THE RELATIONSHIP BETWEEN SANITATION, HYGIENE AND HOUSEHOLD SOCIOCULTURAL-DEMOGRAPHIC FACTORS: A CASE STUDY OF BOGOSO IN THE WASSA WEST DISTRICT

by

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Declaration

hereby declare that this submission is my own work towards the MSc and that, to the best of my knowledge, it contains neither material previously published by another person nor material which has been accepted for the award of any other degree of the University, except where due acknowledgement has been made in the text.

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GLOSSARY

MDG	Millennium Development Goals
UN	United Nations
WHO	World Health Organization
GWCL	Ghana Water Company Limited
WWDA	Wassa West District Assembly
CWIQ	Core Welfare Indicators Questionnaire
GSS	Ghana Statistical Service
UNICEF	United Nations Children and Education Fund
CIA	Central Intelligence Agency
NGO	Non Governmental Organization
GGL	Goldfields Ghana Limited
WACAM	Wassa Association of Communities Affected by Mining
FON	Friends of the Nation
USAID	United States Agency for International Development
EIS	Environmental Impact Statement
MOH	Ministry of Health (Ghana)
IRC	International Resource Centre on water supply, sanitation and hygiene
CBR	Canadian Bogoso Resources
BGL	Bogoso Gold Limited
WEDC	Water Engineering and Development Centre (Loughborough University)
CDC	Centre for Disease Control
US EPA	United States Environmental Protection Agency
GSB	Ghana Standards Board
TCU	True Colour Units
CFU	Colony Forming Units

MF	Membrane Filtration
TNTC	Too Numerous To Count
NTU	Nephelometric Turbidity Units
PHAST	Public Health Action Support Team
SPSS	Statistical Package for Social Scientists

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DEDICATION

This project is dedicated to the memory of the late Kweku Acheampong Bonful.

ABSTRACT

Clean water and adequate sanitation are vital in the fight against the incidence of diseases in rural communities. Mining companies and other NGOs sponsor improved water and sanitation projects in attempts to curb the occurrence of disease in the Wassa West District. However, the prevalence of diseases like malaria and infant diarrhoea is still high. This thesis examines the effects of sociocultural and demographic factors on household sanitation conditions, identifies the presence of common bacteria in household drinking water and investigates the prevalence of diarrhoea among infants in the Wassa West District. It is based on structured interviews of 120 household heads and 77 caretakers of infants, spot observation of clues that indicate household sanitation practice as well as laboratory analysis of 125 household stored drinking water samples from communities in the Wassa West District of Ghana. The study showed that diarrhoea among infants was highly prevalent and its occurrence had no relationship with the education level of the child caretaker. Furthermore, the sanitation condition of households improved with high educational attainment and ageing household heads. On the contrary, sanitation deteriorated with overcrowding in the households. Also, the sanitation conditions of households depended on the religion of the head. Water quality analysis, indicated that the majority (66.7%) of stored drinking water of households tested positive for total coliform bacteria and also Escherichia coli was detected in 3 samples. In conclusion, rapid water and sanitation infrastructural development without both formal and behavioural change education policies integrated proportionally may not attain the desired results. Such education programmes must target young heads of household, households with large family size and households whose heads are Christians and Moslems. Also, social learning capacity must be strengthened at the household level to promote good sanitation practice.

CHAPTER ONE

INTRODUCTION AND BACKGROUND TO THE STUDY

1.1 Introduction

Efforts to assuage poverty cannot be complete if access to good water and sanitation systems are not part. In the 2000, 189 nations adopted the United Nations Millennium Declaration, and from that, the Millennium Development Goals were made. Goal 4, which aims at reducing child mortality bytwo thirds for children under five, is the focus of this study. Clean water and sanitation considerably lessen water-related diseases which kill thousands of children every day (UN, 2006). According to the World Health Organisation (WHO), 1.1 billion people lacked access to an enhanced water supply in 2002, and 2.3 billion people got illfrom diseases caused by unhygienic water. Each year 1.8 million people die from diarrhoea diseases, and 90% of these deaths are of children under five years (WHO, 2004).

Ghana Water Company Limited had traditionally been the major stakeholder in the provision of safe water and sanitation facilities. Since the 1960's the GWCL has focused its activity in the urban areas at the expense of rural areas (GWCL, 2007) and thus, rural communities in the Wassa West District are no exception. According to the Ghana 2003 Core Welfare Indicators Questionnaire (CWIQ II) Survey Report (GSS, 2005), roughly 97% in Accra, 86% in Kumasi and 94% in Sekondi-Takoradi owned pipe-borne water. Once more, the report show that a few households do not own any toilet facilities and depend on the bush for their toilet needs, that is 2.1%, 7.3%, and 5% for Accra, Kumasi, and Sekondi-Takoradi correspondingly. Access to safe sanitation, improved water and improved waste disposal systems are more of an urban than rural occurrencein Ghana. In the rural poor households, only 9.2% have safe sanitation, 21.1% use improved waste disposal method and 63.0% have access to improved water. The major diseases prevalent in Ghana are malaria, yellow fever, schistosomiasis

(bilharzias), typhoid and diarrhoea. Diarrhoea is of critical concern since it has been recognized as the second most universal disease treated at clinics and one of the major contributors to infant mortality (UNICEF, 2004). The infant mortality rate in Ghana stood at about 55 deaths per 1,000 live births (CIA, 2006).

1.2Facilities provided by mining companies and other organizations

The Wassa West District of Ghana has seen an improvement in water and sanitation facilities during the last decade. Most of the development projects in the district are sponsored by the mining companies, individuals and some non-governmental organisations (NGOs). Between 2002 and 2008, Goldfields Ghana Limited (GGL) constructed 118 new hand dug wells (77 of which were fitted with hand pumps) and repaired48 wells which were in poor condition. Also, a total of 44 modern style public water closets were constructed in their operational catchment areas. The company also donated 19 large refuse collection containers (skips) to the District Assembly and built 6 new nurses quarters. GGL has so far spent 10.5million US dollars of which 26% went into health, water and sanitation projects, 24% into agricultural development, 31% into formal education and the remaining went into other projects like roads and community centre construction (GGL, 2008). Golden Star Resources (consist of Bogoso/Prestea Mine and Wassa Mine at Akyempim) also established the community development department in 2005 and has since invested 800 thousand US dollars. Their projects include 22 Acqua-Privy toilets, 10 hand dug wells (all fitted with hand pumps) and supplied potable water to villages with their tanker trucks (BGL, 2007). Other development partners complimenting the efforts of the central government include NGOs like WACAM, Care International and Friends of the Nation (FON). WACAM is an environmentally based NGO which monitors water pollution by large scale mining companies. They have sponsored about 10 hand dug wells for villages in the district. Care International sponsors hygiene and reproductive health programmes in schools and on radio. They have also donated a couple of

bicycles to public health workers in the district who travel to villages to organise health education programmes. Despite efforts by the development partners, water supply and sanitation related diseases are highly prevalent in the district. Data obtained from the Public and Environmental Health Department of the Ministry of Health (M.O.H., 2008) showed that the top ten most prevalent diseases in the district include malaria, acute respiratory infections, skin diseases and diarrhoea. The others are acute eye infection, rheumatism, dental carries, hypertension, pregnancy related complications and home/occupational accidents. A lot more illnesses occur but on a lower scale and these include intestinal worm attacks, coughs and typhoid fever. A complete data on the top ten diseases prevalent in the district is attached as Appendix E. Table 1.1 is a selection of the illnesses that directly result from poor quality water and sanitation practices in the Wassa West District.

Table 1.1: ***HIGHLY PREVALENT DISEASES THAT DIRECTLY RESULTS FROM POOR WATER AND SANITATION PRACTICE***

Diseases	Prevalence rate per 1,000 population		
	2006	2007	2008
Malaria	350	320	300
Infant Diarrhoea	30	30	30
Acute respiratory infection	60	60	60
Dental Carries	10	20	10

Source: Regional Directorate of the Ministry of Health, 2008

The number of malaria cases decreased from 350 in 2006 to 300 cases per 1000 population in 2008. Despite the decrease, the values involved are still quite high as compared to values available from neighbouring WassaAmenfi East District for the same period (compare Appendix F and Appendix G). The incidence of diarrhoea among infants and acute respiratory infection remained 30 and 60 cases per 1,000 populations respectively. This can be attributed to several reasons, including populationgrowth, lack of continuousservices and inadequate functioning of facilities. In fact, according to the WHO(2004), an estimated 90% of all incidence of diarrhoea among infants can be blamed on inadequate sanitation and unclean

water. For example, in a study of 11 countries in Sub-Saharan Africa, only between 35-80% of water systems were operational in the rural areas (Sutton, 2004). Another survey in South Africa recognised that over 70% of the boreholes in the Eastern Cape were not working (Mackintosh and Colvin, 2003). Further examples of sanitation systems in bad condition have also been acknowledged in rural Ghana, where nearly 40% of latrines put up due to the support of a sanitation program were uncompleted or not used (Rodgers , 2007). In the Wassa West District approximately there are 224 public toilets, 560 hand-dug wells, 1,255 public standpipes and 3 well-managed waste disposal sites. According to the 2006 projection, the population of the district was expected to reach 295,753 by the end of the year 2009 (WWDA, 2006).

Development partners in the past have concentrated their efforts on facilities provision only. These facilities are prerequisites for the attainment of good sanitation practice but they have not looked well at the possible causes of the persistence of disease transmission despite the effort they are making. Relationships between household's sociocultural demographic factors and people's behaviour with respect to the practice of hygiene could prove an essential lead to the solution of the problem. The fact is, merely providing a water closet does not guarantee that it could be adopted by the people and used well to reduce disease transmission. Epidemiological investigations have revealed that even in dearth supply of latrines, diarrhoeal morbidity can be reduced with the implementation of improved hygiene behaviours (IRC, 2001: Morgan, 1990). Access to waste disposal systems, their regular, consistent and hygienic use and adoption of other hygienic behavioural practices that block the transmission of diseases are the most important factors. In quite a lot of studies from different countries, the advancement of personal and domestic hygiene accounted for a decline in diarrhoeal morbidity (Henry and Rahim, 1990).For example, a literature meta-analysis by Curtis and Cairncross (2003) based on data from Burkina Faso found that the single hygiene practice of

hand washing with soap is able to reduce diarrhoea incidence by over 40% and intestinal infections (cholera, dysentery, hospitalized diarrhoeas due to other causes) by over 50%. The World Bank (2003) identifies the demographic characteristics of the household including education of members, occupation, size and composition as factors influencing the willingness of the household to use an improved water supply and sanitation system. Education, especially for females results in well spaced child birth and greater ability of parents to give better health care. This in turn contributes to reduced mortality rates among children under 5years (Grant, 1995).

1.3The problem statement

The Wassa West District in the Western Region is home to six large scale mining companies and hundreds of small scale and illegal mining units. Towns and villages in the district have been affected by mining, forestry and agricultural activities for over 120 years (BGL EIS, 2005). Because of this development, the local environment has been subjected to varying degrees of degradation. For example, water quality analysis carried out in 1989 by the former Canadian Bogoso Resources (CBR) showed that water samples had total coliform bacteria in excess of 16 colonies per 100ml (BGL EIS, 2005). Most of the water and sanitation programmes executed in the district exerted little positive impact and thus, diarrhoeal diseases are still very high in the towns and villages (See Appendix F and Appendix G).

However, in order to solve any problem it is important to appreciate the issues that contribute to it; after all, identifying the problem in itself is said to be a solution in disguise. Numerous health impact research have evidently recognized that the upgrading of water supply and sanitation alone is generally required but not adequate to attain broad health effects if personal and domestic hygiene are not given equivalent prominence (Scherlenlieb, 2003).The troubles of scarce water and safe sanitation provisions in developing countries have

previously been dealt with by researchers for quite some time. However, until recent times they were mostly considered as technical and/or economic problems. Even rural water and sanitation issues are repeatedly dealt with from an entirely engineering point of view, with only a simple reference to social or demographic aspects.

Therefore, relatively not much is has been learnt about how the socio-cultural demographic factors impinge on hygiene behaviour which in turn influences the transmission of diseases. The relationship between household sociocultural factors and the sanitation conditions of households in the Wassa West District especially the Bogoso Rural Area Council has not been systematically documented or there is inadequate research that investigates such relationship.

1.4The research questions

The following research questions were posed to help address the objectives:

1. Why are the several sanitation intervention projects failing to achieve the desired results?
2. Why is the prevalence of malaria and diarrhoea diseases so high in the district?
3. What types of common bacteria are prevalent in the stored drinking water of households?

1.5Objectives

1.5.1 General objectives

The main aim of this research was to investigate people's awareness and practice of personal hygiene, access to quality water and sanitation, possible causes of diarrhoeal diseases and suggest ways to reduce the incidence of diseases in the community.

