PATTERNS OF DIARRHOEAL DISEASES IN UNDER-FIVE CHILDREN IN EMEKUKU: A HOSPITAL-BASED STUDY

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CERTIFICATION

I certify that this work "Patterns of Diarrhoeal Diseases in Under- Five Children in Emekuku: A Hospital-Based Case-Control Study of Risk Factors" was carried out by Njoku, Chinonyerem John (Reg. No: 20085634628) in partial fulfillment for the award of the degree of Master of Public Health (MPH) in Public Health Technology in the Department of Public Health Technology of the Federal University of Technology, Owerri.

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DEDICATION

I dedicate this thesis to God Almighty for His mercies in my life; to my parents, brothers and sisters, friends and to everybody who participated in this study and in making it a success.

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ABSTRACT

This study was undertaken to determine the patterns of diarrhoeal diseases in under-5 children and the associated risk factors in Emekuku, Imo State, Nigeria. A matched pair case control study design with strict inclusion and exclusion criteria was adopted. Cases were children with loose watery feces, pathologically diagnosed with diarrhoea by the physician. Each case was captured immediately after diagnosis by the physician and administered with the questionnaire. Controls were children diagnosed of any other disease other than diarrhoea. Both cases and controls were appropriately matched in terms of age, sex, and other determinants and enrolled from the outpatient and children's wards of the Hospital. A total of 176 under-5 children were enrolled with 88 cases and 88 controls. The results showed that most cases of diarrhoea observed were acute (93.2%), while persistent diarrhoea accounted for 6.8%. Ninety five percent (95%) of diarrhoeal cases were watery, with mean number of stools/child/day being 4.3 times (SD 1.92). Of the 17 exposure variables analyzed, only age (6-11 month); breast feeding (complementary feeding) ($P<0.001$); birth weight, maternal employment (unemployed women); toilet type (pit toilet); hand washing with water only ($P<0.001$); use of rain water and crowding index were significantly associated with diarrhoeal disease occurrence observed in this studied. The study shows that diarrhoeal diseases are still prevalent in this area. Interventions on exclusive breast feeding, provision of improved toilet type, and education on appropriate hand washing methods and improved sanitation should be intensified.

Keywords: Diarrhoea Diseases, Pathologically, Exclusive Breast Feeding.

CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND OF STUDY

Diarrhoea is one of the leading causes of morbidity and mortality among children aged 0-5 years in the developing world (Kosek *et al*., 2003). Annually 1.5 billion diarrhoea episodes and 4 million deaths caused by this occur in children under 5 years of age (Martha, 2004). Pooled data published in 1992 from 22 longitudinal studies conducted in 12 countries showed that infants aged 6-11 months had a median incidence of 5 episodes of diarrhoea per year (Bern *et al.*, 1992a). According to Martha (2004), a wide range of bacteria (e.g. *Shigella spp*, *Salmonella spp*, *Escherichia coli* and *Vibrio cholerae*), enteroparasites (e.g. *Giardia spp*, and *Entamoeba histolytica)* and viruses (Rotaviruses, Adenoviruses and Norwalk viruses) have all been implicated in diarrhoea episodes.

According to Park (2009), the term “diarrhoeal diseases” should be considered only as a convenient expression – not as a nosological or epidemiological entity – for a group of diseases in which the predominant symptom is diarrhoea. The World Health Organization (1990), defined diarrhoea operationally as the passage of three or more liquid or watery stools in a 24-hour period. Diarrhoea according to Bern and Glass (1994), is a symptom complex defined by increased number of stools of looser consistencies than usual per 24-hour period. In a comparison of definitions commonly used in epidemiological studies, Baqui et al (1992) reported that those with the best balance of sensitivity and specificity were 3 or more loose stools, or any number of stools containing blood, in a 24-hour period, while the operational definition of the end of an episode was 3 diarrhoea-free days. The authors concluded that differences in definition especially of the end of episode, made a substantial difference to the final estimate of diarrhoeal incidence, and that the validation of the definition of diarrhoea was important to the overall validity of the study.

According to WHO (1985), diarrhoea lasting 3 weeks or more may be called chronic; within this period, all acute diarrhoea will have resolved. Acute diarrhoea according to WHO/UNICEF (1983), is defined as an attack of sudden onset, which usually lasts 3 to 7 days but may last up to 10-14 days. In his suggestion Park (2009), posited that it is the recent change in consistency and character of stools rather than the number of stools that is more important.

While rotaviruses are associated with diarrhoea in industrialized nations, bacterial species are the leading cause of diarrhoea in children in developing nations. Several reports have identified socio-economic (poverty, parental income and education), environmental (poor sanitation, lack of water supply, crowding, season, residence etc) and other characteristics as risk factors for diarrhoeal morbidity and mortality (Awasthi *et al*., 1996; Mirza *et al.,* 1997; Clemens *et al.,* 1999). In Nigeria, the United Nations Children's Fund (UNICEF) has reported that about 200,000 cases of diarrhoea occur every year and is worsened by poor environmental sanitation and lack of potable water supply. Oral Dehydration Therapy and use of antibiotics have contributed to a major decline in diarrhoeal morbidity rate in the world.

1.2 PROBLEM STATEMENT/JUSTIFICATION OF STUDY

Despite the enormous public health interventions which include: education on exclusive breast-feeding, good environmental sanitation and provision of potable water and other home-case management methods, diarrhoeal diseases still remain a public health problem especially in Sub-Saharan Africa. However, the extent of compliance to exclusive breast-feeding, utilization of potable water and other sanitary hard-wares provided in addition to personal and environmental hygiene has not been ascertained by available studies in Nigeria. In Nigeria in particular, there has been paucity of recent data on socio-economic, environmental, demographic and nutritional risk factors on the aetiology of diarrhoea. In addition, a thorough analysis and assessment of the risk factors involved which should be a basis for effective case management remains a challenge. Furthermore, available data from hospital based studies are grossly inadequate and represent only a fraction of the actual cases occurring in the population. The aforementioned challenges have made it difficult to appreciate the magnitude of the diarrhoeal problem in Imo State, Nigeria, especially the risk factors in under-5-year-olds.

1.3 PURPOSE OF STUDY

This study therefore aimed at assessing the patterns of diarrhoeal diseases in under-5-year-olds and the risk factors using a hospital-based case control study design.

1.4 STUDY OBJECTIVES

The specific objectives of this study were:

- To determine the type and distribution of diarrhoeal diseases in relation to maternal and child risk factors.
- To determine the distribution between cases and non cases in relation to socioeconomic risk factors.
- To determine the distribution of between cases and controls of environmental risk factors
- To identify the risk factor(s) most strongly associated with diarrhoeal disease causation

1.5 STUDY QUESTIONS

This study was meant to unravel the following questions:

- What is the mean age, type of diarrhoea, mean number of stools and duration of diarrhoeal disease occurrence according to cases and controls?
- Would acute watery diarrhoea account for more than 75% of all diarrhea cases in under-5 children than persistent diarrhoea?
- Does any association exist between the risk factors and diarrhoeal disease occurrence among cases than in controls?
- Are the breast-feeding mode practiced, age of child, toilet type, crowding index and water source associated with increased risk of diarrhoea in cases as compared to controls in this study?
- Is hand-washing method a significant risk factor of diarrhoea disease occurrence in cases than in controls?

1.6 RESEARCH HYPOTHESIS

The following constituted our bivariate and multivariate statements of hypotheses:

- **Ho:** Acute watery diarrhoea would not account for more than 75% of all diarrhoea cases than persistent diarrhoea in under-5-year-olds in this area.

  Ha: More than 75% of all diarrhoea cases in under-5-year-olds observed in this study would be acute watery diarrhoea than persistent diarrhoea.
- **Ho:** There is no relationship between breast feeding mode (complementary), age (<6, 6-12 month-olds), toilet type (pit), crowding index (>3 children in a room) and water source (rain) and increased risk of diarrhoea in cases than in controls.

Ha: There is at least a 2-fold increased risk of diarrhoea in cases than in controls in terms of age (<6, 6-12 month-olds), breast-feeding mode (complementary), toilet type (pit), crowding index (>3 children in a room) and water source (rain) in this study.

- **Ho:** Hand-washing method (water only) would not be significantly associated with increased risk of diarrhoea in cases when compared with controls in this study.

  Ha: Hand-washing method (water only) carries an increased risk of diarrhoea in cases than in controls.

CHAPTER TWO

LITERATURE REVIEW

Diarrhoea remains a leading cause of morbidity and mortality in the world, predominantly affecting children in developing countries. It is both preventable and treatable. Diarrhoeal diseases kill 1.5 million children every year and globally there are about 2 billion cases every year. Diarrhoeal diseases affect children under 2 years old. Each child in the world experiences an average of one to three episodes of diarrhoea per year, with incidence rates as high as 100 per year for children in some areas (Bern *et al.,*1992b). During the 1990s, diarrhoea was estimated to cause 20 to 25 percent of mortality among children younger than 5 years in the developing world (Bern *et al.,*1992b). In this chapter, we review available literature on aetiology and clinical patterns, morbidity and mortality in Sub-Saharan Africa, measurement of morbidity and mortality, risk and prognostic factors, type of diarrhoea and finally interventions for the control of diarrhoea diseases in children.

2.1 ETIOLOGY

While non-infectious causes of diarrhoea may play a role, for example among the hospitalized elderly (Lew, 1991), the most important aetiological agents of diarrhoea are viral and bacterial with rotavirus and enterotoxigenic *E. coli* generally identified most frequently among children in developing countries, and viral aetiologies playing a proportionately greater role in industrialized settings (Huilan, 1991; Bern & Glass, 1994). Even among the elderly, infectious diarrhoea may be an important contributory cause of mortality (Lew, 1991). The following pathogenic microorganisms were isolated by (Lucas & Gilles, 2003; Ogbu *et al*., 2008): Enteroviruses e.g. rotavirus; *E. coli* (Enterotoxigenic *E. coli* (ETEC), Localized-adherent *E. coli* (LA-EC), Diffuse- adherent *E. coli* (DA-EC), Enteroinvasive *E.coli*

(EIEC) and Enterohaemorrhagic *E. coli* (EHEC)), *Salmonella spp*, *Klebsiella spp*, *Campylobacter spp, Shigella spp*, *Vibrio cholera 01* and *0139*, *Yersinia enterocolitica Enterobacter spp, Entamoeba histolytica*, *Giardia lamblia*, *Trichuris trichiura* and *Cryptosporidium spp.*

(A) Rotaviruses:

The rotaviruses, first discovered in 1973, have emerged as the leading cause of severe, dehydrating diarrhoea in children aged <5 years globally, with an estimated more than 25 million outpatient visits and more than 2 million hospitalizations attributable to rotavirus infection each year (Park, 2009). Severe rotavirus gastroenteritis is largely limited to children aged 6-24 months. Fatal outcome, estimated to be approximately 527,000 in 2004, occur predominantly in low-income countries. Rotavirus re-infection is common, although the primary infection is usually the most significant clinically (Park, 2009).

In temperate climates, the incidence of rotavirus gastroenteritis typically peaks during the winter season, whereas in tropical settings rotaviruses occur year round and a marked seasonality may be marked by high background levels (WHO, 1988). Rotaviruses are shed in very high loads ($>10^2$ particles gram) and for many days in the stools and vomit of infected individuals. Transmission occurs primarily by the faeco-oral route, directly from person to person or indirectly through contaminated fomites (Park, 2009). According to WHO (2004), the universal occurrence of rotavirus infections shows that clean water supplies and good hygiene are unlikely to have a substantial effect on virus transmission.

(B) Bacterial Causes

Besides the well-known bacterial causes of enteric infections and diarrhoea diseases such as *V. cholerae* 01, *Samonella Shigella*, enterotoxigenic *E. coli* and

Campylobacter jejuni are the most frequent cause of diarrhoea (Park, 2009). They produce a potent enterotoxin similar to that produced by *V. cholerae*. Enterotoxigenic *E. coli* (ETEC) is an important cause of acute watery diarrhoea in adults and children and it is also the most common cause of traveler's diarrhoea. The *Campylobacters* namely *C. jejuni* and to a lesser extent *C. coli*, are the major cause of diarrhoeal illnesses, rivaling and even surpassing *Salmonella* in importance in many countries. The diarrhoea produces stools containing 10^6-10^9cells/gram, which are often foul-smelling and can vary from being profuse and watery to bloody and dysenteric (Adams & Moss, 2008).

