhea is the main problem. The source is often a combination of food and poor hygiene. If the personnel gets diarrhea, precautions are taken in case
the disease is caused by a transmissible pathogen. The ill are told to stay indoors or can opt to stay at Role 1, a primary care unit for military personnel\textsuperscript{27}. Most cases of diarrhea are usually treated by administration of fluids and electrolytes, as these factors exhibit massive drops in severely-ill patients.

When operations take place in warmer climates, there are precautions taken regarding the possibilities of vectors being present, for diseases like malaria and leishmania. Long sleeves and pants, in addition to mosquito nets over the beds, are good and cheap precautionary measures. Ida specified that there were examples of soldiers in the field that have gotten leishmania when neglecting this in Afghanistan. For the Swedish military it is very important that there is good healthcare available for the peacekeeping forces, as well as essential survival education before and during a mission. The ability to treat combat injuries and to keep wounds clean are some of the priorities for soldiers sent in Mali.

Some of the main concerns of the Swedish Army are preventing and treating malaria, and to this end, they employ on-site diagnostics which are available in camps. If the medical team declares itself unable to treat the patients at the base, the Swedish Army usually collaborates with Karolinska University Hospital, where the patient is transported via a Strategic Evacuation intensive care airplane (STRATEVAC)\textsuperscript{28}.

Many refugees cross several borders along the way to their destination. The border crossings are opportunities for refugees to get examined by voluntary healthcare workers, such as Medecines Sans Frontiers (MSF). They can, swiftly and efficiently, put up mobile clinics designated for primary care purposes. According to a 2015 MSF report, the main problems for refugees walking from Syria to Europe have been the need of psychosocial support, in addition to the danger of contracting contagious diseases, such as diarrhea and bronchitis. Children were, again, the most important risk group\textsuperscript{29}.

For people living in rural areas, the mobile clinics give them an opportunity for healthcare, which otherwise would have been very hard to get. Many live as far as 50 km from the nearest healthcare center and may not be able to travel that distance. The road through the bushes can also be dangerous, so having mobile clinics enables people, which might otherwise not be able to, to see a healthcare professional\textsuperscript{30}.

Over the board, MSF is trying to help in as many ways as they can. Currently, they also work with the public education in several ways. Vaccination programs are established and general health education is given. In Afghanistan, where many women don’t know how to properly breastfeed their children, MSF has seen a lot of malnourished children, relates Lajos Jecs, a MSF nurse. Thus, they contribute with basic health education, healthcare expertise and medication\textsuperscript{31}.

In Africa, malaria kills more than 430,000 children per year and MSF treated more than 2.1 million people in 2014, which makes it the most treated disease in their projects\textsuperscript{32}. UNHCR is working to educate the public about malaria and, together with WHO, is recommending the usage of mosquito nets to prevent bug bites. It has been shown that if 60% of a population uses full covered bed
nets it is enough to protect the whole population from malaria infection.\(^3\)

Throughout the world, there is a dire need for better living conditions in refugee camps, and thankfully, there are a few well-known examples.

**A story of success – Kilis Refugee Camp**

Although most refugee camps are far from perfect, there are some which have managed to provide a decent, and sometimes even unexpected, level of welfare and adequate facilities. According to renowned New York Times reporter Mac McClelland, the Syrian refugee camp situated in Kilis, Turkey offers living standards found in very few other such camps. The camp offers shelter to 14,000 people and each resident own a pass card, which must be scanned upon entry into the camp. Similarly to airport customs, the residents must then pass through a metal detector, while their carry-ons are X-rayed.

Inside, the Turks opted to install 2,053 containers which act as apartments, meeting areas, cafés and stores. All are arranged in rows, with brick-laid streets in between.

There are no improvised tents, and no raw waste or sewage.

The general sense of order and neatness is further underlined by the readily available utilities found in normal neighborhoods. Every apartment has electricity, plumbing and sanitation, and its residents can even call for maintenance, if need be. There are several supermarkets within the compound, as well as various playgrounds for children.

Child education is one of the biggest problems in refugee camps, with most camps dealing with resource constraints and limited access. This is another key area in which Kilis manages to excel. The camp has several schools, as well as preschools and kindergartens. In total, there are over 2000 children attending school in Kilis. The facilities are viewed by many as exceptional, with one Syrian teacher admitting that “this refugee-camp school is nicer than the public schools at home”.

Healthcare is another important issue in such scenarios, with many camps experiencing disease outbreaks, malnutrition and drug shortages. However, this camp has its own clinic, where several Turkish doctors are working full-time, and it has the resources to both treat and transport patients which cannot be treated onsite to nearby hospitals.

So what is the secret to Kilis’s success? As opposed to most refugee camps, Kilis is run by Turkey’s Disaster and Emergency Management Presidency (AFAD), and not
by the UNHCR. And even though it is based on UNHCR guidelines, Turkey has full control over every aspect of the camp’s administration, giving Kilis a unique level of independency, high above any other UN-ran refugee camp.

Additionally, most of the financial resources are also provided by Turkey, making it much better funded. Finally, from a security standpoint, it is much easier, albeit expensive, to employ governmental workers, rather than NGO volunteers. This is because most NGOs operate in any number of countries, and sometimes are unable to offer their services due to shortages of resources or clashes in their hierarchies. All these factors combined have resulted in a highly organized, clean and secure settlement, with Turkey at the helm$^{34,35}$.

In conclusion, the worldwide refugee crisis is an intrinsically complex issue and one of the biggest problems that our modern culture has to tackle. It covers various facets of the human society and in order to successfully confront it, we must improve our overall efforts. If we would be able to address the roots of the matter, worldwide poverty and violence, then the answer to this crisis will follow. But this may be one of the hardest things to do, to change the human nature
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Bangladesh is a developing country in South Asia, with a population of over 160 million people living in a relatively small area. The country has been independent since the Liberation war in 1971, separating it from Pakistan. It is also one of the Next Eleven developing economies and had been one of the few countries to succeed with the Millennium Development Goal (MDG) of decreased child mortality. While Bangladesh is largely Muslim (over 90%), the people take pride in celebrating the holidays of many other religions and welcoming these traditions.

The health system is growing, and moving towards a form of universal health coverage. The health care system is divided into tiers, with the community clinics at the base. From here, people can go to health and family welfare centers. Upazila (subdistrict) health centers are able to provide a larger variety of services and care. District hospitals are at a sub-population level, and provide specialty surgeries, etc. Medical college hospitals make up the most extensive level of care. There are country-wide vaccination programs, as well as other programs to provide aid for select groups.

Aside from the governmental health care system, there are also private hospitals and clinics, as well as specialty hospitals such as the international center for diarrheal disease in Bangladesh (icddr,b). icddr,b originated in 1960 as a cholera research facility, with a field station in Matlab in 1963. The center was recognized in 1978 by a government ordinance, and is funded by international aid from other countries, such as Sweden and Canada and non-profit organizations, such as the Bill and Melinda Gates foundation. The research at icddr,b has led to the development of oral rehydration solution and other significant treatment methods and interventions. The hospital provides treatment for anyone for free. More extensive care is provided for patients with more serious, underlying issues, such as severe acute malnourishment. The center also provides training for health care workers, as well as surveillance of diarrheal diseases in Dhaka and international work with diarrheal outbreaks.

While the economy is growing, urbanization does lead to population boom in the cities, which are not entirely prepared and lacking the infrastructure needed to support such large populations. This leads to a large amount of people living in slum areas. As much as 40% of Dhaka’s population lives in slums, often without proper sanitary conditions. Also, a large part of the country has an elevation barely above sea level, leaving it vulnerable to climate change and monsoon flooding, which may speed up urbanization. More recently, the country has been struggling with internal issues, including violent attacks on secular writers and publishers, as well on attacks on foreigners and minorities. While turmoil was common in Bangladesh during its early years, this is a new phenomenon now, in a Bangladesh that treasures tolerance while holding on the traditional ways. While Bangladesh has made significant strides recently, there are still efforts to be made to improve the quality of life for many citizens.