1.5.2 Specific objectives

The specific objectives were:

1. To assess the quality of stored household drinking water
2. To establish the extent to which sanitation behaviour is affected by household socio-cultural demographic factors like age and education level of the head
3. To investigate the occurrence of diarrhoea among young children (0-59 months old) in the households and
4. To identify and recommend good intervention methods to eliminate or reduce the outbreak of diseases and improve sanitation.

1.6Hypothesis

In addition to the above objectives, the following hypotheses were tested:

1. Occurrence of infant diarrhoea in the household is independent of the educational attainment of child caretakers and
2. There is no relationship between households' background factors and the sanitation conditions of the household.

1.7limitations of the study

The study was self-financed and that made it difficult for the researcher to cover more households for water quality sampling. Most of the study communities had very bad roads and that made transportation expensive. Also, some respondents took the researchers for community and environmental health workers (popularly called saman-saman) and were unwilling to cooperate. They only accepted to respond after researchers explainedthe project and showed student ID cards.

CHAPTER TWO

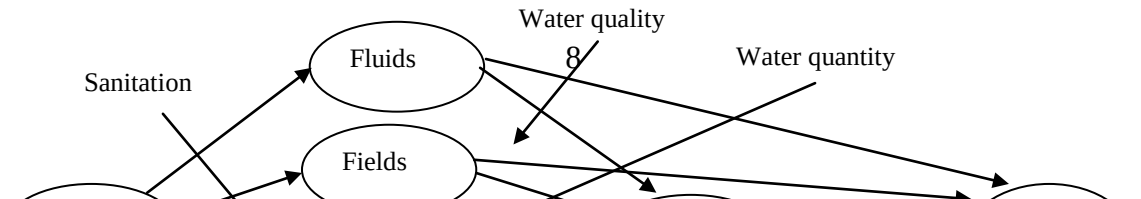
LITERATURE REVIEW

2.1 Introduction

In this chapter, various literature related to the subject matter of the study are reviewed. Areas covered are sanitation, hygiene, waterborne diarrhoealdiseases, other protozoan parasites,water quality and the data collection techniques. Theories and models the study referred to include USAID's Sanitation Improvement Framework, the "F diagram" by Wagner and Laniox and the theory of Social learning.

2.2Sanitation

Until recently, many intervention strategies focused on access to latrines by households as the prime sign of sanitation coverage. However, there must be a change or a broadening understanding of the term sanitation. Sanitation can best be defined as the way of collecting and disposing of excreta and community liquid waste in a germ-free way so as not to risk the health of persons or the community as a whole (Cotton and Saywell, 1998). Ideally, sanitation should end in the seclusion or destruction of pathogenic material and, hence, a break in the transmission pathway. The transmission pathways are suitably proven and are potted and shortened in the "F diagram" (Wagner and Laniox, 1958) shown in Figure 2.1. The more paths that can be blocked, the more useful a health and sanitation intervention programme will be.



It should be noted that factors that show the health effect of sanitation interventions are hard to quantify, especially in the short term. Thus, it feels more appropriate to see sanitation as a set of services and actions which can have some impact on the health of a person and the health status in a community when taken together (IRC, 2001).

2.3Hygiene

Hygiene is the discipline of health and it's safeguarding (Dorland, 1977). Health is the capacity to function efficiently within one's surroundings. Our health as individuals depends on the healthiness of our environment. A healthful environment, devoid of risky substances allows the individual to attain complete physical, emotional and social potential. Hygiene is articulated in the efforts of an individual to safeguard, sustain and enhance health status (Anderson and Langton, 1961).

Measures of hygiene are vital in the fight against diarrhoeal diseases, the major fatal disease of the young in developing countries. The most successful interventions against diarrhoeal diseases are those that break off the transmission of contagious agents at home. Personal and domestic hygiene can be enhanced with such trouble-free actions like ordinary use of water in adequate quantity for hand washing, bathing, laundering and cleaning of cooking and eating utensils; regular washing and change of clothes; eating healthy and clean foods and appropriate disposal of solid and liquid waste.

2.4Water related diseases and their geographic distribution

Each year, water-related diseases take the lives of 3.4 million people worldwide, the greater part of whom are children (Dufour*et al*, 2003). Water related diseases can be grouped into four categories (Bradley, 1977) based on the path of transmission as:

- *Waterborne diseases*
- *Water-washed diseases*
- *Water-based diseases and*
- *Insect vector-related diseases.*

Waterborne diseases are caused by the drinking of waterpolluted by pathogen bearing urine or faeces. They include typhoid, bacillary and amoebic dysentery, cholera and other diarrhoeal diseases.Water-washed diseases come about as a result of bad personal hygiene and some skin and eye contact with contaminated water. Examples aretrachoma, flea, scabies,lice and tick-borne illnesses. Water-based diseases result from parasites that live in water-based organisms. The water-based organisms serve as intermediate contacts for these parasites. These diseases include schistosomiasis, dracunculiasis and other helminths.Water- related illnesses result from insect vectors, for example mosquitoes that breed in uncovered water sources. These include malaria, trypanosomiasis, onchocerciasis,filariasis,dengueand yellow fever (Bradley, 1977).

Cholerais asevereillnesscaused by bacteriathat affect the intestinal tractresulting in serious dehydration diarrhoea that can be fatal without instant treatment. Cases of cholera are reported world-wide especially in emergency situations like areas affected by natural disasters. Good food and water hygiene can prevent it. There are 500 million cases of malaria worldwide each year resulting in 1.3million deaths (90% of whom are infants under 5years) and mostly the morbidity is in Sub-SaharaAfrica. Irrigation dam construction and other water development projects are the causes of the burden of the disease but reducing mosquito

populations in the household and eliminating stagnant water or covering up water containers can be essential in minimising malaria episodes. About 200 million people are infected with schistosomiasis (also known as bilharzia), 20 million of whom experience grave consequences like liver, intestines, lungs and bladder damage. Tens of thousands of people die every year, mostly from sub-Saharan Africa due to bilharzia. It is caused by parasitic worms or their eggs that live in some freshwater snails and human hosts. The worms can enter the skin of swimmers or those washing things in polluted water. Sufficient water supply and sanitation lessen the use of polluted surface water and could reduce infection rates by 77% (WHO,1993).

Trachoma is an eye disease spread generallyout of poor hygiene due to lack of sufficient amount of water and poorsanitation conditions. Approximately 6 million people world-wide are blind today due to trachoma. It affects women two to three times more than men and infants are particularlyvulnerable. Studies have found that providing adequate water supplies could reduce infection rates by 25% (WHO, 2004). Approximately, 133 million people world-wide are diagnosed with high intensity intestinal helminths illnesses mostly resulting in acute conditions such as cognitive impairment, heavy dysentery or anaemia. In fact, roundworm and whipworm alone are approximated to affect one-fourth of the world's population and 10% of the population of the developing world has intestinal worm infestations. Test carried out on 1377 refugees and asylum seekers entering Sweden showed that intestinal parasites were commonly found in refugees from south-eastAsia (48%), Africa (43%), and Latin America (42%) than in those from Eastern Europe (22%) and the Middle East(32%) (Benzeguir*et al*,1999). Guinea worm (also known as Dracunculiasis) is contracted by drinking water polluted with larvae. The larvae mature into adult Guinea worm (about 1 metre) and come out of the host's body after about a year creating devastating sores. In 2002, there were 50,000 episodes reported in a total of 13 African countries. Safe water and sanitation facilities can reduce the 9400 deaths due to intestinal helminths cause per year,

hookworm by 4% and the burden of ascariasis by 29%. Hepatitis A is a viral infection caused by the ingestion of contaminated food and water. Symptoms are similar to the common flu with some temperature and vomiting. There are 1.5 million cases of clinical hepatitis A every year world-wide.Typhoid fever is a bacterial disease transmitted by eating polluted food and water. Symptoms include headaches, nausea and loss of appetite. About 12 million people are affected by typhoid every year world-wide. Heavy metal contamination of natural water sources is also a major cause of diseases. Underground water especially due to its coolness and absence of particles is regarded as safe by users. Arsenic pollution of ground water has been detected in several countries, namely; Argentina, Bangladesh, Chile, China, India, Mexico, Thailand and the United States. An estimated 1.5 million people in Bangladesh develop drinking-water related skin lesions and can bring about cancers of the skin, lungs, bladder and kidney (WHO, 2004). Fluorosis is also a serious bone infection caused by high concentrations of fluoride naturally occurring in groundwater and it is prevalent in at least 25 countries across the globe. In China for example,about 26 million people suffer from dental fluorosis and over one million episodes of skeletal fluorosis are believed to be as a result of contaminated drinking-water. Fluorosis is also prevalent in the Upper East Region of Ghana.Poliomyelitis is caused by a virus that enters the body through the faecal-oral path mostly from the hands and eating utensils polluted with faeces of infected persons. The virus thrives in the throat and intestines of infected people and attacks the nervous system causing paralysis in victims. Cases of Polio are now rare in the United States due to the availability of extensive immunization policies. Polio was common worldwide but immunization efforts helped to reduce the circulation of the virus. Currently the risk is limited to the Indian Subcontinent and to a less significant degree, West and Central Africa.

2.4.1Geographic distribution ofcommon diarrhoea diseases and waterborne microorganisms

Diarrhoea can be classified into two groups namely, total diarrhoea and comparative diarrhoea based on either the rate of recurrence of bowel movements or the consistency (or looseness) of stools (CDC, 2006). Total diarrhoea is having more bowel movements than normal. Comparative diarrhoea is defined based on the consistency of stool. Thus, an individual who develops looser stools than normal has diarrhoea even though the stools may be within the range of normal with respect to consistency. According to the United States Centre for Disease Control and Prevention (CDC),with diarrhoea, stools are characteristically looser whether or not the rate of bowel movements is increased. This looseness of stool which can differ all the way from somewhat soft to watery is caused by increased water in the stool. For example, some viruses, bacteria and parasites cause increased release of fluid, either by attacking and inflaming the lining of the small intestine or by producing toxins. Inflammation stimulates the lining to secrete fluid and the toxins also fire up the lining to secrete fluid but without causing swelling (CDC, 2006).

Escherichia coli (E. coli)O157:H7,is perhaps the most feared bacteria these days by caretakers of young children.These bacteria can be found mainly on domestic mammals especially cattle. In 1993, this strain was detected as the cause of 4 deaths and more than 600 cases of bloody diarrhoea among children less than 5years in the North-Western USA outbreak. The Northwest epidemic was traced to undercooked hamburgers served in a fast food restaurant (Bell et al, 1994)

In peri-urban areas of Varnasi, India, tested samples from complementary infant milk feeds showed *E. coli* contamination (Ray *et al*, 2000). Also, during the summer of 1992, an epidemic of bloody diarrhoea happened in South Africa and Swaziland (Isaacson *et al*,1993) killing many of the thousands of people it affected.*E. coliO157* was detected as the cause and studies revealed that some affected men ingested surface water sources without treatment. The primary cause of the outbreak was apparently found to be decaying dead cattle and dung

carried downstream into rivers and dams after heavy downpour soon after some drought.Other possible sources of this strain include raw spinach, raw sprouts, contaminated water and fruit juice. However, heating food well over 60^{o}C can easily destroy this strain.

Campylobacter jejuni is assumed to be the main cause of infant diarrhoea in developing countries (Oberhelman*et al*, 2003), and strains identified in Peru implicated free range chicken as the main source of transmission.Data collected from 1989 to 1996 from *Oita prefecture*in Japan showed *Campylobacter* accounted for 40% of the 1707 diarrhoeal specimens collected(Narimatsu*et al*,1997).There exists a documented evidence of toxoplasmosis occurrence related to drinking of oocyst infected water in Central America. According to Benenson*et al* (1982), 32 US Army soldiers returning from military exercises in Panama experiencedindicative infection with *Toxoplasma*in 1979. Investigation suggested the cause was due to the drinking of stream water polluted with *oocyst*excreted by wild cats. Toxoplasma existence in Asia, Africa and South America is likely to be underrated due to the inadequate testing equipment for *oocyst* in the environment.

In a 2-yearsurveillance of 6760 patients withincapacitating diarrhoeal diseases in Indonesia, 59.3% of the samples had some varieties of *shigella*, 29% had varieties of *salmonella*and the remaining had *Campylobacter jejuni* and the *vibrio spp.*Grace*et al*(1979) went on to find that 48% of samples from river water used for drinking in Jakarta tested positive for *Salmonella* presence. The mode of transmission of non-typhoidal*Salmonella* in tropical Africa is not yet known but as shown by Graham *et al*(2000), there is an increase in cases during the rainy season and this suggest some waterborne or water associated transmission. Faeces of wild animals are the suspects, providing the faecal-oral route of transmission especially during the wet seasons. For example, in 1999 out of 62 faecal samples collected from mountain gorillas in Bwindi and Mgahinga National Parks, Uganda, 19% contained *campylobacter spp*., 13% *Salmonella* spp., and 6% *Shigella spp*.(Nizeyi*et al*,2001).