The diarrhoeagenic *Salmonella* which include *S. enteritidis*, *S. typhimurium* and *S. virchow* are the most common cause of enteritis. The infectious dose of salmonella is high, of the order of 10^6 cells, but this will vary with a number of factors such as the virulence of the serotype, the susceptibility of the individual and the food vehicle involved. The *Shigellas* namely: *Sh. flexneri*, *Sh. boydii*, and *Sh. sonnei* are all human pathogens though they differ in the severity of the illness they cause (Adams & Moss, 2009). *Shigella dysenteriae* has been responsible for epidemics of bacillary dysentery in tropical countries. The *V. cholerae* and *V. parahaemolyticus* cause profuse, watery diarrhoea containing flakes of mucus, described as rice water stools. The diarrhoea, which can be up to 20L/day and contain up to 10^8 vibrios /ml is accompanied by vomiting, but without nausea or fever.

Diarrhoea causes morbidity and mortality through several mechanisms. **Acute watery diarrhoea** can lead to dehydration severe enough to require hospitalization and cause death. Rotavirus is the agent most frequently associated with acute dehydrating diarrhoea, and affects children younger than 2 years (Kapikian & Chanock, 1990). *Vibrio cholerae* can cause epidemic of dehydrating diarrhoea affecting all age groups, and may lead to high case fatality rates in the absence of public health intervention, as in the epidemic among Rwandan refugees in Goma, Zaire (Goma Epidemiology Group, 1995). Dysentery, most often associated with *Shigella spp,* may cause death through bacteraemia or hypoglycaemia (Bennish, 1991), but also is associated with a more marked effect on growth (Black *et al*.,1984). **Persistent diarrhoea**, defined as diarrhoea lasting at least 14 days (WHO,1988), has been recognized recently as an entity which carries a risk of both nutritional compromise and of mortality in excess of that for acute diarrhoea (Bhan *et al.,* 1989; Victora *et al*., 1993). While enteroaggregative *E. coli* and *Cryptosporidium* have been associated with persistent diarrhoea (Bhan *et al*., 1989; Baqui *et al*., 1992; Henry*,* 1992), often no specific pathogen can be implicated (Lanata *et al.,* 1992), and serial infection with different organisms may play a role (Baqui *et al.,*1992).

Non –microbial causes include:

Malnutrition: Children who die from diarrhoea often suffer from underlying malnutrition, which makes them more vulnerable to diarrhoea. Each diarrhoeal episode, in turn, makes their nutrition even worse. Diarrhoea is the leading cause of malnutrition in children under five years of age. The enumeration of the germs causing the enteric infections which lead to acute diarrhoea should not overshadow the fact that diarrhoea may be caused by a parenteral infection (non-digestive origin) and particularly so in younger children. These include ENT infections, respiratory or urinary infections, malaria, bacterial meningitis, or even simple teething (Fricker, 1993). In the developed countries, the cause of diarrhoea may be slightly different. According to Pizzarro (1985), diarrhoea in the newborn is unusual and may be due to inborn errors in metabolism such as congenital enzyme deficiencies. It may be associated with severe infections like septicemia or necrotizing enterocolitis.

2.2 PATHOGENESIS / MECHANISM OF DIARRHOEAL DISEASE.

Diarrhoea is a symptom complex defined as an increased number of stools of a looser consistency than usual per 24-hour period. Frequent passing of formed stools is not diarrhoea, nor is the passing of loose “pasty” stools by breast-fed babies. Any process that interferes with the gut’s capacity to absorb most of the 8-10L of fluid it receives each day will produce this condition (Adams & Moss, 2008). Consequently, the aetiology of diarrhoea can be quite complex as a number of different mechanisms have been identified by Adams & Moss (2008). Viable bacteria ingested with food colonize the intestinal lumen and attach to the epithelial surface by producing **adhesin** molecules often associated with fimbriae on bacterial cell surface. These molecules recognize and attach to specific receptor sites on the microvilli. Once attached the pathogen produces a protein **enterotoxin** which acts locally in the gut changing the flow of electrolytes and water across the mucosa from one of absorption to secretion. Several enterotoxins act by stimulating enterocytes (the cell lining intestinal epithelium) to over-produce cyclic nucleotides.

Most extensively studied in this respect is the cholera toxin produced by *V. cholerae*. The toxin (MW 84,000) comprises five B subunits and a single A subunit. The B subunits bind to specific ganglioside (an acidic glycolipid) receptors on the enterocyte surface. This creates a hydrophilic channel in the cell membrane through which the A unit can pass. Once inside the cell, a portion of the A unit acts enzymically to transfer an ADP- ribosyl group derived from cellular NAD (Nicotinamide Adenine Dinucleotide) to a protein regulating the activity of the enzyme adenylate cyclase. As a result, the enzyme is locked into its active state leading to accumulation of cyclic AMP (cAMP) which inhibits absorption of Na^+ and Cl^- ions while stimulating the secretion of Cl^-, HCO_3^- and Na^+ ions.

To maintain an osmotic balance, the transfer of electrolytes is accompanied by a massive outflow of water into the intestinal lumen. This far exceeds the absorptive capacity of the large intestine and results in profuse watery diarrhoea. A number of other enterotoxins have been shown to act in the same way as the cholera toxin. However *E coli* stimulates the production of (cGMP) which differs from (cAMP) in its activity but also produce diarrhoea as result of electrolyte imbalances.

Other enteroinvasive pathogens like *Shigella* invade the colonic mucosa and produce a dysenteric syndrome characterized by inflammation, abscesses, and ulceration of the colon and the passage of bloody, mucus- and pus-containing stools. They are engulfed by the enterocytes in response to a phagocytic signal produced by the bacterium and multiply within the cytoplasm invading adjacent cells and the underlying connective tissue. The strong inflammatory response to this process causes abscesses and ulceration of the colon.

Dehydration is the most severe threat posed by diarrhoea. During diarrhoea, water and electrolytes (Na, Cl, bicarbonates) are lost through liquid stools, vomit, sweat, urine and breathing. Dehydration occurs when losses are not replaced. The degree of dehydration is rated on the scale of 3:

(1) **Early dehydration** – no signs and symptoms;

(2) Moderate dehydration – thirst, restlessness or irritable behavior; decreased skin elasticity; sunken eyes;

(3) Severe dehydration – symptoms become more severe; shock, with diminished consciousness, lack of urine output, cool, moist extremities, a rapid and feeble pulse, low or undetectable blood pressure and pale skin.

Death can follow severe dehydration if body fluids and electrolytes are not replaced, either through the use of Oral Rehydration Salt (ORS) solution or through an intravenous drip.

2.3 THE MAGNITUDE OF THE GLOBAL PROBLEM OF DIARRHOEAL DISEASES

Of the estimated total 10.6 million deaths among children younger than five years of age worldwide, 42 percent occur in (WHO) African region (Bryce *et al*., 2005). Although, mortality rates among these children have declined globally from 146 per 1,000 in 1970 to 79 per 1,000 in 2003 (WHO, 2005), the situation is strikingly different. As compared with other regions of the world, the African region shows the smallest reductions in mortality rates and the most marked slowing down trend. The under- five mortality rate in the African regions is seven times higher than that in the European region. In 1980s this difference was equal to 4.3 times (WHO, 2005). During the 1990s, the decline of U-5 mortality rates in 29 countries of the world stagnated, and in 14 countries rates went down but then increased again. Most of these countries are from the African region (WHO, 2005). A factor that may contribute to this situation is the HIV/AIDS epidemic in the region, but an underlying weakness of the implementation capacity of the health system is also likely to blame (Walker *et al.,* 2002).

Similar to all cause mortality, global estimates of the number of deaths due to diarrhoea have shown a steady decline from 4.6 million in the 1980s (Synder & Merson, 1982) to 3.3 million in the 1990s (Bern *et al.,* 1992b). However, diarrhoeal diseases continue to be an important cause of morbidity and mortality worldwide, and despite all advances in health technology, improved management and increased use of ORT in the past decades, they remain among the five major killers of children under five years of age. In contrast to mortality trends, morbidity due to diarrhea has not shown a parallel decline and global estimates remain between two and three episodes of diarrhea per child under five per year. Kosek *et al.* (2003), estimated a global median incidence of diarrhoea to be 3.2 episodes per child –year in the year 2000, similar to those found in previous reviews by Synder & Merson (1982) and by Bern and Colleagues (1992b), as well as those reported by Jamison *et al* (1993)

2.4 MEASUREMENT OF DIARRHOEAL MORBIDITY AND MORTALITY

2.4.1 MORBIDITY

Community longitudinal studies provide the most reliable data for diarrhoeal disease incidence and, if the study size is large enough, mortality estimates. Even for longitudinal studies, however, morbidity estimates can be shown to vary with the intensity of surveillance, with twice weekly surveillance resulting in higher estimates than less frequent surveillance (Bern *et al*.,1992b). For example, in one study that made regional estimates for diarrhoeal morbidity, the reported number of episodes per child per year was consistently higher in studies in Latin America than in studies in India or Bangladesh, but the frequency of surveillance in the Latin American studies was also consistently higher (Bern *et al*.1992b).

However, in a more recent study conducted in India with home visits every 3 days, the incidence of diarrhoea was found to be similar to that in the most frequently surveyed Latin American communities (Bhandari *et al*., 1994). This suggests that among children in the poorest communities, diarrhoeal disease incidence is remarkably similar around the world, and that in studies with less frequent surveillance, the shorter or less severe episodes are likely to be missed. However, the major limitations of longitudinal studies as noted by Bosch-Pinto *et al,* (2009), are: lack of representativeness, possible site bias, low frequency of surveillance visits and recall bias. Most reviews carried out so far (Synder & Merson, 1982; Bern *et al*.,1992b; Kosek *et al*., 2003), have relied on published studies to estimate the incidence or prevalence of diarrhoeal disease *via* meta analysis. Some of the limitations of this type of study are the small number of data points and the lack of representativeness, given the specific sites where most studies are carried out.

2.4.2 MORTALITY

While longitudinal studies are best for measurement of incidence of disease, the number of individuals followed is generally too small to allow measurement of mortality. Hence active surveillance, survey data and vital registration are the principal methods used for mortality assessment. For developing countries, where nearly all mortality from diarrhoea occurs, vital registration is unreliable or incomplete and a so-called '**gold standard**" does not exist for its assessment (Bern and Glass,1994).In addition, where vital registration is incomplete or absent, cause of death is ascertained on the basis of verbal autopsy methods, and the sensitivity and specificity of these methods for the diagnosis of diarrhoea and of dehydration have varied substantially in different evaluations (Kalter *et al*., 1990; Snow *et al*.,1992). In one study verbal autopsy identified diarrhoeal deaths with a specificity greater than 80 percent, but a sensitivity less than 50 percent (Snow *et al*.,1992), while in another, the performance of verbal autopsy for the diagnosis of diarrhoea was adequate, but the identification of deaths from severe dehydration is problematic (Kalter *et al*.,1990).

Nevertheless, estimates based on these methods reflect the best available data on the magnitude of diarrheal mortality, and useful for comparison to the estimates published by the Global Burden of Disease Study (World Bank, 1993; Murray & Lopez, 1997). The main limitations of vital registration systems are underreporting of the number of deaths and miscoding of the causes of death, most of the limitations described for the use of longitudinal studies for estimating morbidity also apply to mortality estimation, such as lack of representativeness, possible site bias and misclassification of the causes of death (Bosch-Pinto *et al*., 2009). On the other hand, vital registration coverage in African region has been inadequate and most information on cause-specific mortality relies on special studies available in the literature.

2.5 THE ROLE OF RISK FACTORS FOR DIARRHOEAL DISEASES

Broadly recognized risk factors for diarrhoeal diseases include little or no access to safe water and sanitation as well as poor hygiene and faeces disposal practices at home (Daniel *et al*., 1990; Haggerty *et al*.,1994; LaFond,1995; MacDougall & McGahey, 2003). These and many other factors such as poor housing, crowding, poor parental education, low family income as observed by Bosch-Pinto *et al*, (2009), are intrinsically associated with poverty. Furthermore, poverty usually limits access to health care and restricts appropriate and balanced diets leading to malnutrition and worsening the prognosis of the disease. According to Victora *et al.* (2003), inequities in exposures and resistance are due to inequities in coverage of available preventive interventions, access to an appropriate health provider and care, making poor children more likely to become sick than the better-off children.

Some studies have identified a few family characteristics as protective factors. These are monogamy of the father, defined residential area (Vaahtera *et al*., 2000), having a private kitchen and being cared for by the mother (Oni *et al*., 1991). Many other studies in available literature reported age of mother and child, season, previous diarrhoeal illness in the past 14 days, breast-feeding mode, weaning, pigs in the household and eating of leftovers as important risk factors (Molbak *et al*., 1997; Lucas & Gilles, 2003; El-Gilany & Hammad, 2005;). These factors are of special importance in Sub-Saharan African, where the AIDS epidemic has led to an unprecedented number of orphans (about 12 million by the end of 2001). Reports by Kosek *et al.*

(2003), indicated that diarrheal incidence, duration, severity and mortality are higher in children with HIV/AIDS than in others.

