

Chapter 3

Infectious Diseases

Livelihoods play a role in the infectious diseases that a population can be exposed to and the risk attached to it. In developing countries, infectious diseases pose a huge burden to the population at large with people living in the rural areas bearing most of the burden (Ambrus and Ambrus 2004; Chuma et al. 2007; Daszak et al. 2000; Goodson et al. 2011; Jones et al. 2008). Poor living conditions, lack of income and other basic amenities such as safe drinking water and toilets, poor healthcare facilities and low literacy levels have contributed to the spread of infectious diseases in these rural communities (Fig. 3.1).

Due to lack of income, many households resort to going to affordable treatment such as traditional healers, which are in close proximity than their nearest health facility (Chuma et al. 2007). These traditional healers accept any form of payment other than money. Although a visit to a traditional healer can sometimes save the household from going into huge financial debt, the likelihood that the traditional healer will not be able to diagnose certain illnesses is very high. This puts the household, the traditional healer and the community at a high risk of contracting infectious diseases with a possibility of an infectious disease outbreak (WHO|One year into the Ebola epidemic: a deadly, tenacious and unforgiving virus, n.d.).

Depending on the mode of transmission these diseases can spread from one person, to communities, a country, across borders and a whole region. This makes infectious diseases some of the most dangerous threats to the global population. Vast populations are put at risk when an infectious disease is out of control.

Sub-Saharan Africa (42 %), South Asia (20 %), and the least developed countries (LCDs) carry the heaviest burden of disease. Developing countries suffer from the impacts of both communicable and non-communicable diseases, including effects of underlying diseases such as underweight and nutritional deficiencies (Fig. 3.2).

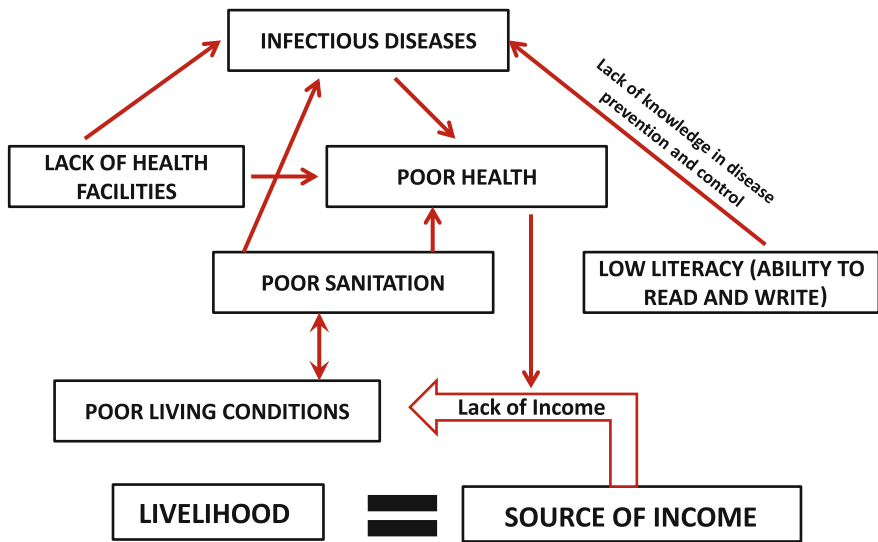


Fig. 3.1 The infectious disease cycle. The infectious disease cycle shows how livelihood (a source of income) is linked to living conditions that affect health through infectious diseases and how lack of knowledge in disease prevention and control and lack of health facilities contribute to infectious disease incidence

3.1 Importance of Infectious Diseases

Infectious diseases are of great importance to the pathogens as well as to the human population. Despite the fact that infectious diseases cause illness, they boost immunity in the human host which allows for survival from attacks by pathogens previously encountered by the host. The development of antibody response against pathogens, and the ability of the human body to fight infections have allowed for the discovery of vaccines and treatments to these diseases.

Due to the impact of infectious diseases for generations, scientists have embarked on studies to understand these diseases and disease causing pathogens to find ways and means to combat these diseases. This opened doors to research in life sciences and so far has led to many discoveries in science which have allowed for survival of the human population.

Infectious diseases date back as early as 430 BC in Greece where there was the Athens epidemic of what could not be properly described then. Many people died from this epidemic and lately epidemiologists have hypothesized what could have been the cause of the disease, which was not known then. Hippocrates described that *“Every disease has its own nature and arises from external causes”*; this changed the mindset of diseases being caused by spirits and other superstitious beliefs. Hippocrates also introduced the theory of **clinical practice** through patient observation. This led to records on theories of occurrence of disease and the