Between 1990 and 1991, 3222 strains of *Salmonella* were found at the National *Salmonella* and *Eschirichia* Centre in Kasauli, India. The sources were from humans, poultry, reptiles, birds and other domestic animals (Mahajan*et al*, 1998). *Giardia duodenalis*cysts, *Cryptosporidium spp. oocysts*, and spores of *microsporidia* have also been discovered in water settings, but their miniature form means they can escape treatment systems and cause large scale outburst of waterborne diseases. For example, two episodes of waterborne outbreak of cryptosporidiosis happened in Japan (Smith and Rose, 1998). In Guinea-Bissau, *Cryptosporidium* was identified as the most vital cause for infant diarrhoea occurrence(Sodemann*et al*, 1999). *Giardia and cryptosporidium spp.* have been identified in several studies, some including hospital based HIV seropositive patients with chronic diarrhoea inIndia(Nath*et al*. 1999), Malaysia(Menon*et al*, 1999), Taiwan(Hsu *et al*, 1999), Kenya (Mwachari*et al*,1998) and Japan(Suwa and Suzuki, 2001).

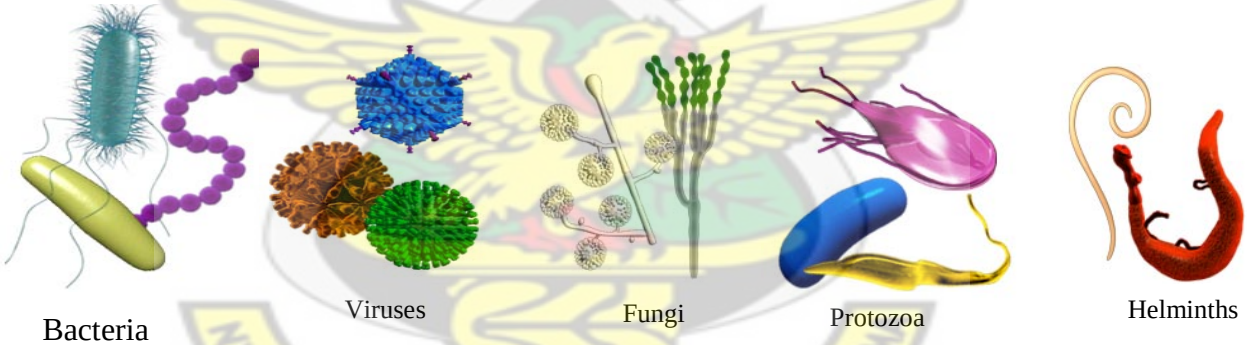


FIGURE 2.2: MICROORGANISMS (Source: ERA, 2007)

2.4.2Reducing diarrhoea morbidity with the comprehensive approach

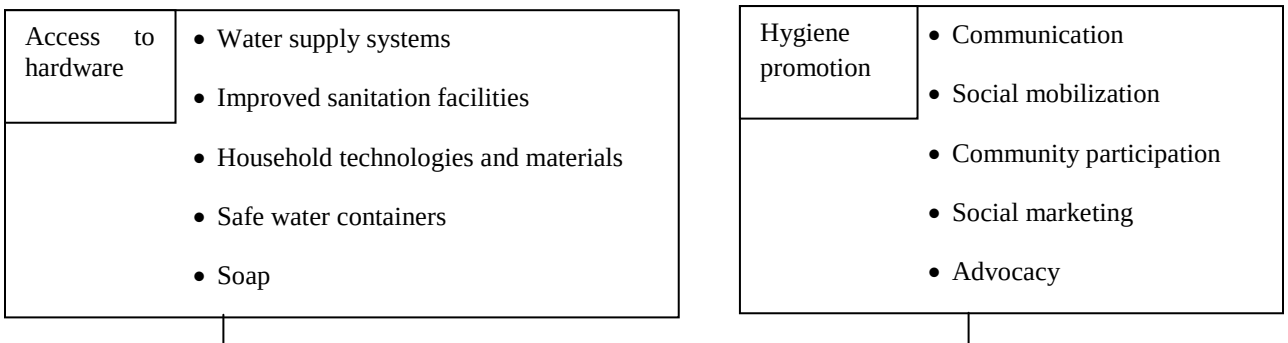
To attain noteworthy improvement in reducing the number of deaths attributed to diarrhoea, itsfundamental causes must be addressed. According to the Joint Publication(2004), for further progress to be made in the fight against diarrhoea, the concentration will need toinclude preventionthrough hygiene improvement and increasing host resistanceto diarrhoea. Some measures gaining effects have been sustained feeding and initiation of oral rehydration therapy. Also improving the child's nutrition and vaccinating against measles, which is a

familiar cause of diarrhoea has proved successful in recent times (The Joint Publication, 2004). Regardless of a drop in deaths due to diarrhoea, morbidity or the health problem due to diarrhoea has not reduced, since health connoisseurs are healing the symptoms but not addressing the roots of the problem. A significant component of successful prevention efforts is an effective monitoring and appraisal strategy.

In order to minimise transmission of faecal-oral diseases at the household level, for example, an expert group of epidemiologist and water supply and sanitation specialists concluded that three interventions would be crucial. These are:

- *Safer disposal of human excreta, particularly of babies and people with diarrhoea*
- *Hand washing after defecation and handling babies' faeces and before feeding, eating and preparing food, and*
- *Maintaining drinking water free from faecal contamination in the home and at the source (WHO, 1993).*

Research on hand washing, as stated in Boot and Cairncross (1993), validate that it is not only the act of hand washing, but also how well hands are washed that makes a difference. At the national level, thorough approach to diarrhoea must tackle the three key elements. These are; contact with the necessary hardware or technologies, encouragement of healthy behaviours and lifestyles, and assistance for long-term sustainability. The concept is explained in Figure 2.3:



The first part, water supply systems, deals with the issues of water quality and water quantity, which lower the risk of contamination of food and drink. Likewise, ensuring access to water supply systems can really reduce the time women spend collecting water, permitting more time to care for young children and more time for income generating activities. The third factor, household technologies and materials, refers to the increased ease of access to such hygiene supplies as soap (or local substitutes), chlorine, filters, water storage containers that have restricted necks and are covered, and potties for small children. The second element of the hardware component, toilet facilities, involves providing facilities to dispose off human excreta in ways that safeguard the environment and public health, characteristically in the form of numerous kinds of latrines, septic tanks, and water-borne toilets (Joint Publication, 2004).

2.5Sociocultural demographic factors

Humans,to a large extent,build their own cultural and social environment. Customs, practices and traditions for continued existence and growthare transferred from one generation to another. In such a manner, the constituents of an individual society become accustomed to believe certain "truths" about life around them. The demography of a district includes population size andstructure, as well as vital socio-economic characteristics such as educational attainment and broad or limiteddifferences in a society's allocation of income. Demography also includes ethnicity and religious orientation of the population. Sociocultural factors to a large extent are the forces inside cultures and societies that affect the thoughts, feelings and behaviours of individuals and they include socio-economic position, social roles and circumstance and cultural factors like housing conditions.These sociocultural patterns are complex and specific to racial groups andsometimes, thetype of society.Socio-economic characteristics or variables of apopulation include factors such as age, sex, educational level, income level, marital status, occupation, religion, birth rate, death rate, average size of a family and average age at marriage. These sociocultural patterns have been recognized by the WHO(1993) asdeterminants that greatly influence collective and personal well-being.

In a study into water resource scarcity in coastal Ghana, Hunter (2006) identified valid correlations between household size, the presence of young children and the gender of the household head. He noted that, female heads were less likely to collect water in larger households. Furthermore, increasing number of young children present increased the odds of female head/spouse being the household water collector. Cultural issues play active part in hygiene and sanitation behaviour especially among members of rural communities. For example, women are hardly seen urinating in public due to a perceived shame in the act but men can be left alone if found doing it. Also, the act of defecation publicly is generally

unacceptable except when infants and young children are involved. The reason is that the faeces from young people are allegedly free from pathogens and less offensive (Drangert, 2004). Ismail (1999) working on nutritional assessment in Africa, detected that peoples demographic features, socioeconomic conditions and access to basic social services such as food, water and electricity correlate significantly with their health and nutrition status. Specifically, factors such as age, gender, township status and ethnicity, which are basic to demography, can play a role in the quality of life especially of the elderly.

Moreover, the construction materials of rural houses make them suitable for insect vector infestation that leads to sanitation related diseases. Studies in Guatemala by Bustamante *et al* (2004), evaluated household construction materials as potential risk factors for the invasion with the Chagas disease vector *Triatomadimidiata*. For that analysis, a house was deemed positive for vector existence if some by-products like eggs,dead insects, insect faeces as well as live insects were discovered by inspectors. The investigation revealed significant relationships between vector presence and construction materials. There was a greater likelihood of vector presence when walls lacked plastering or walls had low quality-incomplete plastering, compared with walls that were completely plastered. The odds for presence of insectwere 9.55 times higher in houses made with adobe (mud and/or earth) walls. Also,houses with unplastered floors had higher odds of infestation than completely plastered ones. Vector infestation was 14.13 times higher in houses roofed with mixed materials (bamboo, thatch, raffia etc). Furthermore, in rustic areas of Morelos, Mexico, *T. pallidipennis*(Mexican vector of Chagas disease) had a higher chanceto infest housesmade with adobe walls as well as those with farm produce stored in it. The storage is normally done on the roofs of the houses as well (Enger*et al*, 2004).

2.6Water quality standards and guidelines

Water quality is defined in terms of the chemical, physical, and biological constituents in water. The word “standards” is used to refer to legally enforceable limit values for the water factors analysed, while “guidelines” refer to threshold values that are recommended and do not have any regulatory status. This study employs the WHO and the Ghana Standards Board (GSB) “standards” and “guidelines” in determining the quality of water.

2.6.1Water Quality Requirements for Drinking Water

The Ghana Standards for drinking water (GSB, 1998) indicate the required physical, chemical, microbial and radiological properties of drinking water. The standards are adapted from the WHO (1993) guidelines for drinking water quality, but also incorporate national standards that are specific to the country’s environment.

2.6.2Physical Requirements

The Ghana Standards set the maximum turbidity of drinking water at 5 NTU. Other physical requirements pertain to temperature, odour, taste and colour. Temperature, odour and taste are generally not to be “objectionable”, while the maximum threshold values for colour are given quantitatively as True Colour Units (TCU) or Hazen units. The Ghana Standards specify 5 TCU or 5 Hazen units for colour after filtration. The requirements for pH values set by the Ghana Standards for drinking water is 6.5 to 8.5 (GS 175-Part1:1998). Although no health-based guideline is given by WHO (2006) for turbidity in drinking water, it is recommended that the median turbidity should ideally be below 0.1 NTU for effective disinfection.

2.6.3Microbial Requirements/Standards

The Ghana Standards specify that E.colior thermotolerant bacteria and total coliform bacteria should not be detected in a 100ml sample of drinking water (0 CFU/100ml). The Ghana

Standards also specify that drinking water should be free of human enteroviruses.Like the Ghana Standards, WHO standards also require that, no E.colior thermotolerant bacteria should be detected in a 100 ml sample of drinking water.

2.7The data collection techniques

2.7.1Interviews

The interview method is a face-to-face meeting of a questioner and a respondent, or an oral presentation of an opinionaire or attitude scale. Very often, it is used in collecting data for descriptive studies, action research, evaluation and sometimes correlational studies. The advantages are that, the response rate is high, the issues can be clarified and the researcher can probe for specific meanings of responses made.Basically, there are 3 types of interviews namely; structured interview, semi-structured interview and unstructured interview.

In a structured interview, the interviewer asks the respondents an established set of questions. Each interview entails exactly the same questions asked in the same way. In fact this method can be called an oral administration of a questionnaire. The instrument for this type of interview is a detailed interview schedule that contains specific questions, response categories for recording answers and instructions to the interviewer. With the semi-structured interview method, the researcher has a general structure for inquiring but not an exact set of questions. The interviewer has the freedom to create specific questions and to probe whenrelevant. The instrument for this type is a set of goals, objectives, issues or general questions that must be completed either during or after the interview.

Unstructured Interview is anopen method to interviewing. It lacks specific instrument but often has a general composition that is in the mind of the interviewer. It is a non-directive type of interview where most of the speaking is done by the respondent. This type is suitable

for counselling, psychotherapy and general problem analysis. The results are usually recorded in the form of notes or tape recordings.

2.7.2Observation methods

Observation involves using one's sense to see, smell, touch, listen and occasionally taste what is going on in a social setting. This can be done in three different ways namely: unobtrusive measures, non-participant observation and participant observation.In an unobtrusive observation study, the researcher can identify patterns of social activity without coming into direct contact with those being studied. An example is a study which involves observing seasonal patterns in sales of cigarettes or maize. For a non-participant observation, the researcher is physically present but only as a spectator who does not become directly involved in the activities of the people who are being studied. The bias here is that people behave abnormally in the presence of a scientific observer (Stoner and Freeman, 1992). Finally, in a study that apply participant observation, the researcher takes part in the activities under investigation, for example the researcher can be an assistant storekeeper in a factory or join a group of trainee nurses.

