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Environmental, demographic and socio-economic factors associated with diarrhea morbidity in children under five in rural Malawi : a study of Solola-Mzimba

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Abstract

Environmental, demographic and socio-economic factors associated with diarrhea morbidity in under-five children in rural Malawi: a study of Solola-Mzimba.

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Diarrhea has been one of the major causes of morbidity in under-five children in Malawi. About 86% of the population lives in rural areas where poverty is very rife. The aim of the study was to investigate environmental, demographic and socio-economic factors associated with diarrheal morbidity in under-five children in Solola, one of rural areas of Malawi.

A cross-sectional study was conducted in seven villages of Solola area, from 10th November to 29th November 2003. A total of seven from thirty-three villages, and thereafter 302 children were recruited using systematic sampling whose mothers totaling 261 were interviewed using a questionnaire. An observational guide was used to gather more information regarding environmental factors.

About 41% of the children had diarrhea out of which 73% and 27% were watery and bloody diarrhea respectively. Only 36% was ongoing diarrhea. About 60.3% (182/302) of children were living in an environment of an overall poor sanitation/rubbish disposal; 72.1% (217/301) in that of poor food hygiene related practices; and 80.4% (242/251) in that of poor drinking water handling practices.

Low education and poor knowledge (about diarrhea) among mothers, inadequate breastfeeding, poor care of hands after defecating, shorter distance to latrine from house, sharing of latrines, unsafe disposal of feces/garbage, unsafe water source, sharing hand-washing water at meals, and uncleanliness of kitchen were significantly associated with diarrhea morbidity in the children (X^2 *test* = $p<0.05$).

The unavailability of safe water, lack of knowledge and having been used to not treating water before use, laziness and not being used to using a rubbish pit, and gender were the main reasons among mothers for not using good practices regarding water and sanitation/rubbish disposal.

The community including mothers must be adequately educated or informed about the importance of using good hygiene practices regarding water, sanitation and food preparation to reduce or control diarrhea. Provision of safe water and more education to women is also important in combating diarrhea in rural areas.

Keywords: diarrhea; under-five; rural; health education.

ABBREVIATIONS

AIDS: Acquired Immuno Deficiency Syndrome

CBR: Crude Birth Rate

CDD: Control for Diarrhea Diseases

CDR: Crude Death Rate

CHAM: Christian Health Association of Malawi

DALY: Disability Adjusted Life Years

E. coli: *Escherichia coli*

GDP: Gross Domestic Product

GNP: Gross National Product

HDI: Human Development Index

IHS: Integrated Household Survey

HIV: Human Immuno-deficiency Virus

HSA: Health Surveillance Assistant

IBD: Inflamatory Bowel Disease

IMR: Infant Mortality Rate

MLG: Ministry of Local Government

MOHP: Ministry of Health and Population

ORT: Oral Rehydrated Therapy

S. boydii: *Shigella boydii*

S. dysenteriae: *Shigella dysenteriae*

S. flexner: *Shigella flexner*

S. sonnei: *Shigella sonnei*

STI: Sexually Transmitted Infections

TA: Traditional Authority

TB: Tuberculosis

UNICEF: United Nations Children's Fund

WHO: World Health Organization

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CHAPTER 1: INTRODUCTION

1.1. INTRODUCTION

Environmental Sanitation, Diarrhea and other related diseases

In its broadest sense, according to WHO, environmental sanitation is about controlling or changing the physical environment in order to prevent the transmission of diseases to human beings, and in real terms, it means access to safe and sufficient water supply, sanitary disposal of human excreta and household waste as well as changing human behavior through hygiene education [1]. From the statement above, one would be interested to know how far the world has gone in achieving this:

The International Drinking Water Supply and Sanitation Decade (1981-1990), saw a period of accelerated and concerted effort to expand water supply and sanitation in the world, which resulted in 1600 million people served with safe water and about 750 million with adequate excreta disposal facilities however with the population growth of 800 million that occurred in developing countries within that time, by 1990 there remained a total of 1015 million people without safe water and 1764 million without adequate sanitation facilities [2].

Since 1990, overall effort to achieve universal coverage on water and sanitation has been poor. Two reasons have been isolated that explain this poor coverage; the first being rapid population growth that outpaced the progress in water and sanitation provision as shown above, and the second being the overwhelming magnitude of resources needed to achieve this goal. At a Global Consultation of Safe Water and Sanitation for the 1990's, held in New Delhi in 1990, it was stated that universal coverage by the year 2000 would require US$ 50 billion per year [2]. This enormity of resources compounded by rapid population growth has affected the progress and has left more people without access to basic sanitation today than in 1990. A WHO report in 2001 on a World Water Day in Brussels, indicated that by 2001, more than 1.1 billion people were drinking unsafe water and 2.4 billion, 40% of the human race, were without adequate sanitation [3]. Essentially though, the percentage of people served with some form of improved water supply rose from 79% in 1990 to 82% in 2000 and for sanitation from 55% to 60% [4].

Considering the water supply and sanitation coverage in the developing world alone, the picture looks grimmer. WHO report of 2000 indicated that fewer than half of all Asians had access to improved sanitation, and 2 out of 5 Africans lack improved water supply,

and about 80% of all these people lacking adequate sanitation lived in the rural areas – 1.3 billion in China and India alone [4].

Further assessment of the situation in Africa alone exhibits a huge problem. By 2000, Africa had the lowest water supply coverage of any region, with only 62% of the total of 800 million people living in Africa having access to improved water supply; the situation being much worse in the rural areas with only 47% compared to 85% in the urban having access to water supply; again sanitation coverage was at 60%, varying from 84% in urban areas to 45% in rural areas, and further assessment in the rural sub-Saharan Africa shows that only 39% and 34% have access to safe water and sanitation respectively [4].

The picture of poor water supply and sanitation coverage as shown above can only be underscored best by the horrifying burden of diseases directly linked to unsanitary conditions. It is estimated that 6 million people are blind from trachoma and the population at risk is about 500million; 200million are infected with schistsomiasis; 10% of the population in the developing world are infected with intestinal worms; and approximately 4 billion cases of diarrhea are recorded each year leading to nearly 2.5 million deaths occurring annually worldwide from diarrhea diseases, including dysentery; 600000 deaths from typhoid, 138000 deaths from dengue and dengue hemorrhage fever, and that the risk of dying from infectious diseases, maternal and perinatal conditions related to bad sanitation for the poorest 1000 people on earth was seven times more than the least poor 1000 people by 1998 [5]. Approximately 3.7% of Disability Adjusted Life Years(DALYs) totaling about 54.2 million are attributable to unsafe water, sanitation and hygiene of which about one-third occurred in Africa, another in South-east Asia, and an overall 99.85% death associated with these risk factors are in developing countries of which further, 90% are deaths of children [5].

Further, health costs are incurred by those who collect water far from their homes. In developing countries where women do most of water collecting, they are exposed to accidents like drowning, attack and assault at and from the water source; they do also suffer from skeletal injuries caused by carrying heavy loads repeatedly over long periods of time. Dufault (1988) showed that in sub-Saharan Africa, where water is most often carried on the head, limitation of flexion and increased incidence of arthrosis

(degenerative rheumatism) appear to be the most common injuries, in addition to the severe loss of energy and time by women due to walking long distances to water sources [6].

Since diarrhea remains the major cause of illness and death related to unsanitary conditions, especially among children in developing countries [7] and globally, this study has focused on diarrhea in rural children under five years of age.

1.2. COUNTRY PROFILE – MALAWI

1.2.1. Geography

Malawi is a landlocked country south of the equator in sub-Saharan Africa in the east of southern Africa. It lies between latitudes 9°S and 18°S, and longitudes 33°E and 36°E. It is bordered by the United Republic of Tanzania to the north; the People's Republic of Mozambique to the east, south, and southwest; and the Republic of Zambia to the west. See figure 1 and 2. The country has a total area of 118484 square kilometers of which 94276 square kilometers is land area, the remaining mostly being occupied by Lake Malawi.

Malawi lies within the tropics; and has a tropical, continental climate with maritime influences. It has two distinct seasons; a wet, warm season and a dryer, cooler season. The wet rainy season runs from October to April, while the dry season runs from May to September.

1.2.2. Administration

The country, administratively, is divided into three regions namely Northern, Central and Southern regions which are further divided into districts making a total of 27 districts in the country. The Northern Region has five districts, the Central Region nine and the Southern Region thirteen. Figure 2 shows the map Malawi. The districts are subdivided into Traditional Authorities (TAs), presided over by chiefs. These TA's are composed of villages, which are the smallest administrative units and are presided over by village headmen. For proper representation to the parliament, in each district the villages are grouped into constituencies which are presided over, each by a Member of Parliament

(MP), who has responsibility of lobbying the government on behalf of the people on various important issues including issues of public health. Each constituency again is subdivided into political wards which are each presided over by a Ward Councillor. Solola, the area under study, is one of the constituencies in Mzimba District which is one of the five districts in the northern region of Malawi.

1.2.3. Population and Demographic Characteristics

Malawi has experienced continued population growth over the years. The latest population census in 1998 showed a total population count of about 10 million. The total population increased by 24% over the ten-year period from 1987 to 1998 when the population count was about 8 million. This represented a natural annual growth rate of about 2%. According to the census, the country has an average population density of 105 persons per square kilometer, however the population density varies considerably at regional level; the Northern Region has the lowest population density of 46 persons per square kilometer, Central Region 114 and the Southern Region has the highest density of 144 [8]. This trend could in part be attributed to the socioeconomic development that started in the Southern Region both before and after independence which could have influenced high in-migration from the other regions [9].

The population of Malawi is young. According to the 1998 population census, in terms of age structure, nearly half of the total population (44%) is under 15 years of age. About 4% of the population is 65 years and above. The population of the under-five year children accounts for about 17% of the total population. The mean age of the total population is 22 years, attesting to fact that the population is young. The population of Malawi is largely rural; about 86% of the population lives in the rural areas and 14% lives in the urban. Urbanization has been growing steadily over the years. The past three population censuses conducted in years 1977, 1987 and 1998 have indicated an increase of urban population from 9% to11% to 14% respectively.

There are more females than males; 51% of the population is females. About 24% (2.4 million) of the population is females in the child-bearing age-group of 15-49. The total fertility rate for Malawi is 6.3 and is one of the highest in Africa and still higher than the

average total fertility rate of 5.0 for the content [10]. The crude birth rate is 40 per 1000 people.

Life expectancy at birth in the total population is at 40 years, and females have higher life expectancy than males, at 44 years and 40 years respectively [8,10]. This low level of life expectancy in the country has considerably been affected by HIV/AIDS pandemic that has ravaged the country's population, with current prevalence of more than 15% in adults aged 15-49 years. The infant mortality rate (IMR) is at 104 per 1000 live births and the maternal mortality rate is at 1120 per 100000 women, while the crude death rate (CDR) is 22 per 1000 people.

Marriage is universal in Malawi. Of about 7 million people aged 10 years and over that were enumerated in the 1998 population census, 55% were married and 37% never married. In terms of religion, Malawi is largely a Christian country. There are two main faiths in the country; in the 1998 population census, about 80% reported being Christians, and about 13% Muslims. The remaining proportion was shared between those that said had a religion other than the above-mentioned two main religions and those that said had no religion; about 3% and 4% respectively [8].

1.2.4. Economy

Malawi is one of the poorest economies of the world. The following basic economic indicators tell explicitly about the poor status of the economy: it has GNP per capita income of only US$ 200, one of the lowest in the Africa continent which has averagely a GNP of US$ 687. Recent external debt figures have ranged from US$ 2.33 billion in 1999 to US$ 2.47 billion in 2002. In terms of the Human Development Index (HDI), out of 174 countries, Malawi was ranked 159 in 1997 [9,10]. With no availability of at least any important mineral, Malawi is largely an agro-economy with the main export crops including tobacco, tea and sugar which are almost entirely produced by very few estate companies. Agriculture accounts for over 40% of the country's gross domestic product (GDP) with 93% of export earnings primarily derived from tobacco [8,9,10]. Manufacturing accounts for only 13-14% of the GDP, other industry for 20%, with the other services accounting for the remainder. The labor-force participation in the economy, at least by 1998, was about 48% and over 80% of the labor-force was engaged

in the non-formal sector which includes self-employment in small scale agriculture, labor estates and larger farms, all of which constitute the major source of income for the rural people. The government and private business together employed only 12% of labor-force [11].

This grim picture of the economy is a mirror-image of the serious situation of poverty prevalent among most people more especially in the rural masses. As 85% of the population is rural with the main occupation as farming (small-holder farming), about 55% of the smaller holder farmers have less than one hectare of cultivable land, which automatically means production for most of the people is largely (almost entirely) for subsistence purpose rather than economic one, which even then does not meet their basic needs. The results of the Integrated Household Survey (IHS) conducted from 1997 to 1998 which had a weighted mean poverty line of 41 US cents per person per day and thereafter which considered households with a per capita daily consumption level under this mean value as poor, indicated that about 64% of the country's population was living in poor households by 1998. The weighted ultra-poverty line for the same year which was calculated at 25 US cents, and which then considered household per-capita daily consumption under this level as ultra-poor, said about 36% of Malawi's population lived in ultra-poor households [9].

1.2.5. Health Services

Almost all formal health services in Malawi are provided by three main agencies; the Ministry of Health and Population (MOHP) providing about 60%, the Christian Health Association of Malawi (CHAM) 37%, and the Ministry of Local Government (MLG) 1%. The remaining 2% is provided by other providers; namely private practitioners, commercial companies, army/police. CHAM is the major government partner in health care delivery and is subsidized by government through an annual grant for personnel emoluments.

CHAM which is made up of independent church-related and other private voluntary agency facilities provides almost all types of health services however at a user fee except for services like growth monitoring, immunization, and community based preventive

services that include treatment for specific communicable diseases such as TB, STI and leprosy.

Health services are provided at three levels: primary, secondary and tertiary. At primary level, services are delivered through rural hospitals, health centers, health posts, outreach clinics and community initiatives such as Drug Revolving Funds. The primary level represents the first point of contact for health care services at community level. District hospitals and CHAM hospitals provide secondary level health care services. The secondary level mainly serves to provide backup services to the activities of the primary level by providing surgical backup services, mostly for obstetric emergencies, and general medical and pediatric in-patient care for common acute conditions. The tertiary level at present provides services similar to those at the secondary level, along with a small range of specialist surgical and medical interventions [11].

Although the organizational picture of the health care delivery system looks good as presented above, the health care delivery facilities are still so inadequate that they are not accessible to many people. Between 1990 and 1996, per 100 000 people, there were only 2 physicians and 6 nurses. By the year 2000, there were about 510 primary health care facilities accessible to general public in Malawi, each serving an average of about 16 000 persons. In the same year, total expenditure on health as percent of GDP was about 8%, the government expenditure on health as a percent of total general government expenditure was about 15% while per-capita government expenditure on health at average rate (US$), was 5.

These facts alone are evidence enough to show clearly that the strategies that were adopted after the endorsement of the concept of Primary Health Care as the main strategy in achieving the world-wide health theme of ***"Health for all by the year 2000"*** one year after the Alma Alta conference in 1978, had not been to an extent in keeping with realizing that goal. Furthermore, a lot more needs to be done to improve the situation if the current over-all policy of the health sector which is to raise the health status of all Malawians is to be fully realized as well.