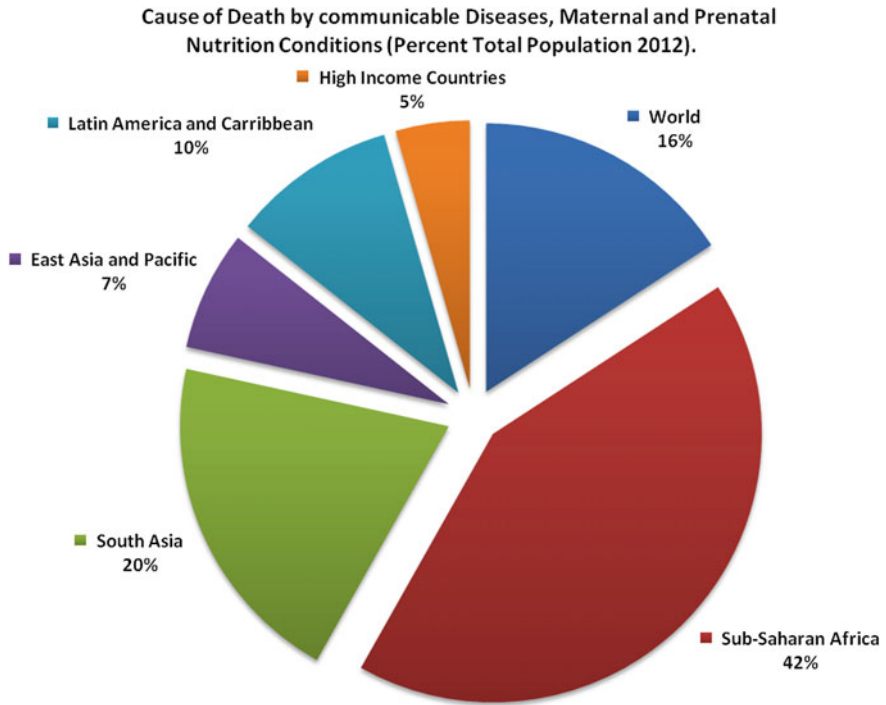


Fig. 3.2 Burden of infectious diseases, maternal and prenatal conditions. Cause of death refers to the share of all deaths for all ages due to underlying causes such as communicable diseases and maternal, prenatal and nutrition conditions including infectious and parasitic diseases, respiratory infections and nutritional deficiencies such as underweight and stunting. *Source* World Bank Development Indicators

understanding that there are certain diseases that are always present in people and/or population, hereby called **endemic diseases**; and those that are not always present but can sometimes occur in great numbers, hereby called **epidemic diseases**. Hippocrates therefore coined what are known as endemic and epidemic diseases (Pappas et al. 2008). Infectious disease occurrence and their impact on populations also led to the development of methods to record and follow the occurrence and effects of disease through registration of vital statistics, including mortality and morbidity as early as in the mid-1600s pioneered by William Petty (1623–1687).

The invention of the microscope by Anton Van Leeuwenhoek (1632–1723) was a great breakthrough as he showed that there were microorganisms which were present in human excreta and other materials such as water. Though Van Leeuwenhoek did not connect these microorganisms to disease, Robert Koch later showed that microorganisms were responsible for causing diseases and that these disease causing microorganisms were passed on from one individual to another through his experiments on mice infected with anthrax (Evans 1976).

This brief history shows how infectious disease outbreaks in the past led to research and discoveries that have enhanced the understanding of infectious diseases today.

3.1.1 Examples of Infectious Diseases

Some of the catastrophic and most deadly infectious disease outbreaks were associated by the following diseases:

1. **Plague**—transmitted by bites from an infected flea; the disease spreads from human to human through contact with infected tissue and/or exposure to cough of an infected individual. This bacterial disease caused by *Yersnia pestis* killed millions of people in the Roman Empire and spread throughout Asia Minor and Greece as people moved away from infected areas running away from the disease. Another well-known outbreak of plague was “Black Death”, which devastated Europe and Asia, killing almost a third of the population.
2. **Viral haemorrhagic fevers**—these are highly infectious diseases caused by viruses. Two of the commonly known and deadly haemorrhagic fevers include Ebola and Marburg virus disease, caused by *Ebola virus* and *Marburg virus* respectively. The worst Ebola epidemic so far since 1976, when the disease first occurred in Zaire, is the 2014 West African Ebola outbreak (WHO|World malaria report 2013 shows major progress in fight against malaria, calls for sustained financing, n.d.).

The outbreak heavily affected three West African countries Liberia, Sierra Leone, and Guinea had killed over eleven thousand people as of August 2015 (Boscarino and Adams 2015; Dhama et al. 2015; Na et al. 2015; Tartari et al. 2015; Van Kerkhove et al. 2015; WHO|One year into the Ebola epidemic: a deadly, tenacious and unforgiving virus, n.d.). Ebola is a viral disease transmitted through contact with body fluids, including the dead body of those who have died from the disease. There is currently no known cure for the disease although there are drugs that have been tested on some patients, some of whom have survived the infections. There are also individuals who have been able to build up immunity and survive the disease. Antibodies from these survivors hold information that could assist in further discoveries on the mechanism of disease. A vaccine has also been tried on some individuals who were in contact with Ebola patients, and these individuals were protected from the disease (Henao-Restrepo et al. 2015).