Written by: Jennifer Jagdmann         Photos: Julia Ellerman
Effects of Cholera in children in Bangladesh

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Cholera infection caused by the bacterial species Vibrio cholera is, if not treated correctly, a highly mortal diarrheal disease. Especially children are vulnerable because of their immature immunity and close contact with infected adults within the family. Cholera has both sporadic outbreaks all over the world and is endemic in some countries, Bangladesh included. Cholera is first of all treated by restoring the huge amount of lost fluids. Antibiotics are only used in very severe cases when the disease burden needs to be shorten or mitigated. There are vaccines available but they are too costly and hard to manage to be used at regular basis in endemic countries. The future beholds more accessible vaccines but the easiest way to prevent Cholera is still to consider good personal hygiene and usage of safe food and water supply, and for the youngest children breastfeeding is the most efficient protections against infections.

Vibrio cholerae is the most common source of death in low incoming countries such as Bangladesh. It is a motile bacteria with a unipolar flagellum that can be found especially in brackish water. The cholera disease is mainly caused by V. cholera O1, sometimes also by the serotype O139 and has a highly pandemic potential (1).

The source of the infection is mostly faecally contaminated drinking water or food prepared with those water. Other sources can be seafood taken from those waters or also fruits and vegetables that were for example irrigated with contaminated water (2). Previous studies has also shown that vibrio cholera is highly associated with the occurrence of plankton. The Vibrios attach to both zoo- and phytoplankton which makes plankton containing water a high risk factor of the spread of the infection (3).

Nevertheless, the infectious dose that is needed to provoke severe cholera in healthy patients is, with $10^8$ bacteria, quite high. But it might be lower under field circumstances and it is also lower in people with low gastric acid. However, without filtering or cooking contaminated water, especially when the bacteria are concentrated in plankton, the probability of getting the disease by consuming the water is quite high. People that get the disease are mostly suffering of severe diarrhea which produces high amounts of watery stool and especially the so called characteristic rice water stool.

Cholera Facts

- Most common cause of death in Bangladesh
- Transmitted through contaminated water
- High attack rate for children
- Leads to severe dehydration
The high loss of fluid leads rapidly to severe dehydration which can lead to shock and finally also to the death of untreated patients (4).

**Situation in Bangladesh/ Dhaka**

In Bangladesh cholera is an endemic disease with yearly epidemics. As an example, in spring 2002 during an outbreak, there were estimated 30 000 cases of cholera only in Dhaka. This shows that cholera is a serious problem in this country because outbreaks occur every year. In previous studies it could be shown that Cholera in Bangladesh has a special seasonality. The highest outbreak peak is every year during the months March, April and Mai which are the hot summer months before the monsoon season starts. A second but lower peak could be shown after the monsoon season during the months September, October, and November. The high peak can be explained with the high temperatures which lead to a rapid growth of the vibrio bacteria. Because dryness during this time there is also a massive lack of water. The sources of drinking water are therefore very limited which leads to a rapid spread of the disease (4). Another reason could be the blooming of the plankton during these months which leads to the release of the cholera bacteria and therefore can be related to the cholera outbreaks as well (3). Apart from this, but less common, outbreaks can also occur during the monsoon season when it comes to floodings. Water sources get easily contaminated during that time what results to a fast spread of cholera (5).

In some cities like Dhaka and Matlab there are already specialized hospitals established that are aware of those outbreaks. The Icddr,b (International Centre for Diarrheal Disease Research, Bangladesh) in Dhaka is highly specialized to diarrheal diseases like cholera and treat those patients the whole year and especially during the outbreak seasons. Those hospital not only treat the patients but also educate them in hygiene and other topics. Apart from that they also do the disease surveillance for the cities and have a lot of research programs especially for local diseases (6).

**Why are children affected?**

Children have the highest risk to get cholera in low income countries. The highest attack rates can be found among children in the age of 2-5 years. Neonates and infants seem to be protected by the breastfeeding and therefore the maternal antibodies (7).

Particularly in the slums there are no sanitary systems and faecally contaminated water can often be found in the streets. Children in the age of 2-5 years are used to play there, that is why they are most likely to be infected. Another aspect is that the parents, mostly the fathers, eat not properly prepared street food while they are working outside. When they get sick they also infect their children at home because children mostly have a lower immunity. That is why cholera in new infected areas can be found in adults first but then spread very fast among the children (4).

Since the attack rate is very high for children there is also a high mortality rate for those. When children suffer from severe dehydration due to the rapid loss of water they rapidly need to get treated at the

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**Facts about children in Bangladesh**

- Children in the age of 2-5 years mostly affected by cholera disease
- Children die from dehydration because they are treated to late
- Children in the Slums of Bangladesh are often malnourished and have low immunity
Unfortunately, the mothers are often not aware of this risk or cannot go to the hospital because they have to wait for their husbands to get home or take care of their other children. This leads to the sadly fact that children often get treated too late and die due to the consequences of the cholera disease.

How to diagnose and treat them?

The World Health Organization (WHO) has set guidelines to suspect a Cholera infection if i) a patient older than 5 years develops severe dehydration from acute watery diarrhoea (usually with vomiting) or ii) any patient above the age of 2 years has acute watery diarrhoea in an area where is an outbreak of cholera (8). In Bangladesh, where the disease is endemic with seasonal bound outbreaks, no further diagnosis is needed (4). Besides Cholera, rotavirus is the most typical cause of severe diarrhoea among infants in Bangladesh (9). The treatment for Cholera infection and infection caused by rotavirus is similar by immediate rehydration (4, 10) and therefore the cause of infection usually does not have to be established by laboratorial procedures. In other cases, for example in surveillance studies, methods like microscopy, culturing or ELISA of stool samples can be performed to examine the cause of the disease burden.

Children who arrive at the hospital with the main characteristic symptoms for a Cholera infection will immediately be placed in special designated beds where the stool can be collected for examination. The level of dehydration is then assessed by observing symptoms, and the first treatment consists of giving oral rehydration solution (ORS). To determine dehydration medicals often check the skin turgor. If the skin goes only slowly back into its old position, patients suffer from severe dehydration and have to get treated immediately. If severely dehydrated, intravenous fluid is provided instead (4).

Antibiotics are usually only administered if the access of ORS or intravenous fluid is limited and the duration of the infection needs to be shorten, or when the patient is severely ill. Examples of antibiotics include erythromycin, co-trimoxazole, ciprofloxacin and azithromycin (4). Zinc supplement can also shorten the duration and reduce severity of the infection, but the cost to provide Zinc prevents it from being used at regular basis for the treatment of children (11).

How to prevent Cholera?

There are three vaccines available on the market up to this date; Dukoral (Valneva, Stockholm, Sweden) and the two close related vaccines Shanchol and mORCVAX. Dukoral differs from the two other ones by containing the bacterial toxin B subunit (4). Dukoral needs to be taken together with a bicarbonate buffer to protect the vaccine from the acidic environment in the gut. That, combined with a high price and cold-storage requirement, makes it problematic to vaccinate children in Bangladesh. Shanchol is cheaper and can be administered directly
from the vial, but nearly all Shanchol doses today are in a stockpile which is only used for cholera outbreaks and not for countries, such as Bangladesh, with endemic Cholera (12).

Food, water and personal hygiene are still the most preferable actions in the prevention against cholera infection (2). Risk factors for Cholera among children include the age, low income of the household, source of drinking water, distance between kitchen and drinking water, education of their mother etc. In addition to that, living in either rural or urban setting also decides the level of severity of the infection (7).

