WASH IN NUTRITION: IMPACT AND EFFICIENCY

THESIS SUBMITTED TO FULFILL THE REQUIREMENTS FOR THE DEGREE OF SPECIALIZED MASTER WASH AT 2IE

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I dedicate this work to my family and my friends.

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ABSTRACT

Since the 1960s, it has been known that poor water and sanitation causes diarrhea, which consequently compromises child growth and leads to undernutrition. Ample evidence shows that poor water and sanitation causes diarrhea, but there is a growing body of knowledge discussing the magnitude of the impact of diarrhea on undernutrition. A recent hypothesis by Humphrey (2009), for example, states that the predominant impact of contaminated water and poor sanitation on undernutrition is via tropical/environmental enteropathy rather than mediated by diarrhea. This hypothesis has generated much debate on the contribution of water and sanitation to Nutrition.

Through the following work, we show how WASH can have an impact on nutrition. In other words we highlight the role of safe drinking water, sanitation and hygiene in enabling good nutrition

For that purpose we did some researches to find existing articles, surveys and documents on WASH and nutrition. This helped to understand the studies already done and summarise the main contents.

Although it is clearly demonstrated that there are several nutrition-related diseases resulting from unsafe WASH, simple practices can be implemented to reduce significantly to problem. When used properly, water, sanitation and hygiene can have efficient outcomes on the nutrition programs.

Keys words:

1- WASH
2- HUMANITARIAN
3- HEALTH
4- UNDERNUTRITION
5- MDG

ACRONYMS:

2IE: International Institute for Water and Environmental Engineering

ACF: Action Contre la Faim (Action Against Hunger)

BCC: Behavior Change Communication

BDHS: Bangladesh Health and Demographic Survey

BNNC: Bangladesh National Nutrition Council

FAO: Food and Agriculture Organization

FSNSP: Food Security and Nutritional Surveillance Survey

GOB: Government of Bangladesh

HKI: Helen Keller International

HNP: Health, Nutrition, and Population

MDG: Millennium Development Goals

MOHFW: Ministry of Health and Family Welfare

NUT: Nutrition

UN: United Nations

UNICEF: United Nation children's Fund

USAID: U.S. Agency for International Development

WASH: Water Sanitation and Hygiene

WFP: World Food Program

WHO: World Health Organization

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INTRODUCTION

1. Background

The concept of WASH, which groups together water, sanitation and hygiene, is an important field for public health in the world, mainly in Sub-Saharan African and Asian countries. Access to safe water, adequate sanitation and proper hygiene can impact on health, poverty and socioeconomic development. The United Nation's Millennium Development Goals include improvement of WASH services in Target 7.C: "Halve, by 2015, the proportion of the population without sustainable access to safe drinking water and basic sanitation."

Although progress has been achieve over the past decade, much remains to be done particularly to reduce inequalities across populations. In fact, the water people drink can also be a source of persistent illness, leading to an early grave. Every 7 seconds, a child in the developing world dies of WASH-related disease or WASH-related malnutrition (Wateraid, 2015). According to the World Health Organization (WHO) and the Centres for Disease Control and Prevention (CDC), 80 percent of all childhood diseases are WASH-related (WHO, 2012). While adults also suffer from WASH-related diseases, 90 percent of those who succumb to them are children under the age of 5.

In Bangladesh for example, between 2004 and 2013, among children under five years of age, underweight rates declined from 43 percent to 35 percent and stunting rates declined from 51 percent to 39 percent (NIPORT 2013). Progress with regards to nutritional outcomes is less than satisfactory and child undernutrition rates in Bangladesh remain among the highest in the world.

Undernutrition is a multidimensional problem requiring interventions that cut across sectoral boundaries. According to a framework developed by United Nations Children's Fund (UNICEF) in the 1990s, now widely accepted and globally used, undernutrition is an outcome of immediate, underlying, and basic causes. There is now mounting global evidence from diverse sources of a strong linkage between poor sanitation and hygiene and child undernutrition.

2. Objectives

a. General objective

The global objective of this work is to review the relationship between WASH and Nutrition

b. Specific objectives

We will focus on:

- The links between an unsafe WASH and Nutrition
- The consequences of malnutrition
- The measures that can be taken to integrate WASH in Nutrtion

3. Structure

This work consist in 5 parts:

The first part is General Introduction which contains the background, the objectives, the structure of the work and the methologie used;

The second one is about notions on WASH and nutrition;

The third part analyse the relationship between WASH and Nutrition;

The part 4 gives keys to reduces malnutrition;

And the last one is about the conclusion and recommendations.

4. Methodology

The methodology consisted in analyse various existing documents, articles, publications, and web site and do a bibliographic synthesis of the essential of WASH and Nutrition.

I. GENERALITY

1. Water, Sanitation and Hygiene (WASH) in humanitarian

a. Water

In humanitarian, a safe water supply has the objective to ensure the access of the consumers to correct quantities of a good quality water.

- ✓ **Quantity**

Water is collected from several sources (surface water, wells, boreholes…) and goes either to treatment and/or storage before consumption. It moves through the intake either by gravity, or it has to be lifted.

In tropical climate, the daily minimum volume of water required for survival (drinking and cooking) would be around 3 to5 litres per person a day, because the human body needs a minimum intake to sustain life before mild and severe dehydration occurs. It is estimated that 2.6 litres of water per day is lost through respiratory loss, perspiration, urination and defecation. In addition, a significant quantity of water is lost through sensible perspiration if hard work is performed.

The need for domestic water supplies for basic health protection exceeds the minimum required for survival. Additional volumes should be foreseen for maintaining domestic and personal hygiene through food and hand washing, bathing and laundry. Therefore should the survival quantity be increased as soon as possible because insufficient water quantities will induce poor hygiene, which in turn will cause all kinds of water-washed diseases. Domestic water supply should thus be minimal 15 to 20 litres per person a day (ACF, 2005).

Table 1 : Sphere norms for water supply

Survival needs: water intake (drinking and food)	2.5–3 litres per day	Depends on the climate and individual physiology
Basic hygiene practices	2–6 litres per day	Depends on social and cultural norms
Basic cooking needs	3–6 litres per day	Depends on food type and social and cultural norms
Total basic water needs	7.5–15 litres per day	

(Sphere book, 2011)

Where possible, it is better not to put any limit on consumption as the health status of the population is influenced by the quantity of water used. The quantities of water used worldwide depend on many variables and cultural practices.

Besides the water needed by the population itself, additional water might be necessary for special needs like cattle and certainly to cover the losses due to leaks and spillages.

Health structures including inpatients and outpatients departments, and specific health facilities such as cholera treatment and feeding centres will always require considerable amounts of water of good quality, even in acute emergencies. When these essential water requirements can't be reached, the correct functioning of the health structure will be jeopardized. In later phases of emergencies and in stabilized situations; the water quantities should be increased because the water demand will most probably rise.

According to the needs, it is important to evaluate the amount of water that can be supplied to cover those requirements. This objective should be to secure water sources that provide more water sources that provide more water in 24 hours than the strict daily volume required for the targeted purpose. In health structures, it is strongly recommended to have a reserve storage capacity lasting for at least two days in order to cope with a water supply failure (ACF, 2005).

- ✓ **<u>Quality</u>**

For water to be potable, it must have the following characteristics:

- Contains no pathogens (good microbiological quality).
- Contains nor only a harmless concentration of toxic chemical products.
- Has a low turbidity.
- Has a low salinity.

- Has no taste, colour or odour.
- Is not corrosive and doesn't favour encrustation.

One has also to keep in mind however that there is no direct relationship between the appearance of a water sample and its drinkability (ACF, 2005).

Microbiological quality

Water can be the cause of diseases, which can spread epidemically in a population. Five categories of pathogens can be found in water: bacteria, viruses, protozoa, helminths (eggs) and fungi. Water contaminated with these biological elements can cause a variety of communicable diseases through ingestion or physical contact. The potential consequences are such that microbial contamination control is always of paramount importance and can never be compromised (ACF, 2005).

Chemical quality

Chemical contaminants present in the water might have been introduced naturally, caused by the geological structure of the underground, or man-made due to agricultural and industrial activities. Removing chemicals from water often proves to be an expensive and very difficult task. The choice of the water source will therefore be of utmost importance.

The chemical quality of drinking water can have a direct health implication, due to the absence of necessary chemical constituents or by the excessive presence of certain chemical elements. This is a rapidly increasing problem in low-income countries. Most of the human intake of chemical occurs through the food, not via the drinking water however.

The health risk due to toxic chemicals in drinking water differs form that caused by microbiological contaminants. The problems associated with chemical constituents at a low concentration within drinking water arise primarily from their ability to cause adverse health effects after prolonged periods of exposure. High concentrations of chemicals in the potable water supply, and certainly massive contamination can cause serious health problems.

The chemical contaminants can be harmful organics like pesticides or harmful inorganic products such as:

- Arsenic: which is widely distributed throughout the Earth's crust, and of great concern for instance in Pakistan and Bangladesh as it is carcinogenic.
- Fluoride: which is an element of importance in eastern Africa. A high concentration carries an increasing risk of dental fluorosis, and can lead to skeletal fluorosis.