2.6 INTERVENTIONS TO CONTROL DIARRHOEAL DISEASES

There is sufficient evidence that several interventions are effective in the prevention and treatment of diarrhoeal diseases (Jones *et al*., 2003). These interventions are exclusive breast-feeding, better weaning practices, complementary feeding, safe water, good sanitation and hygiene, zinc and vitamin A supplementation, ORT and antibiotics for dysentery and higher rates of measles immunization. It is estimated that these intervention could prevent 22 percent of deaths due to diarrhoea (Jones *et al*., 2003). Most of these interventions are feasible for implementation in low-income countries such as those in the African region, however, the capacity to deliver these important interventions effectively should be strengthened (Bryce *et al*., 2003). The availability of safe and effective rotavirus vaccines (Ruiz-Palacios *et al*., 2006; Vesikari *et al.,* 2006), introduced in several countries in Latin America in 2005 are likely to complement these interventions, if effectively delivered.

However, the stability of diarrhoea rates observed in all reviews done since 1980s shows that despite the reduction of diarrhoea mortality, most likely through better case management, very little has been done to prevent the transmission of diarrhoeal diseases (Cynthia *et al*., 2009). The progress toward better water and sanitation observed in other regions has not yielded a reduction of diarrhoeal morbidity, suggesting that poor hygiene practices (Yeager *et al*., 1999) and the ingestion of contaminated food (Lanata, 2003) may be the most important factors and here preventive interventions like hand-washing (Curtis & Caincross, 2003), should be promoted.

2. 6.1 COMPONENTS OF A DIARRHOEAL DISEASE CONTROL PROGRAMME

The intervention measures recommended by WHO (2004) may be classified as below:

1. Short term

a. Appropriate clinical management

2. Long – term

b. Better MCH care practices

c. Preventive strategies

d. Preventing diarrhea epidemics

2.6.1.1 CASE MANAGEMENT: ORAL REHYDRATION THERAPY

Rehydration is the replenishment of water and electrolytes lost through dehydration. It can be by mouth (oral rehydration) or by adding fluid and electrolytes directly into the bloodstream (intravenous rehydration). As oral rehydration is less painful, less invasive, and easier to provide, it is the treatment of choice for mild dehydration from infectious gastroenteritis. Because severe dehydration can rapidly cause permanent injury or even death, intravenous rehydration is the initial treatment of choice for that condition. Oral Rehydration therapy (ORT) is the major intervention that has been promulgated globally for the control of morbidity and mortality from diarrhoeal diseases. ORT is not a primary intervention, in that it does no affect incidence of diarrhoeal disease but it has been shown to be effective in reducing hospitalizations and mortality from diarrhoea in intensive studies (Rahaman, 1979; Oberle, 1980; Heyman, 1990). ORT includes Oral Rehydration Solution (ORS). Treatment with ORS is simple and facilitates the management of uncomplicated cases of diarrhoea of any etiologic agent at home (King, 2003). However, according to King,(2003), the barriers to ORT use for diarrhoeal diseases include cultural practices, lack of parental knowledge and lack of training of health professionals.

Oral rehydration can be accomplished by drinking frequent small amounts of an oral rehydration salt solution. One standard remedy is the WHO/UNICEF glucose-based Oral Rehydration Salts (ORS) solution, which contains 75 mEq/l of Sodium, 75 mmol/l of Glucose, 65 mEq/l Chloride, 20 mEq/l Potassium, and 10 mEq/l Citrate, with a total Osmolarity of 245 mOsm/l. It is important to rehydrate with solutions that contain electrolytes, especially sodium and potassium, so that electrolyte disturbances may be avoided. Sugar is important to improve absorption of electrolytes and water, but if too much is present in ORS solutions, diarrhoea can be worsened. Oral rehydration does not stop diarrhoea, but keeps the body hydrated and healthy until the diarrhoea passes. There are several commercially available products but an inexpensive home-made solution consists of 8 level teaspoon of sugar and 1 level teaspoon of table salt mixed in 1 litre of water. A half cup of orange juice or half of a mashed banana can be added to each litre both to add potassium and to improve taste. If commercial solutions are used, true rehydration solutions should be used and sports drinks should be avoided (especially in younger children) as these solutions contain too much sugar and not enough electrolytes. The amount of rehydration that is needed depends on the size of the individual and the degree of dehydration. Rehydration is generally adequate when the person no longer feels thirsty and has a normal urine output. A rough guide to the amount of ORS solution needed in the first 4-6 hours of treatment for a mildly dehydrated person is:

- Up to 5 kg (11 lb): 200 – 400 ml
- 5-10 kg (11-22 lb): 400 – 600 ml

- 10-15 kg (22-33 lb): 600 – 800 ml
- 15-20 kg (33–44 lb): 800 – 1000 ml
- 20-30 kg (44-66 lb: 1000 – 1500 ml
- 30-40 kg (66-88 lb): 1500 – 2000 ml
- 40 plus kg (88 lb): 2000-4000 ml

WHO estimates suggest that increased global access to ORT coupled with methods to improve usage have the potential to decrease global mortality from diarrhoea (WHO, 1992). The extent to which this will be effective will depend upon the proportion of mortality resulting from acute watery diarrhoea in the locality (Victora *et al*., 1993). In areas where diarrhoeal mortality is very high and ORT access is low, such as Sub-Saharan Africa, a large fraction of deaths may be preventable through improved ORT access and education in addition to other interventions.

2.6.1.2 INTRAVENOUS REHYDRATION:

Intravenous infusion is usually required only for the initial rehydration of severely dehydrated patients who are in shock or unable to drink. Such patients are best transferred to the nearest hospital or treatment centre (Park, 2009). The solutions recommended by WHO for intravenous infusion are:

(a) Ringer's lactate solution (also called Hartmann's solution for injection): it supplies adequate concentrations of sodium and potassium and the lactate yields bicarbonate for correction of the acidosis.

(b) Diarrhoea treatment solution (DTS): Also recommended by WHO as an ideal polyelectrolyte solution for intravenous infusion.

However, if nothing is available, normal saline can be given because it is often readily available.

2.6.1.3 MAINTENANCE THERAPY

After the initial fluid and electrolyte deficit has been corrected (i.e., the signs of dehydration have gone), oral fluid should be used for maintenance therapy. In adults and older children, thirst is an adequate guide for fluid needs; they can be told to drink as much as they want to satisfy their thirst. The general principle is that the oral fluid intake should equal the rate of continuing stool loss, which should be measured.

2.6.1.4 APPROPRIATE FEEDING

The current view is that during episodes of diarrhea, normal food intake should be promoted as soon as the child whatever its age, is able to eat. This is especially relevant for the exclusively breast-fed infants. Newborn infants with diarrhea who show little or no signs of dehydration can be treated by breast-feeding alone. Those with moderate or severe dehydration should receive ORS. Breast-feeding is continued along with ORS given after each liquid stool. Not only breast milk helps the infant to recover from an attack of diarrhoea both in terms of the nutrients it supplies, and its rehydrating effect, but it helps to prevent further infection because it has protective properties.

2.6.1.5 CHEMOTHERAPY:

Unnecessary prescription of antibiotics and other drugs will do more harm than good in the treatment of diarrhoea. Antibiotics should be considered where the cause of diarrhoea has been clearly identified as *Shigella*, typhoid or cholera.

2.6.1.6 ZINC SUPPLEMENTATION

When a zinc supplement is given during an episode of acute diarrhoea, it reduces the episode’s duration and severity. In addition, zinc supplements given for 10 to 14 days lower the incidence of diarrhoea in the following 2 to 3 months. WHO and UNICEF therefore recommend daily 10mg of Zn for infants < 6 months and 20mg for children older than 6 months for 10-14 days.

2.6.1.7 BETTER MATERNAL AND CHILD HEALTH CARE PRACTICE

(A) Maternal Nutrition: Improving prenatal nutrition will reduce the low birth weight problem and improve quality of breast milk.

(B) Child Nutrition:

Promotion of Breast-feeding: Any measure to promote breast feeding is likely to reduce the diarrhoeal diseases in infants. Promotion of breast-feeding should include strong efforts to limit the use of commercial and artificial formulas. Breast-feeding should be continued as long as possible. Health education of mothers and caregivers on the benefits of exclusive breast-feeding on enhancing mother-child bonding, prevention of diseases and cognitive development of the child should be carried out.

Appropriate Weaning practices: Poor weaning practices are a major risk factor for diarrhoea. The child should be weaned neither too soon, nor too late, in any case not earlier than the sixth month of life using nutritious and locally available foods and the foods should be hygienically prepared and given.

Supplementary feeding: This is necessary to improve the nutritional status of children aged 6-59 months. As soon as the supplementary food is introduced, the child enters the high-risk category.

2.6.1.8 PREVENTIVE STRATEGIES

Sanitation: Measures to reduce transmission emphasize the traditional improved water supply, improved excreta disposal, and improved domestic and food hygiene. Without an adequate supply of clean water close to the homes, it is extremely difficult to promote personal and domestic hygiene. Simple hygiene measures like hand washing with soap before preparing food, before eating etc should be promoted. All families should have a clean and functioning latrine.

Health Education: Environmental sanitation measures require support, to ensure their proper use and maintenance of such facilities. An important part of health worker's job is to help prevent diarrhoea by convincing and helping community members to adopt and maintain certain preventive practices such as breast-feeding, improved weaning, clean drinking water, use of plenty of water for hygiene, use of latrine, proper disposal of stools of young children etc. Education on the formulation of ORT using locally available ingredients should be encouraged.

Immunization: Immunization against measles is a potential intervention for diarrhoea control. When administered at the recommended age, the measles vaccine can prevent up to 25% of diarrhoeal death in children under 5 years of age.

Fly control: Flies breeding in association with human or animal faces should be controlled.

In order to ensure and maintain a reduction in mortality and morbidity due to diarrhoeal diseases, control efforts must be continued and intensified. Promotion of correct case management of acute watery diarrhoea and dysentery; appropriate care-seeking and access to treatment; continued improvement in measles immunization coverage; promotion of exclusive breast-feeding; improved weaning foods and good domestic hygiene and health education should be incorporated into National Communicable Diseases Control Programme in Nigeria.

CHAPTER THREE

MATERIALS AND METHODS

3.1 STUDY SETTING AND SITE SELECTION

Emekuku is one of the peri-urban areas in Owerri-North Local Government Area, Imo State, Nigeria. It is located about 3Km from the city of Owerri along Owerri-Umuahia highway. It has a population estimate of about 20,000 people and occupies about 500Km^2 area giving a population density of about 100 people/Km^2. It has 10 villages. The neighbouring Local Governments Areas are Mbaise and Ikeduru LGAs. The area has a highly educated population with a medium-sized population of under-five children giving an average of about 4 children/family. The inhabitants are farmers, teachers, traders and other allied occupations. Emekuku has adequate supply of water and good sanitation, although the Oramurukwu stream occasionally serves the water needs of the people. Holy Rosary Hospital, a Catholic-owned secondary health institution is located here in Emekuku and serves as the major source of medical care. This hospital was chosen for feasibility, sophistication, level and effectiveness of health care services rendered and other logistic reasons for the study.

3.2 STUDY POPULATION

The study population was children less than 5 years of age resident in the area and its environs during the period of study. The exclusive and inclusive criteria for enlisting them in the study are summarized below:

3.2.1 Exclusive Criteria:

- Children currently under years but who were more than 59 months before the end of the study;
- Under-5 children who left the area due to one reason or the other; and

- Under-5 children whose guardians declined consent.

3.2.1 Inclusive Criteria:

- Under-5 children who were not indigenes were in the area and made use of the Hospital during the study period.
- Children born few days or within 1 month into the study.
- Children diagnosed of other ailments other than diarrhoea were included as controls

3.3 SAMPLE SIZE AND SAMPLING TECHNIQUE

The WHO definition of a “case of diarrhoea” as the passage of three or more liquid or watery stools in a 24-hour period was adopted. Controls were children of similar age, sex and socio-economic background as cases who visited the hospital but were diagnosed of other ailments other than diarrhoea. Every case of diarrhoea diagnosed by the doctor was documented and the questionnaires administered on their mothers or caregivers after thorough explanation of the purpose of the study and their consent sought. This was done immediately the child was examined by the doctor and after laboratory confirmation of preliminary diagnosis. The period was from October 2010 to April 2011. Other under-five-year-olds diagnosed of other ailments other than diarrhoea were enrolled as controls and asked questions on the risk factors only. A total of 176 children under 5 years of age (1 month to less than 60 months of age), namely 88 cases and 88 controls were enlisted in the study and questionnaires administered on their mothers or caregivers. These 176 children were the total number of children seen in the outpatient and children’s wards of the hospital whose caregivers gave informed consent to be administered with the questionnaire based on inclusion criteria.