1.2.6. Water and sanitation

Water supply coverage in Malawi as whole is low. Only 57-65% of the total population has access to clean water, out of which, the urban population has a relatively far better

coverage of 95% as compared to only 44% of the rural population. Sanitation coverage for the total population is 77%, and is also far better in the urban population i.e. 96% than in rural, although the rural coverage of 70% is fairy still good [12].

1.3. DISTRICT PROFILE – MZIMBA

Mzimba district is one of the five districts in the northern region of Malawi. See figure 2. The total population of Mzimba district is 610994 according to the 1998 population census [8], of which the female population is 310707. The age structure for the district is not different from that of the population as whole. About 4% is less than one year old, 13% is 1-4 years old, 27% is 5-14 years old, 52% is 15-64 years old and 4% is 65 years and above. The proportion of children under five years of age is 17%.

The district has two hospitals which are run by the MOHP and serve as referral hospitals to several health centers, health posts and dispensaries that are scattered over the rural areas of the district. CHAM health facilities and other private clinics also operate in a few places in the district.

Village headmen areas are made up of conglomerates of huts and houses that are separated by family blood ties or clans strewn over the whole area with no clear boundaries between them. However, even for the different village headmen areas, the people share one culture. The population varies approximately from 500 to 700 people per village headman area. The main occupation in the district is peasant farming, producing mostly at subsistence level. The district has basically one language which is Chitumbuka.

Figure 1: Map of Africa showing the position of Malawi.

Figure 2: Map of Malawi showing districts including the position of Mzimba district.

(Mzimba district)

CHAPTER 2: BACKGROUND

2.1. WHAT IS DIARRHEA?

Definition

Almost everyone has become ill of, or will be affected by diarrhea at some point in their lives. Diarrhea can occur as a symptom of many different illnesses, as a side effect of some drugs or may be due to some anxiety amongst other things. According to Webster's New International Dictionary, the word 'diarrhea' comes from the Greek word "diarrhoia" which means the act of flowing through, and defines diarrhea thereafter as an abnormal frequency of discharge of more or less fluid intestinal evacuations due to infections, fermentative or toxic causes or physiologic disturbances [13]. Similarly, UNICEF defines it as the passing of increased amounts of stools, more often than is normal for you [14]. Clinically, diarrhea is looked at as the passage of stool at increased or reduced consistency, where normal consistency is considered stool mass of 100-200g per day and normal frequency of once every 2-3 days to 2-3 times per day [15].

Types of Diarrhea, symptoms and their causes

Based on clinical syndromes, WHO (1998) [15] and Timo (1994) [16] have indicated that there are basically 4 types of diarrhea, each reflecting a different pathogenesis, and these include acute watery diarrhea, dysentery, persistent diarrhea and chronic diarrhea.

Acute watery diarrhea: - this term refers to diarrhea that begins acutely, lasts less than 14 days (most episodes last less than seven days), and involves the passage of frequent loose or watery stools without visible blood. Vomiting may occur and also fever may be present. About 90% of this diarrhea is from infectious causes and of the most common illnesses; it is ranked second from common cold. It is the leading cause of morbidity and mortality worldwide in individuals of all ages with most mortality in children. In developing countries, it results in 50% deaths in children. It directly causes dehydration, and indirectly results in hypovolaemia which leads to circulatory collapse; hypokalaemia and metabolic acidosis; contributes to malnutrition which increases susceptibility to further infections. Acute watery diarrhea is caused by viruses, bacteria, parasites and non-

infectious causes. The most important causes of this diarrhea in developing countries especially among children include Rotavirus, enterotoxigenic *Escherichia coli*, *Shigella*, *Campylobacter jejuni*, and Cryptosporidia. In some areas, *Vibrio cholera 01*, Salmonella and enteropathogenic *E. coli* are also important causes. A study in Malawi, between 1997 and 1998, by the Welcome Trust Research Program had detected 100 rotavirus strains in children under-five with acute diarrhea in a hospital based study [17].

Dysentery: - This term refers to diarrhea with visible blood in feces. The symptoms include anorexia, rapid weight loss, and damage to the intestinal mucosa by the invasive bacteria. The most important cause of acute dysentery is *Shigella*. According to WHO's program - Control for Diarrhea Diseases (CDD), there are four types of *Shigella* that are pathogenic to man, namely *S. sonnei*, *S. boydii*, *S. dysenteriae* and *S. flexneri*. S. dysenteriae causes both epidemic and endemic shigellosis however it is S. flexneri that is the chief cause of endemic shigellosis in the developing countries. Shigellosis causes most of the estimated 370 000 deaths from dysentery that occur worldwide each year in children under-five, and the risk is greatest in infants and those that are severely malnourished [18]. Other causes include *Campylobacter jejuni*, and infrequently enteroinvasive *E. coli* or Salmonella. *Entamoeba histolytica* can cause serious dysentery in young adults but rarely a cause of dysentery in young children [18].

Persistent diarrhea: - this term refers to diarrhea that begins acutely but is of unusually long duration (at least 14 days). The episode may begin either as watery diarrhea or dysentery. Marked weight loss is frequent. Diarrhea stool volume may also be great, with a risk of dehydration. There is no single cause for persistent diarrhea but enteroadherent *E. coli* and Cryptosporidia may play a greater role than other agents.

Chronic diarrhea:- refers to diarrhea which is recurrent or long-lasting due to non-infectious causes, such as secretory causes that include medications, bowel resection, mucosal disease, fistulae, exogenous stimulant laxatives, chronic ethanol ingestion, endogenous laxatives: dihydroxy bile acids, hormones and congenital defects; osmotic causes that include osmotic laxatives, lactose deficiency; steatorrhoeal causes that include

maldigestion, mucosal malabsorption; inflammatory causes like idiopathic IBD; and dysmotility diseases.

2.2. TRANSMISSION ROUTES AND POTENTIAL RISK FACTORS FOR DIARRHEA IN CHILDREN UNDER-FIVE

Diarrhea causing pathogens can be regarded harmful to humans only when they are in contact with our bodies. According to WHO, these pathogens get into contact with humans through fecal-oral route that includes: ingestion of fecally contaminated water or food, person to person contact, and direct contact with fecal matter. These transmission patterns occur in two ways; as domestic domain transmission corresponding to in-house contamination, and public domain that corresponds to pollution directly at the water sources [19,20]. Since ORT can only prevent mortality but not the next case, many studies have been done to assess the various factors that could be associated with the transmission of the pathogens such that effective programs towards prevention would be possible. This section is a result of reviewing literature on factors that have been associated with diarrhea occurrence and are therefore regarded as potential risk factors for the enhancement of diarrhea spread.

Seasonal prevalence

The fecal-oral transmission route for diarrhea pathogens is in one way enhanced by the contamination or pollution of drinking water sources like the unprotected wells, rivers, ponds etc by unsafe fecal disposal most likely, defecating of people in the bush. These feces pollute the unprotected water sources after being transported down slope by run-off or overland flow. The run-off is largely experienced in the rainy season within the tropics hence high level of pollution should occur in the rainy season in the region. In a study in Malawi on bacteriological quality of drinking water, among the traditional water sources, water quality was better in springs than in wells and rivers, and during rainy season there was considerable deterioration of water quality which was most pronounced in the wells [21]. The children, in rural Malawi, therefore are at higher risk of contracting diarrhea in the rainy season than the dry season.

Socio-economic factors

Some studies that have even included socio-economic factors in exploring the risk factors for diarrhea in the children less than five years of age have found that poor status or living conditions[22,23,24], living in house with fewer rooms [25], were associated with more diarrhea occurrence in the children.

Demographic factors

Some demographic factors like age and sex of child, age of mother, marital status of mother, number of children per mother, number of siblings per child, education level of child have been studied to see their relationship with diarrhea occurrence in the children less than five years of age: younger age [25,26,27,28,29,30], male gender [25,26,30], mothers' lower level of education [26,31,32,33], high number of siblings[22], larger household size [23,26], have been associated with more diarrhea occurrence in the children, while high number of siblings on the other hand has been inversely associated with diarrhea [34].

Sanitation and rubbish disposal factors

Sanitation and rubbish disposal practices are also important determinants of diarrhea occurrence in the children less than five years of age. Studies have shown that no existence of latrine [34,35,36], bad mothers' behavior in the disposal of children's stools [35,36], inadequate disposal of feces and household refuse [26,24,30,32,37,38], no use of latrines [23,35,37], visible feces on latrine floors [39], sharing latrines [40], were associated with more diarrhea prevalence in the children.

Drinking water related factors

For drinking water related factors, some studies have found diarrhea occurrence to be more associated with unsafe water sources e.g. ponds, wells, rivers, lakes [22,26,32,37,38,40], distance to water source [34], low per-capita water used [25,32], use of wide-mouthed water vessels [20,23,30,38,39,41], obtaining water from vessels by dipping [25], not putting lid on water storage vessels [23,30].

Food hygiene related factors

Studies in the area of food hygiene related factors have explored a number of activities that are involved in the preparation of food in the homes either through interviews or observation, and have shown that no use of soap in cleaning feeding utensils [38], dirty utensils [30], children eating with their hands [35], not washing hands before feeding child or preparing food [36,38], presence of animals in the food preparation area [42], poor cleanliness of kitchen [36], dirty feeding bottle [30,38], use of left over food in the next feed [38], presence of too many flies in the kitchen [38], were associated with diarrhea morbidity and mortality.

Other factors

These factors include measles exposure, breastfeeding and nutritional statuses of the children.

Measles

Generally, measles has been associated with diarrhea in 20 percent of the cases, and studies in Guinea-Bissau have shown that children that were exposed to measles had more diarrhea mortality than their counterparts that were not exposed to measles [43].

Breastfeeding

Breastfeeding status again is determinant factor for diarrhea occurrence in the children under-five years of age. Studies in Dhaka slums-Senegal and Metro-Philippines showed a more than 4-fold higher risk of deaths attributable to diarrhea in the children that were partially or not breastfed when compared to those that were exclusively breastfed [33,44]. In a study in Guinea-Bissau, the incidence of diarrhea was higher in weaned children than in partially breastfed children [45].

Malnutrition

Nutritional status is also a determinant of diarrhea prevalence in the children under-five years of age. Malnutrition in the children under-five has been associated with more diarrhea prevalence [42,46,47], although sometimes it has been so difficult to establish which of the two has initiated the other in the children with both conditions [46,47].

Immunodeficiency or immuno-suppression

When immune-suppression is severe, it can result in diarrhea can be caused by unusual pathogens and may also be prolonged e.g. in AIDS patients [15,47]. Diarrhea incidence, duration, severity and mortality are higher in children with HIV/AIDS than others, and chronic diarrhea is also the major cause of morbidity and death among adults with HIV [16].

2.3. HOW MUCH OF DIARRHEA IS THERE?

World, Africa and Sub-Sahara Africa Situation:

Diarrhea remains the major burden of all water and sanitation related diseases and yet it is preventable. Approximately 4 billion cases of diarrhea are recorded globally each year leading to 2.2 million deaths, mostly among children under age five (15% of deaths) equivalent to one child dying every 15 seconds [3,4].

Even-though massive effort has been put in a bid to control diarrhea, reports show that for over 20 years, from 1980 to 2000, only a reduction by half of diarrhea deaths has been achieved, much of which attributed to the introduction of ORT by 1980 [48]. By 1980, diarrhea was accounting for 4.6 billion deaths annually [48].

In the Western Pacific Region, 200 000 children die every year from dehydration, a complication from diarrhea [49].

In African region, it is estimated that each child in the region has five episodes of diarrhea per year and that about 800000 die each year from diarrhea and dehydration. Since 1992, the region has been facing a severe epidemic of Shigella dysentery and the bacteria causing this epidemic are rapidly developing resistance to the first line antibiotics normally used for treatment. In addition to killing children directly, dysentery is the common cause of persistent diarrhea, responsible for 15% deaths from diarrhea children [50].

In 1996, it was estimated that about 40% of childhood deaths from diarrhea worldwide would occur in sub-Saharan Africa by the year 2000 [51].

2.4. CLINICAL IMPORTANCE OF DIARRHEA

Apart from its heavy death toll in the population especially children under-five, diarrhea's impact on the population's health and social well-being is highly important requiring much attention as is regarded below:

In terms of children's growth, research has shown that linear growth (height retardation) which is highly prevalent in developing countries is associated with the effect of diarrhea in childhood. A study in 1995 to 1998 on Peruvian children at 24 months of age, which indicated that acute diarrhea in the children during the first 6 months of life resulted in long-term deficits in height that were likely to be permanent [52].

Further research on diarrhea in children has shown an association between diarrhea and diminished cognitive function. A study in Brazil on children with early childhood diarrhea in the first 2 years of their lives was associated with diminished cognitive function 4 to 7 years later. A Test of Non-Verbal Intelligence-III (TONI) scores were inversely correlated with early childhood diarrhea, even when controlling for maternal education, duration of breast feeding, and early childhood helminthiasis (Ascaris or Trichuris). Furthermore, Wechsler Intelligence Scale for Children (WISC-III) Coding Tasks and WISC-III Digit Span (reverse and total) scores were significantly lower in the children with a history of early childhood persistent diarrhea [47].

Another important research related to diarrhea has concluded that it poses a potential problem with drug mal-absorption in patients with AIDS and/or tuberculosis. According to Bantley, in pilot studies in Brazil, it has been found that in contrast to excellent drug levels seen in non-wasted AIDS patients, antiretroviral drug levels in six patients with AIDS wasting and persistent diarrhea were sub-therapeutic or undetectable which could result in stretched health budgets for the governments that are striving to provide already costly drugs to those in greatest need, most in tropical and developing areas [47].

Diarrhea again has been associated with some complications in pregnancy. In a study in New York, a multi-parous woman presented at 25 weeks with pre-term premature rupture of membrane showed fetal blood, placental membrane, and vaginal pool cultures revealing presence of Shigella sonnei [47], however the situation can not be conclusive by basing on one patient only.

Other studies have shown the effect diarrhea on physical fitness. Long term studies in Kenyan and Zimbabwe showed that decreased physical fitness scores (as determined by

Havard step tests) 4-7 years later correlated directly with early childhood diarrhea illness rates(the total number of episodes of diarrhea in the first 2 years of life) as well as with cryptosporidial infections [47].

The relationship between diarrhea and malnutrition is bidirectional: see figure 3 below.

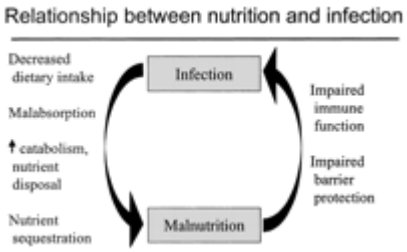


Figure 3. Relationship between nutrition and infection

Scrimshaw et al. in 1968 showed that infection adversely affects nutritional status through reductions in dietary intake and intestinal absorption, increased catabolism and sequestration of nutrients that are required for body tissue synthesis and growth. On the other hand, malnutrition can predispose to infection because of its negative impact on the barrier protection afforded by the skin and mucous membranes and by inducing alterations in the host immune function [46]. The former is more prominent in the case of acute diarrhea which results in dehydration and eventually may cause death while the latter may enhance the susceptibility to infections like diarrhea which may result in dehydration then eventually death.