- Mercury: which presence should be suspected in areas where gold extraction is carried out. It is a toxic heavy metal.
- Nitrates; which are introduced by over-fertilizing or due to high amounts of excreta (mainly urine) being disposed of in very population settings. A relatively low concentration of nitrates can already cause the blue-baby disease in new-born babies.
- Nitrates: which is a reduced form of nitrates can be introduced by backfilling wells with termite hills and can lead to immediate death (ACF, 2005).

Turbidity

This characteristic is a measure of the amount of suspensible particles in the water. The turbidity of water is mainly of importance because it inhibits the effectiveness of disinfection and hence the correct microbiological quality of the water. Turbidity will also directly affect the acceptance of the water by the consumers (ACF, 2005).

Salinity

Salinity is a measure of the amount of dissolved salts in the water which should be low for the accessibility of the consumers, and to avoid corrosion of the equipment. A high concentration can also cause negative health effects such as diarrhoea, vomiting and renal failure (ACF, 2005).

Colour, taste and odour

Colour, taste and smell are characteristics due to the presence of some micro-organisms and/or chemical substances in the water.

Corrosion and encrustation

Corrosion can also be caused by the high acidity (low pH) of the water, and encrustation is due to certain minerals (calcium carbonate for example). Both may affect the longevity of equipment. The pH also has a serious influence on water treatment procedures (coagulation/flocculation, chlorination).

The chemical water quality and the above mentioned characteristic may affect the consumer's acceptance to drink that particular water, therefore turning to more palatable but potentially biologically unsafe water from a contaminated source. As such, these factors can also become an indirect health hazard (ACF, 2005).

- ✓ **Water related-diseases**

Water related infectious diseases can be classified according to their transmission routes:

- Water-borne diseases: caused by the ingestion of water containing pathogenic micro-organisms. Water can b e a transmission route of certain diseases when it has been contaminated by faeces or urine of human beings or warm-blooded animals. But some of these diseases may also be transmitted by any of the other faecal-oral routes like dirty hands and contaminated food, which are grouped in water-washed diseases.
- Water-washed diseases: due to the lack of proper domestic and personal hygiene. Insufficient water supply is one factor leading to improper hygiene. The disease linked to lack of water for hygiene are:
    - Faecal-orally transmitted diseases: lack of hygiene, particularly of hands and food, allows the transmission of these diseases from infected individuals and animals to uninfected individuals. This results in the so-called "dirty hands diseases".
    - Dermatological and ophthalmic disease: lack of personal hygiene can lead to skin and eye infections.
    - Diseases transmitted by lice: lack of personal hygiene and washing of clothes encourages the proliferation of lice which, in addition to the problems caused by their presence (itching and scratching, skins sores), are disease vectors.
- Water-based diseases: their causal agent (pathogen) has to pass part of its life-cycle in an intermediate organism (host) that is living in the water.
- Water-related insect vector diseases: are related with an insect vector which develops in or lives near water (ACF, 2005).

The following table summarises these water-related diseases.

Table 2 : Water-related diseases

Transmission Route	*Diseases*	*Control*
Water borne	Cholera Typhoid Dysenteries Diarrhoeas Infectious hepatitis	Improve drinking water quality. Prevent use of other contaminated sources.
Water washed	Skin and eye infections Louse borne typhus	Increase quantity and use of water. Improve personal hygiene by increasing accessibility and availability of water.
Water based	Schistosomiasis (penetrating skin) Guinea worm (ingested)	Decrease contact with contaminated water in the environment. Control appropriate aquatic animals. Reduce excreta contamination of surface water.
Water related insect vector	Yellow fever River blindness Malaria Sleeping sickness	Eliminate breeding sites by improving Drainage. Keep people away from the breeding or biting sites. Use mosquito netting.

(Cairncross and Feachem,1993)

b. Sanitation

Human excreta transmit many infectious diseases. The pathogens leave the body of the infected person via the excreta and can then be transmitted to healthy individuals. This problem is particularly acute in health care facilities due to the high number of sick people present and to the high level of infectiousness of their excreta.

Five types of excreta-related diseases or transmission routes may be identify:

- Faeco-oral transmission (bacterial and non-bacterial): Pathogens are transmitted by direct contact and domestic contamination (water, food and objects contaminated by excreta). As said above, pathogens may be viruses, bacteria, protozoa and certain helminths. The list of faeco-orally transmitted diseases includes notably amoebic dysentery, cholera, giardiasis; hepatitis A and typhoid fever.

- Helminths (worms) transmitted by the soil: Helminth eggs have a latent period between the moment they are excreted and the moment they become potentially infectious. The transmission of these helminths takes place through the contamination of the soil and the crops. It mainly concerns ankylostoma, ascaris ans stronguloides. Infection by these helminths is very frequent and the prevalence may be higher than 90% in certain populations.

- Beef and pork tapeworms (taenia): Cattle and pigs are intermediate hosts of taenia. The transmission cycle involves the contamination of soil and forage by human excreta, then the ingestion of undercooked meat by humans.

- Water-based helminths: The excreted eggs of those helminths pass part of their life cycle in one or several intermediate aquatic hosts, before becoming infectious to humans. An example is schistosomiasis. Its transmission cycle involves the contamination of surface water by human excreta, development within a snail host and finally the penetration of the skin of a new human host when he enters the waters.

- Excreta-relates diseases transmitted by insect vectors: This includes all the, with can be transmitted by insects like flies and mosquitos, which breed in environments containing excreta (ACF, 2005).

The coming figure illustrate the pathogens routes from the excreta to the human.

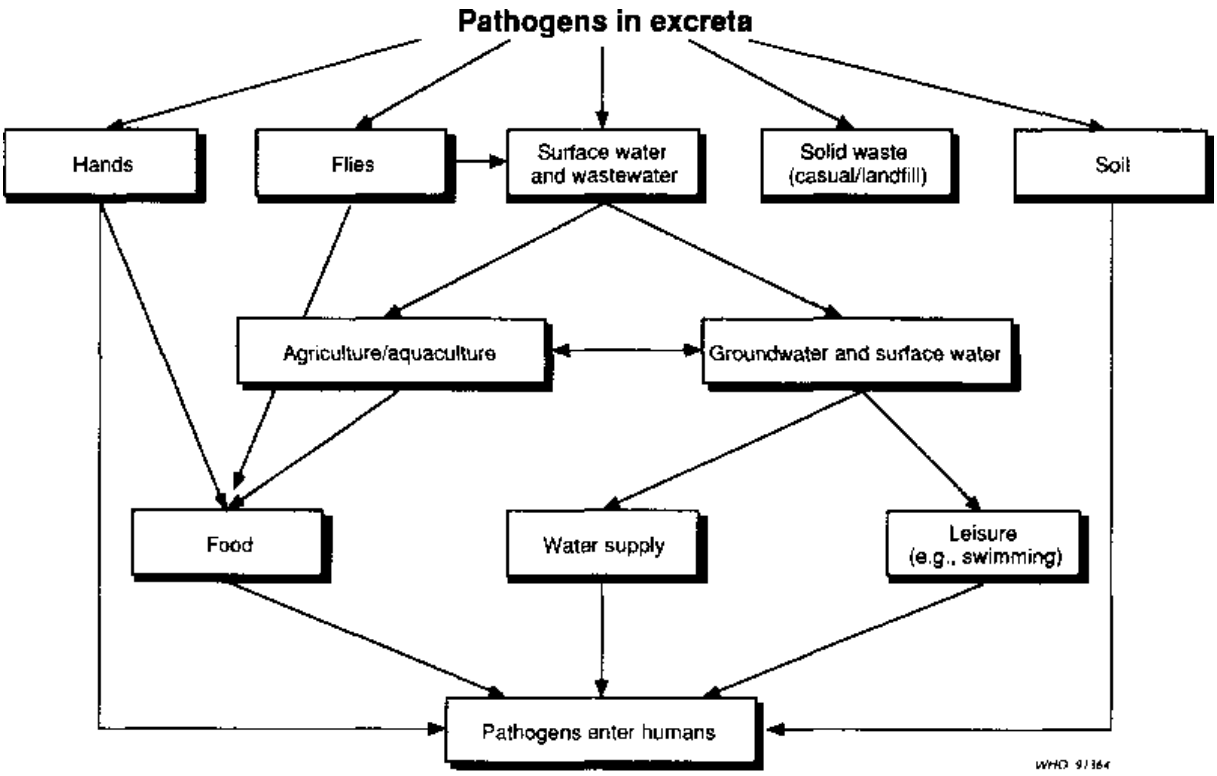

Figure 1 : Pathogens routes to human (WHO, 91 364)

To avoid these diseases, some sanitation facilities should be properly implemented and used. The following table set the norms in terms of toilets use by the sphere handbook.