3.4 INSTRUMENTS AND DATA COLLECTION

We designed a structured questionnaire that covered all the risk factors under study and which captured diarrheal disease occurrence among the target group was used to collect data. No translation of the questionnaire was required as most of the respondents could understand English language in most cases (see Appendix 1). The researcher and the designated research assistants (doctor and nurses) ensured that no participant was administered the questionnaire more than once. The questionnaire was in four parts namely: diarrhoeal status; maternal and child risk factors; socio-economic risk factors and environmental risk factors. Only under-5 children diagnosed with diarrhoea by the doctor (cases) were asked questions on their diarrhoea status and other risk factors, while controls were asked questions on risk factors only.

3.5 DEVELOPMENT AND VALIDATION OF INSTRUMENTS

The questionnaire instrument was pre-tested on a pilot scale on selected mothers or care-givers to enhance the validity and reliability of this instrument. After the pilot test, observed gaps and necessary modifications on the questionnaire especially in terms of the content were carried out to ensure clearer understanding and a reduction in the number of questions, and better internal validity and reliability of the instrument. Thorough cross-checking in order to reduce errors was carried out. The professional opinions of my supervisor and other lecturers were sought in determining the validity and reliability of the instrument.

3.6 ADMINISTRATION OF INSTRUMENTS

The researcher trained the nurses on methods of completion of the questionnaire both in the outpatient and children’s wards of the hospital. No money or any other financial inducement was paid until the end of the study to reduce bias and ensure that accurate data was collected. A doctor was assigned to coordinate the study. The researcher visited the hospital weekly or bi-weekly to check and correct any difficulties encountered while completing the questionnaires. Questions about diarrhoeal status were not administered to the controls but rather cases. Other questions on the risk factors were administered to both cases and controls.

3.7 DATA ANALYSIS

The prevalence of diarrhoeal disease according to each risk factor group was calculated and tabulated. Simple bar and pie charts and means were used to carry out preliminary data analysis. Calculation of Adjusted Odds Ratio based on each risk factor group was done using logistic regressional analysis. Data generated was computed and analyzed using SPSS version 16.0. Chi - square was used to test hypotheses and relationship between each risk factor group and diarrhoeal disease occurrence. Our statistical significance was set at $P<0.05$, our power of study was put at 80%.

3.8 ETHICAL CONSIDERATIONS

Ethical standards for conducting studies were maintained through the following measures: Institutional ethical clearance was obtained from the Head of Department of Public Health of the University.Permission to use the hospital for the study was sought with the letter addressed to the Chief Medical Director of the Hospital and advocacy visit. Sequel to this introduction, a doctor was designated for the study who acted as the overall coordinator and helped in convincing participants and in assigning nurses for the data collection process. Participation was by way of informed consent of mothers and caregivers after explanation of the aim of the study and on voluntary basis.

CHAPTER FOUR

RESULTS

The results showed that most diarrhoea cases were acute diarrhoea (93.2%) while persistent diarrhoea accounted for only 6.8% of all cases observed. Ninety five percent of all diarrhoea cases were watery, only 4.5% were bloody, as shown in Figure 1. The mean number of stools per child per day was 4.3 times (SD 1.92).

4.1 TYPE AND DISTRIBUTION OF DIARRHOEA IN RELATION TO MATERNAL AND CHILD RISK FACTORS:

The mean age of cases and controls were 13.5 months (SD=11.23; 95%CI=11.1-15.9) and 11.2 months (SD=10.75; 95%CI=8.9-13.5) respectively. The mean age difference (2.3; SE(d)=1.66) in both cases and controls was not statistically significant. More than a half of cases of diarrhoea were observed among children 6-11 months (55.7%) as shown in Figure 2. A gradual decrease in the incidence of diarrhoea was observed as age increased ($\mathbf{X^2}$ =6.704, P-value = 0.244). There was an increased risk of diarrhoea at lower age groups whereas older age groups exhibited a significant level of protection from diarrhoea. There were 42 (47.7%) and 46 (52.3%) males in cases and controls and 46(52.3%) and 42(47.7%) females in cases and controls respectively ($\mathbf{X^2}$ =0.569, P-value = 0.546), but the risk of diarrhoea based on sex was not statistically significant. Diarrhoea occurred more among children in the second and third birth order 52 (59.1%); ($\mathbf{X^2}$ =5.110, P-value =0.078). Most cases reported that they had received measles vaccination as this was equally distributed between cases and controls. Breast-feeding mode was associated with diarrhoeal disease occurrence and was statistically significant (X^2= 23.577; $P<0.001$) among cases as compared to controls. Complementary feeding (breast-feeding with water and other foods) showed a strong association with increased risk of diarrhoea. The use of complementary feeding was more among cases 61 (69.3%) than exclusive breast-feeding 23 (26.1%). On the other hand, more of the controls reported exclusive breast-feeding 55 (62.5%) than complementary breast-feeding 61 (35.25%). This was most significant and useful to the model as P-value was less than 0.001. Children with birth weight of <2.5kg had over nine times increased risk of diarrhoea when compared in both groups and this trend was followed by children with birth weight 2.5-2.99kg respectively. Table 2 shows the distribution of Cases and Controls by Maternal and Child Risk Factors in HRH Emekuku.

4.2 DISTRIBUTION OF CASES AND NON CASES IN RELATION TO SOCIOECONOMIC RISK FACTORS

The percentage distribution of diarrhoea among educated mothers was more among secondary school leavers 48 (54.3%), followed by tertiary 25 (25.4%) and primary school leavers 15 (17.0%) respectively as compared to the distribution in the non case group. Maternal employment was statistically significant and associated with increased risk of diarrhoea as most of the mothers in the controls reported having a job (P<0.001). More than twice the number of nursing mothers in the cases was unemployed as compared to controls. Paternal employment was not statistically significant and had no association with the risk of diarrhoea in the study. Table 3 shows the distribution of cases and controls by socioeconomic risk factors.

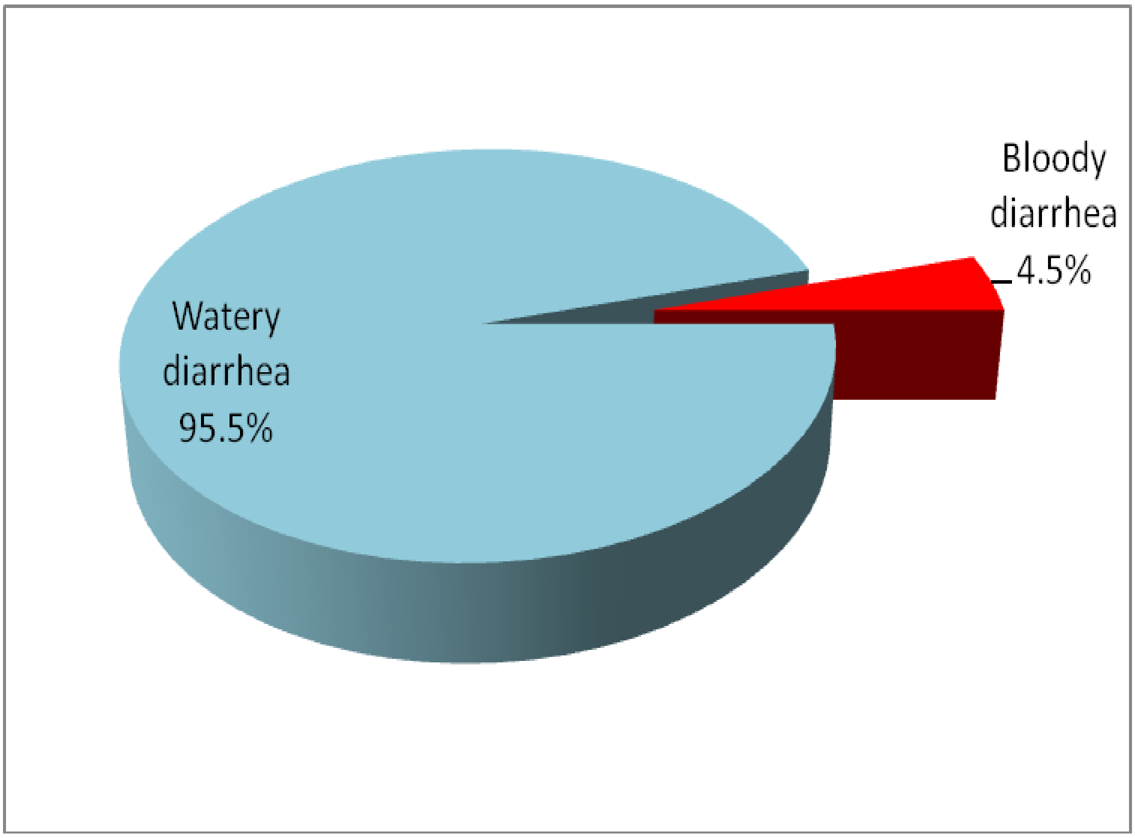

Figure 1: Pattern of diarrhoea presentation in under-fives in HRH Emekuku

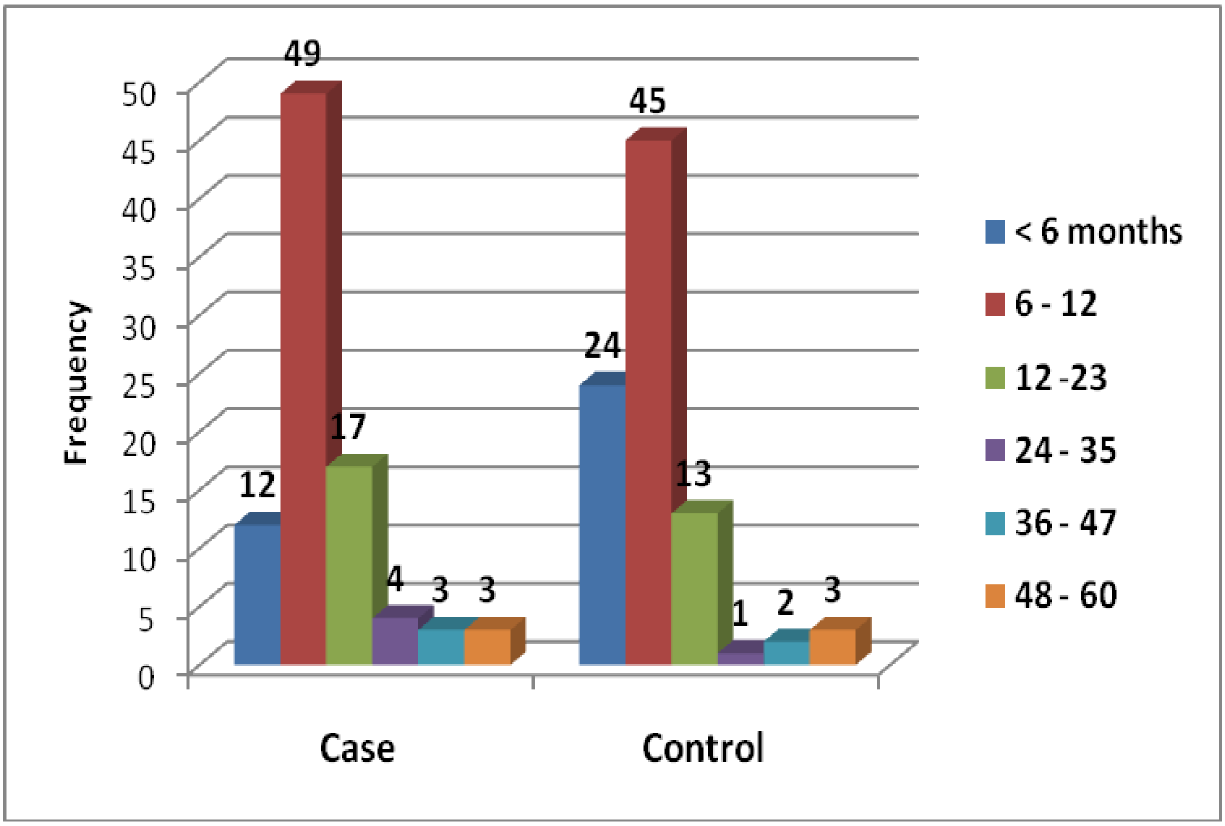

Figure 2: Age (months) distribution of under-fives in HRH Emekuku

Table 1.0 Distribution of Cases and Controls by Maternal and Child Risk Factors In HRH Emekuku.