It has also been proved that children under the age of 30 months gain good protection against Cholera through breast milk. The same protective effect was achieved no matter if the mother was vaccinated or not (13).

Bangladesh with its lowland landscape and many rivers makes it extremely vulnerable for global warming that results in severely flooding. Together with the flooding comes the spread of infectious diseases, Cholera one of them. As a part of encountering Cholera outbreaks connected to climate changes, surveillance of demographic and microbiological features during flooding need to be performed (5, 14).

**Conclusions**

Cholera is a severe infectious disease but is easily treated by immediate rehydration. Children are especially vulnerable to the infection, therefore it is of great importance to educate adults within the family about food- and water hygiene, and that hygiene is preferred in the prevention against Cholera infection where vaccination may be too costly and inefficient.

**Acknowledgments**

A lot of thanks go to ASG Faruque and the icddr,b for providing us with information and pictures.
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Reproductive tract infections and its socio-economic relationship with the women of Bangladesh

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Reproductive tract infections, left untreated, can lead to severe complications in pregnancy affecting the health of the mother as well as the fetus. Women in developing countries such as Bangladesh run a higher risk of contracting RTIs as the spread of these infections are in strong correlation to socio-economic factors. In terms of sexually transmitted infections, the prevalence in the Bangladeshi general population is rather low compared to its occurrence among female sex workers. Due to stigma surrounding the sex network, these women may be too ashamed to seek medical care or do not see it as an immediate priority in context of their other problems. In order to improve the sexual health of women in Bangladesh, underlying social issues need to be addressed and dealt with in addition to how society views the topic of female sexual health.

Reproductive tract infections (RTI) are widespread around the world and happen to be highly influenced by biomedical, behavioral, and socio-economic factors. This correlation and prevalence can clearly be seen among Third World countries, including Bangladesh. Without early diagnosis and accurate treatment regimens, RTI complications can compromise women’s health and fertility, infant health and survival, and the effectiveness of family planning programs.

These infections can occur during gestation, birthing, or post birth. During gestation, these infections can pose a risk to the mother and her pregnancy due to the underdevelopment of the fetal immune system, whose primary defense includes the placental barrier and maternal cell mediated immunity. Prenatal infections occur in utero prior to birth and can affect the placenta via the blood system or placental crossing. These RTIs are often caused by bacteria such as Listeria monocytogenes, Treponema pallidium, viruses such as human immunodeficiency virus (HIV), herpes simplex virus (HSV), cytomegalovirus, rubella, and parasites such as Toxoplasma gondii. In addition to these microorganisms, those that are associated with ascending placental infections and urinary tract infections (UTI) are also influential in maternal and fetal reproductive infections. Such microorganisms include Streptococcus agalactiae (GBS), Escherichia coli, Chlamydia trachomatis, Mycoplasma spp. and Ureaplasma urealyticum.

The microorganisms previously mentioned also have an effect on natal infections which occur as a result of exposure during birth,
often via the eyes, nose, mouth, and ears. Postnatal infections usually occur after birth during the initial four weeks of life and may be acquired from nursery environments. Delivery by a mother affected by RTIs can result in stillbirths, babies with low birth weight, chronic infections such as HIV or HSV, sepsis, hepatosplenomegaly, scaled skin syndrome caused by *Staphylococcus aureus*, and listeriosis. Possible postpartum infections include bacterial vaginosis, prolonged labor, retention of contraceptive products, endometritis, perineal cellulitis, and episiotomy. These infections can be attributed to polymicrobial accumulations including aerobes such as *Staphylococcus* spp., *Streptococcus pyogenes* (GAS), GBS, *Enterobacteriaceae* and anaerobes such as *Bacteroides* spp.

Training of midwives to help meet millennium goal targets (photo source: healthynewbornnetwork.org; google images)

**RTIs prevalent in Bangladesh and Pakistan**

In a recent study to determine the most common RTIs in pregnant women in Bangladesh and Pakistan, blood, urine, and endometrial samples were collected from early identified pregnancies (12 weeks) at 19 weeks. From the 276 collected blood samples, 2 were definite positives identified as *Salmonella typhi* and *Klebsiella pneumoniae*. Of the 287 urine samples, 144 were identified as positive for bacteria commonly associated with UTIs (*E.coli, K.pneumoniae*, GBS, non-hemolytic *Streptococcus*). Additionally, there were heavy growths of *S.aureus* on culture, which may indicate contamination as well as mixed flora. Using qPCR techniques, the mixed flora was identified as *Mycoplasma* and *Ureaplasma*. Out of the 179 endometrial samples, 67 were positively identified as either anaerobic or aerobic bacteria, *E.coli*, GAS, and GBS. In addition to testing blood, urine, and endometrial samples, researchers also collected samples from subjects with varying symptoms: fever, lower abdominal pain, and/or vaginal discharge. Of those specifically presenting with fever, 2 were identified as having *S.typhi* and *K.pneumoniae* induced bacteremia. It is unclear of major STI correlated infections, however, testing of vaginal swabs indicate that of those infected with UTI causing microorganisms, 14% were experiencing bacterial vaginosis.

**STI prevalence among urban and FSW in Bangladesh**

A study to identify the prevalence of STIs among urban women was conducted; all new visitors to a primary health care facility were approached to take part in the study, regardless of the reason why the patient came to the clinic. The majority of the patients tested (n=2335) were at the clinic for reasons other than symptoms or suspicion of STIs, including family planning services, antenatal care and vaccination services. Only 1.2% (n=28) of the women were not and had never been married, and only serological tests were performed on these women. All in all, 0.5% of the women were found to have *Neisseria gonorrhoeae*, 1.9% *Chlamydia trachomatis*, 2.0% *Trichomonas vaginalis*, and 2.9% *Treponema pallidum*. HBV prevalence was
found to be 7.9%, while closer to 30% were positive to antibodies. HSV-2 infection was found in 11.7% of the patients. HIV was not confirmed in any patients, and HCV prevalence was very low (0.9%). In general, these STI rates are relatively low, compared to countries in Africa and Central America. While sexually transmitted infections (STIs) do not appear to be a major problem to the general population of Bangladesh, they are significantly more prevalent among female sex workers (FSW). Street-based sex workers were sampled for STIs. 35.6% of the women were found to have N. gonorrhoeae, 25.0% C. trachomatis, 45.5% T. vaginalis, and 32.6% T. pallidum. Another brothel-based study in Bangladesh found a higher level of syphilis, at 57%. HSV-2 was found in 62.5% of the women. 82% of the women had some infection, and many had multiple infections. Many of the women were married, with children, and with a low education level. These levels are similar to those found in other countries, such as some African countries.

N. gonorrhoeae can cause pelvic inflammatory disease, which can result in infertility or ectopic pregnancy due to tubal scaring. Gonorrhoea can also cause more serious illness in pregnant women, as well as preterm ruptured membranes and birth. Neonatal infections are also possible, often as eye infections. Low birth weight can also be a serious complication in countries such as Bangladesh, where malnutrition is a serious problem. Treatment in pregnant women is adjusted to ensure the safety of the woman and the fetus. C. trachomatis causes the same complications as gonorrhoea, and the infection can spread to the child during delivery as eye or lung infections. T. vaginalis can also cause the same complications, but infection of the child is very rare. HSV-2 can, in rare cases, cause serious birth defects in the baby or even miscarriage if an infection occurs in the first trimester. A woman can also transmit the virus during delivery. The herpes simplex virus can cause the baby to develop skin infections and can even cause inflammation of the brain. Encephalitis can then lead to spinal cord injuries and brain damage. Risk of transmission of the virus from mother to baby is higher if primary infection happens late in the pregnancy (third trimester) since she has not developed antibodies against the virus which could potentially provide fetal immunity. Since the baby is more likely to be infected during delivery when passing through the infected birth canal, a cesarean section is the recommended option when in labor.