2.7.3Multistage Cluster Sampling

Cluster sampling is a technique by which the entire population is divided into segments or groups (clusters) then a random sample of these clusters is selected. The multistage cluster sampling method is a modification of the cluster sampling method in which the sample is chosen in steps. The Population is divided into larger units from which some are randomly selected. The second stage sample is selected from those clusters selected in the first stage. This is in fact a method of subdividing the population into progressively smaller units and can be used to achieve as many stages as desired. It is more practical and/or economic

when the list of subjects is so widely scattered that surveying them would be too expensive and burdensome.

2.8The Theory of Social Learning

Learning is any relatively permanent change in behaviour that can be attributed to experience (Coon, 1998). Social learning theory focuses on the learning that takes place in a social context.Albert Bandura is considered the principal proponent of this theory. Bandura's social learning theory according to Kearsley(1994), "*emphasizes the importance of observing and modelling the behaviours, attitudes, and emotional reactions of others*". Kearsley further points out that moraljudgment regarding right and wrong can in part develop through modelling. As cited in Kearsley(1994) Bandura (1977) theory states:

> *Learning would be exceedingly laborious, not to mention hazardous, if people had to rely solely on the effects of their own actions to inform them what to do. Fortunately, most human behaviour is learned observationally through modelling: from observing others one forms an idea of how new behaviours are performed, and on later occasions this coded information serves as a guide for action.*

Bandura revealed fourindispensableconditions required before an individual can effectively model the behaviour of someone else. These conditions are as follows:

- *Attention: the learner must pay attention to the model*
- *Retention: the learner's ability to remember the behaviour observed, this can be improved by the technique of rehearsal*
- *Motor reproduction: the observer's ability to replicate the behaviour which has just been observed. Further practice is the key to improve this aspect*
- *Motivation: Finally, the observer has to be motivated to imitate the behaviour that has been modelled. Reinforcement and punishment play an important role in motivation.*

According to the social learning theory, behavioural processes are directly acquired by the continually dynamic interplay between the individual and its social environment (Mc Connell, 1982). By observing a role model, a person may learn new responses, learn to carry out or avoid previously learned responses (depending on what happens to the model for doing the same thing) or learn a general rule that can be applied to various situations (Rosenthals and Zimmerman, 1978).Numerous actions can be learned, at least partly, through modelling. For example, children learn what to do at home by observing what happens when their siblings talk back to their parents or throw rubbish into the household compound. Aggression can also be learned through models. In his famous "bobo doll" study, Bandura (1973) found that children become more aggressive when they observe aggressive or violent models. He allowed children to observe an adult acting violently to a doll and when later the children were made to play with the doll they began to imitate the actions they previously observed. Additional examples that can be mentioned are; children can observe parents read, can watch the demonstrations of simple water treatment methods, or see someone acting bravely in a fearful situation.

The learning process occurs through reinforcement and punishment. Reinforcement refers to any event that increases chances that a response will occur again (Coon, 1998). When a child is rewarded with a candy for doing something good, like using toilet seat correctly, then this behavior becomes more likely to be repeated by the child. The reinforcement then is the candy. The environment also naturally reinforces the observer intrinsically. For example, a child can change his/her way of dressing or begin to practice simple personal hygiene like cutting finger nails and brushing teeth in order to be accepted by a group of colleagues without any external reinforcement.Bandura (1969) described intrinsic reinforcement as a form of internal reward, such as pride, satisfaction, and a sense of accomplishment. Punishment is any event that follows a response and decreases its likelihood of occurring

again (Bandura *et al*, 1980). If a child is caned for not washing the hands before eating, this behaviour may become less likely to be repeated by the child and caning becomes a punishment. Another example is if the child's favourite toy is seized by parents or caretakersfor not washing dirty plates, there is less likelihood that such behaviour will happen again. Reinforcement and punishment can be learned through education where the person can read about what happens to people as a result of actions they take.

The elementary unit of society is the household and this can be defined as a residential group of persons who live under the same roof and eat out of the same pot (Friedman, 1992). Persons living in the household may be blood related or not and they relate to each other according to a complex moral code in which many of their responses are culturally patterned. These responses are what have been defined as behaviour by Reber (1985). Health behaviours are learned in one's most influential learning environment, which is the home, and from one's most potent models, the parents. The sort of behaviour the parents exhibit in the household therefore has a significant effect on the sanitation conditions that prevail in the household.Social learning is necessary for the household in acquiring the skills pertinent to the maintenance of health promoting behaviour. Most of our daily activities are learned in the household. Individuals begin to learn behaviour patterns from childhood by observing especially the parents and later on their siblings. The environment is understood as comprising the whole set of natural or biophysical and man-made or sociocultural systems, in which man and other organisms live, work or interact (Ocran, 1999). The environment is human life's supporting system from which food, air and shelter are derived to sustain human life. Humans interact with the physical and man-made environment and this interaction creates a complex, finely balanced set of structures and processes, which evolve over the history of a people. These structures and processes determine the culture of the society, their social behaviour, beliefs and superstition about health and diseases. Social relationships seem to protect

individuals against behavioural disorders and they facilitate health promoting behaviour (Barlow and Durand, 1995; House *et al*, 1988). Cultural systems shape peoples' motivation so that they want to act in ways that the system needs them to act (Agbola, 1993) and as humans develop; they learn to behave in ways that conform to cultural standards. To function as adults, children must learn the cultural beliefs and behaviour patterns of their society. They must construct an understanding of social rules and gradually come to experience cultural beliefs and values on their own (Maccoby, 1980, 1992)

CHAPTER THREE

MATERIALS AND METHODS

3.1 Introduction

The study was undertaken to examine issues in rural water supply such as sanitation conditions, hygiene and the incidence of some hygiene related diseases. It was to determine the extent to which bacteria have contaminated households' water and to identify the types of bacteria that might be present. The chapter describes the area of study, the samples and sampling technique, the instruments for data collection, data collection and procedure for data analysis procedures.

3.2The wassa west district

The Wassa West District is located in the South Western part of the Western Region of Ghana. It is located between latitudes 4^{o} 50˙ N and 5^{o}40˙ N, and longitudes 1^{o} 10W and 2^{o} 10W. It has a total land area of 2,354km^2. The district capital is Tarkwa and it is about 90km from the regional capital SekondiTakoradi. The District falls within the forest-dissected plateau of Ghana. Pre-Cambrian rocks of Birimian and Tarkwaian formations underlie the forest – dissected plateau. The relief is generally undulating with few scarps rising between 150m and 300m above sea level (WWDA, 2006).

3.2.1The Bogoso Community

The study area, Bogoso, is about 35 km from the district capital with an estimated population of 8,659 people (2006 projection, WWDA) representing 3.95% of the population of the district. The population density is 96.27 persons per km^2. Male to female ratio is 100:97. Traditional authority is exercised by a paramount chief who is supported by two divisional chiefs Adontehene and Benkumhene(WWDA, 2006).

The dominant tribe is the Wassa tribe who constitute about 43% of the population. Other tribes include Asante, Ewe, Ga, Kokomba and Brongs among others. Bogoso forms part of the Birimian and Tarkwaian geological formations. Economically, the Birimian rocks are regarded as the most important formations due to their mineral potentials. They account for the existence of many gold mining companies operating in the town. Soils in Bogoso are the forest oxysols formed from Tarkwaian and Birimian rocks, suitable for cultivation of food and tree crops. The vegetation of Bogoso is the Equatorial Rain Forest type with moist semi deciduous forest. This yields various tree species including Odum, Mahogany, Wawa, and Utile to the Ghana Timber Industry. Climatically, the community lies within the south-western equatorial zone and is marked by double maximum rainfall pattern starting from March. It has an annual mean rainfall of 187.83mm per month and a uniform temperature ranging

between 26^{o}C in August and 30^{o}C in March. Relative humidity is generally high throughout the year between 70% - 80% in the dry season and 75% - 80% in the wet season.

3.3Data collection methods used for the study

The aim of this study was to gain knowledge into the extent to which households' drinking water can be bacteriologically contaminated and to identify factors that have contributed to the pollution. Three methods (interview, observation and laboratory analysis) were combined to study the problem so that the strengths of each method could overcome the deficiencies of single method studies (Sarantakos, 1998). The interview method was chosen to enable the researcher establish rapport with respondents so as to explain further any questions respondents may find difficult to answer. Direct spotobservation of sanitation indicators were undertaken to help the researcher capture at first hand, the sanitation behaviour of the people and also to neutralize any biasedness in the interviews. The spot observation used in this study is a variation of the non-participant method but in this case indicators of sanitation practice were observed instead of the real sanitation behaviour of respondents. For example, the researcher observed the availability of soap and water for regular hand washing as an indication of good sanitation that also augments the respondents performing the real act of hand washing. This method of observation is faster and also less intrusive (Arimond and Ruel, 2002).Due to the cost involved and the tremendously large and scattered population of the Bogoso community, multi-stage cluster sampling was employed in the administration of the interview guide. The respondents included heads of the various households or their representatives and people who cared for infants below age 5years in the households, some of who were the spouses of the household heads.

Interview schedule was developed for household heads and caretakers of children below 5 years as well as an observational guide. Slight changes were made to the questions for the heads and that for the child minders. It covered general sanitation and hygiene behavioural

issues. Copies of questionnaire for household heads, caretakers and the observational guide are attached as Appendices A, B and C. The general sub-topics for the interview questions were; household characteristics, waste disposal methods, water use behaviour, water storage, occurrence of diseases in households, presence of sanitation facilities, hygiene practice and health education of infant caretakers. Personal interviews were conducted at the respondents' home in the dialect of the respondents with the help of research assistants. The observation involved looking out for physical clues of sanitation practices as well as water storage conditions.

First, the study area was divided into six cluster communities (centres indicated with red spots on the map). These clusters had centres at; Kumsono, Abekakrom, Kokoase, Odumasi, Ayensukrom and Kwametintin. At the second stage, some houses were identified at random within each cluster. Out of these houses, a household was sampled and given household identification numbers in the third stage followed by individuals within these households in the final stage. A total of 120 household heads and 77 caretakers of children below 5 years responded. This sample size is in line with the guidance suggested by Nwana (1992) that if the population of the study area is several thousands, 5% or less sample size may be representative enough. The review of secondary data helped in obtaining information that has been documented about water, sanitation and health in the region and elsewhere. Review of secondary data also provided criteria for analysing the water as well as standards of bacteria and their concentrations.

3.4The Data Analysis

Field notes, interviews and all other information were collated, edited and coded. The information was tabulated and frequency tables obtained using the SPSS software. The data

was then analysed to extract meaning and understanding using Pearson Product Moment Correlation Values. The relationships between continuous variables were determined by using scatter plots whilst cross tables were used for categorical and nominal data sets. Continuous data is one that can be counted, ordered and measured like age, weight and the family size. Nominal data have values that can be coded in the form of numbers where the numbers are merely labels. For example in a data set males could be coded as 1 and females as 2 where the order or size does not matter. For categorical data sets, values are sorted according to a particular group that does not overlap with any other category. For example, people have the characteristics of gender as male and female. The use of correlation analysis for categorical and nominal data is always done with caution since the order of the codes is irrelevant. For that reason,scatterplots cannot be used to show accurately the relationships between categorical and nominal variables. Cross tabulation, which is a combination of two or more frequency tables, rather allow us to observe frequencies that belong to specific categories on more than one variable. This makes it easy to identify the relationship between cross tabulated variables.

3.5Water quality sampling

The number of samples tested by the author of this study was limited to the 3 months time available and the main aim was to sample as many households as possible. Water samples were collected between June and August 2007 from stored water containers of 30 households in the target communities for analysis. The sources of these stored water are shown in Figure 4.8. In all, a total of 125 water samples (including duplicates and blanks)were tested from these 30 household sources. Physical observation of the stored drinking water revealed that some containers had no covers and most households collect water from the containers by dipping cups and bottles into them. The number of water samples collected for analysis was not equal to the number of respondents because of resources and financial

burden. Water samples were collected in sterilized standard 500ml Whirl-Pak® bags with sodium thiosulfate tablet. They were transported in ice packs and coolerbags to ensure that low temperatures (2-8ºC) were maintained at all times. This was done to preserve the integrity of the samples since bacteria reaction cannot progress at that temperature. If any excess reaction is not stopped, the results of the analysis may be affected. Analysis of the water samples began within 4 to 6 hours of collection at the Environmental Quality Department of Golden Star Bogoso/Prestea Mine. When testing within 4 to 6 hours was not possible, the samples were transferred to a refrigerator andtested within 24 hours. Distilled, bottled or boiled water was used to meet sterile water requirements.