2.5. GLOBAL EFFORT TO CONTROL DIARRHEA

In the face of this burden of diarrhea, international organizations, countries, etc have not just stood back and watch the disease take its toll on the human race, instead they have worked closely and in conjunction, in the effort to control and prevent the disease. A number of tangible results have come out from such effort as detailed below:

WHO through its department of research of Control for Diarrhea Diseases (CDD) introduced Oral Rehydration Therapy (ORT) in 1979 which speedily became the cornerstone of programs for control of diarrhea [43,48]. It is estimated that ORT is accessible now to more than 60% of children, and is used in about 20% of all diarrhea episodes; other forms of ORT are given in further 10% of the cases [16]. The proportion

of episodes managed by ORT in developing countries soared from 40% to 69% and it is on record to have contributed to the reduction of children's deaths from 4.6 million in 1980 to around 1.5 million today [48]. It must be noted that another form of ORT has emerged called Rice-based ORS. Recent studies in Bangladesh and India have shown that dehydrated diarrhea patients given an ORS solution containing 50 grams of rice powder in place of the usual 20 grams of glucose were satisfactorily re-hydrated and had an appreciably reduced rate of stool output during treatment as compared with patients given glucose-ORT [18]. Although this effort was directed at controlling deaths from diarrhea rather than prevention since an ORT can not prevent the next case of diarrhea.

Further, the CDD commissioned a research with the London School of Hygiene into developing vaccines against rotavirus and cholera which has been done with some success. Preliminary results show that the rotavirus vaccine proved efficacious in USA though not successful in Peru; and a killed oral cholera vaccine has recently been licensed in Sweden and is available to travelers. It was tested in Bangladesh with over 60% efficacy in the native population [48].

WHO's Water Sanitation and Health Program issued a report supporting the invention of a new cost-effective technique for providing safe water individually and collectively which is a highly effective Solar Thermal technique called SODIS promoted by the Swiss Federal Institute for Environment Science and Technology [3], however its accessibility by the very poor in developing countries who are by far predominant can not be guaranteed..

Research carried out at the Centre for Disease Control and Prevention in Atlanta Georgia, and by the Pan American Health Organization that were supported by WHO, show that chlorination in households without water can work well although the prevailing wisdom is that chlorination should follow not precede the creation of water and sanitation services [3]. Similarly, according to the Department of Civil Engineering-University of Zimbabwe, low strength Chlorine solutions like *Jik* and *javel* manufactured for bleaching can be used to purify water: a teaspoon of *jik* in a 10 liter bucket disinfects the water for

60 minutes and with two teaspoons, disinfects water in 30 minutes, a very low cost technique costing about ½ US cent per liter to disinfect [53].

The CDD through the London School of Hygiene, through research recommended interventions with potential effectiveness which includes promotion of breast-feeding, improvement of complementary feeding, improvement in water supply/sanitation and hygiene behaviors to prevent diarrhea. A program consultation in 1992 found that 3 priority water-related hygiene behaviors had impact in the incidence of diarrhea: hand-washing, sanitary disposal of feces, and keeping drinking water free from contamination [18,48].

In Zimbabwe, through the Blair Research Laboratory, simple technologies that can be accessible by the rural community have been used to purify water. Sand has been used to purify water using a sand filter on the basis that when water passes through the sand, the pathogenic bacteria do not find either sand or soil a good medium in which to multiply hence die off. This explains why water taken from adequately protected wells and tube wells excavated in the soil yield water with very few bacteria count in it [53].

2.7. DIARRHEA IN MALAWI

All types of diarrhea as mentioned in section 2.1 above are present in the population of Malawi. Of the serious global burden of diarrhea that has been portrayed above, Malawi as a country has a share. Even-though both water supply and sanitation coverage look to be above average, diarrhea still poses a big threat to public health in the country. In 2002 alone, about 33000 cases of cholera were reported in the country which resulted in about 1000 deaths [54]; and diarrhea prevalence is 28% in the population while in children under-five, it is estimated at 18% qualifying it as one of the major causes of morbidity and mortality among the children [55]. It is ranked fourth to malaria, ARI, skin illnesses; and resulted in 71465 hospital reported cases in 2002 in the country. Even then, hospital data does not adequately quantify the magnitude of diarrhea morbidity or mortality among the under-five children in the country; in the year 2000, only 28% of the under-five children were taken to hospital in response to a recent attack of diarrhea (rural and urban figures were 28% and 35% respectively) [10].

The strategies to control diarrhea in the country are targeted both towards preventing new cases and deaths from dehydration in the children, who are the ones that are more susceptible to the disease. The use and availability of ORS have been promoted widely. In the surveys that were conducted in the country in 1992 and 2000, results showed that about 90% and 86% of women, respectively, knew about the ORS and its importance although the trend showed that those in the rural were less aware about this [55]. Further, to ensure adequate availability of the ORS, in addition to the supplies by the ministry of health in the hospitals, a non-governmental organization has been engaged to produce and sell over the counter ORS called “Thandzi” to mothers for use on sick children. Other than this, in all government health facilities, health education programs are given to all out-patients concerning dangers and prevention of various diseases including diarrhea. Health Surveillance Assistants (HSA) otherwise, community health workers have been allocated different rural communities where they are stationed and among other basic health services they provide to the people, they have been tasked with monitoring disease outbreaks and delivering health education to the people which include prevention of communicable diseases like diarrhea [11]. Furthermore, the school curricula with health education is 100% which among others teaches about infectious diseases and their prevention [12], although this only benefits those that go through the school system.

2.8. JUSTIFICATION OF THE STUDY

In addition to the current situation of poor water supply and sanitation coverage in developing countries, estimates have shown that by 2015 in order to achieve water and sanitation for all in developing world alone, an additional 2.2 billion and 1.5 billion people would need access to safe water and sanitation respectively equivalent to providing water supply services to 280000 people and sanitation facilities to 384000 people everyday for the next 15 years from the year 2000 [3]. If these facts are to go by, it implies that diarrhea morbidity will still remain a prominent health problem in the population of the developing world for the unforeseeable future as it looks very unlikely that the problem of access to safe water and improved sanitation can be solved quickly.

The problem of diarrhea spawns further problems in the developing world in terms of the impact it has on the stretching of health budgets as countries have to meet the cost of

treatment of diarrhea cases, yet it is preventable. For example, a diarrhea health promotion intervention study in Burkina Faso involving 37 319 mothers which analyzed data on direct medical savings, indirect savings of care giver time and lost productivity associated with child death were estimated from interviews with households and health workers, the cost per case of childhood diarrhea averted, and found that saving to the provider from reduced treatment cost were estimated at $10 716 and saving to households from averted treatment costs were $9 136, resulting in total saving to society of $19 856 increasing to $393 967 if indirect savings were included [56]. This awesome amount of money can be concentrated in other development areas, even in improving services in non-preventable diseases.

In recognition of the fact that this huge unmet safe water and sanitation coverage gap in the developing world, of which the effort to narrow the gap has been as daunting as ever and that the hope of providing water and sanitation for all is likely unachievable in the foreseeable future which implies that diarrhea morbidity will still remain a major unsanitary related health problem and therefore continue absorbing a large portion of the health budget in these developing countries, Malawi inclusive, it is of paramount importance that all the stakeholders should equally focus much of their resources on prevention as on treatment of diarrhea.

To effectively strategize prevention of diarrhea, it is imperative that the important risk factors associated with diarrhea occurrence be identified first in a community through research. Although a great deal of research has been done towards identifying the diarrhea associated risk factors over the world, very little is known in many rural areas of Malawi as to which could be the important factors in order to attract effective and specific intervention activities in the effort to control diarrhea. A nation-wide demographic and health survey conducted in 2000 assessed factors in association with diarrhea morbidity in children under five, namely: age/sex of child, use of latrine for disposal of stools, parent education [55]. In a study in another rural area of Lungwena, unsafe water source, weight in early life, numbers of siblings, father’s marital status were found to be risk factors for diarrhea in children [22]. The purpose of this study therefore was to extend the scope to explore more socioeconomic, environmental and demographic factors related to diarrhea prevalence in another very rural area of Solola-Mzimba.

Studying the risk factors in the rural area was important as most of the population of Malawi is rural where good water supply and sanitation coverage are very poor as stated in 1.2.

Lastly, the study was conducted as an important requirement for the partial completion of a Masters Degree in International Community Health.

CHAPTER 3: RESEARCH QUESTION AND OBJECTIVES

3.1. RESEARCH QUESTION

What are the factors associated with diarrhea morbidity among children under-five years of age in rural Mzimba - Malawi?

3.2. RESEARCH OBJECTIVES

The broad objective was to study the factors associated with diarrhea morbidity in the children less than five years of age.

Specific Objectives

The more specific objectives in this study were:

1. To study the existing water, food and sanitation related practices in Solola area.
2. To study the effects of the above-mentioned factors on diarrhea morbidity in children under-five years of age.
3. To study the reasons for not adopting the good water, food and sanitation related practices.
4. To suggest potential areas of intervention in the control of diarrhea.

CHAPTER 4: METHODS AND MATERIALS

This chapter outlines the methods and materials that were used in the Solola study which was conducted specifically in seven of the villages of M'mbelwa East Ward, from 10th November to 29th November 2003.

4.1. STUDY DESIGN AND SAMPLE SELECTION

4.1.1. Selection of study area

Solola was chosen for the study because no similar research assessing the exiting water, sanitation and food hygiene practices, and the risk factors/factors associated with diarrhea has been done before. This presented a good opportunity to explore the practices and factors associated with diarrhea in the children less than five years in these very rural communities for the first time.

At the same time, the familiarity of the researcher with the local language was considered important as regards the reduction of information distortion that would occur during the transcription to the local language from English of data and data collection tools.

4.1.2. Study Design

A cross-sectional study design was used to study diarrhea morbidity and the factors that are associated with the morbidity. A cross-sectional study was suitable for this study because it is less time consuming as there was less time available for the study [57].

4.1.3. Study Population

The total population for the Solola-M'mbelwa East ward is not known however it could be approximated to at least 20 000. The study population was children less than five years of age. Since the children are too young at this age to be interviewed, the mothers of the recruited children instead were then interviewed for environmental, demographic and socioeconomic factors associated with diarrhea.

4.1.4. Sample Size

There was inadequate information of the prevalence of diarrhea in the population of the area for which to calculate a sample size for a requisite statistical power. Therefore we agreed to include 300 children with the assumption that this would have the requisite statistical power taking into consideration that the prevalence rate would be 30%. We felt the sample was big enough to fetch out adequate variations in the population on the variables that were studied.

Selection of villages

All the prominent village-headmen areas in the Mzimba-Solola (M'mbelwa East Ward) were listed alphabetically, and then a systematic sampling was used to select the villages. A total of 33 villages were listed and 7 villages were chosen; 33/7 = 4.7 which meant every 5^{th} village from the list was recruited for the study. The first village to start the systematic sampling was arrived at by random selection [58].

Selection of subjects

After the seven village-headmen areas in which the study was to be done were known, the selection of the subjects (children) was thereafter done using systematic sampling. Each village-headman area was mapped to know the dwelling units that were in that area, then the enumerator started from the centre going in one direction picking every 3^{rd} house after which he would do the same in the opposite direction. Several directions were chosen and at least 30 subjects from each village were recruited for the study. In a chosen house if there was no child under five years, the enumerator moved to the next house until such a child was found, then would proceed with the systematic sampling. When these children were identified, their mothers were interviewed on matters related to diarrhea.

Only a child that was under five years of age and had a mother or a long-time guardian (a woman) present at the time of the visit by the research assistants was recruited into the study, and the mother/guardian was alongside the child recruited into the study after expressing willingness to participate in the study. If the mother/guardian did not express the willingness to participate in the study, both she and the child were not recruited into the study. The willingness to participate by the mothers/guardians was confirmed after

spelling out to them the contents of the subject consent form. See appendix I, for the consent form. The age of a child was verified by cross-examining with the information provided in their health, growth and vaccination cards. All mothers but one had expressed willingness to participate.

4.1.5. Inclusion and exclusion criteria

Inclusion criteria

All the children that were less than five years of age at the day of the interview were eligible for the study. However, out of these children, only a child that had a mother or a long-time guardian present at the time of interview was recruited for the study. The basic understanding here is that the mother or long-time guardian (a woman) was the suitable person to provide adequate information about the child and other variables surrounding the child's environment since children spend more time with their mothers than fathers [58].

Exclusion criteria

Children with the following conditions were not recruited for the study: those with malaria, and children who were less than five years of age but at the time of interview had no mother or long-time guardian present. Fortunately only less than 10 children were not recruited; one for the condition of malaria and the rest for not having their mothers/long-time guardian present at the time of the interview.

4.2. DATA COLLECTION

This section outlines the materials that were used in the data collection for this study.

4.2.1. Training of research assistants and Pre-testing

Training of research assistants

Three research assistants were recruited for the survey. The questions and their meanings were thoroughly explained to the assistants. The assistants were then instructed on how to ask questions and how to exactly report what the respondent answered. The use of the other data collection tools was demonstrated.

Pre-testing

The data collection tools were pre-tested on 10 mothers with children less than five years of age in one of the villages that were not recruited into the study after the village selection process. The idea was to check if they fetched the relevant answers to the questions to avoid information distortion that would arise from this or changes were to be made. Some very few changes were indeed made: treatment of drinking water at the source was never done in all women hence was dropped; on breastfeeding status of children, mothers again could not remember the time the child had stopped being exclusively breastfed or when they had introduced other foods or had weaned the child, so the issue of time on these were ruled out; and there were difficulties in collecting information on family income as many were peasants hence could not even estimate their income and therefore was cancelled.

The exercise again was important in equipping the researchers with the field experience they were to go through.

4.2.2. Data Collection Tools

The following were the tools that were used to collect the required information in the study: questionnaire, observation guide.

The questionnaire

The questionnaire was the main research instrument. It was a pre-tested questionnaire and had closed and open-ended questions. Interviews based on a questionnaire were conducted on mothers/guardians recruited into the study to assess the existing practices, knowledge, and reasons for or not for adopting the existing water/food/sanitation-related practices. The questionnaire had several sections; a section on socio-demographic and economic situation of the subjects, a section on knowledge of diarrhea by the mothers/guardians, a section on sanitation and rubbish disposal, a section on drinking water related practices, food hygiene related practices and a section on breastfeeding and vaccination status of the children. The questionnaire was developed in English language and had all the questions with parallel translation of the vernacular language – Chitumbuka. See appendix II for the questionnaire.

The observation guide

The observation guide was used to determine the existing water, sanitation, food and other hygiene related practices. It focused on conditions of the kitchen, house and its surroundings, pit latrine and distance to the latrine, disposal of garbage and rubbish pit, drinking water sources and their distances. The research assistants used the observation guide to indicate the existing water, sanitation and food hygiene practices by ticking on the guide the conditions of the kitchen, house surroundings, latrine, rubbish pit and the water sources.

Since no instrument was available with which to measure both distances to the latrine and water sources, measurement of these distances was guessed however an agreement was to be reached among all the research team every time. See appendix III for the observation guide.

All data collection tools, observation guide as well as questionnaires, were developed and selected using variables that were developed for the study in the research protocol.

4.3. VARIABLES AND DEFINITIONS USED IN THE STUDY

The section outlines the variables and their definitions as were used in the data collection. Two types of variables were used: Dependent variable and Independent variables. The independent variables are regarded as the potential risk factors in the study.