Table 3 : Sphere norms for sanitation facilities

Institution	Short term	Long term
Market areas	1 toilet to 50 stalls	1 toilet to 20 stalls
Hospitals/medical centres	1 toilet to 20 beds or 50 outpatients	1 toilet to 10 beds or 20 outpatients
Feeding centres	1 toilet to 50 adults 1 toilet to 20 children	1 toilet to 20 adults 1 toilet to 10 children
Reception/transit centres	1 toilet to 50 individuals; 3:1 female to male	
Schools	1 toilet to 30 girls 1 toilet to 60 boys	1 toilet to 30 girls 1 toilet to 60 boys
Offices		1 toilet to 20 staff

(Sphere book, 2011)

c. Hygiene

Hygiene practices includes all the activities aimed at increasing people's health status through the improvement of the hygienic practices in their day-to-day life.
Health is one of the main concerns of humanitarian programmes and is a full component of the fight against vulnerability and malnutrition. Emergencies can cause an increase of water- and sanitation related diseases and in some cases can cause epidemic outbreaks, putting many people's lives in danger.

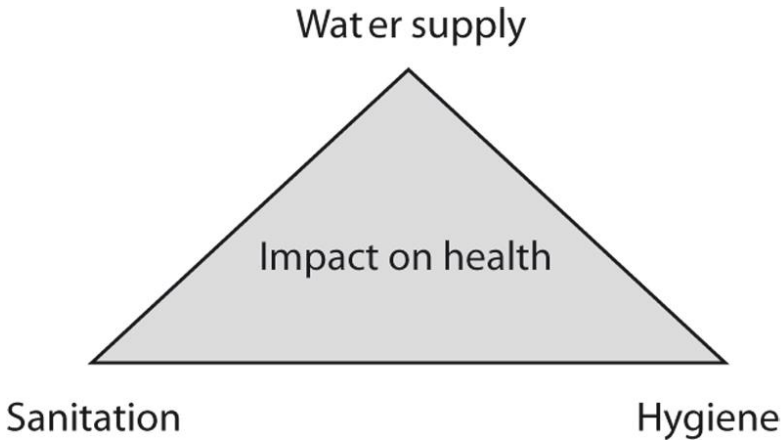

Figure 2 : WASH triangle (ACF, 2005)

Improvement of health can be achieved by focusing on three fundamental areas: the healthcare system, water and sanitation infrastructure and the population's health-related behaviour.
Water- and sanitation-related diseases are the main health problem within developing countries and therefore the main cause of mortality. Their development and transmission depend directly on access to facilities, vector-control measures and water-handling and hygiene habits. Clean water and sanitary facilities are essential for improving the sanitary environment, but poor results will be achieved in terms of public health if hygiene practices are not appropriate: the clean water provided by a protected source can be contaminated if it is not correctly handled; the impact of a latrine will be reduced if people don't use it properly and don't wash their hands after using it; and the stagnant water accumulated around a badly-maintained water point can be a serious sanitary risk for its users and nearby inhabitants (ACF, 2005).

The objective of many programmes is to reduce the risk of spreading water-and sanitation related diseases, through an integrated approach where water, sanitation and hygiene promotion are closely connected.

Hygiene promotion focuses on reducing the main risks related to health and the use of water supply and sanitation facilities though an improvement in people's knowledge and behaviour. The more frequent topics developed in Hygiene Promotion programmes are:

– Transmission of diseases, understanding of risks and solutions;
– Proper use of facilities;
– Proper water use: collection, transport, storage and consumption;
– Promotion of appropriate sanitation;
– Basic personal hygiene;
– Environmental hygiene;
– Food hygiene;
– Child hygiene.

2. Notions of nutrition and Malnutrition

a. Nutrition

Nutrition provides the cells of an organism with food, in a form they can use. Organisms need food to be able to keep their bodies working properly. They also need food to be able to do certain things. Malnutrition can happen when a person doesn't eat the right amount of nutrients. They can get better by changing their diet to have the right amount of the various nutrients (Wikipedia, 2015).

Different organisms have different food requirements, and they eat different things in order to meet those requirements. Animals that do not eat meat, for example, will have to get certain nutrients like protein from other foods.

The six main types of nutrient are carbohydrates, fats, minerals, protein, vitamins, and water. A macronutrient is a nutrient that needs to be eaten a lot. A micronutrient is needed in smaller amounts but it is still important. Carbohydrates are not needed by the body but most people eat a lot of them. Complex carbohydrates are more nutritious than simple carbohydrates. They take longer to digest. Because they stay in the stomach for longer they leave the person who has

eaten them feeling fuller for longer. Protein is needed for building cells. It is found in milk, meat, fish, beans, eggs and other foods like quinoa. Protein is made of amino acids.

Fat is found naturally in some foods. People often eat it in processed foods such as cakes and chocolate. It is high in energy. Omega 3 and omega 6 fats are needed by the body. There are saturated fats and unsaturated fats. It is recommended that people avoid the saturated type. It has been linked with heart disease. A lot of people think that fat is bad in general and should rarely consume (figure 3). It is controversial. People are also advised not to eat too much sugar or salt (Wikipedia, 2015).

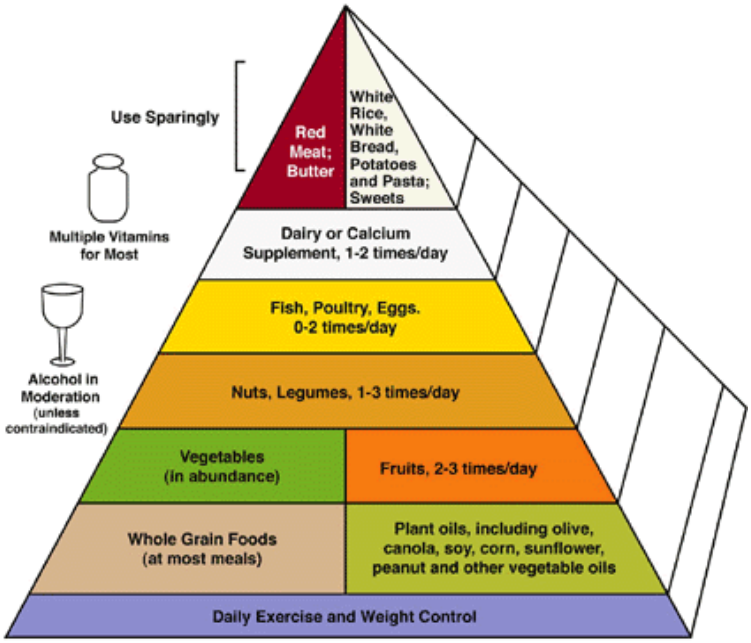

Figure 3 : Nutrition pyramid (Wikipedia, 2015)

a. Malnutrition

Malnutrition or malnourishment is a condition that results from eating a diet in which nutrients are either not enough or are too much such that the diet causes health problems. It may involve calories, protein, carbohydrates, vitamins or minerals. Not enough nutrients is called undernutrition or undernourishment while too much is called overnutrition. Malnutrition is often used specifically to refer to undernutrition where there is not enough calories, protein, or micronutrients. If undernutrition occurs during pregnancy, or before two years of age, it may result in permanent problems with physical and mental development. Extreme undernourishment, known as starvation, may have symptoms that include: a short height, thin body, very poor energy levels, and swollen legs and abdomen.

People also often get infections and are frequently cold. The symptoms of micronutrient deficiencies depend on the micronutrient that is lacking.

There were 925 million undernourished people in the world in 2010. This is an increase of 80 million people since 1990 or a 2.5% drop in the percentage of undernourished people. Another billion people are estimated to have a lack of vitamins and minerals.

In 2013, protein-energy malnutrition was estimated to have resulted in 469,000 deaths—down from 510,000 deaths in 1990. Other nutritional deficiencies, which include iodine deficiency and iron deficiency anemia, result in another 84,000 deaths.

In 2010, malnutrition was the cause of 1.4% of all disability adjusted life years. About a third of deaths in children are believed to be due to undernutrition, although the deaths are rarely labelled as such. In 2010, it was estimated to have contributed to about 1.5 million deaths in women and children, though some estimate the number may be greater than 3 million. An additional 165 million children have stunted growth from malnutrition.

Undernutrition is more common in developing countries (figure 4). Certain groups have higher rates of undernutrition, including women—in particular while pregnant or breastfeeding—children under five years of age, and the elderly. In the elderly, undernutrition becomes more common due to physical, psychological, and social factors (Wikipedia, 2015).