3. **Measles**—This is one of the leading causes of death in young children. Caused by the *measles virus*, this infectious disease has also caused outbreaks in both adults and children despite the availability of a vaccine (Goodson et al. 2011; Nsubuga et al. 2006; Sniadack et al. 1999; WHO|Measles, n.d.). Although active immunization occurs in developing countries, in some developed and developing countries the population is not immunized against the disease. This

could be due to interruption of vaccination campaigns due to conflicts and breakdown in security and/or out of choice, as is the case of some developed countries where the vaccine is available but parents choose not to vaccinate their children against the disease. Spreading through droplets, from coughs and sneezes of infected individuals, the disease is highly infectious and mortality due to disease has been recorded worldwide. Approximately 1,45,700 deaths in 2013 were reported by WHO (Sniadack et al. 1999).

4. **Malaria**—Malaria is one of the highest causes of mortality in endemic areas with around 3.2 billion people (Approximately half of the world population) at risk of the disease. Since the year 2000, malaria mortality rates have reduced by 45 % globally and 49 % in Africa (WHO|World malaria report 2013 shows major progress in fight against malaria, calls for sustained financing, n.d.). Transmitted by *Anopheles* mosquitoes, the parasite from the genus *Plasmodium* is responsible for the disease. *Plasmodium falciparum* causes the most severe form of malaria (Beare et al. 2011; Boeuf et al. 2008; Milner et al. 2012; Montgomery et al. 2007; Roca-Feltrer et al. 2012). *P. falciparum* is common in sub-Saharan Africa while *P. vivax* is common in Asia. Despite the availability of drugs that treat malaria, complications have risen due to development of resistance to the drugs by the parasite. This has led to change in the first-line drugs for treatment of malaria over the years. Since the 1950s drugs such as Chloroquine, Sulphoxine pyrimethamine (Fansidar), Lumefantrine artemether (LAR) and Artemisinin combination drugs are some of those that have been used as first-line drugs. Sadly the parasite has developed resistance to most of these drugs. The current malaria treatment uses Artemisinin combination therapy, which is recommended by WHO for treating uncomplicated malaria. It has been observed in the past decade that the parasite is developing resistance to Artemisinin in South-East Asia (Cambodia, Laos, Myanmar, Thailand and Viet Nam). Several methods for malaria prevention have been used including indoor residual spraying to kill the mosquito vector, sleeping under insecticide treated bed nets to prevent mosquito bites and destruction of mosquito habitats. Children under the age of 5 and pregnant women are at high risk (WHO|World malaria report 2013 shows major progress in fight against malaria, calls for sustained financing, n.d.).
5. **Smallpox**—Is one of the success stories in infectious diseases as it was declared eradicated by WHO in 1980. Smallpox was one of the most devastating diseases ever known. The last case diagnosed with smallpox was in 1977. The smallpox eradication programme, which ran from 1966 to 1980 was successful in identifying and following up on infected cases and finally in eradication of the disease. The viral disease caused by the *Variola* virus was highly contagious and was transmitted through droplets during close contact with an infected person. Eradication of smallpox is a success story in the infectious disease history. The efforts put together to contain the disease in the areas where it was endemic, active surveillance, vaccination and informative campaigns including following trails of the disease by “smallpox detectives” led to the eradication of the disease. The smallpox vaccine prevented infection and

lessened the severity of the disease (WHO|Smallpox, n.d., WHO|The Smallpox Eradication Programme—SEP (1966–1980), n.d.).

6. **Yellow fever**—is spread by several species of the *Aedes* mosquito. Over 900 million people are at risk of yellow fever in endemic countries in Africa and Latin America. The disease has 50 % mortality in those with severe infections if untreated. The yellow fever vaccine is available and provides lifelong immunity. Despite the availability of the vaccine there has been an increase in cases of yellow fever in the past two decades. Human factors such as deforestation, urbanization, migration of people and lack of, and/or decline of immunity and climate change have contributed to the increase in cases (WHO|Yellow fever, n.d.).
7. **Influenza**—A viral disease spread through droplets in coughs and sneezes, influenza has caused several outbreaks including four major ones. These include the 1918 Spanish Influenza, which was followed 40 years later by the Asian Influenza pandemic of 1958, and 11 years later the 1969 Hong Kong Influenza outbreak and finally 40 years later in 2009 the Avian H1N1 influenza pandemic. Although a vaccine is available, it is only available on a yearly basis as the combinations of the strains to be included in the vaccine are determined by surveillance information collected each year. Influenza affects all ages worldwide (WHO|Influenza (Seasonal), n.d.).
8. **Cholera**—A dangerous infectious disease transmitted through water contaminated with faecal matter. Cholera is a bacterial disease caused by *vibrio cholerae*. Outbreaks are common in developing countries, especially in sub-Saharan Africa due to poor sanitation. Cholera can also be contracted from food that has come into contact with contaminated water, for example fruit and vegetables that have been washed with contaminated water. Characterized by the “rice water” diarrhoea, cholera can easily spread in communities resulting in local outbreaks especially during the rainy season in endemic regions.
9. **Sleeping sickness (Trypanosomiasis)**—Common in sub-Saharan Africa, trypanosomiasis is a parasitic disease transmitted by two vectors, tsetse flies for the African trypanosomiasis and triatomes (kissing bugs) for the American trypanosomiasis (**Chagas disease**). The parasite *Trypanosoma brucei* is responsible for the African sleeping sickness. Two species of the parasite are responsible for African sleeping sickness, *T. b rhodesiense* which causes acute infection and *T. b gambiense* which causes chronic disease.
10. **HIV**—The current HIV pandemic has resulted in approximately 1.5 million deaths in 2013 with approximately 35 million people infected globally. Sub-Saharan Africa carries the huge burden of the disease. Spread through body fluids, including sexual transmission, HIV has spread worldwide. About 3.2 million children were living with HIV in 2013. Mother to child transmission has resulted in children being infected with the virus at birth or during breast feeding. With no vaccine and/or cure at present abstinence and/or practicing safe sex through the use of condoms are the ways of preventing infection, being faithful to one partner is another way of preventing the spread of the disease if