Variable	Diarrhoeal Status							
	Case	(%r.f)	(%D.s)	Control	(%r.f)	(%D.s)	X^2	P-value
Age (Months)								
0-5	12	(33.3)	(13.6)	24	(66.7)	(27.3)		
6-11	49	(52.1)	(55.7)	45	(47.9)	(51.1)		
12-23	17	(56.7)	(19.3)	13	(43.3)	(14.8)	6.704	0.244
24-35	4	(80.0)	(4.5)	1	(20.0)	(1.1)		
36-47	3	(60.0)	(3.4)	2	(40.0)	(2.3)		
48-59	3	(50.0)	(3.4)	3	(50.0)	(3.4)		
Gender								
Male	42	(47.7)	(47.7)	46	(52.3)	(52.3)	0.364	0.546
Female	46	(52.3)	(52.3)	42	(47.7)	(47.7)		
Child Birth order								
First	22	(37.9)	(25.0)	36	(62.1)	(40.9)		
Second & Third	52	(55.3)	(59.1)	42	(44.7)	(47.7)	5.110	0.780
Fourth & Fifth	14	(58.3)	(15.9)	10	(41.7)	(11.4)		
Measles Vaccination								
Yes	65	(53.7)	(73.9)	56	(46.3)	(63.6)	2.855	0.240
No	23	(42.6)	(26.1)	31	(57.4)	(35.2)		
Breast feeding Mode								
Exclusive	23	(29.5)	(26.1)	55	(70.5)	(62.5)		
Complementary Feeding	61	(66.3)	(69.3)	31	(33.7)	(35.2)	23.577	<0.001
Weaned	4	(66.7)	(4.5)	2	(33.3)	(2.3)		
Birth weight (kg)								
>3.00	54	(52.9)	(61.4)	48	(47.1)	(54.5)		
2.5-2.99	29	(44.6)	(33.0)	36	(55.4)	(40.9)	1.218	0.544
<2.5	5	(55.6)	(5.7)	4	(44.4)	(4.5)		

Key: R.f = Risk Factor , D.S = Diarrhoeal Status
X^2 = Chi-Square, P = Probability value

Table 2.0 Distribution of cases and controls by socio-economic risk factors in HRH Emekuku

Variable	DIARRHOEAL STATUS Case (% r.f) (% D.s)	Control(% r.f) (% D.s)	X^2	P-Value
Maternal Education				
Primary	15 (65.2) (17.0)	8 (34.8) (9.1)		
Secondary	48 (52.7) (54.5)	43 (47.3) (48.9)	**4.728**	**0.094**
Tertiary	25 (40.3) (28.4)	37 (59.7) (42.0)		
Maternal Employment				
Yes	49 (40.2) (55.7)	73 (59.8) (83.0)	**15.388**	**<0.001**
No	39 (72.2) (44.3)	15 (27.8) (17.0)		
Paternal Employment				
Yes	83 (49.4) (94.3)	85 (50.6) (96.6)	**0.524**	**0.469**
No	5 (62.5) (5.7)	3 (37.5) (3.4)		

Key;R.f = Risk Factor , D.S = Diarrhoeal Status
X^2 = Chi-Square, P = Probability value

4.3. DISTRIBUTION OF CASES AND CONTROLS IN RELATION TO ENVIRONMENTAL RISK FACTORS:

The results showed that there was no significant difference between cases and controls and diarrhoea occurrence in relation to source of water (**X^2** = 3. 916, P-value = 0.271). Most cases and controls reported the use of borehole as water source. Logistic regressional analysis, however, showed more than thrice an increased risk among rain water users than other subgroups, although, with a wide confidence margin. There was a significant difference in diarrhoea incidence among pit latrine users as more counts were observed among cases than controls. More controls 61(69.3%) reported the use of water system as toilet type when compared to cases 44(50.0%) (**X^2 =** 7.850, P-value = 0.020), as shown in figure 3. Most of the cases and controls reported that they practised hand-washing after toilet and handling child's faeces. However, when asked the method they used, 46 (52.3%) among cases used only water, while only 38 (43.2%) used soap and water and towel. Figure 4 shows the distribution of diarrhoea based on hand-washing method practiced by under-fives in Emekuku. When compared with controls, 69 (78.4%) used soap and water and towel, as only about 14 (15.9%) used only water. When fitted into our model, it was significant (**X^2** = 26.159, P-value < 0.001). The number of children that stayed in a room (crowding index) was significantly associated with diarrhoeal incidence in cases. Sixty five (73.9%) of controls reported that less than 3 children stayed a in room when compared to cases where 51(58.0%) reported that more than 3 children stayed in a room (**X^2** =18.281, P<0.001). Thus this was statistically significant to our model. Eating of left-over food and bottle-feeding were not significant as they were equally distributed between cases and non cases (**X^2** = 0.037, P-value = 0.847, **X^2** =1.737, P= 0.188) respectively. Table 4 shows the distribution of cases and controls by environmental risk factors in HRH Emekuku.

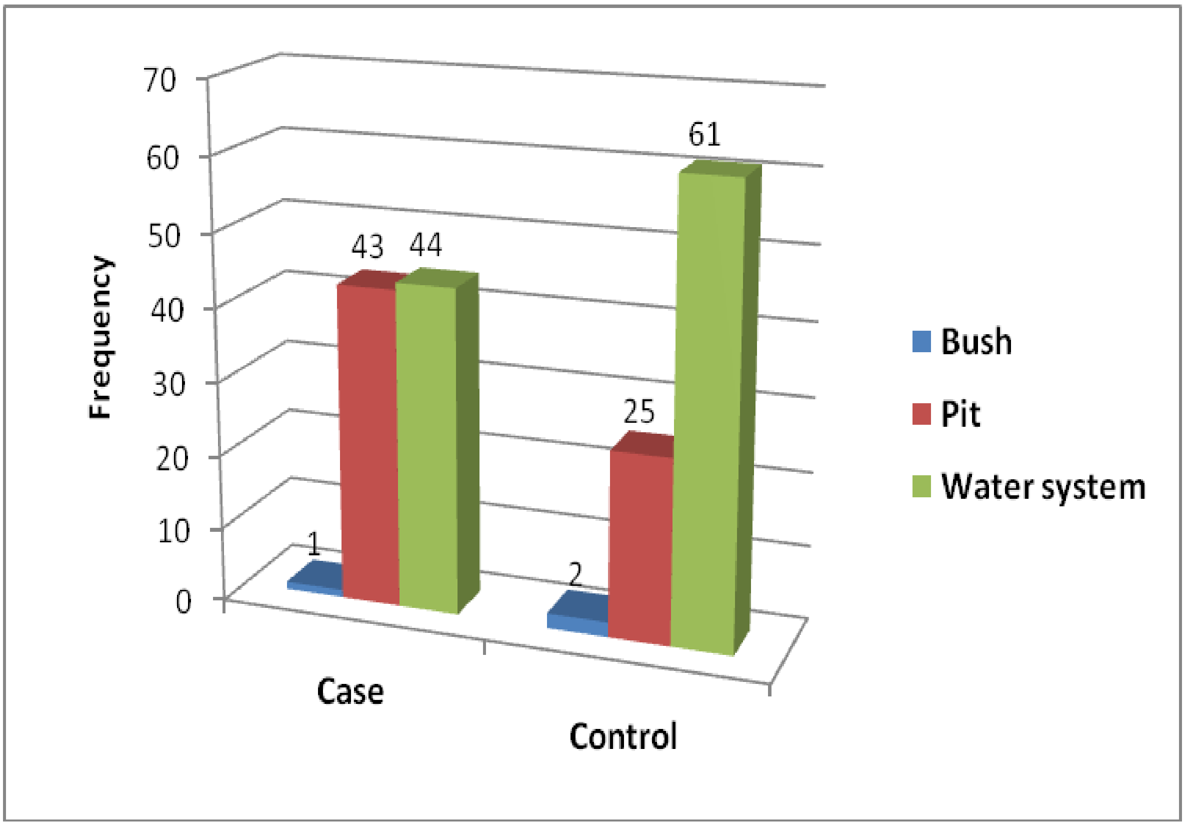

Figure 3: Distribution of type of toilet facility used by under-fives in HRH Emekuku.

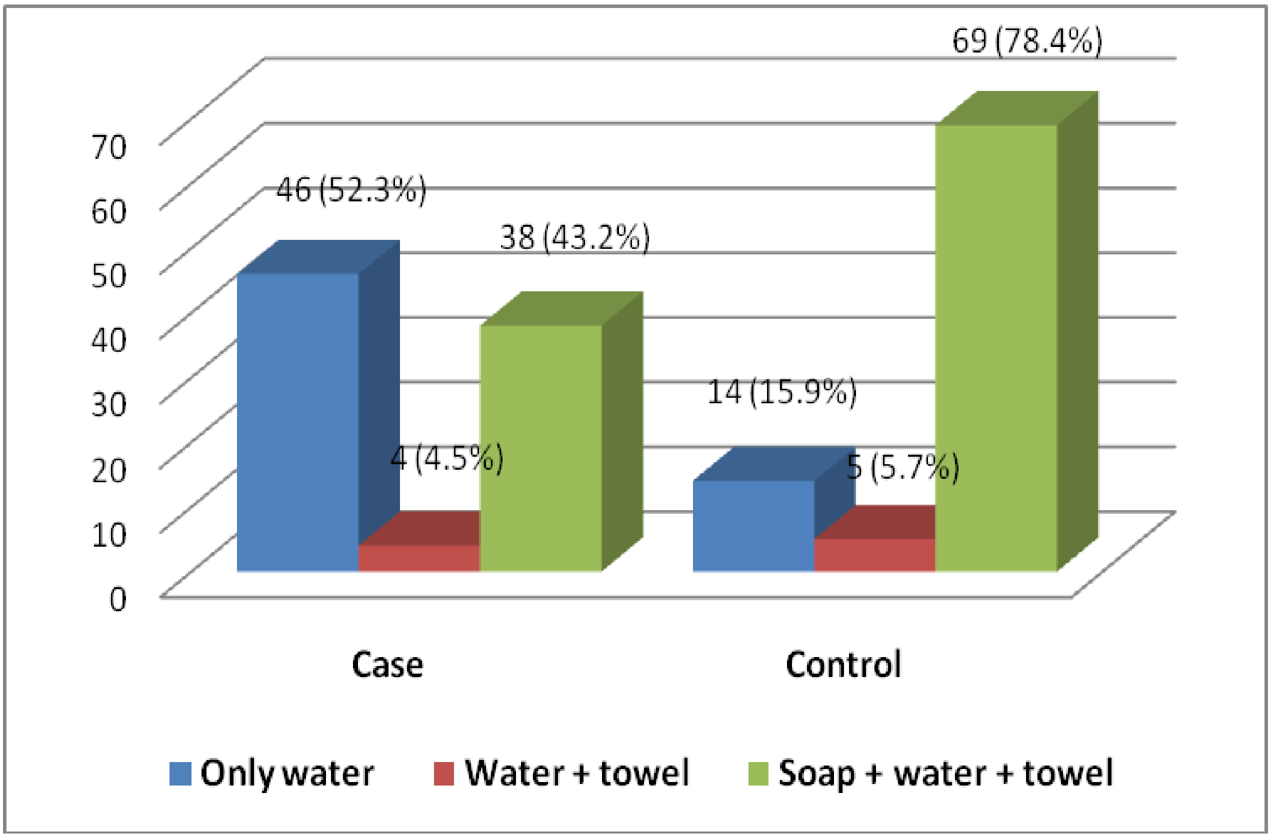

Figure 4: Distribution of diarrhoea based on hand-washing method practised by under-fives in HRH Emekuku

Table 3.0 Distribution of cases and controls by environmental risk factors in HRH Emekuku

	DIARRHOEAL STATUS			
Variable	**Case (% r.f) (% D.s)**	**Control (% r.f) (%D.s)**	**X^2**	**P-Value**
Water source				
Borehole	71(50.4) (80.7)	70(49.9) (79.5)		
Stream	8(72.7) (9.1)	3(27.3) (3.4)	**3.916**	**0.271**
Treated water	1(50.0) (1.1)	1(50.0) (1.1)		
Rain	8(36.4) (9.1)	14 (63.6) (15.9)		
Toilet Type				
Bush	1(33.3) (1.1)	2(66.7) (2.3)		
Pit	43(63.2) (48.9)	25(36.8) (28.4)	**7.850**	**0.020**
Water system	44(41.9) (50.0)	61(58.1) (69.3)		
Hand-washing				
Yes	87(51.2) (98.9)	83(48.8) (94.3)	**2.761**	**0.097**
No	1(16.7) (1.1)	5(83.3) (5.7)		
Method				
Only water	46(76.7) (52.3)	14(23.3) (15.9)		
Water + towel	4(44.4) (4.5)	5(55.6) (5.7)	**26.159**	**<0.001**
Soap + water + towel	38 (35.5) (43.2)	69(64.5) (78.4)		
Crowding index				
< 3	37(36.3) (42.0)	65(63.7) (73.9)	**18.281**	**<0.001**
> 3	51(68.9) (58.0)	23(31.1) (26.1)		
Number of U-5s				
1	32(43.8) (36.4)	41(56.2) (46.6)	**1.896**	**0.169**
2 or more	56(54.4) (63.6)	47(45.6) (53.4)		
Eating of left over/ warming				
Yes	72(50.3) (81.8)	71(49.7) (80.7)	**0.037**	**0.847**
No	16(48.5) (18.2)	17(51.5) (19.3)		
Bottle feeding				
Yes	79(52.0) (89.8)	73(48.0) (83.0)	**1.737**	**0.188**
No	9(37.5) (10.2)	15(62.5) (17.0)		

Key: R.f = Risk Factor , D.S =Diarrhoeal status
X^2 = Chi-Square, P = Probability value

4.4 DETERMINATION OF SIGNIFICANT RELATIONSHIPS BETWEEN RISK FACTORS AND DIARRHOEAL DISEASES INCIDENCE

In order to determine the variables that would be most useful to our model, logistic regressional analysis on the risk factor was carried out. Exp (B) was the predicted change in odds for a unit increase in the predictor. When Exp (B) was less than one, increasing values of the variables correspond to decreasing odds of the event's occurrence. When Exp (B) was greater than one, increasing values of the variable correspond to increasing odds of the event's occurrence. Fitting this into our study, we observed that there was a significant association between diarrhoea occurrence and lower age brackets 12-23 (OR = 1.034, 95% CI = 0.12 - 9.07), 6-11 (OR = 2.164, 95%CI = 0.16 - 28.98). As the child's age increased, the likelihood of diarrhoea occurrence decreased significantly. The use of pit toilet was most strongly associated with diarrhoeal disease occurrence (OR = 8.199, 95 % CI =10.44 - 154.37). Child's birth weight <2.5kg was associated with diarrhoea (OR = 9.144, 95% CI = 1.32 - 63.88), followed by birth weight 2.5-2.99kg (OR = 1.966, 95% CI = 0.35 -10.89). Tertiary education level in our study was significant in the incidence of diarrhoea in our model (OR=1.086, 95%CI= 0.412-2.86). Further analysis revealed that complementary feeding (OR=1.649, 95%CI= 0.186-14.63), crowding index greater than three (OR=2.407, 95%CI= 0.98-5.88), maternal unemployment (OR= 2.575, 95%CI= 0.94-7.03) were all significantly associated with diarrhoea disease occurrence in our study.