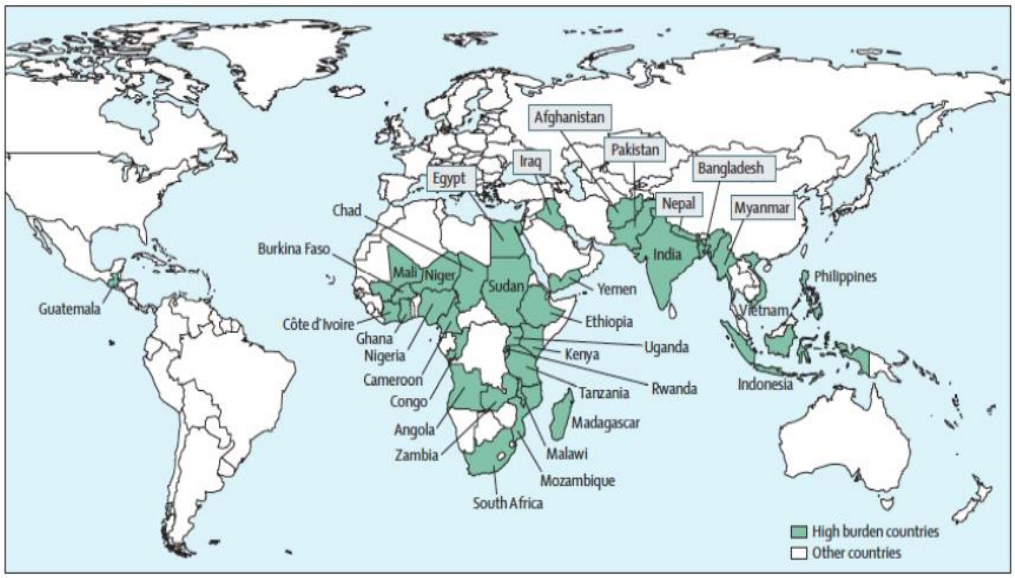

Figure 4 : Undernutrition in the world 5 (Wikipedia, 2015)

II. IMPACT OF WASH ON NUTRITION (CASE OF BANGLADESH)

As WASH in NUT is a wide field, in this part we will focus our work on a study made by the World Bank in Bangladesh in 2015.

1. Links between WASH and Nutrition

a. Multisectoral Response to Undernutrition in Bangladesh

Undernutrition is a multifactorial challenge. The potential causes of undernutrition may be classified as immediate, underlying, or basic. Figure 5 presents a conceptual framework depicting the causes of child undernutrition, which is adapted from UNICEF and subsequent work in this area (Engle, Menon and Haddad 1999, and Haddat et al. 2002). This framework highlights the need to work in multiple sectors in order to address the problem of undernutrition.

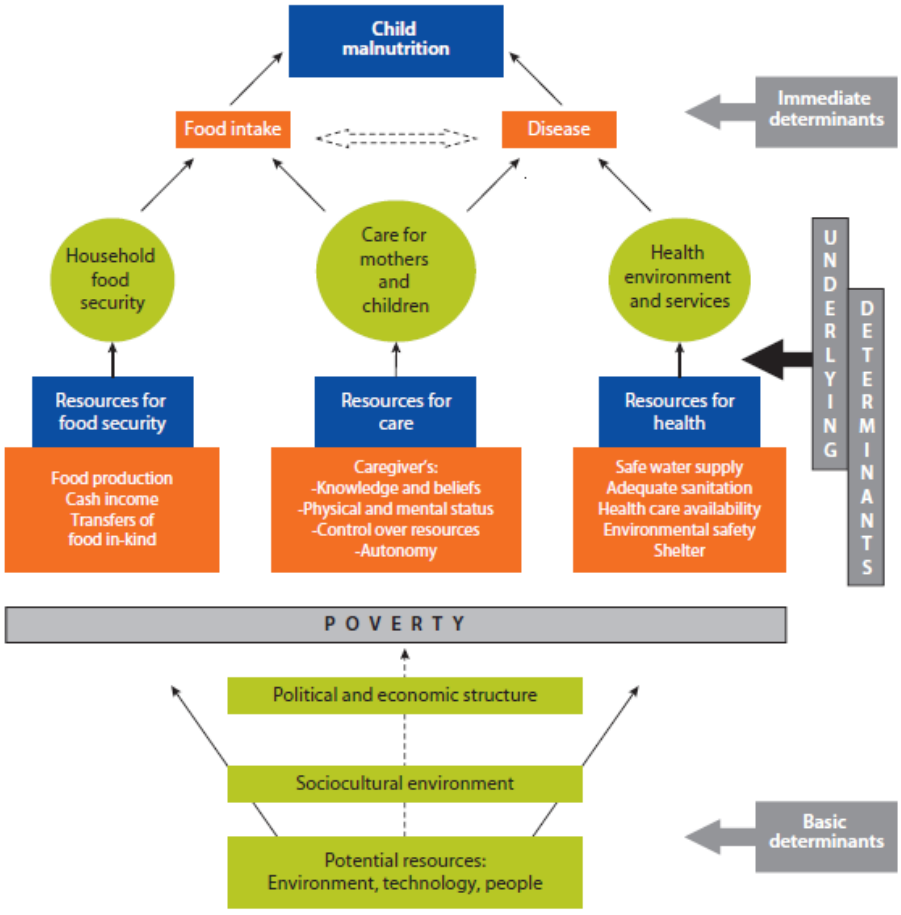

Figure 5: Conceptual Framework for the Causes of Undernutrition (UNICEF; Engle, Menon, and Haddad 1999; Smith and Haddad 2000)

Inadequate dietary intake and disease are often the immediate causes of undernutrition and directly affect the individual. Moreover, they form a vicious cycle: Inadequate dietary intake increases the likelihood of illness because of weakened immune levels; illnesses lead to a loss of appetite and poor absorption, which in turn worsen undernutrition.

The main underlying causes of undernutrition are lack of household food security, inadequate care for mothers and children, and poor health and environmental conditions. Each factor is determined by the social and economic resources available to the individuals and the household as a whole. Poverty is a key factor affecting all underlying determinants.

Caring practices include appropriate nutrition and support for mothers during pregnancy and lactation, infant feeding practices (breastfeeding and complementary feeding), and health-seeking behaviors and cognitive stimulation. The caregiver's knowledge and beliefs also are important resources that influence what types of health services are accessed and what caring practices are adopted.

Factors affecting the health and environment conditions of the household include access to health care from affordable, qualified providers and safe water and sanitation services. Poor environmental safety, including lack of adequate shelter, is also a critical determinant of undernutrition.

The basic causes of undernutrition are insufficient resources available at the country or community level, and the political, social, and economic conditions that govern how these resources are distributed. The basic causes also influence institutions. These include both the formal institutions that provide public sector services, such as health and education, and the informal institutions that determine the social and cultural norms regarding the rights of women and vulnerable groups in the population.

The causes of undernutrition in Bangladesh are multifactorial as discussed above. A Helen Keller International study (HKI 2006) reported that the most important explanatory variables for stunting among under-five children in Bangladesh included food intake, household food insecurity, poor maternal and childcare practices, disease, and limited access to a healthy environment (safe water and sanitation). The study also found that stunting was very high even among the wealthiest groups, an indication that economic growth alone is not sufficient to improve nutrition, a point highlighted earlier in this report. The multidimensional nature of the causes of undernutrition in Bangladesh underscores the diversity of actions that are needed across sectors, levels, and actors to address the problem. Although the HNP sector in Bangladesh continues to and should play a central role in delivering direct nutrition

interventions through the maternal, neonatal, and child health services, the GOB also recognizes that health sector–based nutrition programs, though essential, have not been and will not be adequate in reducing Bangladesh's very high levels of maternal and child undernutrition.

There is now substantial global evidence showing that direct actions to address the immediate determinants of undernutrition (nutrition specific) can be enhanced by actions addressing the more underlying determinants (nutrition sensitive), which are in the domains of ministries other than health, hence the need for a multisectoral approach (Gillespie et al. 2013). Such actions can strengthen nutritional outcomes in three main ways by:

- Accelerating action on determinants of undernutrition;
- Integrating nutrition considerations into programs in other sectors that may be substantially larger in scale;
- Increasing "policy coherence" through governmentwide attention to nutrition.

While the need for a multisectoral response to undernutrition has long been recognized, the required institutional arrangements are not clear. In the 1970s, multisectoral nutrition planning cells were introduced in many countries and placed centrally in a planning commission, or in the Office of the President (Levinson and McLachlan 1999). The planning cells were expected to be able to affect a broad range of development policies and programs as a result of their high level placement. The U.S. Agency for International Development (USAID) and the Food and Agriculture Organization (FAO) supported the establishment of 26 nutrition planning cells in developing countries throughout the 1970s (Levinson 1999; and Rokx 2000). The BNNC described above was set up as part of this global push for multisectoral nutrition planning cells to coordinate nutrition policy.

The design and implementation of multisectoral strategies to address undernutrition have been far from successful in Bangladesh and around the world. The nutrition planning cells initiated in the 1970s had no significant impact. They lack the authority and resources to coordinate the relevant sectors effectively or to introduce incentives to promote cross-sectoral coordination.

A more realistic and workable institutional arrangement is to equip the different sectors with the required latitude and resources to carry out their own programs.