both partners are HIV negative. To suppress the HIV virus and/or stop the progression of the disease, anti-retro viral treatment is available for pregnant women, children born from HIV positive mothers and for people living with the virus (WHO|Use of antiretrovirals for treatment and prevention of HIV infection, n.d.).

11. **Severe Acute Respiratory Syndrome (SARS)**—An emerging viral disease that was first reported in Asia in 2003, SARS is caused by *coronavirus*. Spread through droplets the disease can rapidly spread within a country and across borders. People of all ages are at risk of the disease. There has been no other diagnosis of the disease since 2004. The disease is believed to have been of zoonotic origin. SARS is a good example of how infectious diseases can spread rapidly (Board 2013; WHO|Severe Acute Respiratory Syndrome (SARS), n.d.).
12. **Dengue haemorrhagic fever**—A viral disease that is transmitted by mosquitoes of the genus *Aedes*. The disease is endemic in the tropics and both children and adults are at high risk of contracting the disease. There is no treatment for the disease currently and the only way to prevent the spread of the disease is by controlling the mosquito vector. A vaccine against all four dengue serotypes has currently passed phase 3 trials (Villar et al. 2015). Dengue is one of the neglected tropical diseases in the world causing over 390 million dengue infections every year with 128 countries at risk of the disease. Dengue fever is present in the Americas, South-East Asia and the Pacific with recent outbreaks occurring in Europe (France and Croatia in 2010, Portugal in 2012) and the United States (Florida in 2013). The threat of the disease is increasing and it is a global threat. With the climate change that is being experienced globally vectors are now able to reach and survive in areas that they have never been reported before (Aubry et al. 2012; Brady et al. 2012; WHO|Dengue, n.d.).

The success of the pathogens in causing diseases is attributed to among others, the ability of the pathogens to evade the host immune system. In order to survive the human immune system, the pathogens have developed strategies that have allowed for their survival and perpetuation. These include virulence, genetic modifications that allow the pathogen to evade the host immune system, and adaptation of pathogens to new environments.

3.1.2 Research

Research on infectious disease has resulted in new vaccines and new diagnostic tools that have enabled understanding the pathogenicity and epidemiology of these disease and human development.

Infectious disease outbreaks have led to new research, understanding of the disease causing pathogens, and the ability of the human body to fight and survive disease.

Today there are vaccines to some infectious diseases and yet there are still others where vaccines and/or treatments are not yet available. Despite this fact, the human population has been able to find ways of controlling and preventing the spread of these diseases.

For easy understanding, infectious diseases can be classified according to their modes of transmission.

3.2 Classification of Infectious Diseases

Infectious diseases are classified into four categories; those that are transmitted through contaminated food and water, those transmitted by vectors, those transmitted by contact and finally those that are transmitted through droplets/aerosols.

3.2.1 *Infectious Diseases Transmitted Through Contaminated Food and Water*

Diseases that are transmitted through contaminated food and water are known as food-borne and waterborne diseases respectively. These diseases can be caused by bacteria, viruses, protozoans, metazoans (worms) and parasites that have contaminated food and/or water. The food and water can be contaminated through faeces or urine that has found its way into a water source. If the food or water is consumed without proper treatment the affected individuals could get sick.

Washing fruit and vegetables with contaminated water can result in disease causing agents from the water attaching themselves to these items and consumption of such may result in infection. This mode of transmission is also known as the **faecal–oral transmission**. Another common mode of transmission is the **oral transmission**; this is where a person consumes food and/or water contaminated by disease causing agents.

A person may also be infected through what is known as the **hand to mouth transmission**. This is where an individual contaminates food or water that is being consumed through hands that are contaminated by disease causing agents. For example, if an individual has diarrhoea caused by bacteria or viruses, and does not wash hands properly after using the toilet, the individual can contaminate the food with the bacteria and/or virus by touch, thereby spreading the disease. Also, if a person is taking care of someone who has diarrhoea and does not wash hands properly after handling contaminated clothes or cleaning up faecal material, that person can contaminate the food and/or water by touch resulting in spread of the disease. This also applies to touching vomit that is contaminated by disease causing agents.