Dependent variable

The study had one dependent variable which is diarrhea. Diarrhea was assessed in the recruited children by asking the mothers/guardians whether or not it was present at the time of the interview or it had been present within the past two weeks to the day of the interview. Where present, it was confirmed as per the definition – three or more watery stools within 24 hours. This included even bloody watery stools which were defined as dysentery. The children's growth and vaccination cards were checked to verify if they had gone to hospital for other illness within the past two weeks of the interview, and this was supplemented with asking the mothers about it.

Independent variables

The independent variables were considered in the study as the potential risk factors for diarrhea in the children under-five years of age based on the literature reviewed, and included environmental factors, and socio-economic and demographic factors:

Environmental factors included sanitary and garbage disposal methods, drinking water handling related methods, and food hygiene related methods.

Socio-economic and demographic factors included economic status of the family, occupation of the father, age of both the child and mother/guardian, education level of the mother, marital status of the mother/guardian, total number of children per mother/guardian, and total number of older siblings per child.

Environmental factors considered the following areas:

Sanitation: The study assessed whether or not the following things were done regarding sanitation. Using a structured questionnaire, mothers for the recruited children were asked if children defecated in latrines or open surroundings. If they defecated in open surrounding, to know if the stools were properly removed right away in order to see whether or not flies, animals were given chance to have contact with them. On the same note, questions were asked to find out if children's bottoms are cleaned by water or by

dragging on the ground. Dragging on ground leaves stools, wiped to the ground, exposed to flies and animals.

Again they were asked if they (adults) used the latrine or defecated in the bush. Questions were asked again as to whether or not, hands were washed with water only or with soap or if they were not washed at all after defecating or disposing of children's feces. Further questions were asked whether there was a latrine present or not, if present whether or not was in use and was for private or communal use. Studies have shown that latrines that are commonly used increase the infectivity of diarrhea. If again latrine was present, how regularly it was cleaned and who was responsible for cleaning if it was communal.

Awareness of diarrhea prevention measures were assessed by asking them how important it was to dispose of feces in latrine only, to wash hands after visiting the latrine. Answers were to be assessed whether they showed very good/ good/poor/no knowledge. Little knowledge about good sanitation has been associated with more diarrhea prevalence in some studies.

To complement the questions, was the observation guide which was used to check the existence of the following: whether or not there was fecal contamination in the surroundings of the house/upper ground to the water sources especially wells/rivers/ponds; whether or not there were feces on the slabs of latrines; whether or not latrines holes were covered after use; whether garbage was disposed of in rubbish pits or in the open surroundings; whether or not hand-washing facilities (water, soap, ash) were present, and if they were next to latrine/away from latrine/in the house/not present at all.

Water: In terms of water, the study assessed water sources, protection of water sources, treatment of water, activities taking place around the sources.

Mothers of recruited children were interviewed using the questionnaire to find out where they fetched drinking water from i.e. whether from wells, ponds, rivers, tubes; if water collecting vessels were cleaned before fetching water; whether or not water storage vessels were cleaned and emptied before refilling. Also to be found out were how long it took to replace the drinking water in the vessels (hours, everyday or more days); whether or not water was treated (boiling/filtering/chlorination); whether or not vessels were

narrow-mouthed or not and that whether or not they had lids; whether or not water was drawn by dipping or pouring, if children drew water from the vessels themselves. Further, amount of water available for domestic use was assessed by counting number of standard pails used in the community and converting them in liters per day, and whether or not the water was adequate for use. The questionnaire was complemented by an observation guide. It was used to check the existing water sources, to check if water sources were protected or not from contamination: wells if they were fenced/had raised walls to keep out animals and run-off respectively, if water was treated at source e.g. by chlorination, filtering. Also distance to the water source was examined in meters/kilometers (it determines the amount of water that will be available for use in the home). Further, how water is transported from the sources to the home: if vessels are covered with lids or not (for uncovered vessels sometimes women put in leaves to reduce spilling over of water as they move – leaves may contaminate the water), and the vessels used to store water (if narrow-mouthed or not, if covered or not).

Food preparation behavior/others: This was to examine how children's food was prepared, how children were fed and tidiness of food preparation area. A questionnaire was used to find out if mothers washed hands before preparing food for children and before beginning to feed the children. Also whether young children fed themselves or not – if they did whether or not their hands were washed before eating.

Whether or not children were fed stored-cooked food was inquired which included period of storage, if food was covered or not, if stored at room temperature, if food was reheated before reuse.

Again if flies seen landing on food whether or not feeding was discontinued. Further questions were asked about feeding utensils: if they were cleaned with water/with hot or cold water and soap/or not at all.

Mothers were asked again to find out if they cooked in a kitchen or at an open cooking place (at the latter food may be contaminated by blowing wind, flies, animals). Further, if they cleaned the food preparation place; if they did, how regularly? – is every-time before cooking, everyday or none at all?

Then an observation guide was used to check, whether or not kitchen was available, tidiness of the kitchen, presence of flies and animals.

Knowledge of Diarrhea: Mothers were asked using a questionnaire on diarrhea and other issues around diarrhea. Questions were asked about whether or not they knew about diarrhea disease. If they did, were asked to state some of the signs/symptoms they know about the disease. Further, they were asked if one of the members of their household had suffered from the disease. And more importantly, they were asked if they knew what caused the disease, and also what spread diarrhea: they were also asked if they knew how diarrhea could be prevented, if they did, to mention some of the ways they could remember and how they might have known about these. Lists on signs/symptoms like watery stools within 24 hours, abdominal pain, fecal agency, cramps, nausea, vomiting, fever, blood/mucus in stools, other); on causes like evil spirit, indigestible food, worm infection, crawling, teething, organisms entering the body; on means of spread like unsafe drinking water, unsafe fecal disposal, not washing hands before preparing food/eating, careless disposal of garbage, not covering food to avoid flies; and on means of prevention like disposing of stools in latrines, washing hands after defecating and before eating food, drinking tube water unlike well/pond/river water, filtering/boiling/chlorinating water from unprotected sources, others were ticked against their answers and the list would be categorized according to very good/good/poor/no knowledge.

Nutritional status: A questionnaire was used to find out if the children were still being breastfed or weaned. In case of breastfed children, mothers were asked if children were exclusively breastfed to the day of the interview or not, if other foods were introduced by that time, or if the child was weaned. In the study, exclusive breastfeeding adopted the definition of World Health Organization: practice of feeding infants only with breast milk for the first four to six months of life [55].

Background variables: The following background variables were used: a questionnaire was used seek the age of child and mother. Age and sex of child/age of mother were recorded. Further, the age of mother, child, and sex of child were confirmed by using the health, growth and vaccination card of a child. Age to be recorded at last birth day: sex was female or male. Further the total number of children per mother/guardian and the total number of older siblings was again inquired from the mothers.

Again whether the child had a single parent or both parents was inquired.

Highest level of education attained by parents was also inquired. The following education levels were used primary, or secondary or tertiary education, and the highest class reached was inquired.

Again questions on socioeconomic status were asked: mother was asked if the father of the child was employed or was just a peasant. Also they were asked if they owned a radio, a bicycle, an oxcart, livestock (what livestock, size of herd/flock).

Using the observation guide information on whether the house cemented, has window panes, has iron sheets were recorded.

Additionally, the measles vaccination status of a child was checked on the health, growth and vaccination cards.

4.4. DATA HANDLING AND DATA ANALYSIS

Continuous variables like age of child and mother, distance to water source and latrine, number of liters of water, total number of children per mother, and total number of older siblings per child were entered as they were (not in pre-coded sections) while all the categorical variables like sex, diarrhea presence etc were entered in the pre-coded sections of the data collection tools. The principal researcher was checking all the data collection tools for errors after each field day of data collection exercise and corrections were made where necessary and possible.

After the field work, all the data was entered into a computer in the SPSS 10.0 program for analysis. Two people entered the data into the computer program: one was spelling out the variable entries from the data collection tools and the other was typing them on the program. This helps to minimize data entry errors by one person doing both [61].

Continuous variables

All the continuous variables were collapsed into groups and were therefore treated as categorical variables in statistical analyses; they were again not transformed to assume the state of a normal distribution and therefore non-parametric methods were used in testing their association with diarrhea occurrence [61]. The groups can be studied in the results section.

Categorical variables

All the variables that were pre-determined as categorical variables in the planning stage of the study and were pre-coded during the data collection phase remained as they were even during statistical analyses except the following variables:

Education level of the mother has been re-categorized into two groups; fourth grade or less, and fifth grade or more as you can scarcely find mothers/guardians that have attained secondary school education in the very rural areas of Malawi [55].

Breastfeeding status of child only considered children up to the age of 24 months (2 years) when testing for its association with diarrhea occurrence as mothers in rural Malawi normally breastfeed up to this age of a child 24 months [55].

Measles vaccination status considered children that were 9 months and above when testing the association of this status with diarrhea. In Malawi, children receive measles vaccination at 9 months of age [62].

Categorization of the knowledge of diarrhea was in four groups, namely very good knowledge, good knowledge, poor knowledge and no knowledge. Mothers/guardians were asked using separate sets of questions to mention what they knew as signs, causes, means of spread, and prevention of diarrhea.

For signs of diarrhea, those that mentioned at least four signs correctly were put in the category of having very good knowledge, those that mentioned less than four in the category of good knowledge, those that mentioned any signs other than the correct signs were said to have poor knowledge while those that failed to mention any sign were said to have no knowledge. As regarding causes of diarrhea, those that mentioned correctly at least three causes were said to have very good knowledge, those that mentioned less than

two causes were said to have good knowledge, those that mentioned no any correct cause were said to have poor knowledge while those that failed to mention anything were said to have no knowledge. In terms of the means of spread of diarrhea, those that mentioned ways that covered altogether at least the three areas of water, sanitation and food hygiene, which are important transmission routes of diarrhea [63], were said to have very good knowledge, those that only covered less than three areas were said to have good knowledge, those that had answers that did not cover the above-mentioned areas were said to have poor knowledge while those that failed to say anything were said to have no knowledge. Similarly, in terms of prevention, those that mentioned correct answers that altogether addressed the three areas of water safety, good sanitation, good food hygiene were said to have very good knowledge, those that only covered less than the three areas were said to have good knowledge, those that mentioned non-correct or irrelevant answers were said to have poor knowledge while those that did not say anything were said to have no knowledge.

Knowledge of diarrhea (overall) was categorized into two groups; good and poor by summation of similar level scores for the four categories of knowledge namely knowledge about signs, causes, spread and prevention which were arranged in similar order – very good/good/poor/none. The cut off points for categorizing knowledge were chosen arbitrarily.

Similarly, the variable sanitation and rubbish disposal (overall) was a result of summing up all 13 sanitation and rubbish disposal variables after arranging their scores in the order good to poor. Therefore a cut-off point was chosen arbitrarily that ended in categories poor sanitation and good sanitation.

Similarly again, drinking water related practices (overall), and food hygiene related practices (overall) were a result of the summation of the drinking water related practices that were used in the study and were categorized good or bad; and the summation of food hygiene related practices used in the study which were finally categorized good or poor respectively.

Data on the economic status of a household was categorized into two groups; poor or well-off. A household was said to be well-off if it had the following items: at least a house with iron sheet roof and either an oxcart or cattle or both. A household that did not satisfy the conditions mentioned above was said to be poor.

Finally, having done all the necessary categorization of the variables, the SPSS program was used to analyze the data. The general description of the data was done using frequencies. The description of the spread of some skewed variables was done by using the five-number summary which includes minimum and maximum values, the median, first and third quartiles, while for the variables that were close to symmetric distribution, the mean and standard deviation were used [64]. The relationship between the independent variables and the dependent variable was done using the Chi-square test (x^2) with the statistical significance that was set at the level $p < 0.05$.

4.5. ETHICAL CONSIDERATION

Participants for the study were recruited totally on voluntary basis. They were neither forced nor persuaded to participate in the study instead once approached it was upon themselves deciding whether or not to participate or provide information. Even for those that initially accepted to participate were free to withdraw in the course of the study without any consequences.

As a matter of ensuring that prospective participants make a well informed choice regarding whether or not to participate in the study, the investigator had a duty to comprehensively explain the purpose, objectives, and benefits of the study, and even the means of collecting data to be used, to the people in their language. Furthermore, issues of anonymity had to be guaranteed to the participants so that their social face is protected as much as possible owing to which, data collected and generated has been treated with highest possible degree of confidentiality to the extent that only the investigator and the project leader have been the people to have access to it.

It must be noted again that this study is only a community survey which was restricted to only gathering of information by means of asking questions and observation in which case, it did not pose any health risk to the participants.

Approval to undertake the study had been sought from the Ethical Review Committee of Norway. Again the permission to proceed with the study in Malawi had been sought from the Ethical Committee in Malawi. Further permission to undertake the study in Malawi had been sought from the District Commissioner in Mzimba district and also from the village headmen in the selected villages at the lowest level.

CHAPTER 5: STUDY RESULTS

The results presented below are based on the rigorous analysis of data that was collected by interviewing mothers or guardians to the children recruited into the study, and by observing the house surroundings and water sources. The data was collected from seven villages in Solola- M'mbelwa East Ward in Mzimba district.

A total of 302 children were recruited into the study after fulfilling the inclusion criteria. Since some mothers had more than one child under the age of five, only a total of 261 mothers or guardians to the children were recruited for the interviews.

5.1. DEMOGRAPHIC CHARACTERISTICS OF THE SAMPLE POPULATION

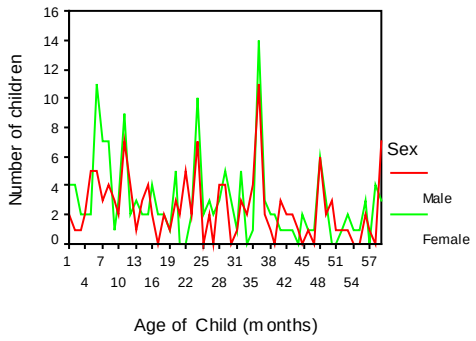
5.1.1. Children

For the total 302 children recruited into the study, the minimum age was 1 month and maximum age was 59 months representing an age range of 58 months. The median age of the children was 24 months. The first quartile of their ages was 11 months and the third quartile was 36 months, representing an Inter-quartile range of 25 (36 -11) months. Furthermore, of these 302 children recruited into the study, 138 (46%) were males and 164 (54%) were females. In almost all the age groups, there were more girls than boys. The minimum and maximum ages and therefore the age ranges, and the median ages for both the males and females considered separately were the same as for total sample of the children regardless of sex except for the first and the third quartiles which for the males were 11 months and 37.25 months respectively and for the females were 10 months and 36 months respectively. No child under one month was found. Distribution of the children on age and sex is shown in Table 1 and figure 4 below.

Table 1. Distribution of under-five children by age (months) and sex in Solola-Mzimba, Malawi 2003.

Age of child (months)	Frequency					
	Sex				Total	
	Male	%	Female	%	n	%
< 12	35	25.4	52	31.7	87	28.8
12-24	36	26.1	35	21.3	71	23.5
25-36	31	22.5	39	23.8	70	23.2
37+	36	26.1	38	23.2	74	24.5
Total	**138**	**45.7**	**164**	**54.3**	**302**	**100.0**

Figure 4. Distribution of children by age and sex in Solola-Mzimba, Malawi 2003.