The nutrition coordination agency can be granted the authority to define overall policies and guide the allocation of resources (Heaver 2005). The coordination agency's role would be to ensure that correct incentives are in place to motivate sector agencies to prioritize nutrition, to operate accountability mechanisms to ensure that the sectoral agencies do carry out their

nutrition functions, and to engage in sectoral policy design and implementation to ensure that undernutrition remains a priority (World Bank 2006).

b. Pathways of influence between WASH and Nutrition

❖ *Diarrhea*

Diarrhea and undernutrition, alone or together, constitute major causes of morbidity and mortality among children throughout the world. Scrimshaw, Taylor, and Gordon (1968) presented the synergistic relationship of undernutrition and infectious diseases. Infections have more serious consequences in malnourished people, and, conversely, infectious diseases can result in borderline nutritional deficiencies becoming more severe undernutrition. An early estimate of the

World Health Organization (WHO) showed that almost half of undernutrition in the world was associated with repeated diarrhea or intestinal worm infections. These were caused by unsafe water, inadequate sanitation, or insufficient hygiene.

Subsequent studies from various countries suggested that diarrheal illnesses affect a child's growth by reducing gains in weight and height of a child (Guerrant et al. 1992). They concluded that the greatest effects of diarrhea are witnessed with frequent/recurrent bouts of the illness, which reduce the critical catch-up growth that otherwise occurs after diarrheal illnesses or severe undernutrition.

Analyses from Northeast Brazil (Guerrant et al. 1992) indicated that undernutrition can lead to a 37 percent increase in frequency and a 73 percent increase in duration of diarrheal illnesses, accounting for a doubling of the diarrhea burden (days of diarrhea) in malnourished children.

The concept of diarrhea causing and being a consequence of undernutrition has also evolved over time. Brown (2003) compiled various studies on diarrhea and nutrition undertaken from 1968 to 1998 documenting the impact and risk factors of diarrhea. Brown found an intertwined relationship between diarrhea and undernutrition: Children with diarrhea eat less and are not fully able to absorb the nutrients from their food; while malnourished children are more vulnerable to diarrhea (compared to normal children) when exposed to fecal material from their environment. Brown concluded that infection adversely affects nutritional status by reducing intake of food, lowering absorption capacity of the intestine, increasing catabolism, and taking away nutrients from the body that are required for growth. Furthermore, undernutrition reduces

the protection of the body against infection and alters the immune function, thereby prompting infection.

Martorell, Yarbrough, and Klein (1980), Rowland, Coal, and Whitehead (1977), and Black, Brown, and Becker (1984) developed statistical models based on data from Guatemala, West Africa, and Bangladesh, respectively, to estimate the proportion of the total growth deficit that could be attributed to diarrhea.

They concluded that as much as one-fourth to one-third of the observed growth failure could be attributable to enteric infections. Martorell, Yarbrough, and Klein (1980) noted that fully weaned Guatemalan children reduced their energy intake by almost one-third during acute infections. However, Brown et al. (1985) suggested that the reduction of energy intake caused by diarrhea was partially prevented by breastfeeding based on data collected from Bangladesh. They found that Bangladeshi children who were still breastfeeding reduced their intakes by only about 7 percent; while intake of nonbreast-milk energy declined by about 30 percent during illness, there were no changes in breast milk consumption. Rowland, Coal, and Whitehead (1977) also found that the previously observed diarrhea-induced growth deficit was absent in fully breast-fed infants in an urban field site in West Africa, and they concluded that exclusive breastfeeding extends protection from the adverse nutritional consequences of diarrhea.

Subsequent studies by Brown et al. (1989) in Peru, Popkin et al. (1990), and Kramer et al. (2001) in Belarus found that exclusively breast-fed infants, compared with infants who either received other foods or liquids along with breast milk or were fully weaned from the breast, had considerably reduced risks of diarrhea (and other infections). There is also some evidence suggesting that vitamin A reduces the severity of diarrheal illness but has no effect on the incidence. There is evidence that zinc supplementation can reduce the incidence of diarrhea by almost 20 percent (Brown 2003).

The weak linkage between diarrhea and undernutrition assists in interpreting the successful management of diarrhea in Bangladesh. Through an extensive oral rehydration program and very high coverage of vitamin A supplementation across the country, Bangladesh has been successful in managing diarrhea. As shown by the Bangladesh Demographic and Health Survey (BDHS), the prevalence of diarrhea among children below the age of five years declined significantly from 12.6 percent in 1993–94 to 4.6 percent in 2011 (NIPORT et al. 1993–94 and 2011). This is mirrored by a marked decline in child mortality from 133 deaths per 1,000 births in 1993–94 to 53 deaths in 2011 (NIPORT et al. 1993–94 and 2011). However, these trends are accompanied by little effect on nutrition outcomes. In 2013, the rates of undernutrition in

Bangladesh (underweight rate of 35 percent and stunting 39 percent) remain among the highest in the world (NIPORT 2013).

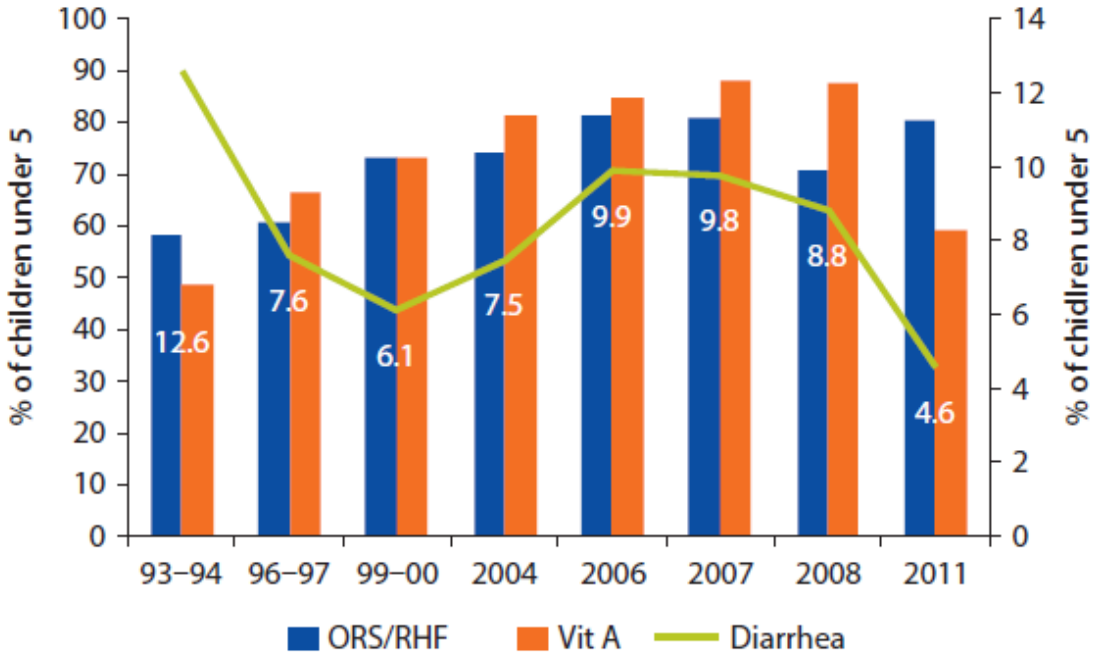

Figure 6: Prevalence and Treatment of Diarrhea in Bangladeshi Children Aged Less Than 5 years, 1993–2011 (NIPORT et al. 2013)

❖ *Tropical/Environmental Enteropathy*

Humphrey (2009) hypothesized that "the primary causal pathway from poor sanitation and hygiene to under-nutrition is tropical enteropathy and not diarrhoea." She noted that "a key cause of child under-nutrition is a subclinical disorder of the small intestine known as tropical enteropathy, which is characterised by villous atrophy, crypt hyperplasia, increased permeability, inflammatory cell infiltrate, and modest malabsorption."

Basically this means that because of chronic exposure to (mostly) fecal bacteria, the structure (decrease in the villous height) and function of the small intestine changes, which initiates a sequel leading to undernutrition. Villi are small fingerlike projections present in the lining of the small intestine. Digestion largely occurs in the ileum of the small intestine and from there the digested end products (glucose, amino acids, and so forth) move into the blood through a process called absorption. In order to make absorption quicker and more efficient, the ileum

walls need to have a large surface area, which is provided by villi. Decreased villous height reduces the total area of the small intestine and the absorption of nutrients. In addition, increased permeability of the intestinal tract affects the ability of the body to prevent pathogens from breaching the intestinal barrier. This triggers the body's immune response, resulting in nutrients being prioritized for defense rather than normal growth.

Humphrey further stated that "tropical enteropathy is caused by faecal bacteria ingested in large quantities by young children living in conditions of poor sanitation and hygiene." Such conditions are linked to poor sanitation and hygiene practices which are prevalent in developing countries. Humphrey suggested that greater "provision of toilets and promotion of handwashing after faecal contact could reduce or prevent tropical enteropathy and its adverse effects on growth."

Children living in household with poor sanitation facilities are exposed to high concentrations of fecal bacteria and end up ingesting more bacteria than children living in relatively cleaner households. The fecal bacteria colonize the small intestine and induce tropical/environmental enteropathy. These changes, coupled with reduced nutrient absorption, marginal dietary intake, and the high growth demands of the first two years of life, cause growth faltering. Lin et al. (2013) undertook a study in rural Bangladesh that lends support to Humphrey's hypothesis. They suggested that "children living in clean households with good hygiene would have lower prevalence of parasites and environmental enteropathy and better growth (less stunting, wasting, and underweight conditions) compared with children living in contaminated households with poor hygiene." Consistent with this supposition, they found that children in environmentally clean households had lower levels of parasitic infection, gut function, and growth compared with children in contaminated households, even in the absence of drastic infrastructure improvements. The prevalence of stunting was 22 percent lower among children living in clean households compared with children living in contaminated households.