Studies done by Obiri-Danso*et al* (2003) indicated that all samples of bottled water tested were free of microbial contamination (0 CFU/100ml for both E.coliand total coliforms), which implies that using bottled water as sterile water could not have been a major source of error for the tests conducted in this study. Blanks were consistently run of this water and (with one day's exception on distilled water that was obtained from St Augustine's School laboratory andpotentially contaminated by the collection container) came out blank. Where the household used bagged sachet water, thesesamples were transported in their original sachet-packs. Water samples were onlytransferred to the Whirl-Pak® bags at the testing lab, so that the sodium thiosulphatetablet contained in the Whirl-Pak® bags would neutralize any chlorine in the sachetwater. The sodium thiosulfate tablet contained in one bag is capable of neutralizing500ml of a chlorinated water sample (HACH, 1999). The neutralization by sodiumthiosulfate ensured that no residual chlorine would interfere with the microbial analysis.

3.5.1Membrane Filtration Method (MF) using mColiBlue24®

In the Membrane Filtration (MF) method, water of a known volume (usually 100ml) is passed through a sterile filter paper with 0.45 microns pore diameter. These pores are small

enough to filter out bacteria. The filter paper is then transferred to a Petri dish which contains a pad saturated with medium. For this study, mColiBlue24® broth (ready-to-use broth sold in plastic ampoules) was the media for coliform growth. mColiBlue24® is a nutritive membrane-filtration media that simultaneously detects total coliforms and E. coliwithin 24 hours. The media is lactose based and contains inhibitors to selectively inhibit growth of non-coliform cells (HACH, 2003). Total coliforms are "highlighted" by non selective dye, 2,3,5-Triphenyltetrazoliumchloride (TTC), which produces red colonies. E.coli, on the other hand, is "highlighted" through the action of β-D-glucuronidase enzyme and/or 5-bromo-4-chloro-3-indolyl-β-glucoronide (BCIG or X-Glu). Red and blue colonies combined are total coliforms while blue colonies alone are E. coli. The media is provided in 2ml ready-to-use ampoules, which have a shelf life of one year when stored under temperature conditions between 2-8 ºC. The detection limit (or sensitivity) is one CFU coliform bacteria or E. coliper 100ml of sample (HACH, 1999).

The Petri dish is incubated at 35ºC ± 0.5ºC for 24 hours, during which coliforms, if present, multiply and grow in size, and can thus be identified and counted. Visible coliforms form since dye present in the media causes the coliforms to appear coloured. For drinking water, the counts are reported as coliforms forming units per 100ml of water (CFU/100ml). Where necessary, various dilutions were applied to obtain coliform counts within a given range. Colonies that entirely cover the plate grid, causing it to be red or pinkin color, are recorded as "too numerous to count" (TNTC).

3.5.2Sterilization

Before testing the water samples, all the Petri dishes, pipette tips, and measuring cylinders were sterilized by being boiled in water for 10 to 15 minutes and left to cool at

ambient temperature before use. Isopropylene was used to clean all working surfaces as well as the outer wrap of sachet-water packets. The forceps were flame sterilized (by candle flame) before every use. The Millipore stainless steel, portable filtration unit was sterilized by soaking the wick attached to its lower plate with methanol, igniting the methanol and immediately capping the filtration unit. The methanol ignition produces formaldehyde, which sterilizes the unit. The unit was left closed for 15 minutes for effective sterilization to take place.

3.5.3Preparation of Petri Dishes

To prepare the Petri dish, a sterile absorbent pad was placed in a Petri dish (with labelled base plate) using flame sterilized forceps. In some cases, disposable Petri dishes, bought with absorbent pads were used. Otherwise, recyclable Petri dishes made of stainless steel were used. The mColiBlue24® medium was added evenly on to the absorbent pad after inverting it two to three times to mix it. Excess liquid was poured off.

3.5.4Preparing Sample Dilution

For water samples that were suspected to have high counts of total coliform and E.colicounts above the 20 to 80 range, mainly the surface water sources, dilutions of 1:10 and1:100 were used. For the 1:10 dilutions, a sample of 10ml was pipetted using theautomatic pipette and this was placed in a graduated cylinder that contained 90ml ofsterilized (bottled or boiled) water. Similarly for the 1:100 dilutions, 1ml of the sample was pipetted into 99ml sterile water.

3.5.5Filtration

Using sterile forceps, a sterile membrane filter paper was placed in the filtration unit over the porous plate of the receptacle with the grid side up. Well mixed samples of 100ml

were then filtered under a partial vacuum. After filtration, sterilized water in the squeeze bottle was used to rinse the interior surface of the funnel 3 times with 20 to 30 ml water. The rinsing ensured that coliform that could have been stuck on the sides of the vessel would be washed onto the filter paper. The membrane filter was then removed using sterile forceps and placed, with the grid side up, on the prepared Petri dish by applying a slight "rolling motion". The sample was then incubated for 24 hours at a temperature of 35ºC ± 0.5 ºC, upside-down (inverted with the base side up) to prevent steam(bubbles) from forming on the filter thus making it difficult to read the samples.

Sterile water was also run through the filtration unit, before each sample, as a blank to make sure there was no contamination. If blank samples contained coliforms, as they did on several occasions, the corresponding tests were repeated. In some cases, where coliforms in the samples were much larger than those in the blanks, instead of repeating the test, the actual coliform count was taken to be the difference between the coliforms in the sample and those in the blank. While it may have been ideal to also ran blanks between dilutions, because of time constraints not all tests done on sample dilutions were preceded by blanks. In all cases however, the lowest dilutions were first tested and the filter unit always sterilized after testing a given series of dilutions, of the same sample. A magnifying glass was used to determine colony counts on the filter papers. All waste material generated from the tests were soaked in disinfectant bleach, and allowed to stand for 30 minutes to 24 hours before they were disposed off.

3.5.6Interpretation of Results

Red and blue colonies combined indicated that the sample had total coliforms, while blue colonies indicated E.coli. The absence of red or blue colonies indicated that the sample

contained no total coliforms or E.coli. The coliform density was directly given by the number of coliforms counted based on the formula, $CFU/100ml = \frac{\text{N X 100}}{\text{V}}$

Where: N = the number of colonies counted;

V = the sample volume in ml.

In cases where no colonies were observed, the coliform colonies were reported as 0 CFU/100ml.

3.5.7Averaging Counts

For duplicate tests that were carried out on samples with varying dilutions, the average values of colonies counted were obtained after multiplying the counts with appropriate dilution factors. 57% of the samples tested (17/30) were also run as duplicates. Where duplicated samples were taken with some results being TNTC, only the average of the countable colonies was obtained. In cases where the "blanks" that preceded samples being tested had more coliforms than samples run subsequently, the colony counts in samples associated with those blanks were disregarded (spoiled samples). Nevertheless, when blanks tested had colonies, but the sample test that followed had none, the corresponding sample was taken to have 0 CFU/100ml.

3.5.8Testing Apparatus

− Incubator capable of operating at 35ºC ±0.5 ºC

− Vacuum pump

− Millipore membrane filtration stainless steel funnel unit and flask

− Pre-sterilized 45 mm filter papers of 0.45µm pore diameter

− Petri dishes of 50 mm with or without absorbent pads (with base plate labelled)

− Pre-sterilized absorbent pads (for Petri dishes without absorbent pads)

− Lab supplies: Graduated cylinders, stainless steel forceps and disposable pipette tips

2 squeeze bottles, one for sterilized water and the other methanol

− Automatic pipette and magnifying glass (3X and 10X)

− Candles and lighters for flame sterilization

− Boiling equipment (pots, stove or burner) and

− Stop watch and bleach disinfectant.

3.5.9Reagents

- Methanol for flame sterilisation

- isopropylene for sterilisation of working surface

- mColiBlue24® pre-packed culture medium and

- sterilised water (distilled or bottled water).

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

This chapter discusses the socio-cultural profile of the respondents to throw more light on the relationship between variables such as age of head of household, educational attainment of household heads and infant caretakers if present, family size, religious affiliation of the head, the sanitation conditions and the occurrence of diarrhoeal diseases in the households.

4.2Household characteristics

The risk of diseases like diarrhoea heightens when people continuously drink or use water obtained from unprotected wells and lives in poor housing conditions (Isely, 1985). The type of dwelling and certain household conditions can affect the health of the members of the household. The household conditions considered in this study included wall construction, floor construction, roof construction and the presence or absence of children below the age of 5years and their caretakers.

4.2.1Wall Construction

Out of the 120 households, 52 representing 43.33%, used mud; 38 representing 31.67%, used cement; 18 representing 15%, used stones; 10 representing 8.33%, used raffia and 2 representing 1.67%, used a combination of building materials. This is illustrated in Figure 4.1.

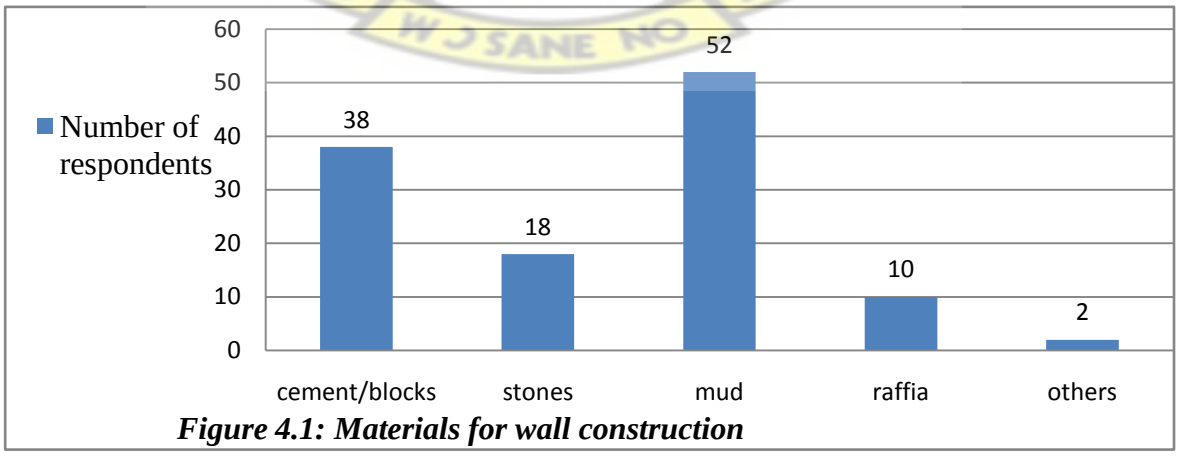


Figure 4.1: Materials for wall construction

4.2.2Floor Construction

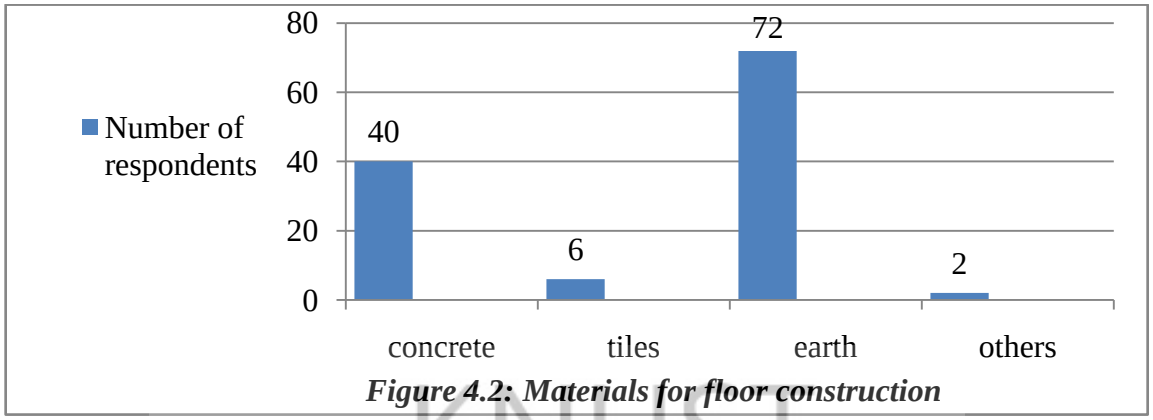


Figure 4.2: Materials for floor construction

As shown in Figure. 4.2, out of the 120 households sampled, 72 households representing 60%, used earth for floor construction; 40 representing 33.33%, used concrete; 6 representing 5%, used tiles and 2 households representing 1.67%, used other forms of materials to construct the floors of their houses.

4.2.3Roof Construction

Materials used by respondents for roof construction are shown in Figure. 4.3. A total of 68 households out of the 120 sample size, representing 56.67%, used corrugated sheets; 38 representing 31.67%, used straw; 8 representing 6.67%, used cement; 4 representing 3.33%, used other materials and 2 households representing 1.67%,used mud.