Table 4.0 Logistic regressional analysis on risk factors for Diarrhoea occurrence in under-fives in HRH Emekuku

Variables	Categories	OR	95%Conf. Interval	P-value
Age (months)	**0-5 ***			
	6-11	2.164	0.16 – 28.98	0.560
	12-23	1.034	0.12 – 9.07	0.976
	24-35	0.797	0.08 – 8.05	0.848
	36-47	0.376	0.01 – 14.28	0.598
	48-59	0.233	0.01 – 5.84	0.376
Water source	**Borehole ***			
	Stream	0.752	0.19 – 2.97	0.684
	Treated water	0.346	0.04 – 3.23	0.352
	Rain	3.189	0.08 – 117.12	0.528
Toilet Type	**Bush ***			
	Pit	8.199	0.44 – 154.37	0.160
	Water system	1.430	0.53 – 3.84	0.478
Hand-washing practice	**Only water ***			
	Water+towel	0.118	0.04 – 0.39	< 0.001
	Soap+Water+Towel	0.338	0.04 – 2.65	0.302
Child's birth weight	**>3.0kg ***			
	2.5-2.99	1.966	0.35 – 10.89	0.439
	<2.5kg	9.144	1.32 – 63.88	0.026
Childs birth order	**First ***			
	Second and third	0.624	0.155 – 2.51	0.506
	Fourth and fifth	0.349	0.094 – 1.29	0.116
Measles Vaccination	**Yes ***			
	No	0.000	0.00 – 0.00	1.000
	Yet to be vaccinated	0.000	0.00 – 0.00	1.000
Maternal Education	**Primary ***			
	Secondary	0.371	0.078 – 1.75	0.211
	Tertiary	1.086	0.412 – 2.86	0.868
Breast-feeding mode				
	Exclusive *			
	Complementary feeding	1.649	0.186 – 14.63	0.653
	Weaned	0.491	0.054 – 4.42	0.526
Crowding index	**<3 ***			
	>3	2.407	0.98 – 5.88	0.054
Gender	**Male ***			
	Female	0.569	0.556 – 2.91	0.569
Eating of left-over/warming	**Yes ***			
	No	0.483	0.51 – 4.22	0.483
Bottle Feeding	**Yes ***			
	No	1.427	0.47 – 4.66	0.556
Maternal Employment	**Yes ***			
	No	2.575	0.94 – 7.03	0.065
Paternal Employment	**Yes ***			
	No	0.657	0.09 – 5.33	0.694
Hand-washing	**Yes ***			
	No	0.347	0.03 – 4.19	0.406

Key:* Reference Group; OR = Adjusted Odds Ratio; P = Probability value
95% CI = Confidence Interval

CHAPTER FIVE

DISCUSSION

Diarrhoeal diseases rank with acute respiratory infections as among the major causes of morbidity and mortality among children under five years of age (Kosek *et al*., 2003).The World Health Organization started the Diarrhoeal Diseases Control Programme (DDCP) in 1980 with the objective to decrease diarrhoeal morbidity and mortality among young children in developing countries (El-Gilany and Hammad, 2005). Persistent high rates of morbidity are of concern because early childhood diarrhoea may have long term effects on linear growth, physical and cognitive function (Molbak *et al*., 1992; Jinadu, 1991; Pison *et al*., 1993).

Most diarrhoeal disease cases observed in our study were acute watery diarrhoea (93.2%). This carries a severe risk of associated dehydration. The duration of diarrhoea may have been reduced due to administration of ORS and good nutrition as a home-based intervention before taking the child to the hospital. However, we did not investigate the administration of ORS prior to hospital visit. On the other hand, only about 6.8% of all cases were persistent diarrhoea and poor nutritional status and exposure to a child with diarrhoea in the last 2 weeks preceding the onset of illness, according to Sodeinde *et al* (1997), could account for this. These findings are in line with other recent studies of persistent diarrhoea (Bhandari *et* al. 1992; Victora *et al*., 1993; Molbak *et al*., 1997), although rates may slightly differ. The mean number of stools per child per day was 4.3 (SD 1.92). In another study by Patel *et al* (2008), the mean number of stools per child per day was 6.8 (SD 3.3). The lower rate in our study may be due to greater immunity and resistance together with other factors which played a role in reducing diarrhoeal incidence in this area.

Of the 17 exposure variables included in the analyses, only a few exhibited strong association with diarrhoeal rates.

5.1 MATERNAL AND CHILD RISK FACTORS

The prevalence of diarrhoea was highest (55.7%) among children 6-11 months (OR= 2.164, 95%CI= 0.16-28.98). This coincides with the time when weaning began and a decline in maternally acquired immunity. A slightly higher rate of diarrhoea was equally observed among children 12-23 months and this could be attributed to less mother care, advent of another pregnancy and onset of crawling. Apart from the first 6 months of life when maternally acquired immunity and breast-feeding without supplementation (exclusive) played a protective role, diarrhoeal morbidity decreased significantly with increasing age. This decline may be attributed to slight immunity due to previous diarrhoea, vaccination against measles and improved nutrition. In addition to the reasons adduced for higher incidence of diarrhoea post breast-feeding and weaning i.e. ages (6-11, 12-23) months, is the introduction of other foods which may be contaminated and unhygienic environment in which the child is allowed to crawl (El-Rafie and Hassouna, 1986; Oni *et al*., 1991; Manun'ebo *et al*., 1994; El-Gilany and Hammad, 2005). Furthermore, most nursing mothers are not well educated on the methods of weaning because abrupt weaning rather than gradual withdrawal of breast-milk can destabilize the fragile digestive system of the child resulting in poor absorption and consequent diarrhoea. Breast-feeding and gradual introduction of other hygienically prepared foods should run concurrently after 6 to 12 months of exclusive breast-feeding as the case may be.

No significant gender difference in diarrhoeal prevalence was observed. This is in line with other studies by El-Gilany and Hammad, (2005). Boys and girls were probably equally exposed as the risk factors associated with diarrhoea are environmental and socio-demographic, rather than biological (Manun'ebo *et al*., 1994). However, Vafee *et al,* (2008) in their study, observed that the chance of diarrhoea infection decreased in boys and that the female sex is more liable to the risk of diarrhoea episode. This conclusion is controversial and has been contradicted by most of the literature reviewed.

Children in second and third birth order had the highest prevalence of diarrhoea followed by those in the first order. With higher birth order children, the distribution of mother care and attention to a larger number of children may mean more exposure to enteropathogens (Al-Mazrou and Farid, 1992). Again the experience of the mother may be lacking in the case of first born children. However, the Odds Ratio did not indicate any association with diarrhoea, in fact, it was protective. Vaccination against measles had no association with diarrhoea in our study in contrast to other reports by Bani *et al* (2002), where they observed higher episodes among those not vaccinated.

Complementary feeding (breast-feeding and other foods including water) was more among cases and was significantly associated with diarrhoea **(X^2** =23.577, P<0.001). More reports of exclusive breast-feeding were observed among the control groups. This illustrates the fact that maternal antibodies and water in breast-milk were protective and enough for the baby. Complementing the breast-milk with other foods and water introduces enteropathogens and destabilizes the fragile epithelial linings of the child's intestine so that it could not resist such organisms.

The protective roles of exclusive breast-feeding has been documented in most of the literature reviewed (Molbak *et al*., 1997; Bani *et al*., 2002; Fuchs and Victora, 2002; El-Gilany and Hammad, 2005; Amsalu & Tigabu, 2008). Exclusive breast-feeding encourages mother-child bonding, reduces the incidence of diarrhoeal diseases and other infections, improves the cognitive development of the child and supplies adequate nutrients to enhance the child's nutritional status. Breast-milk contains immunoglobulins (IgA and IgG and more) which facilitate immunity against infections and diseases. In their submission, Molbak *et al* (1997) opined that breast-feeding could be an effect modifier of other risk factors for diarrhoea. The synergistic and additive relationship between exclusive breast-feeding, environmental and personal hygiene could play a significant role in the reduction of prevalence of diarrhoea in controls rather than cases.

Lower birth weight (<2.5kg) was found to be strongly associated with diarrhoea when logistic regression was used. There was more than nine times an increased risk of diarrhoea, however, the conclusion should be done with caution as the margin of confidence is very wide(OR= 9.144, 95%CI= 1.32-63.88). This is in agreement with the findings of Fuchs and Victora (2002). Low birth weight increases the risk of malnutrition, which in turn, increases the risk of infection and diarrhoea. However, we did not measure the weight of the child and depended only on the mother's recall which may be inadequate.

5.2 SOCIO-ECONOMIC RISK FACTORS

Although more counts were recorded among children whose mothers were in the secondary level, this was not associated with diarrhoea. When adjusted and Odds Ratio was calculated using logistic regression, the risk of diarrhoea was slightly higher among tertiary level. This could mean that mothers who had secondary education are more likely to be unemployed and may not be able to take good care of their children especially in terms of treatment and visiting the hospital. In contrast to our findings, El-Gilany and Hammad, (2005) observed a decrease in diarrhoeal morbidity with higher education level of the parents. This could be interpreted with caution as higher education was not operationally defined.

Paternal employment which should probably translate to more income and better standard of living was not significant and was not useful to our study. Most women who had tertiary education, although, are more educated and have better jobs, the nature of their jobs does not guarantee more time to spend with their children coupled with very short duration of maternity leave in this country and other compounding factors. Although this is corroborated by the Chi-square value (X^2=15.388, P<0.001**),** it was not strongly associated with diarrhoea when logistic regression was used to determine the strength of association (Odds Ratio). This is in agreement with other studies (Hussain and Smith, 1999; Fuchs and Victora, 2002). Maternal work may keep women outside the home without simultaneously ensuring adequate child care (Reed *et al*., 1996; Lamontagne *et al*., 1998). However, once their children had developed diarrhoea, working mothers reinforced their care and were thus, able to prevent dehydration and diarrhoea duration especially at work places where crèches are provided for mothers to breastfeed and care for their babies while at work.

5.3 ENVIRONMENTAL RISK FACTORS

The availability of potable water (borehole and treated water) in our study was protective against diarrhoea. Although there was not significant difference in counts between cases and controls, logistic regression analysis indicated a 3-fold increase in risk of diarrhoea among those using rain water. This could be attributed to the hygiene of the containers and long periods of storage in addition to cross contamination. This finding is in agreement with the report of El-Gilany and Hammad, (2005). Other researchers, however, reported an association between diarrhoea and water source (Sinai Consultation Group, 1987; Manun'ebo *et al*., 1994). The type of toilet was associated with diarrhoea ($\mathbf{X^2}$=7.850, P= 0.02). However, this association was not significant when fitted into logistic regression model. Pit latrine users had an 8-fold increased risk of diarrhoea than water system users, however, it should be interpreted with caution as there is a very wide margin of confidence (95%CI= 0.44-154.37). Pit toilet provides a breeding ground for flies and other insects which may convey enteropathogens mechanically from faeces to food. This is in line with other studies (Ekanem *et al*., 1991; Jinadu, 1991; El-Gilany and Hammad, 2005).