In rural areas of most developing countries where sanitation is poor, diarrhoeal infections are a common occurrence. In sub-Saharan Africa and most parts of

South-East Asia, lack of toilets has led to people defecating in water and/or in the bush. When the rain comes, these excreta are washed away and end up in unprotected wells and other water sources such as rivers. Domestic use of contaminated water may result in infection.

In parts of the world where the diet includes eating raw or undercooked food, there is a high risk of infection by pathogens. Consumption of raw or undercooked pork can result in infections of tapeworm, *Taenia solium*. Tapeworm infections can result in a serious disease known as cysticercosis. Cysticercosis mainly affects the health and livelihoods of subsistence farming communities in developing countries of Africa, Asia and Latin America. Cysticercosis infections can lead to epilepsy and death in humans. It also reduces the market value of pigs and cattle and makes pork and beef unsafe to eat. This disease causes loss of human labour through sickness or death, which directly affects the livelihoods of communities in affected regions. Reduction of market value of infected livestock affects the households' income which in turn could affect their livelihoods.

In areas close to water bodies, where livelihoods include fishing and other vocations that involve spending time in slow moving water, populations are at risk of parasitic infections. These include diseases such as bilharzia, where standing and swimming in water infested with disease causing parasites could result in an infection.

3.2.2 Infectious Diseases Transmitted by Vectors

The beautiful tropical paradises around the globe are a source of great beauty and relaxation, at the same time the tropics are a habitat of diseases that are commonly called tropical diseases. Most of these tropical diseases are contagious, that is, they can spread from one individual to another directly through contact or indirectly through vectors. A vector is any agent, human, animal or microbe that carries and spreads an infectious disease pathogen from one individual to another. The most common vectors are insects. These include mosquitoes, flies, ticks, lice, fleas, mites and sandflies. Most of these vectors feed on blood and transmit the pathogen through their saliva and mouthparts as they feed. The disease pathogen is therefore introduced directly into the bloodstream. Other vectors such as triatomines introduce pathogens through their excreta. The triatomines defecate during feeding and if their excreta gets into an open wound or cut that may result from the host scratching in response to a bite from the triatome bug; the pathogen is then introduced into the host. Human lice have been known to transmit deadly diseases including typhus (Fournier et al. 2002; Mokrani et al. 2004). The lice introduce the pathogens during feeding on human blood. Ticks have also been known to transmit pathogens responsible for Rickettsia infections in sub-Saharan Africa (Raoult et al. 2001).

These insect vectors transmit diseases by biting a person infected with the disease and thereafter biting another person during their next meal. This cycle is very critical as it is challenging to control the spread of the disease without human

intervention. This intervention includes humans protecting themselves from insect bites, controlling vector breeding sites and personal hygiene.

3.2.3 Infectious Diseases Transmitted by Contact

Infectious diseases transmitted by contact include Ebola, HIV, cholera and skin infections such as scabies and yaws disease. These diseases can be spread through person-to-person contact (parasitic skin diseases), contact with contaminated material such as clothes, fluids from an infected person (cholera, Ebola) and/or a corpse (Ebola), as well as sexual transmission as in the case of HIV.

3.2.4 Infectious Diseases Transmitted Through Air Particles and Droplets

Infectious diseases spread through droplets include measles, TB, influenza, common colds and SARS. These diseases easily spread in closed environments and overcrowded areas.

3.3 Stages of Infectious Diseases

1. **Incubation stage:** This is the time between the exposure to the pathogen and the appearance of the first signs and symptoms in an individual. During the incubation period, the pathogen establishes itself within the human host. During this period the host does not show any signs or symptoms of illness.
2. **Prodromal period:** Though not all infectious diseases have this period, this is the time that general signs and symptoms start to appear in the infected host. These symptoms are general hence cannot be directly linked to a specific disease.
3. **Illness period:** During this time the specific signs and symptoms for a disease start to show, the infected individual is clinically ill and may manifest mild and/or severe symptoms of disease.
4. **Decline period:** Due to the host immune system and/or treatment the signs and symptoms of disease start to decline at this stage. The infected individual is now progressing into recovery.
5. **Convalescence stage:** This is the recovery period, the signs and symptoms of disease have disappeared and infected individual is showing signs of recovery.

3.4 Water and Sanitation

Lack of potable water and poor sanitation is directly and indirectly associated with infectious diseases. In developing countries and regions where potable water is scarce, communities have developed and adopted ways to purify and/or make the water safe to drink. Below are some of the methods that have been used.

3.4.1 The Boiling Water Method

It was a tradition that was passed on from generations in rural villages of sub-Saharan Africa, to boil water before drinking in order to kill microorganisms. Most people would boil drinking water because that is what they saw their mother do as they were growing up; while others knew that they were boiling the water in order to kill microorganisms that could have contaminated the water. With time, those who did not understand why they had to boil their drinking water would relax and stop especially if there was not enough firewood to perform the task. Those who knew that they had to boil their water to kill microbes, worked hard to do so even when there was little firewood.