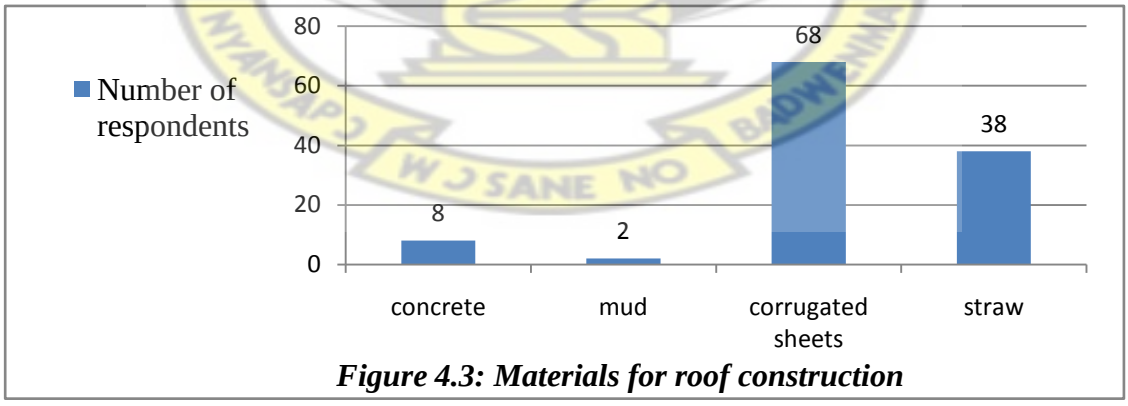


Figure 4.3: Materials for roof construction

From the data in Figure 4.3, it is obvious that the walls of most houses in the study area are built with mud, and earth is the most used material for floor construction. Mud (earth mixed with vegetation materials) and earth are easily attacked by insects and termites, hence

uncovered stored water in the households could be contaminated with dead insects, nest materials, eggs and faeces. The usage of the contaminated water without proper treatment increases the incidence of water-borne diseases. Besides the use of straw, corrugated sheets are the most used material for roofing in the community. The use of straw for roofing may also create sanitation problems. Straw may provide breeding place for insects such as tsetseflies, cockroaches,and mosquitoes. These insects may attack the dwellers of a household leading to all forms of diseases. Pests like rodents, birds, lizards and pets are always on the lookout for food, water, warmth and shelter. These may find the use of poor quality building materials like earth, mud and vegetal matter as a good condition. Birds could cause huge damage by building their nest up the roof.Rodents may create holes into the house and begin to breed. The risk of disease outbreak comes in because these pests will now bring in beetles, grasshoppers, mites and other flies to feed their young. Insects are known to carry several types of bacteria on their legs, body and inside them. Mice for example can enter a house through a hole as small as a pencil depending on the size. Elsewhere, chagas disease vector survey in Guatemala (Hashimoto *et al*, 2003) revealed that rural houses with walls, floors and roofs made from earthen or vegetal materials are more prone toinsect vectorinfestation.In as much as majority of the people use earth, others appreciate the use of modern materials such as cement and tiles. The use of quality materials like tiles and cement blocks need to be vigorously encouraged to reduce the incidence of health problems.

4.3Socio-cultural characteristics of the sampled households

Socio-cultural characteristics of a household determine the models for learners (Robine*et al*, 1999). The socio-cultural characteristics that were considered as relevant to the objectives of this study were gender, age, marital status, occupation, educational attainment and the religious affiliation of the heads of the households and the caretakers of children below 5years in the households.

4.3.1Gender of heads of households and caretakers of children below five years of age

The head of household is the person around whom the household is organized. The caretaker of a child is the one who provides the essential needs of the child such as healthcare, feeding, bathing and tendering the child. It is usually the mother who spends a lot of time with the child. Fathers give more confidence to the child and the more supportive of the mother the father tends to be more mature the child will become (Mc Connell, 1982). The head of the household is expected, in the Ghanaian society, to fend for the whole household.

The presence of infant caretakers in the household is very important because infants readily pick up things around them and put them into their mouths out of curiosity. Apart from putting their dirty hands into their mouths, infants can as well put toys, leftover food from the floor or even their dirty hands into uncovered stored water sources. This can lead to the contamination of these water sources with disease causing pathogens. Some parasitic infection in childhood can lead to general immune system imbalances, escalatingstunted growth and inhibiting brain development (Berkman*et al*. 2002).Worm infestations for example, lessen the effectiveness of reliablevaccines like tuberculosisBacillus Calmette-Guérin(BCG), human immunodeficiency virus [HIV] (WHO,2004) and malaria (Markus, 2002). It is thus, very important for infants to be given around the clock care at the household level especially in rural communities by parents or relatives brought in for the purpose of caring for children.

TABLE 4.1: GENDER OF HOUSEHOLDSHEAD AND CARETAKERS IN THE COMMUNITY

Gender	Heads of households	Caretakers
Male	84 (70%)	3 (3.9%)
Female	36 (30%)	74 (96.1%)
Total	120 (100%)	77 (100%)

Table 4.1 shows that the gender of the head of household was predominantly male and the proportion of male heads of household was 70%, which is higher than the national average

of 66.4% (GSS, 2002). Caretakers of children were predominantly female maidservants purposely brought in for that particular job of caring for the children. These maidservants usually did not attend school and their main duty was to cater for children whilst the household heads and their spouses were engaged in some economic activities.

Culturally and naturally, males are the head of the household and therefore command much authority and respect. Consequently, children adhere to the instructions of their fathers.

This is a good platform for the father to instil proper sanitation and hygiene practices into the children. This reinforces the statement that ***Charity begins at home***. Through the Ghanaian culture, mothers do spend a lot of time with their children and are responsible for their nursing and nurturing. In every society, there are educational systems by which local knowledge is modified to new information and broadcast through conversation and sharing. Women are predominantly the organisers in local learning systems concerning water, health and sanitation (Roark, 1980;Amsyariand Katamsi, 1978). However, in the study community, males determine roles in the household and this ultimately defines the learning process in the household. This situation does not auger well for the informal learning of good hygiene behaviour in the household since women who have the knowledge, are not taking the decisions on the rewards and punishment systems in the household. In a study of sanitation in rural Ghana, Kendie (1999) notes thatwomen are accorded low status in the households and suggest such a view of women promote poor environmental hygiene.

4.3.2Marital status of the head and the caretaker of children in the households

The traditional ideal of the family size in the Wassa West district is large families. Status and prestige of the family group are measured by size: the more numerous, the higher the status.

TABLE 4.2: MARITAL STATUS OF HEAD OF HOUSEHOLDS AND CARETAKERS OF CHILDREN BELOW 5YEARS IN STUDY COMMUNITY

Marital status	Head of household	Caretakers
Married	58 (48.3%)	5 (6.5%)
Single	36 (30.0%)	69 (89.6%)
Widowed	8 (6.7%)	3 (2.5%)
Separated	5 (4.2%)	-
Divorced	13 (10.8%)	-
Total	120 (100%)	77 (100%)

From Table 4.2, it can be seen that 58 heads of households representing 48.3%, were married whilst 62 representing 51.7%, were single (single, widowed, separated and divorced). In the case of the caretakers 5 representing 6.5%, were married whilst the rest were single. In the case of the married, there is responsibility sharing which reduces the demand on them for providing for their households. This increases the attention they give to child caring and proper management and sanitation of their respective homes. The inverse situation holds for the case where the household is dominated by a single parent. On the other hand, the predominance of the caretakers being single, that is, 92.1 % (single and widowed) is a positive indication that children under their care receive the needed attention.

4.3.3Household size

TABLE.4.3: HOUSEHOLD SIZE OF SAMPLED COMMUNITIES

	N	Minimum	Maximum	Mean	Std. Deviation	Variance
The number of persons living in the household(Size)	120	1	12	5.8	2.5	6.3

The average size of the households sampled for this study as shown in Table 4.3 is 5.79 which is slightly above the national average of 5.55people (GSS, 2002). This implies that

there would be poor sanitation and hygiene practices in the study community which is detrimental to the health of the people.

4.3.4Age of Head and caretakers of children below five years in the households.

The age for marriage is crucial in determining fertility behaviour. Marriage for women in most societies, including the Wassa West District, takes place soon after puberty, usually between 15 and 20 years. Early age of marriage for women in traditional societies contributes to high fertility, as almost the entire child bearing period of the woman from puberty to menopause is available for utilisation (Nukunya, 1992).

TABLE 4.4: AGES OF HEADS AND CARETAKERS OF CHILDREN IN SAMPLED HOUSEHOLDS

	N	Minimum	Maximum	Mean	Std. Deviation	Variance
Age of head of household	120	26	74	46.7	11.5	132.4
Age of Infant caretaker	77	14	65	38.6	11.4	129.8

The mean age of head of household in the Bogoso community is 46.67 years and that for the caretakers of children below 5years is 38.64years. The average age of male head of household for Ghana is 44years (GSS, 2002). The average family size of approximately 6 (see Table 4.3), means there is a pressure on the economic resources of the household and the household's life will revolve very much around the task of meeting the basic needs of food, healthcare , water and clothing (Awortwi, 1999).

4.3.5Religion of Head of Household

Religion affords an unusually effective vehicle for change in attitude and behaviour because of its ability to link what people say and do with what they think (Zanden, 1990). Because religion shapes peoples beliefs and attitudes, the religious affiliation of the heads of household was considered.

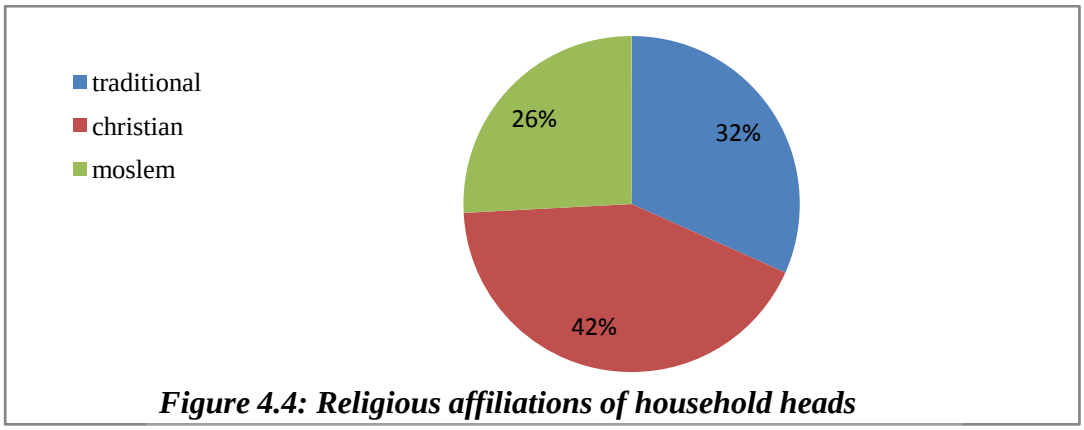


Figure 4.4: Religious affiliations of household heads

From Figure 4.4, the predominant religion of the households in the study community is "Christianity" with 42.5% of respondents followed by "Traditional belief" with 31.7%. The least was "Islam" with 25.8% of respondents. Religion has often times prescribed practices that adherents have to follow and some of these border on health and hygiene. With Christians, a weekly day of rest was a health promotion as well as a religious measure. Separating lepers, as recorded in Leviticus Chapter 13 verse 1, was the first practice of preventive medicine. The Mosaic Law encompassed personal and community responsibility for health (Anderson, 1969).

With Muslims their doctrine requires that they pray five times each day and before each time of the prayer, they perform ablution which is the cleansing of their bodies with water. This enables them to physically wash off dirt from their bodies thus improving their health conditions and promoting hygiene. The traditionalists also have some health promoting beliefs. For example, it's a taboo to pick food from the ground or enter a shrine with your shoes on. It is evident then that religion plays a vital role in inculcating sanitation and hygienic practices into individuals.

4.4Socioeconomic characteristics of respondents

Socioeconomic characteristics of a family affect the family's participation in community development issues (Hausknecht, 1962) and health inequalities are systematically

associated with economic status (Wagstaff, 2000). Research by Hausknecht (1962) indicates that low economic status, as measured by income, education and occupation has a negative correlation with rates of participation in community organizations. As such, low economic status populations feel powerless to change processes that affect them and therefore separate themselves from active community roles. In addition, such groups have little time and resources to partake in such outside activities that do not directly provide livelihoods. This isolation of some level of the population will affect the extent of learning that takes place in the community as well as the rate at which new knowledge that are disseminated at health education meetings is learned in the community. In this sub-section, occupation and formal education levels of sampled households are discussed.

4.4.1Educational attainment of head of household and caretaker of children below 5years

It was observed in the sampled district that the women were always engaged in petty trading and subsistence farming when they were not doing anything at home. There would also be little time and resources for the formal education of children from such households. Formal education will let them become more aware of the health benefits of improved water supply and sanitation and more likely to use improved services if they were available (World Bank, 1993).