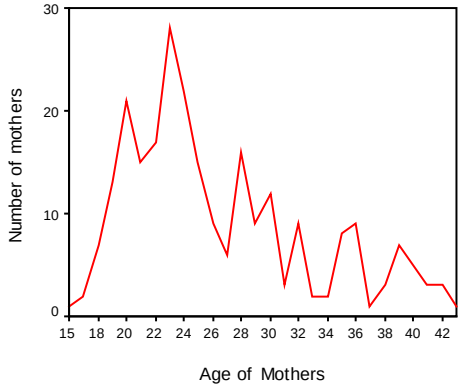
5.1.2. Mothers

For the total 261 mothers/guardians recruited into the study, the minimum age was 15 years and the maximum age 43. The age range was therefore 28 years. The median age of the mothers/guardians was 24 years, and the first quartile of their ages was 22 years while the third quartile was 30 years. The Inter-quartile range of their ages was 8 years. There were more young women in the sample; 50% were between 22 and 30 years of age and about 40% were less than 24 years. The distribution of the mothers by age is shown in table 2 and figure 5 below.

Table 2. Distribution of mothers by age in Solola-Mzimba, Malawi 2003.

Age-group (years)	Frequency	%
15-23	104	41.6
24-28	68	27.2
29+	78	31.2
Total:	**250**	**100.0**

Figure 5. Distribution of mothers by age in Solola-Mzimba, 2003.



5.1.3. Other demographic characteristics

Marital status

Of the 261 mothers that were recruited into the study, 28 (11%) mothers were single and 233 (89%) mothers were married.

Education

In terms of education, two categorization were done based on the number of grades attained in school; those who had done the fourth grade or less, and those who had done the fifth grade or more. Based on this categorization, 183 (70%) of these mothers had done at least the fifth grade while 78 (30%) had done the fourth grade or less.

Number of children

Total number of children per mother/guardian, and total number of older siblings per child that was recruited into the study were examined.

In terms of the total number of children per mother within the sample population, the minimum number of children was 1 and the maximum number was 7. The median total number of children was 2. The first quartile was 1 child and the third quartile was 4 children representing an Inter-quartile range of 3 children. The distribution of total number of children per mother/guardian is shown in table 3.

Table 3. Distribution of mother by total number of children in Solola-Mzimba, Malawi 2003.

Number of children	Frequency	%
1-2	137	52.5
3	45	17.2
4+	79	30.3
Total	**261**	**100.0**

Furthermore, of the total 302 children that were recruited into the study, the total number of older siblings per child was assessed. The minimum number of older siblings per child was 0 (zero) and the maximum number of older siblings per child was 6 children. The median number of older siblings was 1 child, the first quartile was 1 and the third quartile was 3, representing an Inter-quartile range of 2 children. Table 5 shows the distribution mothers by number of older siblings.

Table 4. Distribution of under-five children by number of older siblings in Solola-Mzimba, Malawi 2003.

Number of siblings	Frequency	%
0-1	168	55.6
2	53	17.5
3+	81	26.8
Total	**302**	**100.0**

5.2. SOCIOECONOMIC CHARACTERISTICS OF SAMPLE POPULATION

5.2.1. Economic status

Data on the economic status of a household was categorized into two groups; poor or well off. A household was said to be well-off if it had the following items: at least a house with iron sheet roof and either an oxcart or cattle or both. A household that did not satisfy the conditions mentioned above was said to be poor.

Therefore of the 261 mothers that were recruited into the study, 37 (14%) were categorized as well-off and 224 (86%) as poor.

5.2.2. Knowledge of diarrhea among mothers

Data on the knowledge of diarrhea comprised how much the mother knew of the signs, causes, means of spread, and prevention of diarrhea. Knowledge about how the mothers got to know about diarrhea was also sought from the mothers. Categorization of the knowledge of diarrhea was in four groups, namely very good knowledge, good knowledge, poor knowledge and no knowledge. Mothers/guardians were asked using separate sets of questions to mention what they knew as signs, causes, means of spread, and prevention of diarrhea. More mothers had averagely good knowledge about signs and spread while poor knowledge about causes and prevention of diarrhea. Table 5 shows the distribution of mothers by their knowledge of diarrhea signs, causes, spread and prevention, in the sample population.

Table 5. Distribution of knowledge of diarrhea in mothers in Solola-Mzimba, Malawi 2003.

Categories of diarrhea knowledge

	Very good N (%)	Good N (%)	Poor N (%)	None N (%)	**Total N (%)**
Knowledge of signs	32 (12.3)	205 (78.5)	3 (1.1)	21 (8.0)	**261 (100.0)**
Knowledge of spread	8 (3.1)	154 (59.0)	12 (4.6)	87 (33.3)	**261 (100.0)**
Knowledge of causes	12 (4.6)	89 (34.1)	104 (39.8)	56 (21.5)	**261 (100.0)**
Knowledge of prevention	10 (3.8)	94 (36.0)	68 (26.1)	89 (34.1)	**261 (100.0)**

Furthermore, about how the mothers/guardians acquired the knowledge of diarrhea, 203 (78%) said they had known through their attendance of the under-five clinic, 45 (17%) had known because of attending formal school, 46 (18%) had known through radio, 23 (9%) had known through the village health worker, 6 (2%) through reading, and 8 (3%) through interaction with friends or other people.

5.3. ADDITIONAL CHARACTERISTICS OF THE SAMPLE POPULATION

The other additional information sought regarded breastfeeding status, and measles vaccination status of the children recruited into the study.

On breast feeding status, an average mother breastfeeds, at most, up to the age of 24 months of a child in Malawi [54]. Basing on this condition, out of 158 children who were twenty-four months or less and information was provided on their breastfeeding status; 16 (10.1%) children were exclusively being breastfed, 124 (78.5%) children were both being breastfed and eating other foods while 18 (11.5%) children were weaned at the time of the study.

On the status of measles vaccination, information for only 300 children was available. Of the 300 children, 209 (70%) had been vaccinated against measles at the time of the study while 91 (30%) had not been vaccinated. Those not vaccinated had either not reached the age for receiving the vaccination of nine months or had not gone for vaccination at all. Children in Malawi are recommended for measles vaccination at the age of nine months [54].

5.4. EXISTING WATER, SANITATION, FOOD PREPARATION PRACTICES IN SAMPLE POPULATION

The existing water, sanitation, food preparation practices that were observed and were collected data on in the study area and population have been summarized in tables 6,7,and 8 below. For the description of the distribution of the continuous variables; distance to latrine, number of people per latrine and the number of liters:

The minimum and maximum distances to the latrine were 5 meters and 26 meters respectively. The median distance for the distance to latrine variable was 12 meters with the first quartile and third quartile distances as 10 meters and 15 meters respectively.

The mean number of people per latrine was 8 people with standard deviation of 3.06. The minimum and maximum numbers of people per latrine were 2 and 15 respectively.

The minimum and maximum number of liters collected by each mother/guardian was 36 liters and 180 liters respectively. The median number of liters was 90 liters with the first and third quartiles as 72 and 90 liters respectively. Ideally, the amount of water should be inversely related to distance [6], with more water being collected when the distance is smaller. However the difference between amount of water collected by women and the distance to water source was not statistically significant in this study, ($p > 0.05$).

Table 6: Distribution of sanitation- and rubbish disposal-related practices in Solola-Mzimba, Malawi 2003.

Practice	**n**	**%**
Sanitation		
Cleaning of child after defecating:	301	100.0
Wipe with water	252	83.7
Water with soap	3	1.0
Dragged on ground	19	6.3
Use leaves/paper/other	27	9.0
Disposal of child feces:	302	100.0
Pit latrine	241	79.8
Buried	16	5.3
Open surroundings	45	14.9
Adult's defecating place:	261	100.0
Pit latrine	222	85.1
Bush	39	14.9
Care of hands after defecating:	261	100.0
Water and soap	94	36.0

Water only	167	64.0
Presence of latrine:	261	100.0
Present	221	84.7
Not present	40	15.3
Distance to Latrine:	221	100.0
< 11 meters	102	46.2
11-15 meters	69	31.2
16+ meters	50	22.6
Latrine private or common:	221	100.0
Private	106	48.0
Common	115	52.0
Number of people per latrine:	221	100.0
<7 people	81	36.7
7-10 people	106	48.0
11+ people	34	15.4
Stools in toilet surrounding:	221	100.0
Seen	72	32.6
Not seen	149	67.4
Latrine hole with cover:	221	100.0
Yes	14	6.3
No	207	93.7
Presence of stools on toilet floor:	221	100.0
Yes	150	67.9
No	71	32.1
Feces in house surroundings:	261	100.0
Yes	25	9.6
No	236	90.4
Rubbish pit presence:	260	100.0
Yes	96	36.9
No	164	63.1
Disposal of garbage:	260	100.0
Rubbish pit	50	19.2
Open surroundings	210	80.8

Table 7: Distribution of drinking water related practices in Solola-Mzimba, Malawi 2003.

Practice	n	%
Water		
Water source:	261	100.0
Tube (Borehole)	162	62.1
Well (river, pond	99	37.9
Distance to water source:	261	100.0
200 m or less	99	37.9
>200-500	79	30.3
>500	83	31.8
Activities at water source:	261	100.0
Cleaning containers/utensils	70	26.8
Cleaning containers/utensils/washing clothes	161	61.7
Cleaning containers/utensils/washing clothes/bathing	10	3.8
Cleaning containers/utensils/washing clothes/bathing/watering animals	20	7.7
Water replacement in vessels:	260	100.0
Everyday	228	87.7
Every two days	28	10.8
Every three days	3	1.2
More than three day	1	0.4
Drawing of water from vessels:	261	100.0
Dipping	261	100.0
Water storage vessels:	261	100.0
Narrow-mouth with lid	261	100.0
Children drawing water from vessels:	261	100.0
Yes	233	77.2
No	69	22.8
Amount of water (liters):	261	100.0
<73	88	33.7
73-10	94	36.0
109+	79	30.3

Table 8: Distribution of food hygiene related practices in Solola-Mzimba, Malawi 2003.

Practice	n	(%)
Food hygiene		
Hand treatment at child's food preparation:	261	100.0
Washing (water only)	240	92.0
Water and soap	17	6.5
Don't wash	4	1.5
Child feeds self:	302	100.0
Yes	207	68.5
No	95	31.5
Care of hands for the child feeing self:	209	100.0
Washing (water only)	203	97.1
Water and soap	6	2.9
Flies landing on food:	261	100.0
Continue feeding	183	70.1
Discontinue feeding	72	27.6
Recook/boil/heat food	6	2.3
Food stored for later use:	301	100.0
Yes	135	44.9
No	166	55.1
Cleaning of feeding utensil:	261	100.0
Water only	50	19.2
Water with soap	6	2.3
Sharing of hand washing water:	302	100.0
Yes	148	49.0
No	154	51.0
Kitchen available:	261	100.0
Yes	237	90.8
No	24	9.2
Kitchen swept or not:	261	100.0
Yes	103	39.5
No	158	60.5
Animals enter the kitchen:	261	100.0
Yes	230	88.1
No	31	11.9

5.5. DIARRHEA OCCURRENCE/PREVALENCE

5.5.1. Diarrhea prevalence, number of days, and types

Mothers or guardians were asked whether or not a child had diarrhea at the time of the interview or within the past two weeks of the interview, and for those who had diarrhea, the duration of the sickness and whether diarrhea was only watery or watery with blood, was inquired from the mothers. From this information, the prevalence of diarrhea within the one month reference period of the study, number of days of diarrhea (duration), distribution of diarrhea by age and sex, and where possible the type of diarrhea were examined and have been listed in the table 9.1and 9.2 below. The median age for the cases (those with diarrhea) was 20.5 months and was lower when compared to that of the non-cases which was at 27 months. For both the cases and non-cases, the first quartiles were the same at 11 months while the third quartiles were 35 months for the cases and 40 months for the non-cases. As for the cases alone, the median age was lower for the males at 19.5 months than for the female which was at 23.5 months with the first and third quartiles at 9.75 months and 33.5 months respectively for the males, and 11 months and 36 months respectively for the females.

Table 9.1: Diarrhea among under-five children in Solola-Mzimba, Malawi, 2003.

Diarrhea prevalence (2 weeks)	**Frequency**	**%**
Yes	124	41.1
No	178	58.9
Total	302	100.0
Duration		
1-6 days	45	36.3
7-13 days	29	23.4
14+ days	16	13.9
Ongoing*	36	29.0
Missing days#	3	2.4
Total**	124	100.0
Type of diarrhea		
Watery	91	73.4
Bloody***	33	26.6
Total	124	100.0

* 36 (29%) had ongoing diarrhea at the time of the interview and the actual duration is therefore not known however 5 of these cases were already having occurrence of within 14+ days so are again included in the category 14+ days.

** The sum for categories of diarrhea days is more than the total 124 because 5 cases are double-counted for reason stated above in (*).

*** 8 cases in this frequency include bloody diarrhea that was ongoing. # cases that had information on diarrhea days missing.

Table 9.2: Distribution of diarrhea in under-five children by age and sex in Solola-Mzimba, Malawi 2003.

Age of child (months)	Diarrhea occurrence						Total
	sex						
	male			female			
	Cases %	Non cases %	N	Cases %	Non cases %	N	
<12	20 (34.5)	15 (18.8)	35	18 (27.3)	34 (34.7)	52	87
12-24	17 (29.3)	19 (23.8)	36	20 (30.3)	15 (15.3)	35	71
25-36	13 (22.4)	18 (22.5)	31	13 (19.7)	26 (26.5)	39	70
37+	8 (13.8)	28 (35.0)	36	15 (22.7)	23 (23.5)	38	74
Total	**58 (100.0)**	**80(100.0)**	**138**	**66(100.0)**	**98 (100.0)**	**164**	**302**

5.5.2. Diarrhea occurrence within the socio-demographic variable categories

Diarrhea occurrence was more common in younger children, and also in the children of mothers that were younger, less educated and poor while in the other socio-demographic variables like sex of child, total number of children per mother, total number of older siblings per child, marital status, occupation of father, the occurrence was fairly the same.

Of the 158 children that were less than 25 months of age, about 75 (48 %) of them had diarrhea while those that were 25 months and more, only about 49 (34%) had diarrhea, (p-value <0.05). Although for the age 37+ there is a big difference between males and females, it had no significant effect on diarrhea occurrence (p>0.05).

Diarrhea occurrence was also more common in mothers under the age group 24 years than age groups 24-28 years and 29+ years; 57 (48%), 33 (40%) and 30 (33%) respectively though the difference was not significant, (p-value >0.05).

Furthermore, mothers that had done at most the fourth grade in school had also more children with diarrhea than those who had done at least the fifth grade; 76 (36%) and 48 (53%) respectively: p-value <0.05.

Again mothers that were categorized as poor also had more children with diarrhea than those that were categorized as well-off; 111 (43%) and 13 (32%) respectively though the difference not significant (p-value >0.05).

Additionally, age and education level of mothers did not have significant influence on knowledge of diarrhea in mothers, overall sanitation, overall food hygiene, and overall drinking water practices (p>0.05), however low educational level of mother was significantly associated with poor overall sanitation (P<0.05).

5.6. PREVALENCE OF FACTORS ASSOCIATED WITH DIARRHEA IN SAMPLE POPULATION

This section is a result of the tests that were done on all the variables used in the study which had the aim of isolating the variables (factors) that supposedly enhance the spread of diarrhea in the children under-five years of age in the rural area. Most of the variables were categorical; however the few variables that were continuous e.g. age of mother and child, number of children, distance to water source and latrine, were also collapsed into groups and thereby assumed a categorical nature of which therefore the statistic for testing the variables was chosen with regard that all the variables were categorical variables [61]. Tables 10,11,12 and 13 show the prevalence of factors associated with diarrhea in the study area.