Syphilis can be transmitted to the baby by the mother during pregnancy, which can cause severe problems such as premature birth, stillbirth and in more serious cases death shortly after birth. Babies that survive delivery but are untreated usually develop multiple organ complications: cardiac, nervous, optical, hearing, and skeletal.

HIV positive women can transmit the virus to the baby during pregnancy, labor and delivery or during breastfeeding. The prevalence rate for HIV is estimated to be <1% amongst the groups at most risk, including FSW. Surveillance studies show that condoms are rarely used which most likely contributes to the higher prevalence of HIV in this group compared to the general population, which is estimated to be <0.1%.
Even though the prevalence of HIV is quite low in Bangladesh, the country is considered especially vulnerable to an HIV epidemic due to socio-economic factors and social constructions such as poverty, overpopulation and inequality. Another big factor that contributes to the spread of HIV is the sex network in which married men have unprotected sex with FSW, who are HIV reservoirs, and then continue to have unprotected sex with their wives, exposing them to HIV as well as other STIs. In the context of Bangladesh, these women are estimated to be more likely to get infected with HIV than men. And because of their social and political status in Bangladesh, these women require extra attention in terms of interventions. Women in this country are less likely to obtain proper job opportunities and/or access to health care and education. The number of pregnant women living with an HIV infection in Bangladesh is estimated to be 200-500.

Through the Prevention of Parent to Child Transmission (PPTCT) program in Bangladesh different services are provided to pregnant women and their families. These services include anti-retroviral prophylaxis as well as treatment and support. This intervention is deemed important since children that live with HIV usually acquired the infection from their mother. With HIV prevention programs in place and the low prevalence of STIs in the general population, the levels of STIs in FSW can be expected to be lower. Family planning services are generally available to the population, and these services along with social expectations appear to keep STI prevalence low in Bangladesh. Within the society, people marry young and women are often expected to remain abstinent before marriage. For men, however, while infidelity and promiscuity are not necessarily acceptable, it is to a degree expected as men are to be masculine beings. Such differences in expectations for different genders can promote the field of female sex work.

<table>
<thead>
<tr>
<th>Pathogen</th>
<th>General population* (%)</th>
<th>FSW (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>N. gonorrhoeae</td>
<td>0.5</td>
<td>35.6</td>
</tr>
<tr>
<td>C. trachomatis</td>
<td>1.9</td>
<td>25.0</td>
</tr>
<tr>
<td>T. vaginalis</td>
<td>2.0</td>
<td>45.5</td>
</tr>
<tr>
<td>T. pallidum</td>
<td>2.9</td>
<td>32.6-5</td>
</tr>
<tr>
<td>HSV-2</td>
<td>11.7</td>
<td>62.5</td>
</tr>
<tr>
<td>HIV</td>
<td>&lt;0.1</td>
<td>&lt;1</td>
</tr>
</tbody>
</table>

Table 1: Prevalence of STI causing bacteria (* indicates women who visited a primary health care facility)
About half of the tested FSW are married and have children, but this is still a very vulnerable group due to their low socio-economic status. Even though the policies regarding family planning services to married women in Bangladesh have been improved in the recent years, unmarried women are still not allowed to receive contraceptive methods such as pills or implants. This contributes to the continued spread and transmission of both men and women and lead to an unhealthy approach to sex in the society.

As long as sex remains taboo and the underlying societal issues are not addressed, efforts to improve the livelihood of FSW and decrease the prevalence of RTIs may not have the intended effect.

**Acknowledgements**

We would like to thank Dr. Md. Abdul Quaiyum for his help and insight into RTIs and its effect on Bangladeshi women and Dr. Md. Sharful Islam Khan for his eye opening perspective on socio-economic causing attributes as well as the resources and experiences provided by the teams of icddr,b.
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Infectious Disease Control - Vaccination in Bangladesh

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The Expanded Program on Immunization (EPI) introduced by the WHO and UNICEF has led to great achievements in terms of immunization coverage and reduction of child mortality in Bangladesh. The program is an evolving process as a result of progressive vaccine research, evident through recently introduced and prospective vaccines. However, the need for development of vaccines against severe respiratory and diarrheal diseases which are still present in Bangladesh today is of great relevance. Although the coverage increased rapidly during 1985 and in the early 2000's it has remained on the same level over the past few years. In order to overcome practical and social obstacles such as hard to reach areas and the fear of side effects, further improvements of the program is crucial.

The immunization program in Bangladesh: A success story

In the early 1980’s the immunization program was implemented in Bangladesh, quickly becoming a success story. Bangladesh expanded the immunization coverage in children from only 2% in the early 1980’s to around 80% in the 1990’s (2). Nowadays 93.2% of children aged 12-23 months are fully vaccinated (Figure 1), which means that a child receives one dose of BCG, three doses of pentavalent vaccine (Diphtheria, Pertussis, Tetanus, Hep-B and Hib), three doses of polio and one dose of MR (Measles and Rubella) (3). Only 2% of children in the same age group haven’t received any vaccination (2). All 64 districts in Bangladesh have a DTP-Hib-HepB immunization coverage over 80% and 55 of the districts hold a coverage over 90%, demonstrating that no district is overlooked. The highest reported drop-out rate for the pentavalent vaccine is 10%.

Some achievements of the high immunization coverage are the elimination of Maternal Neonatal Tetanus which was declared in 2008, the eradication of Poliomyelitis in Bangladesh, as well as a decrease in child mortality (1). In 2010 Bangladesh obtained a UN award for its success in accomplishing the Millennium Development Goal 4 (reducing child mortality rates) (3).
Expanded Program on Immunization (EPI)

In 1979 the WHO and UNICEF launched a global immunization program to ensure routine vaccinations for every child all over the world. The major goal was to lower child mortality and consequently increase the level of education and chances in life. Special emphasis was placed on developing countries due to problems in immunization services and the severity of child diseases (4). The EPI made rapid progress after 1985, when Bangladesh committed to the United Nations goal to reach universal child immunization by 1990 (3). Non-governmental organizations like the Global Alliance for Vaccines and Immunization (GAVI) started to support the program financially as well as volunteers and health workers (4). The program first included vaccinations against Diphtheria, Poliomyelitis, Whooping cough (Pertussis), Tetanus, Measles and Tuberculosis, though further vaccines was later added by the government.

Challenges to reach full coverage

The goal to vaccinate every newborn child in Bangladesh has proven to be difficult, and the coverage has remained around the same level over recent years (8). Obstacles to reaching the goal are diverse yet well known to the authorities and researchers within the field. The vaccinations are performed at vaccination centres spread out over the country, where parents on their first visit receive a vaccination card for their child (Figure 3). On the vaccination card, all vaccinations to be given are listed in a table and are easily filled in when given by the vaccinator. On each visit the parents are also told when to come for the subsequent vaccinations.