Most of the respondents reported that they washed their hands after toilet and handling of faeces. However, the method used in hand-washing was significantly associated with diarrhoea ($\mathbf{X^2}$=26.159, P<0.001). When logistic regression was calculated, water+towel category was most significant (P<0.001). This was very important as most of the diarrhoeagenic organisms can survive in the finger for a few minutes. Some may produce resistant cysts which may not be killed with water only. This could be worsened when the individual has grown-up fingernails and does not wash properly. This is in line with observations by Curtis and Cairncross (2003). Crowding index was significantly associated with diarrhoea. More diarrhoeal diseases were observed among children who stayed more than three in a room. This could be attributed to greater contacts with a case and potential transmission to other children. This is in consonance with other studies (El-Gilany and Hammad, 2005). Knight *et al* (1992), however, reported no association between family size and diarrhoea morbidity. Bottle-feeding and eating of left-over food were not associated with diarrhoeal diseases. This could be due to improved bottle hygiene as evidenced by daily wash and proper food warming which they all responded to. In other studies by Amsalu and Tigabu, (2008), bottle-feeding was associated with increased risk of diarrhoea because of difficulty in sterilizing the nipples properly and long storage which may facilitate contamination and growth of organisms.

In summary, of all 17 variables analyzed, only hand-washing method (water and towel) and birth weight <2.5kg were most useful in the logistic regression model (P<0.001 and P<0.026) respectively. Therefore, we drew most of our conclusions based on Chi-square test of significance and Odds Ratio test of association which were most appropriate statistical tools for the qualitative data generated and the nature of our study –case control study.

5.4 CONCLUSIONS AND CONTRIBUTIONS TO KNOWLEDGE

In conclusion, our study has shown that complementary feeding, the age of the child, use of pit toilet, washing of hands with water only and crowding are significant risk factors to diarrhoeal disease incidence and occurrence in this area. Furthermore, this study has revealed that acute watery diarrhoea was more prevalent in this area than persistent diarrhoea. We advocate that interventions like exclusive breast-feeding education; maternal employment which may translate to better family income and appropriate treatment; education on appropriate hand-washing method; provision of good sanitary conveniences (water system toilet) and reduction of family size through family planning would all help to control the incidence and transmission of diarrhoeal disease in this area. It is worthwhile to point out that the low incidence of the disease signifies that the interventions aimed at reducing diarrhoeal morbidity and mortality are effective and should be strengthened to bring this second highest child killer disease to the point where it is no longer a public health problem. This will ensure the attainment of the Millennium Development Goals four and ensure child survival.

5.5 LIMITATIONS OF THE STUDY

Our study was a case control design and was fraught with the problems characteristic of such design such as: problems with selection of appropriate control group; lack of representativeness of cases and controls; and recall bias. The disease had low incidence and this could be due to the fact that it was a hospital based study and not all cases of the disease get to the hospital. In fact, only in life-threatening situations does the mother or caregiver seek hospital treatment. This really affected the sample size and the relative ease of generalization of the results (external validity. Some of the questionnaires were poorly completed leading to elimination of such from the total number. Some of the nurses enrolled to collect data were reluctant which may have accounted for some of uncaptured cases of diarrhoea.

A very important limitation is the problem of matching. It was really difficult to match for age, sex and other variables which would have helped to eliminate confounding variables and enhance comparability between cases and controls. Accurate data on the prevalence was lacking and affected sample size determination.

5.6 RECOMMENDATIONS

- Considering the nature of our study and the setting (Hospital), it is most likely that the set of people utilizing the hospital are the wealthy people. This affected the nature of cases and controls, all coming from a particular set of people may not represent the true incidence and magnitude of diarrhoea in this area. Therefore, a community-based study design where representative sample and set of people are enrolled is recommended to determine the true incidence and role of determinants in diarrhoeal disease causation.
- A laboratory identification of the pathogens involved may help in designing appropriate interventions should be instituted.

- An intensive advocacy, education and awareness should be created among nursing mothers and caregivers on the benefits of exclusive breast-feeding on the growth and cognitive development of their children.
- Although hand-washing is being practiced, the method still remains a challenge. Hygiene education on proper hand-washing, environmental sanitation and installation of better sanitary hard wares should be encouraged.
- The importance of Oral Rehydration Therapy (ORT) on the reduction of diarrhoea duration and risk of dehydration has been documented in available literature. It is pertinent that health education of nursing mothers on the methods and formulation of ORT using easily available local ingredients be encouraged.
- The government should consider increasing the period of maternity leave to up to 6 months and to erect crèches at work places to encourage breast-feeding and mother care.

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APPENDIX

SAMPLE OF THE QUESTIONNAIRE INSTRUMENT.

INFORMED CONSENT

Dear Respondent,

This questionnaire is designed to assess the risk factors of diarrhoeal diseases in under-5-year-olds in Holy Rosary Hospital Emekuku. It is not a political, religious or social appraisal tool but to assess the level of health care and environmental hygiene together with other maternal and child risk factors. We assure you of utmost confidentiality and do not require your name or other implicating information.

We humbly solicit your cooperation.

Thank you for your assistance.

QUESTIONS

DIARRHOEAL STATUS (For cases only)

(1) How long has this diarrhoea lasted i.e. duration ________________?

(2) Was the diarrhea watery or bloody? Please thick one.

(3) How many stools were observed on the average per day _____________?

MATERNAL AND CHILD RISK FACTORS

(4) How old is your child? Please thick: (a) Less than 6 months(1) (b) 6-<12 months(2) (c)12-<24 months(3) (d) 24-<36 months(4) (e)36-<48 months(5) (f) 48-<60 months(6).

(5) Sex: (a) Male (1) (b) Female (2)

(6) What is your child’s birth order? (a) First(1) (b) Second and Third(2) (c) Fourth and Fifth(3).

(7)Has your child been vaccinated against measles? (a) Yes(1) (b) No(2)

(8)Do you breast-feed? (a) Yes(1) (b) No(2)

(9) What breastfeeding mode do you practice? (a) Exclusive(1) (b) Complementary(2) (c) Weaned(3)

(10) What was your child's weight at birth? (a)>3.0 kg(1) (b) 2.5-2.99kg(2) (c) <2.5 kg(3)

SOCIOECONOMIC RISK FACTORS

(11) What is your level of Education? (a) Primary(1) (b) Secondary(2) (c) Tertiary(3)

(12)Do you have a job? (a) Yes(1) (b) No(2)

(13) Has your husband a job? (a) Yes(1) (b) No(2)

ENVIRONMENTAL RISK FACTORS

(14) What is the source of water for your family? (a) Borehole(1) (b) Stream(2) (c) Rain(3) (d) Treated water(4).

(15) What type of toilet do you use in your house? (a) Pit(1) (b) Water system(2) (c) Bush(3) (d) None(0)

(16) Do you and your children wash your hands after toilet or after handling waste or faeces?(a) Yes(1) (b) No (2)

(17) If Yes, how do you do so? (a) Soap+water+towel(1) (b) Only water(2) (c) Water+towel(3) (d) Any other means(4)

(18)How many children sleep in a room? (a) <3(1) (b)>3(2) (c) None(0)

(19)How many Under-5-year old children do you have? (a) 1(1) (b) 2 or more(2)

(20)Do you use feeding bottle in feeding you children? (a) Yes(1) (b) No(2)

(21) If Yes, how often do you wash the bottles? (a) Daily(1) (b) Weekly(2) (c) Monthly(3) (d) Yearly(4)

(22) Do your children eat leftover food and do they warm it well? (a) Yes(1) (b) No(2)

STATISTICAL ANALYSIS ON THE PATTERN OF DIARRHOEAL DISEASE IN UNDER-FIVE CHILDREN: A HOSPITAL-BASED CASE CONTROL STUDY OF RISK FACTORS

Age group by Diarrheal status

			Diarrhoeal status		Total
			Case	Non-case	
Age group (Months)	Less than 6	Count	12	24	36
		% within Age group	33.3%	66.7%	100.0%
		% within Diarrhoeal status	13.6%	27.3%	20.5%
	6-12	Count	49	45	94
		% within Age group	52.1%	47.9%	100.0%
		% within Diarrhoeal status	55.7%	51.1%	53.4%
	12-24	Count	17	13	30
		% within Age group	56.7%	43.3%	100.0%
		% within Diarrhoeal status	19.3%	14.8%	17.0%
	24-36	Count	4	1	5
		% within Age group	80.0%	20.0%	100.0%
		% within Diarrhoeal status	4.5%	1.1%	2.8%
	36-48	Count	3	2	5
		% within Age group	60.0%	40.0%	100.0%
		% within Diarrhoeal status	3.4%	2.3%	2.8%
	48-60	Count	3	3	6
		% within Age group	50.0%	50.0%	100.0%
		% within Diarrhoeal status	3.4%	3.4%	3.4%
Total		Count	88	88	176
		% within Age group	50.0%	50.0%	100.0%
		% within Diarrhoeal status	100.0%	100.0%	100.0%

	Chi-square Calculated	df	P-value
Pearson Chi-Square	6.704	5	.244

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Gender * Diarrhoeal status

			Diarrhoeal status		Total
			Case	Non-case	
Gender	Yes	Count	42	46	88
		% within Gender	47.7%	52.3%	100.0%
		% within Diarrhoeal status	47.7%	52.3%	50.0%
	No	Count	46	42	88
		% within Gender	52.3%	47.7%	100.0%
		% within Diarrhoeal status	52.3%	47.7%	50.0%
Total		Count	88	88	176
		% within Gender	50.0%	50.0%	100.0%
		% within Diarrhoeal status	100.0%	100.0%	100.0%

	Chi-square Calculated	df	P-value
Pearson Chi-Square	.364	1	.546

Do your children eat left-over food and do they warm it well * Diarrheal status

			Diarrhoeal status		Total
			Case	Non-case	
Do your children eat left-over food and do they warm it well	Yes	Count	72	71	143
		% within Do your children eat left-over food and do they warm it well	50.3%	49.7%	100.0%
		% within Diarrhoeal status	81.8%	80.7%	81.3%
	No	Count	16	17	33
		% within Do your children eat left-over food and do they warm it well	48.5%	51.5%	100.0%
		% within Diarrhoeal status	18.2%	19.3%	18.8%
Total		Count	88	88	176
		% within Do your children eat left-over food and do they warm it well	50.0%	50.0%	100.0%
		% within Diarrhoeal status	100.0%	100.0%	100.0%

	Chi-square Calculated	df	P-value
Pearson Chi-Square	.037	1	.847

Source of water for your family * Diarrheal status

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			Diarrhoeal status		Total
			Case	Non-case	
Source of water for your family	Borehole	Count	71	70	141
		% within Source of water for your family	50.4%	49.6%	100.0%
		% within Diarrhoeal status	80.7%	79.5%	80.1%
	Stream	Count	8	3	11
		% within Source of water for your family	72.7%	27.3%	100.0%
		% within Diarrhoeal status	9.1%	3.4%	6.3%
	Treated water	Count	1	1	2
		% within Source of water for your family	50.0%	50.0%	100.0%
		% within Diarrhoeal status	1.1%	1.1%	1.1%
	Rain	Count	8	14	22
		% within Source of water for your family	36.4%	63.6%	100.0%
		% within Diarrhoeal status	9.1%	15.9%	12.5%
Total		Count	88	88	176
		% within Source of water for your family	50.0%	50.0%	100.0%
		% within Diarrhoeal status	100.0%	100.0%	100.0%

	Chi-square Calculated	df	P-value
Pearson Chi-Square	3.916	3	.271

Type of toilet * Diarrheal status

			Diarrhoeal status		Total
			Case	Non-case	
Type of toilet	Bush	Count	1	2	3
		% within Type of toilet	33.3%	66.7%	100.0%
		% within Diarrhoeal status	1.1%	2.3%	1.7%
	Pit	Count	43	25	68
		% within Type of toilet	63.2%	36.8%	100.0%
		% within Diarrhoeal status	48.9%	28.4%	38.6%
	Water system	Count	44	61	105
		% within Type of toilet	41.9%	58.1%	100.0%
		% within Diarrhoeal status	50.0%	69.3%	59.7%
Total		Count	88	88	176
		% within Type of toilet	50.0%	50.0%	100.0%
		% within Diarrhoeal status	100.0%	100.0%	100.0%

	Chi-square Calculated	df	P-value
Pearson Chi-Square	7.850	2	.020

Children wash hands after toilet or after handling feces/waste Diarrheal status

Crosstab

			Diarrhoeal status		Total
			Case	Non-case	
Children wash hands after toilet or after handling faeces/waste	Yes	Count	87	83	170
		% within Children wash hands after toilet or after handling faeces/waste	51.2%	48.8%	100.0%
		% within Diarrhoeal status	98.9%	94.3%	96.6%
	No	Count	1	5	6
		% within Children wash hands after toilet or after handling faeces/waste	16.7%	83.3%	100.0%
		% within Diarrhoeal status	1.1%	5.7%	3.4%
Total		Count	88	88	176
		% within Children wash hands after toilet or after handling faeces/waste	50.0%	50.0%	100.0%
		% within Diarrhoeal status	100.0%	100.0%	100.0%