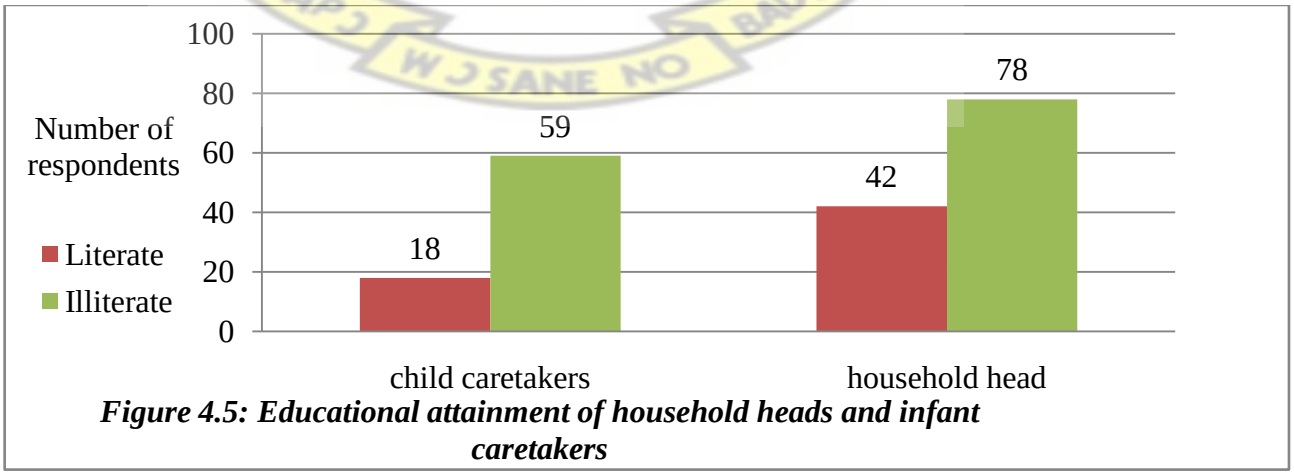


Figure 4.5: Educational attainment of household heads and infant caretakers

For the purpose of this study, the definition of a literate is someone with at least 6years of formal education, which is up to class six in Ghana's education system. This study found that 65%(78) and 76.6%(59) of heads of household and caretakers of children below the age of 5years respectively in the sampled communities had no formal education as compared to the national ratio of 31.8% (GSS, 2002). The heads of household in the sampled communities are thus less educated than their counterparts in Ghana generally. This may mean that they are not equipped with knowledge to make informed decisions about health promoting behaviour as required.

4.4.2Occupation of household heads

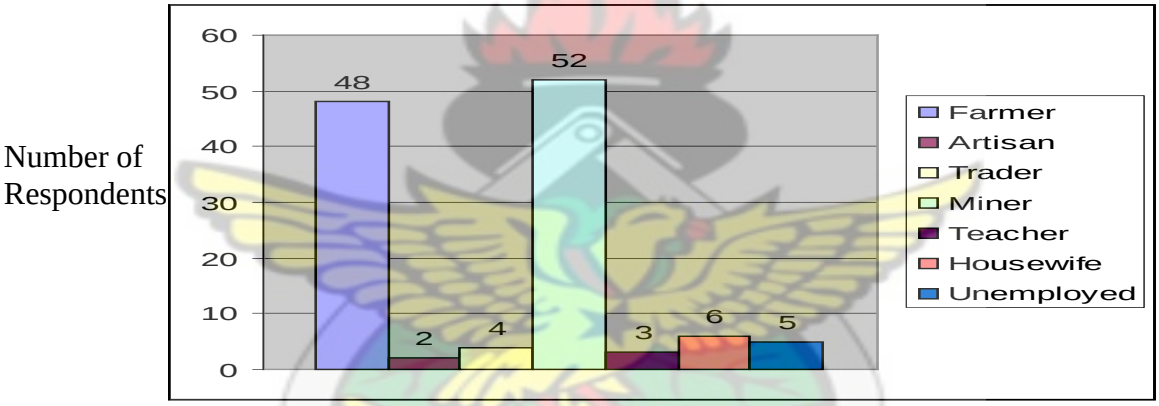


Figure 4.6: Occupation of household heads

Out of the 120 households sampled, 48 households representing 40% are farmers; and the rest of them are artisans, traders, miners, teachers, housewives and unemployed. The predominant occupation of heads of household is mining followed by farming. Most of these miners are engaged in small scale mining popularly called "Galamsey" with a few in the legal mining companies. The percentage of the population engaged in farming is less than the national average. In Ghana, 54.3% of workersare involved in agricultural activity and 70.1% of rural economic activity is in agriculture (GSS, 2002) as compared to the 40%(i.e. 48 respondents) for the study community. The agricultural activity the respondents are engaged in is subsistence farming and this normally does not fetch much money.

4.5Sanitation conditions of the sampled houses

In this section, the work examines the availability of sanitation facilities such as toilets, rubbish dumps and the sanitation conditions of the sampled households. The relevance is due to the fact that the values associated with a household like the availability of adequate waste and excreta disposal facilities and their hygienic use are an integral part of primary health care (McJunkin, 1982).

4.5.1Toilet facilities

The spot observation methods revealed that majority of households in the study area have no household toilets. The presence of household toilets is shown in Figure 4.7. From Figure 4.7, 80% of sampled households did not have household toilets. Some households which had no toilets also had alternative place of convenience.

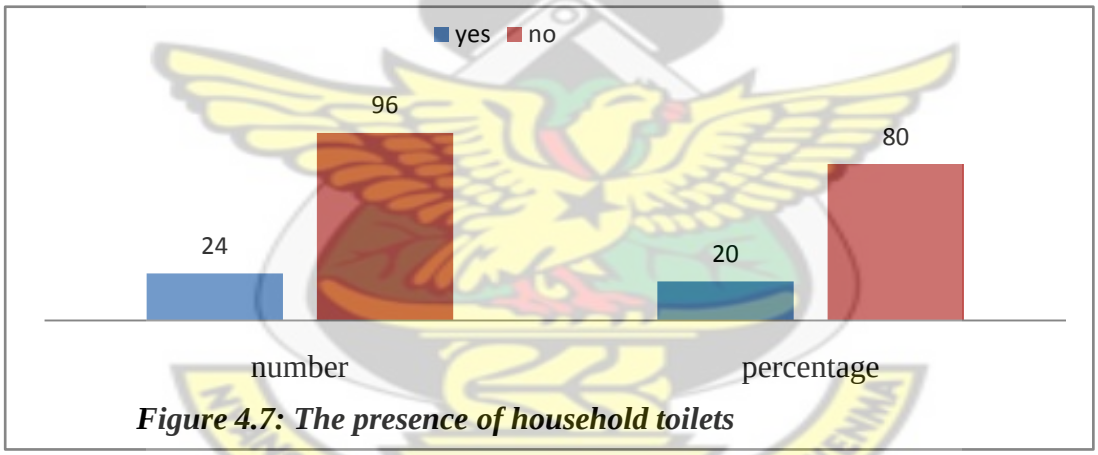


Figure 4.7: The presence of household toilets

The unavailability of household toilets and places of convenience would automatically provide the inhabitants of the community the opportunity to ease themselves in bushes which is the most widely used spot as the study found out, along river banks or even into polythene bags and litter the environment with them. This is a great source of pollution to the environment. Their water source could easily be polluted leading to increase in water-borne diseases in the community.The distribution of places of convenience for households is given in Table 4.5.

TABLE 4.5: THE DISTRIBUTION OF PLACES FOR CONVENIENCE

Places of convenience	Number of respondents	Percentage%
Water Closet	10	8
VIP/Simple pit latrine	14	12
Composting dry latrine	24	20
Manual Bucket latrine	30	25
Field, Bush/Plastic bag	42	35
Total	120	100

In the study community, 35% of the 96 households that had no toilet facilities used the bush as compared to the national average of 20% (GSS, 2002). The remaining households had alternative places of convenience even though they had no household toilets. The higher incidence of the bush as place of convenience in the wet season has serious consequences for the health of the people. Dense vegetation and often wet bushes will not encourage people to go deep into the bush to ease themselves and faeces are found closer to human habitats. In times of heavy downpour, runoff water may wash faeces into nearby water bodies to cause contamination. Flies can digest anything; they live and breed on rubbish, animal droppings, human faecesand human food. As flies are unable to eat solid food they firstly vomit on the food, and then stamp the vomit in until the food is liquefied. They then suck the food back up, probably leaving behind some faeces. Also, 25% of sampled households used the manual bucket latrine and in most cases, the facility was situated a few metres from the household. The method of disposal of the contents in these buckets is a big problem. Usually, the buckets are emptied into nearby bushes creating the same problem as those who ease themselves in the bush. Others dispose into pits created for that purpose somewhere outside the village. It seems safe for them but infiltration and deep percolation can still transport bacteria even into underground water sources. Cockroaches feed on faeces in large groups and can spread harmful pathogens by feeding on filth and then on food.

4.5.2Method of rubbish disposal by households

TABLE 4.6: MODE OF RUBBISH DISPOSAL IN SAMPLED COMMUNITIES

Mode of waste disposal	Number of households	Percentage%

Waste damp/site	56	47
Random	35	29
Burned	17	14
Buried	9	8
Composted	3	3
Total	120	100

Out of the 120 households, 56 households representing 47%, dispose their waste at the dump site; 35 representing 29%, dispose off their waste at random whilst 17 representing 14%, burn their waste; 9 representing 8% bury theirs and the remaining 3 representing 3%, leave their waste to compost. It is therefore not surprising to notice the emergence of communicable diseases such as diarrhoea and malaria in these communities.

4.5.3Distance of household dump from house

The majority of respondents (89 representing 74%) have their dumps less than 50m from their households. Household dumps which are all close to the houses, are exposed to rodents, vermin and vultures and also provide breeding grounds for flies and mosquitoes. Rodents carry harmful bacteria in their faeces, urine, feet and fur. Mice for example, have weak bladders so they nibble and dribble at the same time. Dumping of rubbish close to the household is dangerous, especially when children are present in the household. As children play on the contaminated soils in the backyard, a vicious cycle of worm infestation is set in motion from the soils to the hands and to the mouth (Kendie, 1999).

TABLE 4.7: DISTANCES OF REFUSE DUMP SITES FROM SAMPLED HOUSES

Distance	Number of respondents	Percentage%
Less than 50metres	89	74
51 - 100metres	18	15
101 – 150metres	10	8
Over 150metres	3	3
Total	120	100

From Table 4.7, it is clear that most of the waste dump sites in the study area are close to households and this indicates an unclean environment. The spread of diseases emanating from improper waste management practices is common in such a locality.

4.6Sources of stored drinking water in the households

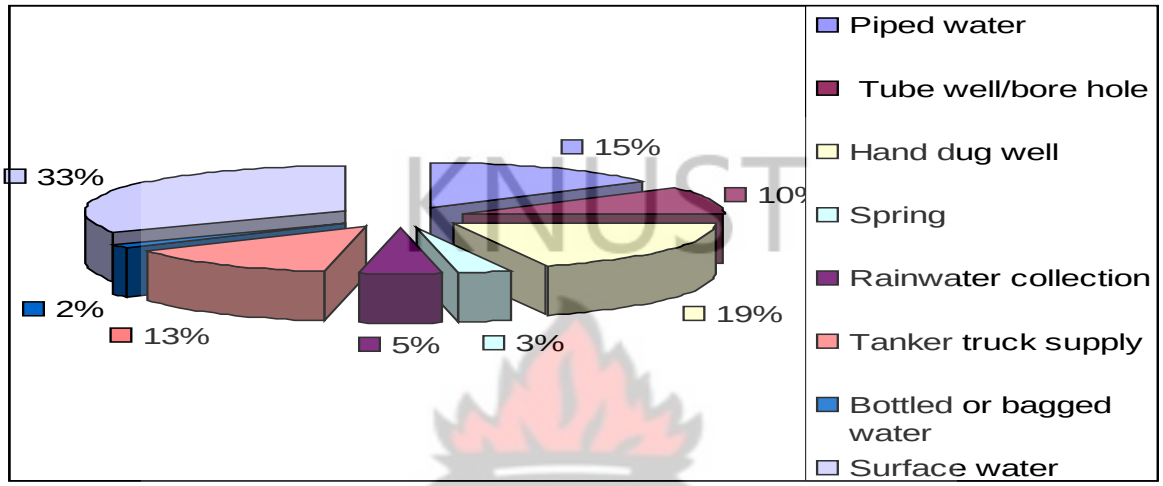


Figure 4.8: Distribution of water sources used in sampled houses

Out of the 120 households, 18 representing 15% used pipe borne water whilst 16 representing 13% obtain their water supply from tanker trucks. Only 2% of the households use bottled or bagged water. The rest of the households get their water from sources such as boreholes (10%), hand dug wells (19%), springs(3%), rainwater(5%) and surface water(33%). It was observed that the majority of respondents rely on surface water sources,however; the improper methods of human and environmental waste disposal are a great source of contamination to these water bodies. Few residents in the community could afford to buy bottled water. This shows that a substantial number of people in the community are subject to contracting water borne diseases since the majority use open surface water sources.