Table 10: Prevalence of socio-demographic and health related practices associated with diarrhea morbidity in under-five children in Solola-Mzimba, 2003.

Variable	Diarrhea		p-value
	Yes	No	
	N (%)	N (%)	
Age of child:			
<12 months	38/87 (43.7)	49/87 (56.3)	.062
12-24	37/71(52.1)	34/71 (47.9)	
25-36	26/70 (37.1)	44/70 (62.9)	
37+	23/7 (31.1)	51/74 (68.9)	
Sex of the child:			
Male	58/138 (42.0)	80/138 (58.0)	.844
Female	66/164 (40.2)	98/164 (59.8)	
Age of mother/guardian:			
15-23	57/119 (47.9)	62/119 (52.1)	.104
24-28	33/82 (40.2)	49/82 (59.8)	
29+	30/90 (33.3)	60/90 (66.7)	
Education level of mother: *			
Fourth grade or less	48/90 (53.3)	42/90 (46.7)	.007
Fifth grade or more	76/212 (35.8)	136/212 (64.2)	
Total number of children:			
1-2	57/137 (41.6)	80/137 (58.4)	.890
3	20/45 (44.4)	25/45 (55.6)	
4+	32/80 (40.0)	48/80 (60.0)	
Older siblings:			
0-1	68/168 (40.5)	100/168 (59.5)	.972
2	22/53 (41.5)	31/53 (58.5)	
3+	34/81 (42.0)	47/81 (58.0)	

Marital status:			
Single	11/29 (37.9)	18/29 (62.1)	.872
Married	113/273 (41.4)	160/273 (58.6)	
Occupation of father:			
Peasant	71/174 (40.8)	103/174 (59.2)	1.000
Employed	43/104 (41.3)	61/104 (58.7)	
Economic status of family:			
Well-off	13/41 (31.7)	28/41 (68.3)	.255
Poor	111/261 (42.5)	150/261 (57.5)	
Measles vaccination status (children 9 months and more):			
Vaccinated	79/204 (38.7)	125/204 (61.3)	.090
Not vaccinated	19/34 (55.9)	15/34 (44.1)	
Breastfeeding status of child (2 years or less): *			
Breastfeeding only	3/16 (18.8)	13/16 (81.3)	.03
Breastfeeding and other foods	65/124 (52.4)	59/124 (47.6)	
Weaned	7/18 (38.9)	11/18 (61.1)	
Knowledge of diarrhea (overall): *#			
Good	51/163 (31.3)	112/163 (68.7)	.001
Poor/none	73/139 (52.5)	66/139 (47.5)	
Knowledge of diarrhea signs:*			
Very good	9/32 (28.1)	23/32 (71.9)	.387
Good	90/205 (43.9)	115/205 (56.1)	
Poor	1/3 (33.3)	2/3 (66.7)	
None	8/21 (38.1)	13/21 (61.9)	
Knowledge of diarrhea causes:*			
Very good	0/12 (0.0)	12/12 (100.0)	.021
Good	36/89 (40.4)	53/89 (59.6)	
Poor	45/104 (43.3)	59/104 (56.7)	
None	27/56 (48.2)	29/56 (51.8)	
Knowledge of diarrhea spread:*			
Very good	0/8 (0.0)	8/8 (100.0)	.001
Good	53/154 (34.4)	101/154 (65.6)	
Poor	8/12 (66.7)	4/12 (33.3)	
None	47/87 (54.0)	40/87 (46.0)	
Knowledge of diarrhea prevention:*			
Very good	0/10 (0.0)	10/10 (100.0)	
Good	36/94 (38.3)	58/94 (61.7)	
Poor	31/68 (45.6)	37/68 (54.4)	
None	41/89 (46.1)	48/53.9)	.033

Note: # Knowledge of diarrhea (overall) is a result of assessing all the knowledge; signs, causes, spread and prevention together. * Significant practices: $p < 0.05$.

Table 11: Prevalence of sanitary practices associated with diarrhea morbidity in under-five children in Solola-Mzimba, Malawi 2003.

Practice	**Diarrhea**		**p-value**
	Yes	**No**	
Sanitation	N (%)	N (%)	
Sanitation/rubbish disposal (overall):*#			
Poor	63/120 (52.5)	57/120 (47.5)	.002
Good	61/182 (33.5)	121/182 (66.5)	
Cleaning of child after defecating:			
Water/water and soap	108/255 (42.4)	147/255 (57.6)	.283
Leaves/dragged on round/paper/ none	15/46 (32.6)	31/46 (67.4)	
Disposal of child feces:			
Pit latrine/Buried	100/257 (38.9)	157/257 (61.1)	.099
Open surroundings	24/45 (53.3)	21/45 (46.7)	
Adult's defecating place:			
Pit latrine	103/257 (40.1)	154/257 (59.9)	.506
Bush	21/45 (46.7)	24/45 (53.3)	
Care of hands after defecating: *			
Water and soap	29/106 (27.4)	77/106 (72.6)	.001
Water only	95/196 (48.5)	101/196 (51.5)	
Presence of latrine:			
Present	103/256 (40.2)	153/256 (59.8)	.600
Not present	21/46 (45.7)	25/46 (54.3)	
Distance to Latrine: *			
< 11 meters	60/116 (51.7)	56/116 (48.3)	.002
11-15 meters	23/82 (28.0)	59/82 (72.0)	
16+ meters	20/58 (34.5)	38/58 (65.5)	
Latrine private or common: *			
Private	37/120 (30.8)	83/120 (69.2)	.006
Common	66/136 (48.5)	70/136 (51.5)	
Number of people per latrine:			
<7 people	29/89 (32.6)	60/89 (67.4)	.152
7-10 people	54/126 (42.9)	72/126 (57.1)	
11+ people	20/41 (48.8)	21/41 (51.2)	
Stools in toilet surrounding: *			
Seen	60/174 (34.5)	114/174 (65.5)	.009
Not seen	43/82 (52.4)	39/82 (47.6)	
Latrine hole with cover:			
Yes	3/14 (21.4)	11/14 (78.6)	.232
No	100/242 (41.3)	142/242 (58.7)	
Presence of stools on toilet floor: *			
Yes	86/182 (47.3)	96/182 (52.7)	.001
No	17/74 (23.0)	57/74 (77.0)	
Feces in house surroundings:			
Yes	14/30 (46.7)	16/30 (53.3)	.644
No	110/272 (40.4)	162/272 (59.6)	

Rubbish pit present:			
Yes	39/109 (35.8)	70/109 (64.2)	.188
No	85/192 (44.3)	107/192 (55.7)	
Disposal of garbage: *			
Rubbish pit	14/56 (25.0)	42/56 (75.0)	.010
Open surroundings	110/245 (44.9)	135/245 (55.1)	

Note: # Sanitation and rubbish disposal (overall) is a result of assessing all the sanitation and rubbish disposal factors in the table above together. * Significant practices: $p < 0.05$.

Table 12: Prevalence of drinking water related practices associated with diarrhea morbidity in under-five children in Solola-Mzimba, 2003.

Practice	**Diarrhea**		**p-value**
	Yes	**No**	
Water	N (%)	N (%)	
Drinking-water related practices (overall): *#			
Good	14/59 (23.7)	45/59 (76.3)	.005
Bad	109/242 (45.0)	133/242 (55.0)	
Water source: *			
Tube (Borehole)	64/185 (34.6)	121/185 (65.4)	.006
Well (river, pond)	60/117 (51.3)	57/117 (48.7)	
Distance to water source:			
200 meters or less	37/111 (33.3)	74/111 (66.7)	.114
>200-500	41/91 (45.1)	50/91 (54.9)	
>500	46/100 (46.0)	54/100 (54.0)	
Activities at water source:			
Cleaning containers only	29/80 (36.3)	51/80 (63.8)	.375
Cleaning containers/washing/bathing /watering animals	95/222 (42.8)	127/222 (57.2)	
Water replacement in vessels:			
Everyday	108/261 (41.4)	153/261 (58.6)	.770
Every after 2 days or more	15/40 (37.5)	25/40 (62.5)	
Children drawing water from vessels:			
Yes	103/233 (44.2)	130/233 (55.8)	.057
No	21/69 (30.4)	48/69 (69.6)	
Amount of water (liters):			
<91	68/153 (44.4)	85/153 (55.6)	.085
91-125	26/55 (47.3)	29/55 (52.7)	
126+	30/94 (31.9)	64/94 (68.1)	

Note: Drinking water related practices (overall), is a result of assessing all the drinking water related practices in the table above tog ether. * Significant practices: $p < 0.05$.

Table 13: Prevalence of food hygiene related practices associated with diarrhea in Solola-Mzimba, Malawi 2003

Practice	**Diarrhea**		**p-value**
	Yes	**No**	
Food hygiene	N (%)	N (%)	
Food hygiene related practices (overall): *#			
Good	23/84 (27.4)	61/84 (72.6)	.005
Poor	100/217 (46.1)	117/217 (53.9)	
Hand treatment at child's food preparation:			
Washing (water only)	119/284 (41.9)	165/284 (58.1)	.35
Water and soap	5/18(27.8)	13/18 (72.2)	
Child feeds self:			
Yes	84/207 (40.6)	123/207 (59.4)	.901
No	40/95 (42.1)	55/95 (57.9)	
Care of hands for the child feeing self:			
Washing (water only)	84/203 (41.4)	119/203 (58.6)	.106
Water and soap	0/6 (0.0)	6/6 (100.0)	
Flies landing on food:			
Continue feeding	95/215 (44.2)	120/215 (55.8)	.08
Discontinue/ Re-cook/boil/heat food	29/87 (33.3)	58/87 (66.7)	
Food stored for later use:			
Yes	57/135 (42.2)	78/135 (57.8)	.753
No	66/166 (39.8)	100/166 (60.2)	
Cleaning of feeding utensil:			
Water only	32/62 (51.6)	30/62 (48.4)	.08
Water and soap	92/240 (38.3)	148/240 (61.7)	
Sharing of hand washing water: *			
Yes	76/148 (51.4)	72/148 (48.6)	.001
No	48/154 (31.2)	106/154 (68.8)	
Kitchen available:			
Yes	114/275 (41.5)	161/275 (58.5)	.81
No	10/27 (37.0)	17/27 (63.0)	
Kitchen swept or not: *			
Yes	32/119 (26.9)	87/119 (73.1)	.001
No	92/183 (50.3)	91/183 (49.7)	
Animals enter the kitchen:			
Yes	111/267 (41.6)	156/267 (58.4)	.75
No	13/35 (37.1)	22/35 (62.9)	

Note: # Food hygiene related factors (overall), is the result of assessing all the variables under food hygiene related factors in the table above. * Significant practices: $p < 0.05$.

5.7. REASONS FOR NO USE OF GOOD PRACTICES BY WOMEN REGARDING WATER AND SANITATION

Information about reasons why some mothers/guardians were not able to use good practices, which are thought to help reduce the spread of diarrhea through the fecal-oral route, was sought in the areas of sanitation and drinking water by interviewing the mothers.

Of the 101 mothers/guardians who provided information about the reasons for not using safe drinking water, 75 (74.3%) attributed this to unavailability of boreholes in the area, 19 (18.8%) cited the reason as due to non-functioning of boreholes, while 7 (6.9%) said it was due to long distance to the nearest borehole around them.

Of the 209 mothers/guardians that provided information about the reason for not treating drinking water before putting in vessels, 8 (3.8%) said had no resources for treating water, 12 (5.7%) said was due to mere laziness, 13 (6.2%) said had no time, 31 (14.8%) said had no knowledge but only thought it was safe even the way they had been doing it, 8 (3.8%) said they were used to it, and 137 (65.6%) thought borehole water is safe.

Of the 206 mothers/guardians that had no rubbish pit, 99 (48.1%) said it was due to laziness, 55 (26.7%) said they were giving food remains to pigs they were rearing, 52 (25.2%) said they were just used to not using the rubbish pit.

Finally, of the 40 mothers/guardians that had houses without pit latrines, all (100%) said it was out of laziness by the men/husbands that they did have the latrine because was the men’s or husbands responsibility.

CHAPTER 6: DISCUSSION

This study is an addition to the very few studies that have been conducted so far in the very rural areas of Malawi.

6.1. METHODOLOGICAL ISSUES

6.1.1. Suitability of the Study Design

Two of the aims of the study were to assess the exiting water, sanitation and food hygiene practices in the area, and at the same time, for those that were found to use poor practices in the manner defined in the study, to assess the reasons (general opinions) for their not being able to use good practices. Such a stand would simply and basically be studying the prevalence or frequencies of the different practices and reasons among the mothers or guardians in the area. Such prevalence or frequencies could be studied appropriately by use of a cross-sectional study [66,67], like was the case in the current study of Solola.

The other aim of the study was to investigate the factors that may be associated with the prevalence of diarrhea in the children under-five. This involved testing the association between the variables developed from the water-, sanitation-, food hygiene-related practices and back-ground variables. These practices, in people, have a behavioral component that will define varied habits in the way they relate to them. For example, a mother may have a latrine but would simply be disposing of children stools in the open surrounding. The use of the cross-sectional study in which the mothers were interviewed once in this study was not an appropriate design for understanding the full behavior of the mothers as regards their sanitation-, water-, and food hygiene-related practices. A better design would have been the use of field observation studies e.g. participant observation. To study people's behavior and their interaction with their environment field observation studies would usually give more valid knowledge than merely asking subjects about their behavior [68]. To the contrary, Gorter in a study in Nicaragua found that repeat visits on mothers did not yield a change in hygiene behavior [36], although the study might still have suffered the subject's alignment of answers with their expectations of the interviewer.

The study design however was suitable for assessing factors associated with diarrhea morbidity as was required by the overall objective otherwise it would not be appropriate for measuring the risk factors [69].

However, although the cross-sectional study design was not very suitable to study behavior, in the current study since subjects were visited once and the visit being a surprise one, information about the statuses of the latrines, kitchen was collected with less distortion than would have been the case if the visit was pre-arranged with subjects. Culturally, people tend to set the home environment in alignment with what they feel would be the expectation of a visitor, should they know in advance about their visit. So it still provided a useful replacement for a participant observation study where the observational part of the study was concerned.

6.1.2. Association of variables

Association between exposure and outcome can only be accorded high level of acceptance if issues of validity surrounding the data in use have been adequately explained. Explaining validity centers on judgment of the suitability of the sample parameters to reflect truly those of the population from which it is drawn [66], the role of bias and the role of confounding that could influence the observed association in any epidemiological study [69,70,71].

6.1.2.1. Sample

When a parameter is investigated using a sample drawn from a population, the immediate question posed is whether or not the sample size is big enough so that the detected effect in the sample is a true reflection of the whole population. Large samples enable us to evaluate effects of interest more precisely while very small samples may fail to detect a difference that is real [66]. A right sample size is possibly calculated using a statistical power, commonly used when comparing two groups [66].

The other way of yielding a right sample without considering power is by drawing numerous samples from a population and then assessing whether or not there are significant variations (sampling variability) in the characteristics of the samples. If the

variation when we take repeat samples from the same population is too large, we can not trust the results of any one sample, the opposite is true [64].