Though vaccination centres are situated through-out the country, they can be located quite far from some villages. Despite knowing the benefits of vaccines, the

<table>
<thead>
<tr>
<th>Vaccine</th>
<th>Age of administration</th>
</tr>
</thead>
<tbody>
<tr>
<td>BCG</td>
<td>At birth</td>
</tr>
<tr>
<td>DTP-Hib-HepB</td>
<td>6 weeks, 10 weeks, 14 weeks</td>
</tr>
<tr>
<td>OPV</td>
<td>6 weeks, 10 weeks, 14 weeks, 38 weeks</td>
</tr>
<tr>
<td>MCV</td>
<td>MR-38 weeks and +15 years female, Measles-15 months</td>
</tr>
<tr>
<td>TT</td>
<td>Females 15 to 49 years (5 doses with an interval of +1 month, +6 months, +1 year and +1 year with preceding dose)</td>
</tr>
<tr>
<td>Vitamin A</td>
<td>6 - 59 months</td>
</tr>
</tbody>
</table>

In 2014 the vaccination schedule (Figure 2) included three doses of the DTP-Hib-HepB pentavalent vaccine, four doses of oral polio vaccine (OPV), one dose of Bacille Calmette-Guérin vaccine against Tuberculosis, one dose of measles-rubella at 9 months and one dose for 15 year old girls as well as the measles second dose (MSD) at 15 months (3). Further vaccines are five doses of Tetanus Toxoid (TT) for women between 15 and 49 years of age and since 2015 the inactivated polio vaccine (IPV) and pneumococcal conjugate vaccine (PCV) (5). Additionally, a Vitamin A capsule is administered to children 6-59 months of age (1).
mothers in these villages often do not have the opportunity to go to a vaccination centre. To counteract this problem there are specific programmes set up to vaccinate the children in their home villages instead. This however, does not solve the whole issue. Other factors can make the villages hard to reach also for the vaccinators, such as having to use a boat to get there. This poses a problem during dry season when there may be no water, and the village is simply beyond reach. Another issue is maintaining the cold chain of the vaccines when going to these hard to reach villages. Areas much closer to the vaccination centres but which are still hard to reach are the slums. The myriads of houses and people make it nearly impossible to find a person living there and unless they themselves come to the vaccination centre it is hard to track them and make sure that they follow up all vaccinations.

It is not only the practicalities that pose a challenge to reach full vaccination coverage. Most parents know that vaccinations are beneficial for their children, but sometimes still don’t take their children to be vaccinated, or don’t follow up all vaccinations. In a report from icddrb (2), the reason behind this was studied in a group of mothers from the slum – the main area affected. They concluded that there were four major barriers to using the immunization services. One of these was unofficial fees ranging from Tk 5.00 to Tk 50.00, which are often charged by the vaccinator despite the fact that all vaccinations should be free of charge for all persons. This mainly affects the poor women who cannot afford this fee and feel humiliated when ‘rich’ people are treated with greater respect. Another reason commonly reported was loss of the baby’s vaccination card. Many mothers were reluctant to return to the vaccination centre after this, fearing the anger of the vaccinator and the additional fee they would have to pay for a new card. According to the mothers, the vaccinators may get very upset by the loss of the card as they have to find out from the mothers which vaccinations have already been given to the child and which are still required, a time-consuming process at a busy centre. Time itself is another barrier to vaccination. The long waiting hours are detrimental to some mothers who simply don’t have the time, having housework to do and several children at home to attend. Fear of side-effects is another reason for drop-outs from the vaccination programme. After a vaccination, it is not unusual that the child develops fever and swelling around the injection site. Some parents are afraid that this is harmful for the child and fear more serious complications. The lack of communication between the vaccinator and the mothers about what is or is not normal is a problem. The study clearly demonstrates that improvements of the vaccination system, beyond simply practicalities, are still needed and should be an important area of focus in attempts to reach full vaccination coverage.

Development of the EPI programme

The ten vaccines included in the EPI programme protect against a broad spectrum of infectious diseases, yet child mortality
due to respiratory infections and diarrhoea is still high (9). For 2018, Bangladesh will include a rotavirus vaccine in their EPI programme to further reduce the diarrheal cases. The vaccine is a live, attenuated strain taken orally, estimated to have 43% efficacy against severe rotavirus gastroenteritis in Bangladesh (10). WHO is now recommending a rotavirus vaccine for any country where the vaccine efficacy suggests a significant public health impact – something which highly applies to Bangladesh.

Another disease receiving a lot of attention and hope for the implementation of a vaccine is cholera. Endemic and epidemic in Bangladesh, it remains one of the leading causes of diarrhoea, and today two oral vaccines, Shanchol and Dukoral, are available on the market (11, 12). Of these two the more recent Shanchol presents a more sustained protection and has the benefit of not requiring a buffer solution when administered. It can also be purchased at a lower cost – raising the opportunity for Bangladesh to implement the vaccine at a national level. Shanchol has shown a protective efficacy of 66% against cholera after three years from administration, something which would have a great impact on the number of cases and hospitalisations in Bangladesh. It has also been estimated that vaccinating 50-70% of the population could stop outbreaks in endemic areas (13). In Bangladesh more research will be conducted regarding its cost-effectiveness and in which way the vaccine could be implemented, such as in which age groups.

What is needed for the future?

While having a well-established and good vaccination programme, there are still a few vaccines not included today that the Bangladeshi population could benefit from. Japanese encephalitis occurs in some areas of Bangladesh, though no thorough surveillance has yet been carried out. Since Japanese encephalitis is a disease with high lethality, targeted immunization programmes for those at risk could be a possibility for the future (14). There are several other vaccines given in many countries today which Bangladesh could also include in the more distant future, such as the HPV-vaccine. At the moment, however, the introduction of the rotavirus vaccine and potentially a cholera vaccine is the first priority. Nevertheless, many infectious diseases causing premature deaths in Bangladesh are not possible to vaccinate against. Despite the vaccine for pneumococcus and Hib, respiratory infections remains a major cause of death under the age of five (9), and despite the upcoming vaccines for rotavirus and cholera, there will still be many causative agents of diarrhoea left, such as enterotoxigenic Escherichia coli (ETEC). The development of the EPI programme must occur alongside the development of other societal structures and services. Education around food and water hygiene will reduce the risk of disease, and work aimed at improving child nutrition will improve their overall health and immune systems. To also keep striving for full vaccination coverage, managing both practical and social challenges will be essential for Bangladesh in the control of infectious diseases.
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Common pathogens associated with the drinking water in Bangladesh/Dhaka

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Bangladesh is a densely populated developing country with an estimated population of 170 million people. Climate, distribution of population, water quality, sanitation, health care coverage and additional factors contribute to the endemicity of diarrheal diseases associated with drinking water. While treatment of diarrhea is not expensive, removing the underlying cause is always the preferred action. This is an overview of water sources, sanitation, Vibrio cholerae (and its algae reservoir), rotavirus, Campylobacter and seasonality.

800 000 deaths per year are caused by inadequate drinking water, sanitation and hand hygiene in low- and middle income countries like Bangladesh (1). World leaders have set 17 global goals for sustainable development which includes clean water and sanitation by 2030 (2).

Vibrio cholerae serotype O1 is endemic in Bangladesh and causes two seasonal peaks, pre- and post-monsoon. These peaks are connected to the blooming of blue-green algae that work as a reservoir for V. cholerae during low season.

Contaminated water sources are a major vector for diarrheal pathogens and poor sanitation effects dissemination.

Water Sources

In Bangladesh there are different kinds of water sources. There are monsoon-filled Ponds, where surface water is collected for use. Since the 1970s tube wells have been installed, but they were not tested for arsenic content. From 2000 through 2003 4.94 million wells were tested for arsenic and marked safe or unsafe.(3) Figure 1 illustrates the trend over the last 25 years. Piped water is considered safer, and
piped onto premises optimal. Rainwater harvesting was neglected (4). Access to safe water sources reduces prevalence of waterborne pathogens. During the dry pre-monsoon season people use water they would normally avoid.

**Sanitation**

Point of use water sanitation by boiling is effective, but fuel to boil water is expensive. Additives; chlorine, alum pot ash and bleaching powder are cheaper (5). The Siraj mixture; lime, bleaching powder, alum pot ash and a secret ingredient, has shown promising results while being extremely cost-efficient (6).