Boiling water is one of the easy ways of making water safe to drink. It is a method that can be easily adopted by rural population who face the problem of lack of safe drinking water.

3.4.2 The Filtration Method

This is one of the methods taught by health workers from village to village in developing countries. These health workers explain the dangers of drinking water from the water sources be it a river, lake, well or borehole without boiling and the importance of filtering the water before consumption. The filtration method removes tiny soil particles that are mixed with the water, especially in the rainy season. During the rainy season, water from rivers and collects soil particles and debris, filtering the water through a cotton/muslin cloth helps remove these particles. In order to kill microorganisms, the water needs to be boiled and again re-filtered using another clean cloth, rendering it ready for consumption.

There are also other water filtration methods that are carried out in many parts of developing countries, depending on the available materials in the respective communities. It is interesting to see that these methods are used as survival methods in the bush in developed countries, while in most parts of developing countries this is a way of life. People have to do this everyday to have safe drinking water. The challenges are enormous; from time to time people drink water from unsafe sources without any treatment and sometimes they do get sick if the water is contaminated. In the worst case scenario cholera outbreaks are common in the rainy season due to

surface run-off which collects faecal matter which is then deposited in unprotected water sources that people use on a daily basis. And if the water is not properly treated an outbreak is eminent.

In recent years, in some developing countries, doses of chlorine are commercially available. The bottles come with directions on how to treat the water. This method is safe and fast but there is need for training on how to use it. Since this is a commercial product only those who can afford use it, making it a luxury for rural populations living on less than a dollar per day.

Governments in most developing countries are working hard together with NGOs to provide safe drinking water to the rural populations at large. The efforts are commendable but the burden is enormous.

In sub-Saharan Africa, cholera outbreaks are a common occurrence. These outbreaks have often been controlled and the sick people treated in the affected nations. Due to the frequency of cholera and the campaigns that are carried out to bring awareness of the disease, many people are able to seek medical attention but there are still fatalities in most cases. The major challenge is transportation. Because some villages are quite isolated, the sick have to travel several kilometres to find the nearest health facility.

Drilling of boreholes has helped to bring safe water to most rural communities in developing countries. Efforts are being made by NGOs and well-wishers all over the world who come and drill these boreholes. The only problem is that when the pumps break down the community members have no expertise and knowledge on how to repair the pumps. The rural populations lack the knowledge, equipment and materials that could help isolate and fix the problem, hence return to their old water sources which may not be as safe.

3.4.3 Toilets, Garbage and Disease

Availability of sanitary facilities such as latrines/toilets and proper garbage disposal sites are important in curbing infectious diseases that are spread due to poor sanitation. Poorly disposed garbage attracts flies that carry disease causing microorganisms and spread them as they land on food thereby contaminating the food with the microorganisms. Lack of latrines/toilets results in open defecation that also attract flies which will also contaminate anything they come into contact with including food.

The squatting toilet (Pit latrine): Due to poor sanitation, campaigns have been launched encouraging people to dig latrines instead of using open defecation. In a typical rural setting in most sub-Saharan countries, there is a grass thatched or tin roofed residential house, an outside bathroom, which is usually a square or rectangular space demarcated by grass and wooden poles/bamboo for privacy and a pit latrine which could have a similar demarcation as the bathroom or could be enclosed in a tiny mud hut with a grass thatched roof. Even though latrines/toilets

are constructed differently in different rural communities in developing countries around the world, they serve the same purpose.

Due to lack of running water in most of the poor rural areas of the world, latrines/toilets are dug in the ground and a slab is placed on top of the pit. The slab has a hole located at the centre where people can pass out urine and faecal matter. If a pit latrine is deep enough it can be used for 2–5 years or more before it fills up, this also depends on the number of people using the latrine. If a pit latrine is used properly, cleaned regularly and is properly covered, it reduces the incidence of infectious diseases especially those spread by vectors such as flies. If the hole of the pit latrine is left open flies come out and they land on fruits and food contaminating them with microbes which can cause diseases to those who consume the food. Proper hygiene is needed in order to safely use and manage pit latrines. In rural schools of sub-Saharan Africa, these are the toilets that are available and students from different villages who attend the school use these facilities. If these facilities are poorly maintained there is a high risk of infectious disease outbreaks. Since most of the children in these schools come from poor families, most of them do not have shoes; if the toilets are dirty the children would opt to go and use the surrounding bushes instead of the toilets. This also encourages the spread of diseases