In the current study, the population data for the study area which is only a subdivision of the district is not known as population census data only provide population figures for a whole district. This made it impossible to calculate a sample based on statistical power. Alternatively the use of drawing several samples from the same population to assess variability for which to justify the suitability of sample that was used was not at any rate feasible given the limitation of time and resources.

6.1.2.2. Bias

The design of a study is said to be biased if it systematically favors certain outcomes [64,69] or bias may be described as deviation from the truth, in which case, it can occur during data collection, analysis, interpretation, publication or review of data that can lead to conclusions that are systematically different from the truth [71]. Systematic errors may lead to distortion of the association between exposure and outcome. There are two types of bias that can affect the validity of the study: selection bias and information bias.

6.1.2.2.1. Selection bias

A selection bias occurs if the relationship between exposure and effect is different for those who participate compared with those who are eligible to participate but do not. Subjects may be excluded from a study by choice (by opting out) or by systematic exclusion resulting from non-random sampling or selection.

To reduce this type of problem in the current study, villages and subjects were selected using systematic sampling (see selection of sample in 4.1.4). Again in terms of willingness to participate, all the mothers but one that were approached expressed willingness to participate and therefore participated. Most of the mothers were found at home as the main occupation of the rural community is farming for which the time of the study was not its season.

However sometimes though not frequent, the systematic sampling principle was being compromised when in the next selected house there was no eligible child, such that the next house would then be chosen until an eligible child was found from which the systematic sample rule would commence again.

6.1.2.2.2. Information bias

Information bias refers to systematic errors in the information obtained from participants. The errors in turn could be due to differences in the ways in which interviewers or data collectors elicit information from participants or to the participants themselves reporting information in a non-comparable manner [66].

The thorough training of research assistants, the pre-testing of data collection tools as described in the methodology section helped to expose possible sources of bias. The use of an observation guide which covered most areas that were asked for in the questionnaire provided a double-check mechanism thereby ensuring minimization of information bias. The use of the cross-sectional study design was one way of reducing recall bias, as it required a recall period of two weeks only [66,67]. Ages of child and mother were inquired from the mother and then verified by using the child's growth and vaccination card.

Due to lack of an appropriate instrument for which to measure distances to water source and latrine, assessment of distance by purely basing on judgment could have caused misclassification bias in these variables. However, agreement on distance by research assistants was the only sure way of ascertaining the distances thereby in away minimizing misclassification bias.

High level of illiteracy in the rural and especially among females could have lead to possible misclassification of age of mother as some mothers could not have rightly stated their ages although the occurrence was infrequent.

6.1.2.3. Confounding

In epidemiological research, there is a possibility that variables other than the exposure of interest, do influence the outcome and this is sometimes called the effect of extraneous factors [69]. The cofounders may typically include age, gender, social class however in most studies they are not known [71]. Where variables are known to be confounders, the investigators can control for them either in the design (by randomization, restriction, or matching) or in the analysis (by stratification and/or multiple regression), provided sufficient valid information is available on the confounding factor [71].

Due to the inability in identifying the possible confounding factors during the planning stage of the study, it was impossible to include possible checks in order to minimize or eliminate their influence in the study.

6.1.3. Generalizability

The population of Malawi is divided into two; urban and rural. As stated above, about 86% of the population is rural. Solola is one of the areas that make the very rural areas of Malawi. There are no health centers/health posts and no trading centers but only government-run primary schools. The area hence very much qualifies to be called a very rural area. The results of this study therefore cannot be generalized to the whole population of Malawi as there are large variations in sanitation and clean water-supply coverage between the rural and the urban with the urban having far better coverage (see section 1.2.6). However since a very large proportion of the population is rural the results still reflect the conditions of many Malawians.

In light of all these limitations that have been exposed and discussed above, it would be advisable to exercise a bit of caution when interpreting or quoting the results.

6.2. THE RESULTS

Existing water-, sanitation-, and food hygiene-related practices

In the study area, the study found that the people engaged in generally poor practices regarding sanitation/rubbish disposal, drinking water handling and food hygiene. Based on the study findings, 60.3% (182/302) of children were living in an environment of an overall poor sanitation/rubbish disposal; 72.1% (217/301) in that of poor food hygiene related practices; and 80.4% (242/251) in that of poor drinking water handling practices. Such an environment should be very conducive in promoting infectious diseases including diarrhea. Access to safe water in Solola of about 62% was higher than findings of the average rural population of Malawi by WHO of 44% in 2000 [12]. However, it must be noted that only 37.9% of the mothers had access to safe water within recommended radius of 200 meters by WHO [6]. Access to sanitation facilities was quite higher for Solola as compared to the assessment of the rural population by the WHO; 84.7% and 70% respectively [12]. However it must be noted that over half (52%) of the mothers in the current study said were sharing latrines.

Prevalence of diarrhea

The one-month prevalence of diarrhea of 41% in the sample population in the current study is quite unusually and alarmingly high when considering that the study was conducted outside the rainy season which is the peak period of diarrhea in Malawi. Almost all the studies on diarrhea have scarcely been conducted in the dry season which makes it difficult to make meaningful and reasonable comparison of the prevalence. However, although slightly higher, the prevalence in the current study is not far removed from the findings of the study that was done in Lungwena – a rural area of Malawi which covered both the peak and non-peak periods with a prevalence of diarrhea of 33%. Three reasons would explain the high prevalence: Firstly internal findings (from the study) that show overall poor sanitation/rubbish disposal-, water- and food hygiene- related practices (see discussion above/below) could have enhanced diarrhea to reach the epidemic proportions even during this non peak diarrhea period.

Secondly, the fact that most studies have only focused on the peak periods due to an upsurge of cases reported to hospitals during this time could have been overlooking the

equally important prevalence of diarrhea in the dry periods. The immediate question becomes: 'is looking at hospital data only adequate enough to gauge the true reflection of diarrhea, even in non-peak period?' certainly not. An article published in 2000 by World Bank/African Developed Bank/ indicated that of the under-five children with diarrhea at that time in Malawi, only 28% were reported to have been taken to hospital for medical help [9]. This represents a gross misrepresentation/underreporting of diarrhea in the country if hospital data is only used.

Thirdly, the fact that most studies about diarrhea focus only on peak periods (rainy season) underlines the notion that diarrhea is largely promoted by the pollution of water sources from poor sanitation. This could be wrong assumption: Studies by Black et al. (1961) in USA, Gordon et al. (1964) in Guatemala and Feachem et al. (1978) in Lesotho observed that fecal-oral transmission of diarrhea did not only mean drinking of contaminated water exclusively, vast majority of transmission episodes may occur by routes which are not water-borne [38]. In the current study, poor hand care after visiting the toilet and sharing hand washing water before taking meals (routes that are not water-borne) were some of the important findings in consonant with the above argument by Black et al.

Factors Associated with Diarrhea

The association between the factors; younger age, education level of mother, knowledge of diarrhea in mothers, breastfeeding status of child and diarrhea has been well and widely documented in previous studies. In the current study, younger age of child was associated with more diarrhea prevalence which is quite in line with the findings of other previous studies [24,25,26,27,28,29]. Lower education level of mother was found to be associated with more diarrhea also quite in line with findings from several previous studies [25,30,31,32]. The association of poor knowledge of diarrhea among mothers, poor breastfeeding of children has also been well documented in previous studies; [72] and [32,43,44] respectively. Poor socioeconomic status that has been significantly associated with diarrhea in some studies [21,22,23,24] was not significantly associated with diarrhea in the current study. The reason for the lack of association could be that poor socioeconomic conditions in Malawi are quite prevalent among rural communities

and the situation being quite more homogenous such that it is difficult to clearly select out the well-off: from the study 86% were categorized as poor while general poverty (including urban) assessed by the IHS in 1998 in the country was at 64%, which should even be far higher for the rural only. Similarly, the universality of marriage in Malawi more especially in the rural areas resulted in a sample that had far few unmarried mothers; this could not fetch enough variation in the marital status variable and could therefore be the reason largely to explain the non-significance of the variable in relation to diarrhea morbidity.

The contribution of sanitation and rubbish disposal related factors in influencing diarrhea has been studied widely. In the current study, poor care of hands after defecating, small distance to latrine, use of common latrine, presence of stools on toilet floors and poor garbage disposal were very significantly associated with more diarrhea occurrence. These findings have been confirmed in some studies; poor care of hands after defecating [40], sharing latrines [39,40], presence of stools on toilet floor [38], poor garbage disposal [23,25,29,31,36,37], nearness of latrine to the house [36].
No presence of latrine has been found to be associated with diarrhea in studies [33,34,35] but the association was not significant in the current study because very few 15% (40/221) said they had no latrine which was not true; many people had no latrines only that 52% (115/221) who were sharing latrines were categorized as having latrines.

The association between unsafe water sources with more diarrhea occurrence in the current study cannot be a misrepresentation. In fact many study findings have borne witness to this [21,25,31,36,37,39]. Even the other study that was conducted in rural Malawi of Lungwena (1998) had found the same results [22]. However obtaining water by dipping which is very common in poor rural areas as there is no running water in the homes, and has been found to be significantly associated with diarrhea in some studies [24,39,41] was not significant in the current study most probably because all the women (100%) said drinking water was drawn from storage vessels by dipping which therefore could not bring any variation.

In terms of food hygiene, the association of uncleanliness of the kitchen/food preparation area with diarrhea in the current study has also been confirmed in some study [35]. An interesting finding was the association between sharing hand washing water from a dish before eating and diarrhea. Due to unavailability of running water (tap water) in the homes of the rural communities, people wash hands from one dish using the same water before eating main meals which could be a major source of contamination as well. However, this finding has not been confirmed elsewhere hence further studies need to be done to verify the finding.

Reasons for no use of good practices by women regarding water and sanitation

The study also sought views from mothers on why they were unable to use good practices regarding water and sanitation. The unavailability of safe water was cited by the mothers as the main reason for using unsafe water sources, while the main reasons for not treating water before drinking was lack of knowledge and having been used to not treating water like that.

The main reasons for not using rubbish pit for disposal of garbage was laziness and not being used to using a rubbish pit.

All the mothers who had no latrines pushed the blame on men/husbands; they said it was the responsibility of men to provide a latrine just as is culturally the case with houses. It must be noted that in the northern region of Malawi, where the study was done, a wife goes to stay at the husband's home and therefore the husband has the responsibility of providing everything for the family.

CHAPTER 7: RECOMMENDATIONS AND CONCLUSION

The final aim of the study was to identify important areas for the intervention of diarrhea in the rural area of Solola. The results analyses show that socio-demographic and environmental factors are associated with diarrhea in this area which therefore means interventions must target these factors.

Within the sphere of influence of the public health managers:

Health education promotion campaigns should be used to raise awareness about diarrhea causes, means of spread and prevention so that the people are equipped with adequate knowledge about diarrhea prevention. Major themes to underline the importance of breastfeeding, good sanitation/rubbish disposal, use of safe water sources and good food hygiene practices in reducing diarrhea in children and therefore encourage people to have clean private latrines, wash hands with soap after visiting the toilet, dispose of garbage in rubbish pits, use clean water from boreholes, keep kitchens clean, stop sharing hand-washing water when taking meals and mothers to breastfeed children adequately.

In the study, attendance of the under-five clinics was by far the most important source of information about diarrhea however it only benefited the mothers. Therefore, equally strengthen other sources of health information like radio programs and community health education by HSA's to reach out to all the people.

Outside the sphere of influence of health managers:

More women must be educated to raise their average literacy levels. Education increases knowledge, among others about diseases infection such that people can easily adopt prevention measures. Increase easy access to safe water in the rural areas by providing more boreholes at convenient points. Both these however can not be achieved in the short-run because the possibility of implementing such policy is largely dependent on the political will.

In conclusion, the public health researchers' invaluable effort in exposing important risk factors through research for the diseases that are considered as of great public health concern can only be considered as fully rewarded if the public health managers fully

utilized the results of researches by implementing interventions strategies designed around these research results. Similarly, the current study has managed to draw up some of the important factors associated with diarrhea in under-five children in Solola; *low education in mothers/poor knowledge of diarrhea in mothers/poor breastfeeding status of child/poor hand care after defecating/shorter distance to latrine/poor garbage disposal/unsafe water source/dirty food preparation area/sharing hand-washing water at meals*, it lies with the health managers to act on these findings as we all work toward reducing diarrhea morbidity in the children.

The high prevalence of diarrhea in the dry season (non-peak period) as revealed by this study is an adequate pointer to the fact that diarrhea is equally a big problem even in dry season.

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Appendix-1:QUESTIONNAIRE

Part 1		
1	Identification number.	…….
2	Village number	…….
3	Tribe of interviewee	…….
4	Date	…….
Part 2	**Demographic and socioeconomic characteristics**	
2.1	How old are you/thechild?…….years. ***Munavyaka vilinga?*** ***Mwana wanavyaka vilinga?***	**Age** **Sex: child <u>M</u> <u>F</u>** ..... ……..
2.2	What is the highest level of education you have attained? ***Sukulu mulikusambira kulekezga mphaa?***	1. No education……. 2. Primary……. 3. secondary : junior….. senior….. 4. post secondary…….. 5. adult education…….
2.3	What is your occupation? ***Nchito iyo mukugwira zuwa na zuwa ni nji?*** What is your income per month? ***Mukusanga ndalama zilinga pa mwezi kufuma muntchito yinu mukugwira?***	**<u>Mother</u>** **<u>Father</u>** 1.Peasant …… …….. 2.Employed …… …….. 3.Self employed …….. …….. ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~ 1.<K1000 …… …….. 2.K1000-2000…… …….. 3.>K2000 …… ……..