An earlier study conducted by Campbell, Elia, and Lunn (2003) in Gambia had similar findings, estimating that environmental enteropathy explained 40–64 percent of stunted growth in a small cohort of children. The study by Lin et al. (2013) had some limitations: It had a small sample size, was observational, and the results, while plausible, were perhaps subject to bias. Additionally, the study lacked the temporal ordering necessary to establish causal relationships and the improvements documented by Lin et al. were possibly brought about by prenatal or early postnatal interventions, such as maternal and child nutrition, which they did not measure in the study. These effects cannot be excluded from the study cohort, as differences in stunting

between clean and contaminated environments were already in place by 2007, but environmental enteropathy markers were not measured until 2010.

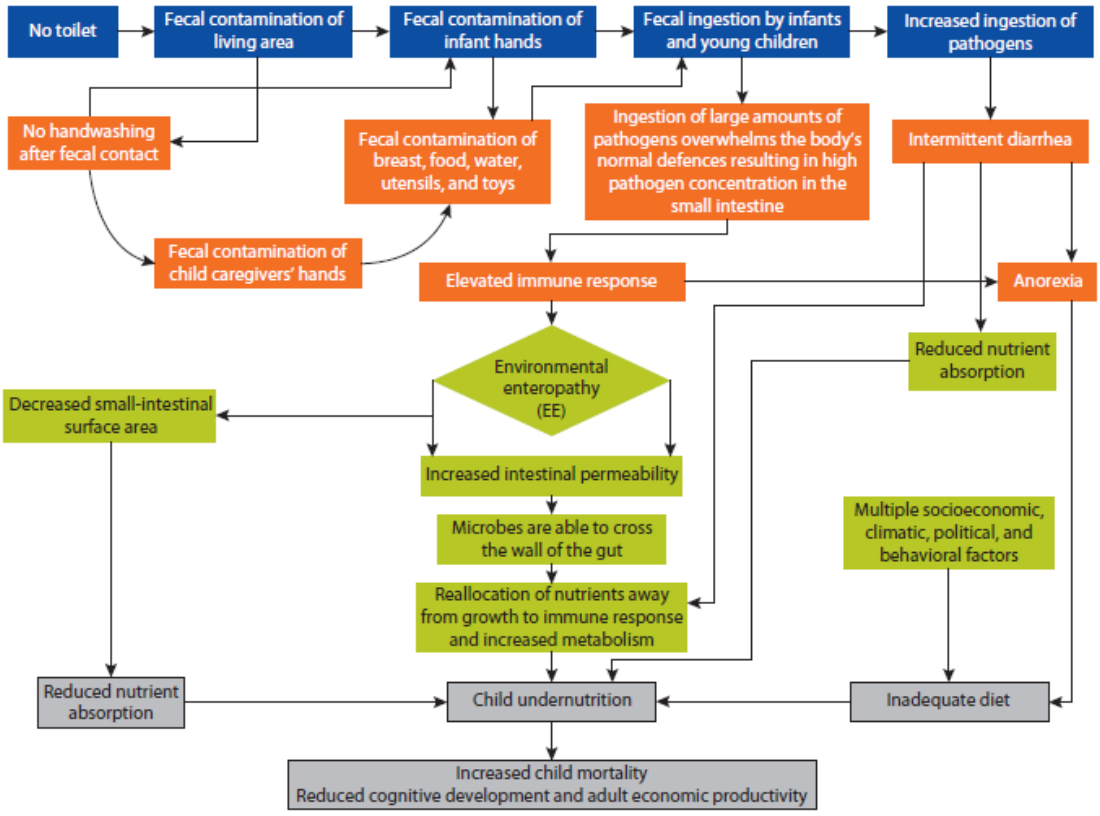

Figure 7 Pathways for Tropical Enteropathy (Humphrey, 2009)

2. Impact of Water and Sanitation Interventions on Nutrition Outcomes

Water, sanitation, and hygiene (WASH) interventions have traditionally been implemented to reduce infectious diseases, and sometimes with a view of subsequently improving nutritional conditions. There is, however, limited evidence of WASH interventions alone improving nutrition.

In a Cochrane Review, Dangour et al. (2013) completed a meta-analysis of 14 studies from 10 low- and middle-income countries to evaluate the effect of WASH interventions on the nutritional status of children. The review included randomized and nonrandomized interventions, or a combination of interventions, for children aged less than 18 years. The interventions were designed to:

- Improve the microbiological quality of drinking water or protect the microbiological quality of water prior to consumption;
- Introduce new or improved water supply or improve distribution;
- Introduce or expand the coverage and use of facilities designed to improve sanitation;
- Promote handwashing with soap after defecation and disposal of child feces, and prior to preparing and handling food.

The authors concluded that WASH interventions may slightly improve the height of children under five years of age. The conclusions are based on relatively short-term studies and, therefore, need to be treated with caution.

Dangour et al. (2013) also state that, "there is suggestive evidence from cluster-randomized controlled trials of a small benefit of WASH interventions on measures of growth in childhood. There is no evidence of the effect of other WASH interventions on nutritional outcomes in children and a major gap in the literature concerns the effect of water supply and sanitation interventions on nutrition outcomes. Non-randomized studies provided mixed evidence on the effect of a variety of WASH interventions on nutrition outcomes. All interventions were conducted in children under the age of five years and there is no evidence of the effect of WASH interventions in children older than five years of age."

Clasen et al. (2014) report that it cannot be inferred that increasing the coverage of latrines can effectively reduce exposure to fecal pathogens if people do not actually use the latrines. They conducted a cluster-randomized trial in 100 rural villages of Odisha, India, to test the effectiveness of rural sanitation program on diarrhea, soil-transmitted helminth infection, and child undernutrition. Clasen et al. found that programs focusing on latrine construction do not actually behavior and thus do not reduce exposure to pathogens.

The authors suggest that to improve sanitation conditions, the interventions should be implemented in a way that ensures uptake of the WASH facilities, reduces exposure to fecal matter, and demonstrates health gains. A target of only increasing coverage of WASH interventions may not be effective.

Newman (2013) concluded that adequate food, environmental health, and care is associated with considerably lower levels of stunting than adequacy in none or only one of the dimensions

(after controlling for wealth, education of the mother, and other control variables). This supports the notion that a multisectoral approach is needed to address stunting. Newman (2013) showed strong correlations between stunting and food, environmental health, and care adequacy for Bangladesh, Peru, and India, countries with differing average levels of stunting. For example, the author shows differences in stunting between Indian children who have adequate food, environmental health, and care and children who are inadequate in all three dimensions: 30 percentage points without controls and 14–22 percentage points with controls. These associations could be further investigated through randomized control trials.

The findings relating to Bangladesh are based on analysis of a data set from the Bangladesh Food Security and Nutritional Surveillance Survey (FSNSP) conducted by Helen Keller International, the James P. Grant School of Public Health of BRAC University, and the Bangladesh Bureau of Statistics. Adequate food included parameters of mother's dietary diversity, exclusive breastfeeding of children, food never being restricted to young child, and household food insecurity access score.

Adequate environmental health included improved water source, improved sanitation source, and handwashing. Care practices included measure of antenatal care visits, immunization of children, duration of breastfeeding of children, mother receiving iron-folic acid supplementation, mother's body mass index, and the proximity to a health clinic.

Figure 8 shows that in 2013, Bangladeshi children who were adequate in all three dimensions—food, environmental health, and care—were less likely to be stunted. The stunting rates of children who are adequate in all three dimensions is almost 30 percentage points lower than the rates of those children who are inadequate in all dimensions. There is also a notable difference in stunting rates across children who are adequate in three, two, or one dimensions.