	Chi-square Calculated	df	P-value
Pearson Chi-Square	2.761	1	.097

If yes, how do they do so * Diarrheal status

Crosstab

			Diarrhoeal status		Total
			Case	Non-case	
If yes, how do they do so	Only water	Count	46	14	60
		% within If yes, how do they do so	76.7%	23.3%	100.0%
		% within Diarrhoeal status	52.3%	15.9%	34.1%
	Water+towel	Count	4	5	9
		% within If yes, how do they do so	44.4%	55.6%	100.0%
		% within Diarrhoeal status	4.5%	5.7%	5.1%
	Soap+Water+Towel	Count	38	69	107
		% within If yes, how do they do so	35.5%	64.5%	100.0%
		% within Diarrhoeal status	43.2%	78.4%	60.8%
Total		Count	88	88	176
		% within If yes, how do they do so	50.0%	50.0%	100.0%
		% within Diarrhoeal status	100.0%	100.0%	100.0%

	Chi-square Calculated	df	P-value
Pearson Chi-Square	26.159	2	< 0.001

How many children sleep in a room * Diarrheal status

			Diarrhoeal status		Total
			Case	Non-case	
How many children sleep in a room	<3	Count	37	65	102
		% within How many children sleep in a room	36.3%	63.7%	100.0%
		% within Diarrhoeal status	42.0%	73.9%	58.0%
	>3	Count	51	23	74
		% within How many children sleep in a room	68.9%	31.1%	100.0%
		% within Diarrhoeal status	58.0%	26.1%	42.0%
Total		Count	88	88	176
		% within How many children sleep in a room	50.0%	50.0%	100.0%
		% within Diarrhoeal status	100.0%	100.0%	100.0%

	Chi-square Calculated	df	P-value
Pearson Chi-Square	18.281	1	< 0.001

How many meals in day does your family eat * Diarrheal status

			Diarrhoeal status		Total
			Case	Non-case	
How many meals in day does your family eat	One	Count	32	41	73
		% within How many meals in day does your family eat	43.8%	56.2%	100.0%
		% within Diarrhoeal status	36.4%	46.6%	41.5%
	Two or more	Count	56	47	103
		% within How many meals in day does your family eat	54.4%	45.6%	100.0%
		% within Diarrhoeal status	63.6%	53.4%	58.5%
Total		Count	88	88	176
		% within How many meals in day does your family eat	50.0%	50.0%	100.0%
		% within Diarrhoeal status	100.0%	100.0%	100.0%

	Chi-square Calculated	df	P-value
Pearson Chi-Square	1.896	1	.169

Childs birth order * Diarrheal status

Crosstab

			Diarrhoeal status		Total
			Case	Non-case	
Childs birth order	First	Count	22	36	58
		% within Childs birth order	37.9%	62.1%	100.0%
		% within Diarrhoeal status	25.0%	40.9%	33.0%
	Second and third	Count	52	42	94
		% within Childs birth order	55.3%	44.7%	100.0%
		% within Diarrhoeal status	59.1%	47.7%	53.4%
	Fourth and fifth	Count	14	10	24
		% within Childs birth order	58.3%	41.7%	100.0%
		% within Diarrhoeal status	15.9%	11.4%	13.6%
Total		Count	88	88	176
		% within Childs birth order	50.0%	50.0%	100.0%
		% within Diarrhoeal status	100.0%	100.0%	100.0%

	Chi-square Calculated	df	P-value
Pearson Chi-Square	5.110	2	.078

Vaccinated against measles * Diarrhoeal status

Crosstab

			Diarrhoeal status		Total
			Case	Non-case	
Vaccinated against measles	Yes	Count	65	56	121
		% within Vaccinated against measles	53.7%	46.3%	100.0%
		% within Diarrhoeal status	73.9%	63.6%	68.8%
	No	Count	23	31	54
		% within Vaccinated against measles	42.6%	57.4%	100.0%
		% within Diarrhoeal status	26.1%	35.2%	30.7%
	Yet to be vaccinated	Count	0	1	1
		% within Vaccinated against measles	.0%	100.0%	100.0%
		% within Diarrhoeal status	.0%	1.1%	.6%
Total		Count	88	88	176
		% within Vaccinated against measles	50.0%	50.0%	100.0%
		% within Diarrhoeal status	100.0%	100.0%	100.0%

	Chi-square Calculated	df	P-value
Pearson Chi-Square	2.855	2	.240

level of education * Diarrhoeal status

Crosstab

			Diarrhoeal status		Total
			Case	Non-case	
level of education	Primary	Count	15	8	23
		% within level of education	65.2%	34.8%	100.0%
		% within Diarrhoeal status	17.0%	9.1%	13.1%
	Secondary	Count	48	43	91
		% within level of education	52.7%	47.3%	100.0%
		% within Diarrhoeal status	54.5%	48.9%	51.7%
	Tertiary	Count	25	37	62
		% within level of education	40.3%	59.7%	100.0%
		% within Diarrhoeal status	28.4%	42.0%	35.2%
Total		Count	88	88	176
		% within level of education	50.0%	50.0%	100.0%
		% within Diarrhoeal status	100.0%	100.0%	100.0%

	Chi-square Calculated	df	P-value
Pearson Chi-Square	4.728	2	.094

Do you have a job * Diarrheal status

Crosstab

			Diarrhoeal status		Total
			Case	Non-case	
Do you have a job	Yes	Count	49	73	122
		% within Do you have a job	40.2%	59.8%	100.0%
		% within Diarrhoeal status	55.7%	83.0%	69.3%
	No	Count	39	15	54
		% within Do you have a job	72.2%	27.8%	100.0%
		% within Diarrhoeal status	44.3%	17.0%	30.7%
Total		Count	88	88	176
		% within Do you have a job	50.0%	50.0%	100.0%
		% within Diarrhoeal status	100.0%	100.0%	100.0%

	Chi-square Calculated	df	P-value
Pearson Chi-Square	15.388	1	< 0.001

Has your husband a job * Diarrheal status

Crosstab

			Diarrhoeal status		Total
			Case	Non-case	
Has your husband a job	Yes	Count	83	85	168
		% within Has your husband a job	49.4%	50.6%	100.0%
		% within Diarrhoeal status	94.3%	96.6%	95.5%
	No	Count	5	3	8
		% within Has your husband a job	62.5%	37.5%	100.0%
		% within Diarrhoeal status	5.7%	3.4%	4.5%
Total		Count	88	88	176
		% within Has your husband a job	50.0%	50.0%	100.0%
		% within Diarrhoeal status	100.0%	100.0%	100.0%

	Chi-square Calculated	df	P-value
Pearson Chi-Square	.524	1	.469

What breastfeeding mode * Diarrheal status

Crosstab

			Diarrhoeal status		Total
			Case	Non-case	
What breastfeeding mode	Exclusive	Count	23	55	78
		% within What breastfeeding mode	29.5%	70.5%	100.0%
		% within Diarrhoeal status	26.1%	62.5%	44.3%
	Complementary feeding	Count	61	31	92
		% within What breastfeeding mode	66.3%	33.7%	100.0%
		% within Diarrhoeal status	69.3%	35.2%	52.3%
	Weaned	Count	4	2	6
		% within What breastfeeding mode	66.7%	33.3%	100.0%
		% within Diarrhoeal status	4.5%	2.3%	3.4%
Total		Count	88	88	176
		% within What breastfeeding mode	50.0%	50.0%	100.0%
		% within Diarrhoeal status	100.0%	100.0%	100.0%

	Chi-square Calculated	df	P-value
Pearson Chi-Square	23.577	2	< 0.001

Use bottle for feeding children * Diarrheal status

Crosstab

			Diarrhoeal status		Total
			Case	Non-case	
Use bottle for feeding children	Yes	Count	79	73	152
		% within Use bottle for feeding children	52.0%	48.0%	100.0%
		% within Diarrhoeal status	89.8%	83.0%	86.4%
	No	Count	9	15	24
		% within Use bottle for feeding children	37.5%	62.5%	100.0%
		% within Diarrhoeal status	10.2%	17.0%	13.6%
Total		Count	88	88	176
		% within Use bottle for feeding children	50.0%	50.0%	100.0%
		% within Diarrhoeal status	100.0%	100.0%	100.0%

	Chi-square Calculated	df	P-value
Pearson Chi-Square	1.737	1	.188

Child's birth weight * Diarrhoeal status

Crosstab

			Diarrhoeal status		Total
			Case	Non-case	
Child's birth weight	>3.0kg	Count	54	48	102
		% within Child's birth weight	52.9%	47.1%	100.0%
		% within Diarrhoeal status	61.4%	54.5%	58.0%
	2.5-2.99	Count	29	36	65
		% within Child's birth weight	44.6%	55.4%	100.0%
		% within Diarrhoeal status	33.0%	40.9%	36.9%
	<2.5kg	Count	5	4	9
		% within Child's birth weight	55.6%	44.4%	100.0%
		% within Diarrhoeal status	5.7%	4.5%	5.1%
Total		Count	88	88	176
		% within Child's birth weight	50.0%	50.0%	100.0%
		% within Diarrhoeal status	100.0%	100.0%	100.0%

	Chi-square Calculated	df	P-value
Pearson Chi-Square	1.218	2	.544

LOGISTIC REGRESSIONAL ANALYSIS ON RISK FACTORS TO DIARRHEAL OCCURRENCE IN UNDER-FIVES

Variables	Categories	OR	95% Conf. Interval	P-value
Age group	**Less than 6 months (reference group)**			
	6-12	2.164	0.16 – 28.98	0.560
	12-24	1.034	0.12 – 9.07	0.976
	24-36	0.797	0.08 – 8.05	0.848
	36-48	0.376	0.01 – 14.28	0.598
	48-60	0.233	0.01 – 5.84	0.376
Source of water for your family	**Borehole (reference group)**			
	Stream	0.752	0.19 – 2.97	0.684
	Treated water	0.346	0.04 – 3.23	0.352
	Rain	3.189	0.08 – 117.12	0.528
Type of toilet	**Bush (reference group)**			
	Pit	8.199	0.44 – 154.37	0.160
	Water system	1.430	0.53 – 3.84	0.478
If yes, how do they do so	**Only water (reference group)**			
	Water+towel	0.118	0.04 – 0.39	< 0.001
	Soap+Water+Towel	0.338	0.04 – 2.65	0.302
Child's birth weight	**>3.0kg (reference group)**			
	2.5-2.99	1.966	0.35 – 10.89	0.439
	<2.5kg	9.144	1.32 – 63.88	0.026
Childs birth order	**First (reference group)**			
	Second and third	0.624	0.155 – 2.51	0.506
	Fourth and fifth	0.349	0.094 – 1.29	0.116
Vaccinated against measles	**Yes (reference group)**			
	No	0.000	0.00 – 0.00	1.000

	Yet to be vaccinated	0.000	0.00 – 0.00	1.000
level of education	**Primary (reference group)**			
	Secondary	0.371	0.078 – 1.75	0.211
	Tertiary	1.086	0.412 – 2.86	0.868
What breastfeeding mode	**Exclusive (reference group)**			
	Complementary feeding	1.649	0.186 – 14.63	0.653
	Weaned	0.491	0.054 – 4.42	0.526
How many children sleep in a room	**<3 (reference group)**			
	>3	2.407	0.98 – 5.88	0.054
Gender	**Male (reference group)**			
	Female	0.569	0.556 – 2.91	0.569
Do your children eat left-over food and do they warm it well	**Yes (reference group)**			
	No	0.483	0.51 – 4.22	0.483
Use bottle for feeding children	**Yes (reference group)**			
	No	1.427	0.47 – 4.66	0.556
Do you have a job	**Yes (reference group)**			
	No	2.575	0.94 – 7.03	0.065
Has your husband a job	**Yes (reference group)**			
	No	0.657	0.09 – 5.33	0.694
Children wash hands after toilet or after handling faeces/waste	**Yes (reference group)**			
	No	0.347	0.03 – 4.19	0.406
How many meals in day does your family eat	**One (reference group)**			
	Two or more	0.555	0.19 – 1.59	0.273

This table summarizes the roles of the parameters in the model.

If the P-value is significant (i.e., less than 0.05) then the parameter is useful to the model. Exp(B) is the predicted change in odds for a unit increase in the predictor. When Exp(B) is less than 1, increasing values of the variable correspond to decreasing odds of the event's occurrence. When Exp(B) is greater than 1, increasing values of the variable correspond to increasing odds of the event's occurrence.