**Vibrio cholerae**

*V. cholerae* is a classic water-borne pathogen, the bacteria can be transmitted via drinking water, contaminated and undercooked food such as raw vegetables and seafood (8). There are two different serogroups of *V. cholerae* causing disease in humans, Serogroup O1 and O139. O1 is divided into 3 different biotypes: Ogawa, Inaba and Hikojima. *V. cholera* O1 is endemic in Bangladesh with two clear seasonal peaks, before and after the monsoons rains (9). O139 was first seen in 1992 when it caused a major epidemic in Bangladesh and India. However, O139 is rarely seen in Bangladesh now a day but is a
V. cholerae has a high infectious dose of $10^8$ bacteria in healthy people. Children between 2-4 years are most affected in endemic areas (11) (12). Symptoms are generally abrupt and include watery diarrhea (resembling rice-water) and vomiting, the loss of fluids will quickly lead to severe dehydration and death if not treated. However, treatment is effective and simple; replace the fluid and electrolytes intravenously or orally depending on the severity of the dehydration, in some cases antibiotics is needed (13).

Reservoir in blue-green algae

During seasonal peaks V. cholerae O1 can be isolated from patients and surface water of ponds, lakes, river etc., but during interepidemic seasons V. cholerae O1 disappears. This suggest that V. cholerae have a reservoir were it “hides” and replicate during low season (15). Dr. Islam suggested blue-green algae as a possible reservoir; he demonstrated using an artificial aquatic environment that V. cholerae could enter the mucilaginous sheath of blue-green alga and survive up to 15 months, this length of time is sufficient for V. cholerae O1 survival during low season (16). Dr. Islam also conducted a field study to detect V. cholerae O1 in blue-green algae from the aquatic environment of Bangladesh; they collected samples every 15 days between May 1988 and April 1989 from a pond in Dhaka city. In 16 of the 24 samples they could detect V. cholerae O1 within the mucilaginous sheath of the blue-green algae, this further demonstrated a strong association between blue-green algae and V. cholerae O1. The mucilaginous sheath seems to provide sufficient nutrients for long term survival and replication of V. cholerae (17). There is a symbiotic relationship between the bacteria and the algae, the host algae supplies the nutrients required for survival and in return bacteria supply the algae with carbon dioxide and reduce the level of oxygen which helps the photosynthesis. The latter is especially important during blooming when the carbon dioxide concentration in water decreases, due to the rapidly increasing demand, and the oxygen concentration increases due to photosynthesis, high concentration of oxygen hampers the photosynthesis (18).

Blue-green algae as a reservoir for V. cholerae O1 also explain the simultaneous outbreak at multiple sites of endemic areas and why it occurs at the same season of the year. There is a strong relationship between environmental factors, the blooming of the algae and the level of V. cholerae in water sources. e.g. During the winter months in Bangladesh the periods of sunshine per day is longer, during which the photosynthesis increase and the algae multiply, there is also very little rainfall during this time, leading to low water levels causing a higher concentration of nutrients in the ponds which favors blooming. The vigorous increase of photosynthesis cause the carbon dioxide levels in the water to decrease and the pH to rise, the increased pH, higher concentration of oxygen and the endless amount of nutrients favors multiplication of V. cholerae O1, which during the blooming of the algae are released to the drinking water and causes outbreaks (19).
Campylobacter

Campylobacter jejuni, slender, spiral or curved gram-negative rods, and among the most common cause of gastroenteritis worldwide(20,21). C. jejuni is referred as one of the leading causes of diarrheal diseases in humans. Campylobacter infections occur worldwide with a higher prevalence in developing countries. Studies in rural Bangladesh has shown that asymptomatic infections in young children are prevalent(24,25). In Bangladesh 40% of the healthy children tested positive to Campylobacter(26). Campylobacter is uncommon in adults since infection and immunity is acquired early in life (Fig 4b), furthermore the observed prevalence did not differ among adults with or without diarrhea(27). There is an increase in isolation of Campylobacter during the hot summer months following a decrease in the cold winter months, in developed countries in temperate climates(28,29). There has been no seasonal variation observed in developing countries in tropical climates(25). In developed countries there are two observed peaks in age groups (Fig. 4a), the first and largest one in children under the age of 5 and the second peak in young adults 20-25 years old(30,31). In developing countries there is no secondary peak only the first in children under the age of 5. The conservative estimate is one or two Campylobacter infections per year in children under 5 years(32).

Figure 4. Number of positive isolates collected in increasing age groups (22,23)
Rotavirus

Rotavirus, a member of the *Reoviridae* family is one of the most common causes of diarrhea among children worldwide (22,23). Most cases are caused by group A rotaviruses which are divided into serotype P and G depending on the outer capsid proteins(23). In temperate climates rotavirus is the most prevalent in the winter and rarely during the summer while being detectable throughout the year in tropical climates (34). Rotavirus has two seasonal peaks which are during January and February and in July and August which relates to the decrease in air temperature (Fig 5a) during the sharp winter months and the higher water levels during the monsoon period (Fig 5b). Out of all diarrheal patients treated at ICDDR,B around one fourth was found to be positive to Rotavirus and 92.5% of these cases were children less than 2 years of age.(33)

Seasonality

Figure 6 shows the most recent surveillance data in Bangladesh at the time of publication(1). The surveillance is based on sampling every 25th patient that admitted to the Dhaka Hospital. The aforementioned biannual peaks of *V. cholerae* are easily recognized and Rotavirus peaks during the winter.

![Figure 5. Observed air temperature (a) and water levels (b) throughout the year in contrast to rotavirus prevalence (33)
Figure 6: Monthly isolation of V. cholerae O1, Shigella, Rotavirus and ETEC (Health and Science bulletin, icddr,b).

Future
Cost-efficient, well documented methods for securing drinking water quality is needed. Improving sanitation, hand hygiene and water sources would impact the spread of pathogens. In addition, further education of the general public is required.

Acknowledgements
We would like to thank Dr. Sirajul Islam for his assistance and provided expertise on Vibro cholerae, as well as the resources and experiences provided by the teams of icddr,b.
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Malnutrition in children, in the context of undernutrition, may be manifested as wasting, underweight or stunting. One third of all children in the world are malnourished, leading to impairment in child development and in the worst case, death. Bangladesh is one of the countries with the highest burden. In order to combat malnutrition, different intervention programs and initiatives are currently taking place throughout the country. The prevalence of underweight children has been reduced from 66% in 1990 to 33% in 2014. However, the final goal is to eradicate malnutrition and so it is important for current challenges in managing intervention programs to be resolved. Overall Bangladesh has made remarkable progress in the fight against malnutrition.

MALNUTRITION IN BANGLADESH

Malnutrition in the context of undernutrition refers to poor health condition resulting from deficiency of either the right quantity of food or the proper proportion of the different food nutrients (1). Without proper nutrition the body’s growth is hampered, mental and physical ability becomes lowered and immunity is greatly affected, leading to recurrent infections such as diarrheal diseases and acute respiratory infections (2).

Malnutrition in children can be manifested in one or a combination of underweight [low weight for age], stunting [low height for age] or wasting [low weight for height] (3). Various factors drive malnutrition (Fig. 1); the most immediate causes being recurrent infections and inadequate dietary intake, while the underlying causes include inadequate care for women and children, ineffective health care services and inadequate access to food (4).

The impact of malnutrition in children is high; about one third of all child deaths in the globe are associated with malnutrition. Surviving malnourished children do not exhibit the same development as healthy children. (5,6).