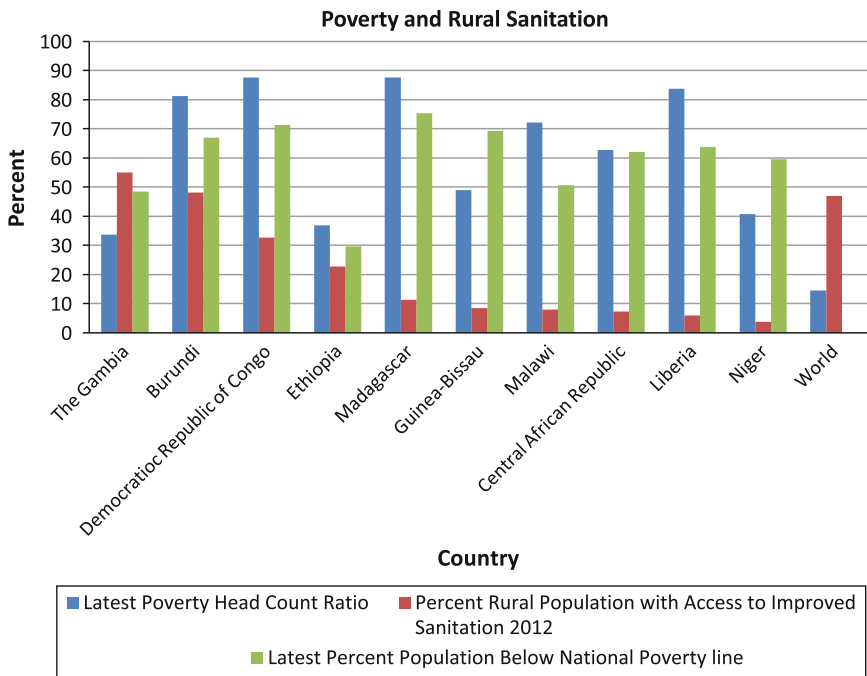


Fig. 3.3 Poverty and rural sanitation in the top 10 poorest countries in the world in 2014. This graph compares poverty head count ratio, percent rural population with access to improved sanitation as of 2012 in the 10 poorest countries of the world to the world average and the percent population below national poverty line between the countries

as the flies will be feeding on these faecal matter and will carry these to the food in their homes, making them sick in return.

It is therefore necessary to understand this vicious cycle of poverty, sanitation and infectious diseases, how infectious diseases have resulted in increasing poverty among the poor populations of the world, which has further resulted in poor living conditions including sanitation. Poor sanitation presents a high risk for infectious diseases, hence the cycle is maintained (Fig. 3.3).

3.5 Lifestyle and Disease

Poor sanitation has allowed for disease vector breeding grounds. Some of the most deadly and dangerous infectious diseases are transmitted by mosquitoes. These include malaria, dengue and filariasis (Elephantiasis) which are prevalent in sub-Saharan Africa and the tropics. Mosquitoes breed in stagnant water, which may collect in water pools around the homes and in unused utensils around the home that are hollow and can collect water. Mosquitoes lay their eggs that hatch and develop to the adult stages in these water pools. Since the water is not moving, there is plenty of food for the developing mosquito stages. Here are some of the possible places where water collects; holes/pools on the ground, old utensils that are lying around in the open, e.g. pots, plates, cups, cans, water fountains, bases of flower pots, on big leaves and hollow stems in tree trunks, old tyres and anything that is hollow and can collect water.

It is therefore very important to drain and/or turn upside down all things that can collect water. Fill all water pools.

For the past decade, campaigns to bring awareness on association of mosquito bites and the transmission of malaria, dengue and filariasis have been ongoing in the affected regions. These campaigns aimed at equipping populations in rural communities with vital information on how to protect themselves from mosquito bites thereby preventing disease, have proved to be a great success. For example since the introduction of insecticide treated bed nets (ITNs), there has been a drop in malaria incidence in those areas where people are using them effectively (WHO| World malaria report 2013 shows major progress in fight against malaria, calls for sustained financing, n.d.).

People in rural areas cannot afford insect repellent as this is costly. In a typical rural setting, people work during the day in their farms and around the home, but gather together in the evening to socialize. It is during this time that these people are at risk of being bitten by mosquitoes that transmit malaria. Because people are usually moving around during this time they may be bitten by mosquitoes but not compared to how much they can be bitten when they are asleep. That is why sleeping under ITNs is one of the strategies that have helped reduce the incidence of the disease. In some countries, prices of ITNs have been subsidized so that most people can afford them. Some are handed out free, especially to expectant mothers and to mothers with children under 5 years of age.

Other infectious diseases associated with poor sanitation include Epidemic typhus. Outbreaks of Epidemic typhus have been associated with poor hygiene in some developing countries (Fournier et al. 2002; Mokrani et al. 2004). Poor body hygiene results in incidence of body lice which can be passed on within the household and the community through contaminated clothing and contact. The lice transmit the pathogens responsible for Epidemic typhus during feeding, and as the lice are passed on from one individual to another they pass on the disease. Proper body hygiene can reduce the incidence of body lice.

Clean surroundings and proper garbage disposal will reduce the incidence of houseflies that can transmit microorganisms associated with diarrhoeal diseases.

Good sanitation goes a long way in reducing the risk of spread of infectious diseases.