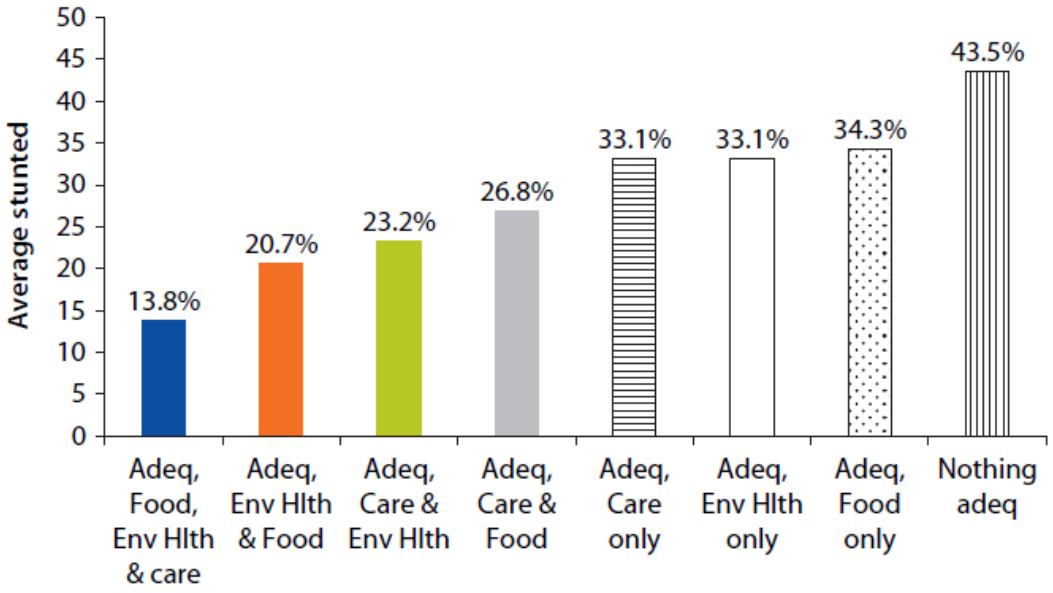

Figure 8: Percentage of Bangladeshi Children (Aged 6–60 months) Who Are Stunted by Adequacy of Food, Environmental Health, and Care, 2013 (Newman, 2013)

The overall conclusion that can be drawn from these findings, and those of other studies described , is that a multisecoral approach that builds on established conceptual frameworks is needed to achieve meaningful gains in nutrition outcomes. Availability and consumption of nutritionally adequate (in terms of quality and quantity) food is essential for a child's growth. Clean water and appropriate sanitation are also necessary to prevent children from experiencing frequent illnesses and losing nutrients and subsequently faltering in their growth. Therefore, in order to make a significant dent in the high levels of undernutrition, Bangladesh needs at a minimum to ensure adequacy in all three dimensions of food, environmental health, and care for all. Building a toilet will not by itself translate into the growth of a child; food alone might not be adequately absorbed and utilized. These various dimensions are necessary, but alone are not necessarily sufficient.

III. EFFICIENCY

Hygiene practices have been proven to reduce diarrhea rates by 30–40 percent (figure 11). This level of reduction can be achieved through a comprehensive approach—promoting improvements in key hygiene practices (hand washing, treatment and safe storage of drinking water, safe disposal of feces, and food hygiene); improving access to safe water and sanitation technologies and products; and facilitating or supporting an enabling environment (improved policies, community organization, institutional strengthening, and public-private partnerships).

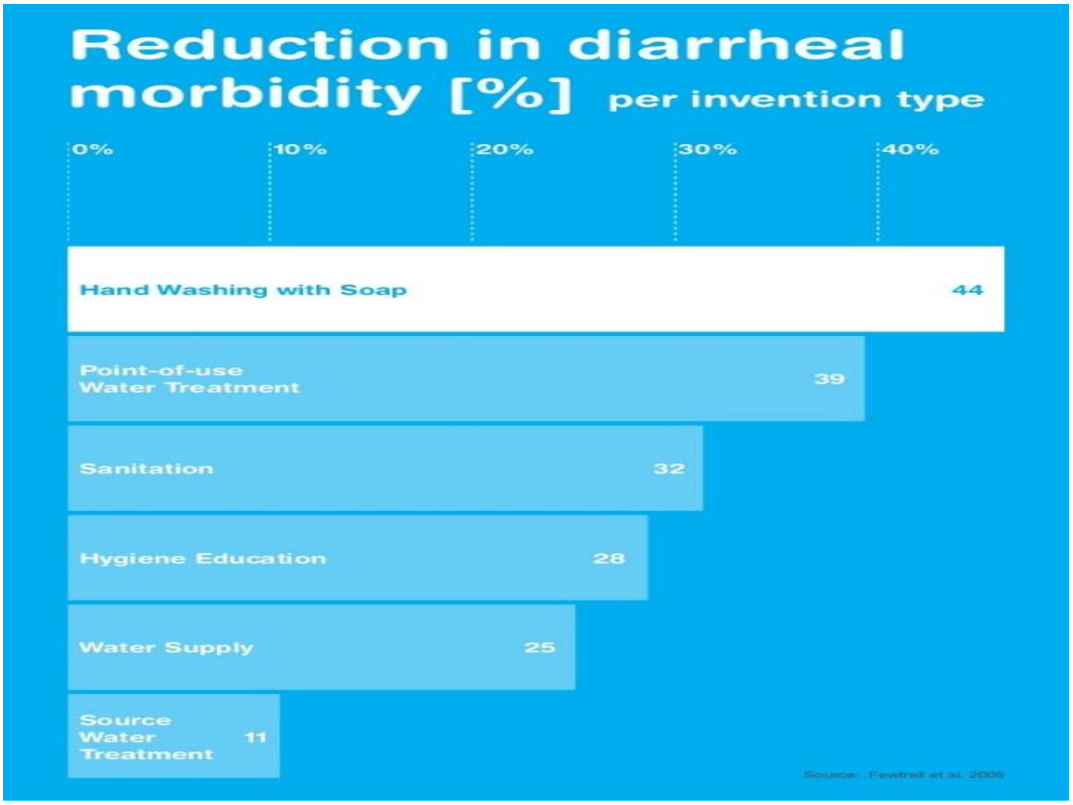

Figure 9: Fewtrell diagram for reduction of diarrhoeal disases by hygiene practices (Fewtrell and al. 2005)

The following figure diagram) 5 represents to barriers to implement for the reduction of diseases transmission.

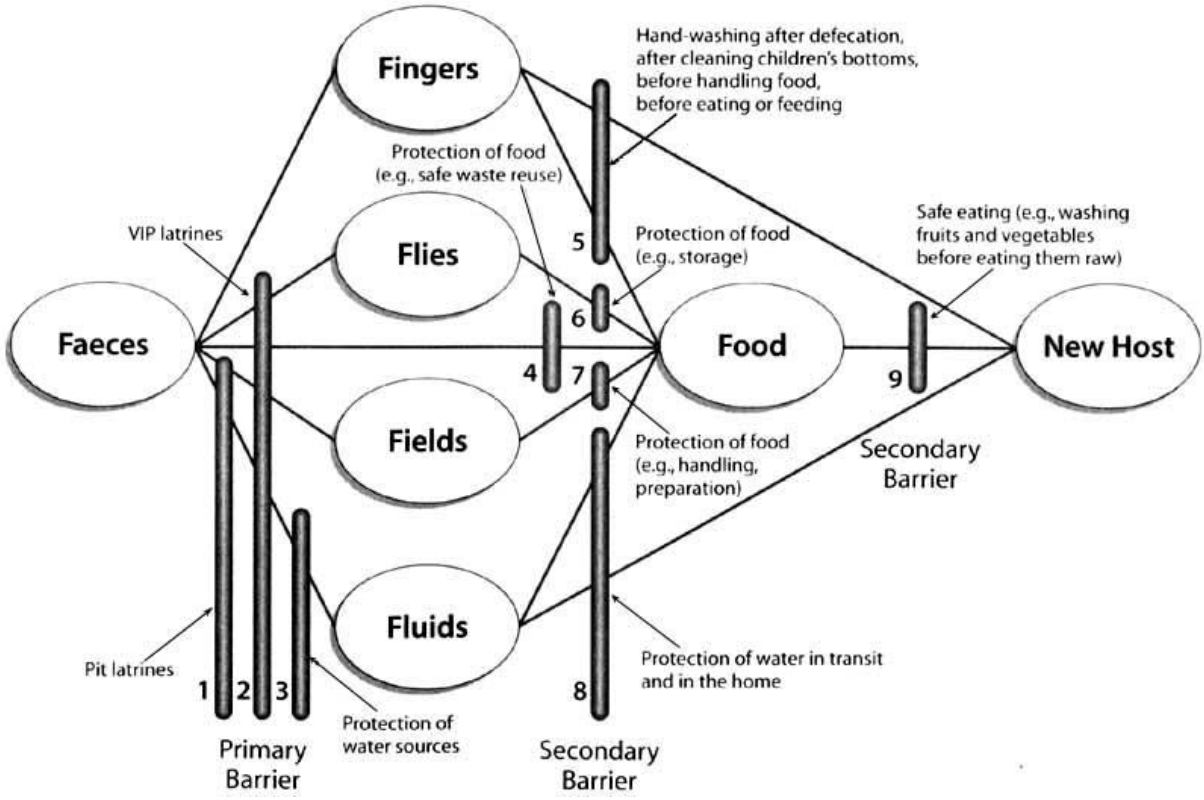

Figure 10 : F diagram (INFDC, 1997)

1. Optimal hand washing

Hand washing prevents diarrhea effectively when done properly and at critical times. A meta-analysis of hand washing studies conducted in developing countries concluded that hand washing can reduce the risk of diarrhea in the general population by 42–44 percent. A recent observational study in Bangladesh found that diarrhea occurred less often in households where residents washed at least one hand after defecation and before preparing food. The study suggested that washing hands before preparing food is particularly important to prevent diarrhea in children.

How and When to Wash Hands

- Use soap or ash every time you wash your hands.
- Wash hands under poured or flowing water. This removes the dirt and germs. A washbasin in which many people wash their hands in the same water does not prevent infection.