Bangladesh is one of the countries with the highest rate of malnutrition (7,8). According to the 2014 Bangladesh Demographics and Health Survey (BDHS), approximately 36% of all children under the age of five years are stunted, 33% are underweight and 14% are wasted (Fig. 2) (9). The general trends observed show that girls are more likely to suffer from malnutrition than boys, children from low income families are twice as much at risk of malnutrition than those from well-off families and that children from the rural areas suffer more than children from urban areas. (10)
NUTRITION INTERVENTIONS

As per the Millennium Development Goal 1 (MDG 1) Bangladesh had set to lower the prevalence of underweight children under 5 years of age from 66% in 1990 to 33% in 2015 (11); a goal they have already achieved according to 2014 BDHS (Fig. 2) (9). However, the final target is to eradicate malnutrition completely, and so several intervention programs are currently ongoing in order to further decrease the rate of malnutrition by adopting the “life-cycle” approach. This approach targets different stages in life, including pregnancy, delivery/ neonatal period, infancy, early childhood as well as adolescence and newlyweds. (12) Several studies have shown that the most effective intervention period for child development is within the first 1000 days after birth (13–15).
Interventions against malnutrition can be divided into either nutrition sensitive or nutrition specific approaches. Nutrition sensitive interventions aim to improve aspects of life such as quality of education, health care and improvement social welfare in general; such interventions usually positively impact nutrition as a by-product. Nutrition specific approaches, on the other hand, address underlying causes of malnutrition directly with the sole aim of fighting malnutrition. Some examples of nutrition specific approaches are vitamin A and iodine supplementation. (16)

Intervention programs are designed around four key strategies: deworming, improving health services, micronutrient supplementation and advice on promoting child health development (Box 1) (12). Regardless of the type of intervention, it remains clear that a successful program must involve a multisectoral approach; that is, different ministries, departments and non-governmental collaborators should come together in order to tackle problem of malnutrition from different perspectives (17).

In Bangladesh, there are several ongoing projects and initiatives being financed and/or supported by different entities, such as the World Bank (WB), the Swedish International Development Cooperation Agency (SIDA) and the United Nations (UN) (18–20). These organizations have become crucial players in supporting the government in the fight against malnutrition. Some examples of the efforts currently taking place in Bangladesh are the World Food Program (WFP) Bangladesh Strategy 2012-2016, the Renewed Efforts Against Child Hunger (REACH), undernutrition initiative or the Scaling Up Nutrition (SUN) movement (20–22).
The goal of the WFP Bangladesh Nutrition Strategy is to decrease undernutrition in children and women, as well as breaking the cycle of undernutrition by 2016. To do so, the strategy focuses on assisting the government in implementing nutrition services and facilitating access to preventive and curative nutrition services for underprivileged people. A nutrition specific approach based on targeting iron deficiency anemia and iodine deficiency is used in this program. In combination with the above mentioned measures, this program also fosters the distribution of micronutrient-rich biscuits at school settings and provision of clean water supply and sanitation in slum areas. With the above measures this program is expected to induce a positive effect in the nutritional state of the target population by 2016 (Box 2). (22)

**BOX 1. The key strategies of interventions, as stated by a World Bank study on National Nutrition Services:**

- **Growth Monitoring and Promotion & Behavior change communication:** promotion of maternal nutrition and exclusive breastfeeding (i.e. not any other liquid or solid food or plain water) for the first six months. In the following 7-24 months a sufficient amount and a good quality of complementary foods should be consumed together with breastfeeding. Advising on feed and care practices, such as the importance of hand washing with soap before feeding the child.

- **Micronutrients supplementation:** supplements are given in order to prevent night blindness and anemia as well as controlling micronutrient-deficiency diseases. E.g. vitamin A, iodine and zinc are given for treatment of diarrhea while iron and folic acid are provided during pregnancy.

- **Deworming:** anthelminthic drugs are administered every other year to children under 5 years in order to prevent anemia and improve weight gain and growth.

- **Improving health services:** improving the overall efficacy including training and coordination of nutrition activities across different sectors.

**WFP Bangladesh Nutrition Strategy 2012- 2016**

REACH and undernutrition initiative

REACH is an inter-agency partnership from the UN, which incorporates the WFP, Food and Agriculture Organization (FAO), World Health Organization (WHO), United Nations Children’s Fund (UNICEF) and more recently, the International Fund for Agricultural Development (IFAD). REACH currently operates in 12 countries around the world, one of which is Bangladesh (20).

Unlike many others strategies, REACH is not to be considered an intervention program. Instead, REACH is an approach where community workers are trained to become facilitators who will work together with UN agencies and the government in order to create more coherent and effective food and nutrition action in Bangladesh (23).

REACH strives for good governance. In order to achieve it, REACH supports the
government by strengthening coordination mechanisms and supporting policy making and reform, among other things. The importance of strengthening communication between the government, UN and the private sector that REACH promotes, was illustrated in 2012, when Bangladesh joined the Civil Society Alliance for SUN-Bangladesh (CSA for SUN-BD) through REACH (24). At CSA for SUN-BD, representatives of non-governmental organizations work closely with the government in an effort to further promote and advise on the importance of addressing malnutrition from a multisectoral approach and implementing SUN measures at a national level (25).

Scaling Up Nutrition (SUN) project

SUN is a global movement which aims to combat malnutrition in 55 countries, including Bangladesh. By definition, SUN strives to bring together various actors from the both public and private sector to reduce malnutrition in the world (26). The initiative is based on the following four core processes: establishing a multisectoral approach towards eliminating malnutrition and increasing commitment from politicians, reinforcing and supporting policy making, aligning nutrition related policies across different sectors and sponsors and increasing the amount of and mobilizing available resources to be invested in fighting malnutrition. (27)

Bangladesh joined the SUN movement in 2012, as an effort of the government to diminish malnutrition in the country (21). Bangladesh has accomplished much with regards to malnutrition since joining SUN in 2012. It is through SUN that the World breastfeeding week was first introduced in August 1st 2013 with the aim of improving child nutritional state and overall health (28). Another example of the contribution of SUN towards increasing awareness on nutrition in Bangladesh comes with nutrition policy discussions held in 2013 in an effort to influence politicians towards increasing commitment and reinforcing the importance of a multisectoral approach in fighting malnutrition (29).

National Nutrition Services (NNS)

In Bangladesh, nutrition has become a prioritized issue and nutrition interventions have been incorporated into two governmental departments, the Health Services and the Family Planning departments, to raise nutrition standards in the country. To coordinate these interventions and reduce redundancy, the government formed the NNS, whose main role is to better coordinate and advocate active engagement between the different directors and compartments included. (30)

**Challenges with NNS interventions in Bangladesh**

In a recent study performed by the World Bank, challenges regarding the delivery efficiency of the Bangladesh National

**BOX 2. Strategy expectations as stated in the WFP Bangladesh Nutrition Strategy 2012-2016:**

- Decrease in the prevalence of undernutrition and nutritional deficiencies in children and women.
- Increase in awareness of the national and individual nutrition problems and solutions.
- Increase in capacity of and access to services for the treatment and prevention of undernutrition.
- Increase in uptake of appropriate nutrition practices by individuals.
- Strengthening of national nutrition policies and programs.
Nutrition Services interventions were pointed out. The challenges were as follows: 1) Too many non-specific interventions to be dealt with effectively in the set timeframe. To face this challenge, the study suggested that interventions should be focused on more narrow areas to increase delivery efficiency e.g. targeting infant and young child feeding; 2) Interventions are not delivered in the right settings. Most interventions are geared towards curative rather than preventive approaches. This implies that more time is being spent on treating sick children rather than giving counselling to and educating parents; and a combination of both approaches are necessary in order to improve the efficiency of the health care system in Bangladesh; 3) The leadership of NNS is not able to guarantee neither the implementation of intended interventions nor the quality of the health service provided. This is due to lack of communication and coordination between the leadership of NNS and other collaborating directorates. Another important factor is the high turnover of management posts; five different NNS directors have held the post during the last three years. The study points out that a consistent leadership is of great importance to increase effectiveness. With short tenures, the development of interventions will not be adequately monitored and as a consequence, there will be a lack of improvement in such interventions; 4) Inefficient use of health care staff training. Due to insufficient record keeping it is difficult to find information about the type and level of training and how many staff at each level have received training at different centers. Furthermore, logistic problems in getting equipment hinder the staff from using their training. These challenges must be addressed in order to deliver effective interventions. (12)

FINAL REMARKS

Malnutrition is a common and severe problem which affects the youngest children the hardest. This is a complex problem that brings together different interdisciplinary and underlying factors which are taken into consideration when designing new interventions. The ongoing interventions have different degrees of delivery effectiveness and some pinpointed challenges should be given attention in order for the effectiveness to rise. One of the most prone challenges in Bangladesh is the inconsistent leadership which hinders efficient coordination and intervention development monitoring. Non-specific interventions can be resolved by establishing better targeted interventions and match them with the right health system delivery settings. (12) An increased effectiveness for the implemented interventions would help reach the goals set for reducing malnutrition and promote a better health standard in Bangladesh.