2.4	What is your marital status? ***Kasi muli pa nthengwa?***	1.Single…… 2.Married……
2.5	How many surviving siblings does your child have? ***Mbana walinga mulinawo sono, apo mwana uyu wakandapo ?***	Younger 1…… Older 2…… 3…… 4 or more…….
2.6	Do you have the following items in your home? ***Kasi katundu uyu muli nayo?***	1.Radio…… 2.Oxcart….. 3.Bicycle…. 4.Livestock: Size of herd cattle….. …… goats….. . …… chickens…. ……. pigs…….. ……. other…… . ……
Part 3	**Diarrhoea occurrence**	
3.1	Do you know diarrhea? ***Kasi nthenda ya pamtima/pamoyo mukuimanya?***	Yes……..No…….
3.1	If yes, what are the main signs/symptoms? ***Vimanyisko vyake nivi?***	1.3-4 unformed stools in 24 hours……. 2.Abdominal pain…. 3.Faecal agency…… 4.Cramps……. 5.Nausea…… 6.Vomiting…… 7.Fever……. 8.Blood/mucus in stools…….
3.2	Has your child suffered from diarrhea within the past days? ***Kasi mwana wakolanapo na pamtima sabata Or 2weeks Or >2weeks yajumpha?***	Yes: Past 7 , Past 2 weeks, Or more Yes, has diarrhea…….. Yes, with blood in stools…..
3.3	If yes, state the stool frequency, and the period of infection. ***Wakufumila/wakafumilanga kalinga pa zuwa, ndipo wakutola/wakatola mazuwa ghalinga kufumila?***	1.Stools: <3 per day……. 3-4 per day…….. >4 per day…….. 2.Days……
3.4	What do you think causes diarrhea in young children? ***Kasi vikwambiska pa mtima mu wana nivichi?***	List: 1.Evil spirit…… 2.Undigestible food…… 3.Worm infection…….. 4.Crawling……. 5.Teething……. 6.Organisms entering the body……. 7.Other…… 8.Don't know…….
3.5	What do you think spreads diarrhea? ***Kasi mukughanaghana kuti ivo vikuwandazga nthenda ya pamtima ni vichi?***	1…….. 5…… 2…….. 6…… 3…….. 7…… 4…….. 8……
3.6	Do you think diarrhea is health hazard to child's health? ***Kasi mukuona kuti nthenda ya pamtima njakofya***	Yes……..No……. Other……..

	kumoyo wamwana olo yayi?	
3.7	Do you know some of the ways for preventing diarrhea? ***Kasi mukumanya nthowa zakuphezgezera pamtima?*** If yes, mention some of them. ***Nenanipo nthowa zinyake mwaizi.***	Yes……No…….. …… …… …… …… …… ……
3.8	How did you happen to know about diarrhea, signs, mode of spread and prevention? ***Mukumanya wuli za pamtima, vimanyisko vyake, nakaphezgero kake?***	1.school…… 5.reading…… 2.radio…… 6.village health 3.hospital…… worker……. 4.friends……7.other…….
Part 4	**Faecal and rubbish disposal**	
4.1	Are children able to use latrine on their own? If not, where do they defecate? ***Kasi wana wakumanya kugwiriska ntchito chimbuzi kuti wajovwire? Pala apo cha, wakujiwovwira nkhu?***	Yes……..No…… **……**
4.2	If not in 3.1, how do you dispose of the feces? ***Pala mwana wachita chimbuzi pa walo mukupwelelera wuli?***	1.Stools disposed of a.right away…… b.after some time…… 2.Stools a.buried…… b.put in toilet……. c. thrown away in open surroundings…….
4.3	What care is given to child after defecating? ***Kasi mwana mukumupwelera wuli pala wachita chimbuzi?***	1.Cleaned: a.right away…….. b.after some time…… 2.Bottoms wiped with: a.water…….. b.dragged on ground…. c. other…… 3.Not cleaned at all: Why…….
4.4	What facilities do you use for defecating yourself? ***Kasi mukuya nkhuni palamwakhumba kujovwira?*** If b. state why? ***Ntchifukwa wuli mukunjira kuthengere?*** Do you think b. can spread diarrhea? ***Kunjira kuthengere kungandazga pamtima?***	a. latrine only b. bush only Why?..... c. both Yes……No…….
4.5	How do you care for your hands after defecating or after helping your child defecate? ***Kasi mukupwelelera wuli m'mawoko palamwamala kujovwira ota palamwamala kupipa mwana?*** If for 1a, what do you use for washing hands? ***Mukugwiriska ntchito vichi pakugeza m'mawoko?.*** If 1b. why not? ***Palani 1b. ntchifukwa wuli?*** If 2a. why not 2b? ***chifukwa mukugeza nasopo yayi?*** Do you think 1b can spread diarrhea? ***Kasi kuleka kugezamawoko kungawandazga pamtima***	1.a. wash hands b. don't wash hands c. other…… 2.a. water only b. water and soap c. other…….. Yes….. No……..
4.6	Do you think young children's feces are harmful in a way? ***Kasi mukuganiza kuti chimbuzi cha mwana***	Yes……No…….

	chingayambiska matenda?	
4.7	Where do you dispose of waste food and water? ***Majighakugwiriskika ntchito na chakulya chakukhala mukutaya nkhu?*** Why not pit latrine? ***chifukwa munkhando yayi?*** Do you think 1 or 2 or both can spread diarrhea? ***Kasi 1 olo 2 olo vyose vingandazga pamtima?***	1.rubbish pit……. 2.open surroundings……. why?..... Yes……..No……..
Part 5	**Water**	
5.1	From what sources do you get your drinking water? and why? ***Kasi maji mukumwa nkhu? ntchifukwa wuli mukumwa maji kufuma kumalo agha mwanena?***	1.pond…….. 2.river…….. 3.well…….. 4.tube…….. 5.other…….. Why?..... …….
5.2	Who collects the water? ***Mbanjani awo wakunegha maji?***	1.women……... 2.children…….
5.3	How do you transport water from the source? ***Maji mukunyamula wuli pala mwa negha.***	1.on head……. 2.oxcart…… 3.wheelbarrow…. 4.other……..
5.4	What utensils do you use for fetching drinking water? ***Kasi maji mukunyamula muvichi?***	1.wide-mouthed pails…… 2.wide-mouthed pails with leaves……. 3.narrow-mouthed clay pots……. 4.containers with lid…..
5.5	What treatment is given to water at the source before carrying home? ***Kasi maji mukupwelelera wuli palamukunegha?*** If 5 why not the others? ***Chifukwa wuli munozga majinthena yayi?*** Do you think 5 can spread diarrhea? ***Kuleka kunozga maji nthenda kungandazga pamtima?***	1.clean utensils: Yes……No…… 2.filtering by cloth…… 3.chlorinating…… 4.other means…… 5.none……. why?..... …… Yes……No…….
5.6	What other activities take place at the source or near the source? ***Kasi vinyake ivo vikuchitika pamalo or pafupi na malo ghakunegha maji nivichi?***	1.cleaning water containers …….. 2.washing clothes……. 3.bathing/washing self…… 4.watering animals……. 5.other……
5.7	Do you always clean/empty the storage container before replacing with fresh water? ***Kasi mukusuka chiwiya chamaji pambere munda wikemo majighanyake?*** If no. why? ***Pala yayi, chifukwa?*** Do you think not cleaning/emptying the water can spread diarrhea? ***Kuleka kusuka na kusintha maji kungaghandazga pamtima?***	Yes……No……. Why?..... Yes……..No……..
5.8	How often do you replace water in the storage container? ***Maji ghakumwa ghakugonera mazuwa gha linga***	Replace water: 1.everyday……

	pambere mundasinthe?	2.every 2 days…… 3.every 3 days…….. 4.more than 3days…….
5.9	How do you treat water before putting in storage vessels? ***Kasi maji mukughapwelelera wuli pambere mundawike mu chiwiya?*** If none, why? ***Pala cha nenani icho chikumutondeskani.***	How: 1. boiling……. 2.filtering……. 3.chlorination….. 4.none…… Why?..... ……. ……. …….
5.10	How is drinking water drawn from the vessels? ***Maji ghakumwa mukutola wuli kufuma muchiwiya?***	1.by pouring…….. 2.by dipping……..
5.11	Do children draw water from vessels themselves? ***Kasi wana wakutola wekha maji muchiwiya?***	Yes…….No……
5.12	What vessels are used for water storage? ***Ka majighakumwa mukusunga muviwiyambu?***	1.narrow-mouthed…… 2.narrow-mouthed with lid…….. 3.wide-mouthed……. 4.wide-mouthed with lid…
5.13	How much water do you fetch per day and how much do you use per day? ***Kasi mukukwaniska kunegha maji ghandi mbu? Ndipo mukugwiriska ghanandi mbu pazuwa?***	Fetch: 1.number of pails…….. Use: 1.number of pails……..
5.14	Do you think you fetch enough water for use at home per day? ***Kasi maji awo mukunegha pa zuwa mukupima kuti ghakumukwanani mose?***	Yes……No……
5.15	If no, state the reason for not being able to fetch enough water? ***Ntchifukwa wuli icho mukuwona chikumutondeskani kunegha maji ghakukwanila?***	Reason:…….. …… …… …… ……
Part 6	**Sanitation**	
6.1	Do you have a latrine? And is it in use? ***Kasi muna chimbuzi? Ndipo chikugwira ntchito?***	Yes……..No……. Yes in use……. Not in use…….
6.2	Is it private or public? ***Kasi wakugwiriska ntchito ndimwe pela olo na wanthu wanyumba zinyake?***	Private……. Common……..
6.3	If private, how often do you clean the latrine? ***Kasi muchimbuzi mukunozga kalinga?***	1.everytime it is spoiled…. 2.everyday……. 3.once/twice/thrice/more than 3 times a week. 4.do not clean……

6.4	How many people use the toilet? ***Chimbuzi ichi ntchawanthu walinga?***	2 3 4 5 6 7 8 9 10 11 12 13 14 15 >15
6.5	If public, who is responsible for cleaning the toilet? And how often is it cleaned? ***Ninjani wakunozga muchimbuzi?***	a. all us……. voluntarily…. Not cleaned…….. b.cleaning done: 1.everytime it is spoiled…. 2.everyday……. 3.once/twice/thrice/more than 3 times a week. 4.do not clean……
6.6	***Nchifukwawuli mukunozga chimbuzi yayi?***	Why?.....
6.7	Do you think no cleaning of latrine can help spread diarrhea? ***Kulekakunozga muchimbuzi kungandazga pamtima?***	Yes…….No…….
Part 7	**Food Preparation/other domestic behaviours**	
7.1	How do you treat hands before preparing child's food? ***Mm'mawoko palamunozgenge chakulya cha mwana mukupwelelera wuli?*** ***Palamukugezayayi nchifukwa wuli?*** ***Kulekakugeza kungandazga pamtima?***	a. washing b. washing with soap c. doesn't wash hands d. other…… why?..... Yes…….No…….
7.2	Does your child feed on her/his own or not? ***Mwana wakulya yekha olo cha?***	Yes…….No……
7.3	If yes, how do you treat his/her hands before eating any food? ***Kasi mwana mukumunozga wuli m'mawoko kuti walye chakulya chilichose?***	a. washing b. washing with soap c. doesn't wash hands
7.4	If no, how do you treat hands before feeding the child? ***Mukupwelelera wuli m'mawoko pambere mundayambe kulyeska mwana?***	a. washing b. washing with soap c. doesn't wash hands
7.7	What do you do when you see flies land on the food? ***Pala membe zadeka pachakulya mukuchitapo vi?***	1.continue feeding……. Why?..... 2.discontinue feeding……. Why?..... 3.recook/boil/heat food….. Why?.....
7.8	Do you store cooked food for later use? ***Chakulya mukusunga kuti mwana walye nyengo yinyake?***	Yes……..No…….
7.9	How long do you keep the food before reuse? ***Mukuchisunga nyengo utalimbu?***	……
7.10	If yes, how do you treat it before reuse? ***Mukunozga wuli pambere mundachigwiriske so nchito?*** Why not cover or heat the food? ***Chifukwa mukubenekelera/kufundiska yayi?*** ***Kasi ivi vingandazga pamtima?*** Do you think unheated food can spread diarrhea? ***Chimbala chingambiska pamtima?***	1.covered not covered ……. …… 2.heated…… not heated……. Why?..... Yes……No…… Yes……No……
7.11	What do you use to clean utensils/containers for feeding child? ***Mukusuka navichi vakulyeskelamo mwana?***	1.water only……. 2.hot water only……. 3.water with soap……

		4.hot water and soap……..
7.12	Do you share hand-washing water with children before meal? ***Maji mukugeza m'moza nawana palamulyenge?*** Why do you? ***Chifukwa mukuchita nthena?***	Yes……..No…… Why?.....
7.13	Do you have a kitchen? ***Munakhichini?***	Yes……...No…….
7.14	How often do you clean the kitchen? ***Mwakuphikila mukunozgamo?***	…… ……
7.15	Do animals enter the kitchen? ***Kasi viweto vikunjira mukhichini?***	Yes…….No……
7.16	Do you keep animals in the house/kitchen overnight? ***Viweto vikugona munyumba/mukhichini?*** Can animals spread diarrhea? ***Viweto vingandazga pamtima?***	Yes……..No…… Animals: goats-dogs-chikens-pigs calves-other Yes……..No……
Part 8	**Breastfeeding status**	
8.1	Do you breastfeed your child? ***Mwana wakuwonkha?*** **{If no, go to 8.4}**	Yes……No……
8.2	If yes, have you exclusively been breastfeeding the child todate? ***Kufika zuwalino, mwana wakhala wakonkha pera kwambula kulya vinyake olo yayi?***	Yes…….No…….
8.3	If no, how long by now have you introduced other foods to the child? ***Kufuma apo mukamuyambiska vakulya vinyake, pajumpha nyengo wuli?***	1.Weeks: 1 2 3 4 2.Months: ……..
8.4	Why is the child not on breastfeeding? ***Ntchifukwa wuli mwana wakuonkha yayi?***	1.weaned: months……./weeks…… 2.others…….. ……
8.5	Do you know that breastfeeding a child adequately and longer before weaning reduces infections (diarrhea) in a children? ***Kasi mukumanya kuti pala mwana waonkha nyengo yitali mundalumule, kukovwira kuchepeska matenda nge pam'mtima?***	Yes…….No…….
Part 9	**Vaccination status**	
9.1	Is your child/children vaccinated against the following diseases? ***Kasi mwana/wana winu walikupokera katemela wa nthenda izi?***	Yes No 1.diarrhoea …… ……. 2.measles …… ……. 3.other: …….. ……..

Appendix: III **Ref. no……**

Structured Observation Guide

Water

1.What are the available water sources?
a. well…….
b. spring……..
c. rain water……
d. seasonal pond…….
c. other…….

4.Observe the latrine.
a. is it in use?
b. hole with cover

e. tube…….
f. hand-dug well…….

2.Are the water sources protected?
a. yes b. semi-protected c. no
…….
…….

3.How far are water sources from people's homes?

Water source	Distance
…….	a. < 100 meters
…….	b. 100-200
…….	c. >200-500
…….	d. < 1 km
…….	e. 1-2 km
…….	f. 3-5 km
…….	g. 6-7 km
…….	h. > 8 km

4.What activities take place at or near the water source?
a. washing water containers.
b. washing clothes
c. bathing/washing self
d. watering animals
e. other

5.What is the average amount of water available for use in the home?
……..
…… liters.

Sanitation

1.Does the house have a latrine?
a. yes……. b. no……

2.How far is the latrine from the home?
……meters.

3.Are stools seen in the toilet surroundings? a. yes……b. no…….
If yes, what is the contamination Observed?
a. infants/young children's feces
b. cow dung/other animal feces
c. presence of fecal matter on the floor.
d. does the latrine provide adequacy?
e. is there sign of use of ash?
f. are there cleansing materials in the vicinity:……
……...

5.How close are hand washing facilities (water and ash or soap) to the latrine?
a. next to the latrine
b. within walking distance
c. inside the house
d. none

6.Is there evidence of fecal contamination in the surroundings of the house?
a. yes…….. b. no……...
If yes, what are they?
a. infants/young children's feces
b. animal feces
c. other

7.Is there a rubbish pit for the house?
a. yes b. no

8.Is garbage disposed of in the pit or just anyhow in the surroundings?
a. in the pit latrine
b. in the surroundings

9.Is there evidence of fecal contamination in the upper ground to the water source (well, pond, river)
a. yes….. b. no…….
If yes, what is fecal contamination?
a. human feces
b. animal feces
c. other

Others

10. Are flies seen in the kitchen/food preparation area? a. yes……. b. no ……
If yes, are they latrine flies or not? a. yes…… b. no……
11. Is the kitchen swept and clean(tidy)? a. yes……. b. no……
12. Are animals seen in the kitchen? a. yes…….. b. no……..
……...
13 .Examine the anthropometry of the children:
a. Height…….cm.
b. MUAC……
c. Weight……grams/kilograms.