- Wash hands before handling, preparing, or eating food; before feeding someone or giving medicines; and wash hands often during food preparation.
- Wash hands after going to the toilet, cleaning a person who has defecated, blowing your nose, coughing, sneezing, or handling an animal or animal waste, and both before and after tending to someone who is sick.

The figure 11 is a demonstration of proper hand washing.

Figure 11: Hand washing demonstration (WHO, 2009)

2. Treatment and safe storage of household drinking water

Treatment and safe storage of drinking water in the household have been shown to reduce the risk of diarrheal disease by 30–40 percent. Conclusive evidence shows that simple, low-cost strategies can greatly improve the microbial quality of water and result in diarrheal disease morbidity reductions comparable to those achieved by hand washing and sanitation.

Water Treatment Methods

Households should first separate drinking water from other household water. Treat all drinking water using an effective treatment method as listed below, and then store safe.

- Chlorination
- Boiling

- Solar disinfection (SODIS) using heat and UV radiation
- Filtration using different types of filters (Figure 15)
- Combined chemical coagulation, flocculation, and disinfection

Water Storage Methods

- Store treated water in an appropriate vessel preferably with a narrow neck and a tap.
- If the container does not have a tap, pour the water into a clean pitcher to serve or use a ladle to dispense water.
- Hang the ladle on the wall.
- Do not touch the inside of the container with hands.

3. Sanitation/faeces management

Safe disposal of faeces reduces the risk of diarrheal disease by 30 percent or more. Best practices for latrine use are listed below. All household members should handle and dispose of faeces safely by defecating in a hygienic latrine. Children and people with limited mobility should use adaptive technologies.

- Ensure a latrine meets minimum standards, including a cleanable platform, a cover over the pit, housing that provides privacy, and a hand washing station nearby (ideally located next to the latrine and/or cooking area). If a latrine is not available, sharing with others in the community should be considered, or, in the interim, burying feces away from the house or facility.
- Maintain latrines properly by clearing the path to the latrine, removing obstacles such as stones and branches, and filling holes in the path to facilitate easier access. The platform, seat, walls, or other surface of the latrine should be feces free. All anal cleansing materials should be placed in the latrine itself. A scoop of lime or ash in the latrine after defecation can reduce odours and deter flies.

- Modify latrines for children and people with limited mobility. The modifications may require building supports (poles, ropes, stools) to make children or weak household members comfortable using the latrine or providing simple commodes to place over the latrine pit or bedpans/potties.

The figure 16 illustrate how WASH provision helps prevent the transmission of schistosomiasis.

4. Food hygiene

1. Keep food preparation areas clean

- Wash all surfaces and equipment used to prepare or serve food with soap and water and if possible, with bleach.
- Protect food from insects, pests, and other animals by covering food with netting, a cloth, or keeping it in containers.

2. Separate raw and cooked food

- Raw eggs, meat, poultry, fish, and seafood can easily contaminate other foods with illness-causing bacteria. Keep them away from other foods.
- Use separate equipment and utensils such as knives and cutting boards to handle raw foods.
- Store foods in covered containers to avoid contact between raw and cooked foods.

3. Keep foods at safe temperatures

- Do not leave cooked food at room temperature for more than two hours.
- Reheat cooked food that has been stored before reserving.
- Do not thaw frozen food at room temperature.
- Prepare fresh food for infants and young children and other people with compromised immune systems and do not store it after cooking.

4. Use safe water and raw materials

- Choose fresh and nutrient-rich foods.
- Do not use food beyond its expiry date.
- Use pasteurized milk or boil milk before use.
- Wash raw vegetables/fruits with treated water or peel the skin before eating.

CONCLUSION AND RECOMMENDATIONS

1. CONCLUSION

Poor sanitation, hygiene practices and lack of improved water sources expose billion of people, particularly children and vulnerable people, to a wide range of preventable diseases and are major contributors to the world's morbidity and mortality.

Lack of WASH causes diarrheal disease and is associated with environmental enteropathy. Both of these inhibit the absorption and use of calories and nutrients, causing undernutrition.

In turn, undernutrition makes children more vulnerable to enteric infections like diarrheal disease. It is recognized that WASH and nutrition programs are both necessary to achieve improved health outcomes. Safe drinking water, proper sanitation, and hygiene can prevent undernutrition and stunting in children by preventing the development of environmental enteropathy and diarrheal disease.

Studies have shown that the most effective interventions will be those that combine both improved nutrition and infection control and prevention efforts. However, there is limited evidence on how WASH and nutrition programs are integrated in the field, what barriers these programs face, and what stakeholders believe to be necessary for successful integration. It is then essential to improve the integration of WASH in nutrition for a better public health and socioeconomic development.

2. RECOMMENDATIONS

a. Improve quality of water and sanitation facilities

It is critical to improve the quality of water (at source, in storage, as well as at point of consumption) and sanitation facilities to limit transmission of infection. There is also a need to ensure that all members of the households that have piped water supply also have safe drinking water. Awareness-raising campaigns along with emotional/social drivers can be effective in ensuring attention to the water supply. In the rural areas, where the majority of the population get water from nonpiped sources, it is necessary to initiate practices for safe collection and transportation of water from the community points and then purification and safe storage of water. For the urban areas, where a piped water supply is provided to households, the water needs to be treated to make it drinkable; thus, it is important to promote safe water storage facilities.

b. Strengthen implementation of hygiene-related activities

Hygiene remains the weakest link in the water and sanitation sector. Indeed, it is necessary to monitor progress of the implementation of the action plan through a highlevel intersectoral committee to ensure better coordination between the various ministries. Particular emphasis will need to be placed on increasing the availability of handwashing stations, soap/hand cleansing substances, and water at the sanitation facilities, and ensuring that these are used. Also, mass-media campaigns should be undertaken for promotion of handwashing. Various ministries, including health, education, local government, and water resources, have a key role to play in promoting handwashing practices. Perhaps the Ministry of Health could take a lead role in implementing the Behavior Change Communication.

c. Strengthen the effectiveness of the National Nutrition Services (NNS)

The MOHFW needs to define a prioritized set of activities that are critical for improving undernutrition, particularly improved hygiene practices. As the recent NNS assessment indicates that the current delivery platform is not being effective, alternative service delivery mechanisms will need to be explored, including the involvement of NGOs, to extend outreach

and achieve greater targeted coverage. NNS, due to its modality of service delivery through public health facilities, is targeted toward mostly the poorer and disadvantaged population, as the richer households tend to opt for private health care services. The MOHFW, therefore, will continue to underserve a large segment of the population with high undernutrition rates if delivery continues through public health facilities. The government should actively consider engaging the media and the private sector for the required BCC as well as promoting handwashing through health sector interventions.

d. Strengthen the health sector response, but also build a nonhealth, multisectoral response for addressing undernutrition

The determinants of undernutrition are multisectoral, yet attempts to implement multisectoral programs have proved largely unsuccessful. Multisectoral nutrition planning agencies have been stymied by the limited control they have over different sectors' resource allocation processes, while sectorally defined priorities have hindered collaboration between sectors. A more realistic response is to "plan multisectorally, implement sectorally" (Maxwell and Conway 2000). Operationally, this involves identifying interventions within sectors that have the potential to significantly improve nutrition and mobilizing resources specific to that sector. An important factor for this strategy to work is to ensure sensitization of sector-specific stakeholders. They need to understand how their sectoral outcomes can be improved through addressing undernutrition and how their sector can contribute to achieving this. The starting point for the approach will be to draw upon the existing policies and strategies and identifying potential avenues for making the sector-specific interventions more "nutrition-sensitive" (World Bank, DFID, Government of Japan, and Rapid Social Response 2013a).

e. Synchronize the efforts the various sectors to align with the overall goal of reducing undernutrition

Individual efforts by MOHFW and other ministries have the desired impact on undernutrition rates. The relevant sectors—HNP, water and sanitation, education, local government, and agriculture—need to come forward and integrate their efforts to attain the broader national goal of improving nutritional outcomes. To enable this coordination,

it is necessary to ensure that alleviating undernutrition remains a high-level policy priority. Undernutrition and poverty are interrelated. In order to augment economic development, it is crucial to ensure that undernutrition is addressed.

There are challenges in coordinating efforts of the HNP sector with those of the water and sanitation sector. Lessons from successful collaboration could be drawn upon to mitigate the challenges. In the Amparae district of Sri Lanka, for example, the introduction of student brigades had a significant impact on hygiene behavior change, contributing to adequate utilization of the water, sanitation, and hygiene (WASH) facilities available in the schools (Yael et al. 2014). Active involvement of the health professionals in WASH is crucial for accelerating and consolidating progress relating to the health and nutrition outcomes (Bartram and Cairncross 2010). The HNP sector needs to take a more assertive role in promoting use of WASH facilities. The sector could include WASH as one of the essential components of all HNP policies, monitor handwashing practices using routine health surveillance, and use WASH messages in advocacy and outreach (Cairncross et al. 2010) through HNP sector interventions.

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