Acknowledgment

We would like to express our sincere gratitude to all who assisted us in getting the information used in writing this article, specially Dr. Kazi Sanin, for meeting us and sharing his knowledge on malnutrition with us.
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Street food safety: an overview of the situation in Dhaka

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Street foods play an important economic and social role providing easy access to food at affordable prices particularly for low and middle income groups. It represents a source of self-employment especially for poor and uneducated people who is migrating to big cities. Dhaka is one of the most densely populated cities in the world with a fast growing population, therefor it is not surprising that street foods are part of the cityscape with approximately 200,000 vendors who provide a complementary source of nourishment to a large part of the population. However, street food vendors operate illegally, often without meeting sufficient hygienic standards as result street food can represent a risk for gastrointestinal diseases by microbial contamination. To improve the current situation, a group of local and international institutions in collaboration with the government of Bangladesh implemented a pilot program which lead to new regulations to improve the street food quality.

Street food from a Global Perspective

The street foods are appreciated for their unique flavors and convenience also by their important socioeconomic role in providing food and nutritional requirements to city customers at accessible prices for the low and middle income groups [1].

Food and Agriculture Organization defined street foods as ready-to-eat foods and beverages that are prepared and/or sold by itinerant or stationary vendors, especially on streets and in other public places [2].

Street vended foods are the least costly and the most affordable way of obtaining meals for many people with limited means [3]. Approximately around 2.5 billion people in the world consume street food everyday [4] for this reason they also represent an opportunity for developing entrepreneurs [1] and can contribute in an important way to the size of the economy in developing countries [3].

It is estimated that in countries like India the street vendors are approximately 2% of the urban population [3]. In urban areas of Indonesia 60% of the total income is spent on food [5]. Meanwhile in developing countries about 25% of the family food budget is invested outside home and in some cases entirely on street foods [4]. Street food business represents an opportunity to generate income and employment for the increasing urban population which is migrating to big cities like Dhaka [6]. Even with the potential benefits, it has been shown that street food vendors are usually poor, uneducated, lack knowledge in food hygiene and use of potable water due these reasons street foods are a public health risk [1].
The principal health hazard linked to street foods is microbial contamination but pesticides residues, transmission of parasites, use of not allowed chemical additives, and environmental contamination have been pointing out as other possible hazards [7].

Food poisoning outbreaks related to microbiological hazards in street foods remain as a potential cause in many countries of the world [8]. In Shandong, China it was showed that 691 food poisoning cases and 49 deaths were related to street foods in a period of 9 years [9].

Street food in Dhaka city

Dhaka is a rapid expanding city with a population of over 13,09 million people [10]. Most of them, independently of their social background consume street food as easy access nutritious and tasty ready to eat, especially poor and slum dwellers that can arrive to eat street food more than one time on a daily bases and middle income class that can also rely every day on different levels on street food [11]. Since Dhaka is such a vast and busy city transport can be time taking and expensive, as a result many workers and students that work and study far from home consume street food during lunch breaks [11]. To meet such vast demand (off food), is estimated that circa 200,000 [12] street-food vendors are operating in Dhaka. The majority of these are untrained and with no or low level of education people that moved from the country to the city in search for a living [10].

Street food and diarrheal diseases

During an interview in 2013 [13], Dr. Shah M. Faruque, the Director of Food and Waterborne Diseases at icddr,b, stated that on overage between 300 and 1000 people visit every day the icddr hospital in Dhaka. Most of these patients are affected by diarrheal diseases that can be caused by enteric pathogens like Shigella, pathogenic Escherichia coli, Salmonella or Vibrio cholera [10, 14, 15] and some of these cases can be traced back to street food consumption. Even if it is very difficult to directly trace back the exact source of the disease using conventional epidemiological investigations tools it is reasonable to expect that a significant fraction of these cases can be attribute to unsafe street food.

The potential threat to public health of street food consumption has been investigated throughout the years by different studies. A study performed by the Institute of Public Health in Dhaka in collaboration with the world health organization in 1994 found that all the 52 tested street food vendor products were contaminated with some pathogenic microorganism [16]. A second study performed by the same authorities during 2003, confirmed that all the tested street food, at different levels, was adulterated and unsafe for consumption [16]. A more recent report (2010) found that the total count of bacteria in all Dhaka street food samples analyzed did not meet the WHO standards specifications for food safety while the total
viable coliforms count did not meet the WHO standards in most of the samples [10].

**Microbial contamination, risk factors and intervention**

Street food can get contaminated with potentially harmful microbial agents in many ways. A survey carried out in 2010 found as potentially source of contamination: water, scares hygienic measures, unsafe food handling and storage [10]. The water used to prepare the food is mostly storage in plastic drums without lids and also the food ready to be sold is often stored and displayed in various kinds of containers without lids (58% of the surveyed vendors) leaving it exposed to contamination. Moreover, between 75-92% vendors did not take any measures for purification of the water and used non boiled or filtered water for preparation of food and beverage. The vendors themselves can carry more or less harmful pathogen, for example hand swabs samples have been found positive for S. aureus and for E. coli. The food can therefore be contaminated while cooked, handled or served. 98% of the vendors stated that they did not cover their hands while vending food and 43% served the food with bared hands and contaminated utensils. The personal hygiene of the street food vendor is also an important factor related to all the factors previously cited. The same study cited before showed that all the vendors uses public toilets or open places during the working hours and while 95% answered that they wash their hands with soap after using the toilet, such practice has not been observed in reality. [10]

In order to improve the food quality and safety a 14-member task force, among which figures the International Center for Diarrheal Diseases and Research-Bangladesh, Institute of Public Health, Dhaka university and Bangladesh Council of Scientific and Industrial Research, Consumers Association of Bangladesh, designed and performed a pilot intervention program. The intervention program consisted in the selection of 300 street food vendors that were willing to follow a two days training to improve their knowledge on different key subjects: personal health and hygiene, safe food preparation, serving and storage of food, food disease (causes and transmission), existing food law and regulation, right and responsibilities of street food vendors and consumers. Eleven participants also received a street food vending cart, comprehending utensils and an outfit composed of apron and hat with the porous to increase the hygienic condition in which the food was prepared stored and sold, as well as to make these trained vendors recognizable.

![Fig 2 Example of food vending cart provided to vendors](10]

The pilot intervention program had very good results both in terms of increased food safety and increased income of the vendors. The total viable bacterial count and viable coliform count in food samples collected after the program where decreased and meet the WHO standards, while the total bacterial count and total viable coliform count levels before the intervention program implementation showed respectively
medium to high and medium to low risk health risk according to WHO [10].

**Current food laws and regulations:** In 1959 the Bangladesh pure food ordinance has been promulgating to regulate food safety and quality but only in 2005, after this old set of rules has been amended as the pure food act, sections also dealing with street food safety have been added [1,17]. The Pure food act (2005) decreed the constitution of the national food safety advisory council to act on food standards and quality control and the recruitment of public analyst to translate into action the act purpose of ensuring food purity, safety and proper nutritional value [1,10]. Even though a lot has been done to improve street food quality and safety more has to be done to improve the coordination between agencies/municipalities, city corporations, public health agencies and police to fully achieve the complete regulation and institutionalization of street food vendors.
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