3.6 Poverty and Disease

Other factors that have contributed to poverty and poor living conditions include: environmental factors such as natural disasters, population growth; political factors including civil wars and tribal conflicts, and social factors. The World Bank indicators on improved sanitation facilities in rural areas estimated that in the year 2012, 46.5 % of the world rural population had access to improved sanitation facilities, with 33.2 % in low income countries, 33.9 % in low medium income countries, 61.5 % in upper middle income countries and 92.8 % in high income countries having access to improved sanitation. According to the World Bank, improved sanitation facilities include, flush/pour flush (to piped sewer system, septic tank, pit latrine), ventilated improved pit (VIP) latrine, pit latrine with slab, and composting toilet <http://data.worldbank.org/indicator/SH.STA.ACSN.RU/countries/1W-XM-XN-XT?display=map>.

The Democratic Republic of Congo and Madagascar have the highest percent of population living under \$1.25 per day at 87.7 % (Poverty Head Count Ratio). National poverty lines, calculated from weighted household surveys, show the actual population within a country that is poor. The national poverty lines vary between countries (Fig. 3.3).

3.7 Impact of Infectious Diseases on Livelihoods

3.7.1 *Decreased Agricultural Production*

Infectious diseases that coincide with the rainy season have a great impact on agricultural production. Families will spend time taking care of their sick instead of working on the farm. The disease lowers the capacity of the farmer to work on the

farm; this in turn affects the crop productivity and yield. Guinea-worm disease for example is known as “*the disease of the empty granary*”, this is because an individual suffering from the disease is non-functional for months and since the disease coincides with the farming season, those infected are not able to take care of their fields hence low crop production (WHO|About guinea-worm disease, n.d.).

3.7.2 Redistribution of Labour

Due to illness in the family, redistribution of labour and responsibility occurs. If the head of the household and/or a family member falls ill, the family has to shift the responsibilities, including taking care of the sick and finding extra work to earn the needed income. This results in older children missing out school and/or dropping out of school in search of piece work to support their families while the parents take care of the sick. If the disease is chronic, this may result in long-term hospitalization thereby changing the equilibrium of the household completely. Death of a parent or both parents due to infectious diseases results in orphans making the situation worse in the household.

3.7.3 Loss of Labour

Loss of labour due to death and/or sickness directly affects livelihoods. When an individual is chronically ill they are not able to carry out their normal day-to-day work resulting in a gap in the workforce. This loss of labour impacts the productivity and output of the household and the community. At the household level, complete loss of labour due to death affects the income of the household due to expenditures to meet costs of taking care of the sick and funeral costs. This further plunges the household into financial stress and poverty.

3.7.4 Loss of Assets

In order to meet the extra financial needs created by disease in a household, the family may be forced to sell off their assets in order to pay for transportation of the sick member to the hospital, to pay for hospital bills and/or to settle funeral costs. This further plunges the family into poverty and may result in loss of their livelihood to lack of capital, hence poverty for the household.

3.7.5 Increased Number of Dependants

Death in a household, especially of the head of the family and/or breadwinner, results in orphans. These orphans will require support from other family members to survive. This puts stress on the remaining family members. If the surviving family members are not able to take up the extra dependants, the orphans will drop out of school to find ways and means to support themselves. Usually, the oldest of the orphaned children will take on the responsibility of taking care of the family.

3.7.6 Human Health and Needs

Infectious diseases can cause malnutrition; this lowers the productivity of the individual and may affect output. Apart from malnutrition, infectious diseases are associated with displacement of populations as people try to move away from areas where disease is rampant. This in turn results in loss of property, poor housing and lack of other resources necessary for their survival such as safe drinking water and proper sanitation.

Infectious diseases have resulted in weakening of the immune system of the affected individuals, making them vulnerable to other infectious diseases. These opportunistic infections further weaken their bodies and affect their productivity.

Even if an individual recovers from an infectious disease, some of these diseases cause crippling and debilitating effects which result in disability. These disabilities could lead to partial or complete loss of a livelihood. Since the rural poor are the most affected by infectious diseases, these ailments further plunge these populations into poverty.

3.8 Conclusion

Infectious diseases are an important aspect in human development and livelihoods. The impact of infectious diseases on the human population has been felt for centuries and has led to discoveries that have preserved and allowed for survival of the human population. Due to exposure to these diseases, humans have developed immunity to infectious diseases. The impact of infectious diseases also led to biomedical research, which has resulted in development of vaccines and understanding mechanisms of disease. Despite these discoveries there are still millions of people affected by infectious diseases worldwide, most of them living in poor rural regions of developing countries. Rural populations suffer the huge impact of infectious diseases. These rural communities are vulnerable to infectious diseases and their livelihoods are greatly affected by the impact of these diseases.

With varying modes of transmission, infectious disease pathogens have been able to survive in different hosts and environments. Sanitation plays an important role in the success of infectious diseases. Poor sanitation provides a breeding ground for infectious disease pathogens. These diseases affect livelihoods, including health and economic growth.

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