4.6.1Water treatment

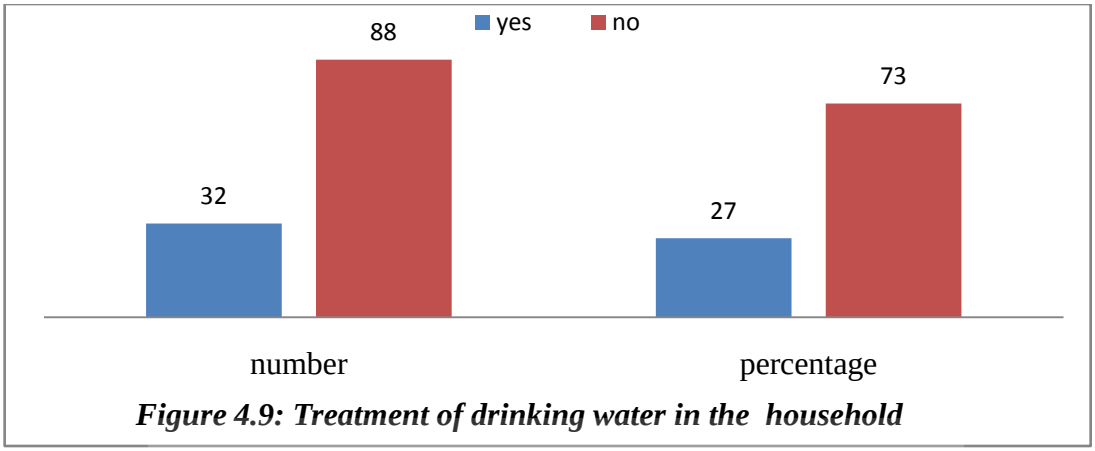


Figure 4.9: Treatment of drinking water in the household

From Figure 4.9, it can be deduced that majority of the respondents do not treat their water before drinking. Out of the total of 120 interviewees, 88 representing 73% did not treat their water before using it. This attitude towards water usage makes the respondents much prone to water borne diseases since majority of the inhabitants use water from unprotected sources such as unprotected hand-dug wells and surface water bodies, which may be contaminated easily due to their improper disposal of waste.

4.6.2Covering for water storage containers in the households

A physical observation of drinking water storage containers in the sampled households revealed that most of the respondents did not cover their water storage containers. The result is shown in Table 4.8; out of the 120 households, 56 households representing 47%, did not cover any of their water containers whilst 38 representing 32%, did cover some. It was only 26 respondents representing 22%, who covered all their containers. This implies that there is a high probability that water will be polluted before it gets used up. Uncovered drinking water sources risk getting polluted with *Ascaris* ova and other geohelminth ova, including *Trichuris* and *Taenia spp*. that exist in the air and in dust. *Ascaris*ova are gluey so can stick to utensils, furniture, fruit, vegetables, money, door handles, and fingers (Kagei, 1983).Infections from Ascaris are all over Asia, Africa and South America.This makes inhabitants prone to diseases associated with contaminated water. Cockroaches are nocturnal so they can accidentally fall

into uncovered water sources whilst feeding, but these insects are known to carry 40 different bacteria on their bodies.

TABLE 4.8: STORED WATER COVERING FOR HOUSEHOLDS IN THE BOGOSO COMMUNITY

Covering of containers	Number	Percentage
All covered	26	22
Some covered	38	32
None covered	56	47
Total	120	100

4.6.3 Infant Diarrhoea Occurrence

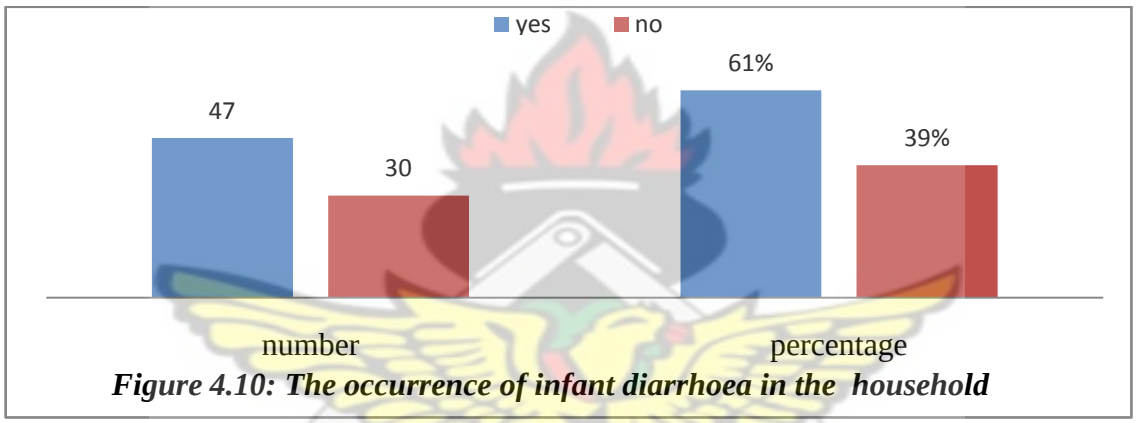


Figure 4.10: The occurrence of infant diarrhoea in the household

Caretakers of infants were asked if their children aged below 5years had diarrhoea in the previous 48hours at the time of the survey and the results are as shown in Figure 4.10. The results showed that 47 representing 61.0%, of the child caretakers did admit that their children were attacked by diarrhoea within the past 48 hours whilst 30 caretakers representing 39.0% had no experience of diarrhoea within that same period. This only confirms the prevalence of diarrhoeal diseases in the community.

4.6.4The Category of household cleanliness

Direct observation of sanitation practice was undertaken to help the researcher obtain first hand information about the sanitation behaviour of the people that has become so much part of them. A quick spot check of the household environment allowed the researcher to tick

for the presence or absence of such physical clues of sanitation practices on an observational guide (Appendix C). A household's score was its sanitation index and the indices were later recoded to obtain the sanitation condition of the household. The category of household cleanliness ranged between 1 and 25 which was recoded to poor and good. The poor sanitation condition had an index of 1 to 15 and good was 16 to 25.

The use of the coding system was inspired by the Joint Committee Report (Joint Publication, 2004) as part of its good sanitation evaluation framework. It suggests that there could be a limit consisting of several factors before any health influence can be observed in field settings. For example the presence or absence of toilet facilities alone cannot be used to notice an impact on diarrhoea prevalence. Arimond and Ruel (2002) explains for example that other factors like presence of animal faeces, dirty utensils and hand washing with soap could form a cluster of hygiene practices. The analysis of such a cluster is often expressed in the form of an indexobtained by counting up the score for each practice in the cluster(Arimond and Ruel, 2002). In a study of children and mothers at risk for diarrhoeal diseases in Nepal, Lastone*t al* (1993) also used the index coding method.This study observed factors like flies on the child, stool on floors, stabling of animals in the households, child placing fingers or objects in the mouth and picking leftover food from floor. Out of the observations, an overall risk score for each behaviour variable was made.

TABLE 4.9: CATEGORIES OF HOUSEHOLD CLEANLINESS BASED ON THE OBSERVATIONAL GUIDE

Index	Category	Number of respondents	Percentage
1 to 5	Very poor	34	28.3
6 to 10	Poor	24	20.1
11 to 15	Somewhat Satisfactory	22	18.3
16 to 20	Satisfactory	27	22.5
21 to 26	Good	13	10.8
Total		120	100.0

FromTable 4.9, out of 120 households, 34 households representing 28.3%, had very poor sanitation, 13 representing 10.8%, of households had good sanitation in their houses whilst 22 representing 18.3%, had somewhat satisfactory sanitation conditions. The recoded result is presented in Figure 4.11;

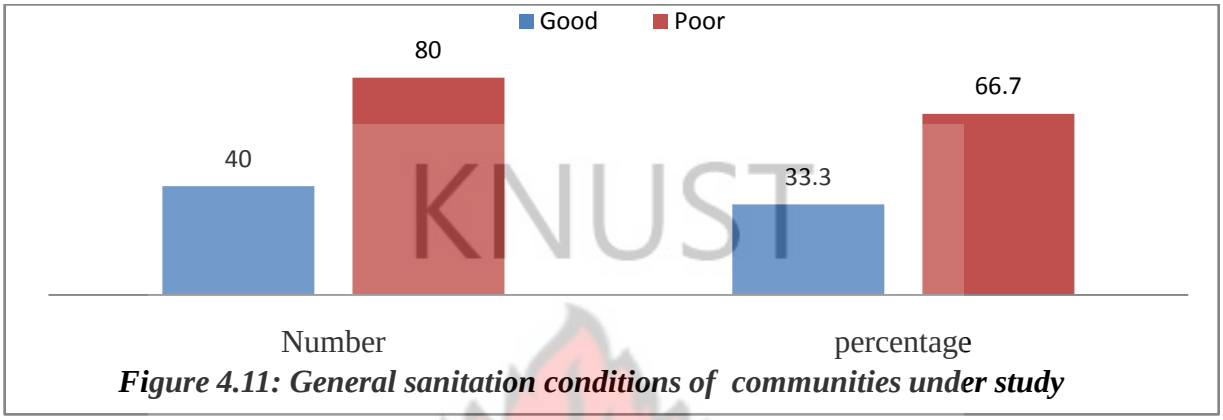
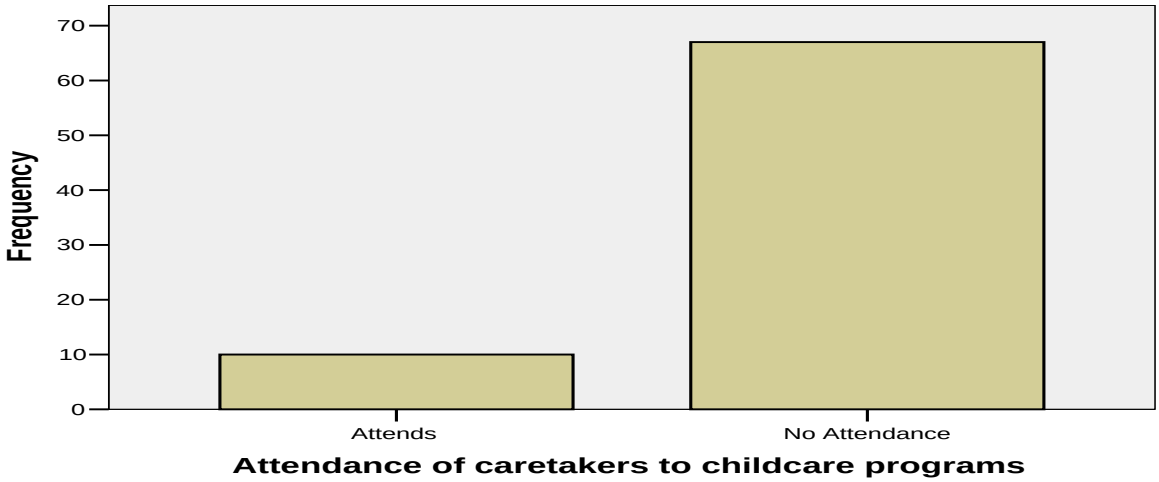


Figure 4.11: General sanitation conditions of communities under study

In general, the sanitation conditions of the sampled communities can be said to be poor. According to Figure 4.11, 80 people representing almost 66.7%, of the respondents had poor sanitation with the remaining 33.3%, having good sanitation practices. Poor sanitation index imply low index value. The physical meanings are that majority of respondents had flies, faeces and weeds in their household based on the observational guide. Also, household rubbish was badly disposed and that most households did not have soap and water for hand washing after visiting the toilet. This is not good enough because children playing around, domestic animals and insects that come in contact with poorly disposed solid waste and excreta can spread some illnesses like intestinal worms.

4.6.5Attendance of caretakers at childcare programmes



10	**67**

Figure 4.12: Attendance of child caretakers at health educationprogrammes

Childcare education programmes take place once or twice in a month depending on the community and it is popularly called “weighing” during which community health nurses visit. On such occasions, the infants are weighed as an indication of nutritional or general well-being and the caretakers are advised on the best way to care for the infants. Caretakers’ attendance at such programmes will help them understand children better and their development which can be transferred positively in the training of the child. It was quiet disappointing that a majority of the respondents did not attend such programmes. Out of the 77 respondents, 67 representing 87%, of the caretakers did not attend childcare programmes leaving the remaining 10 representing 13%, to attend programmes for children. This number is woefully inadequate and therefore the need to address this problem since lack of caretaker’s education may result in improper sanitation education of children.

4.7WATER QUALITY RESULTS

This section discusses the results of tests that were conducted on water samples. The test results are summarized in the form of graphs in this section as well as tabulated in Table 4.11.

4.7.1Turbidity and pH

Upper limit

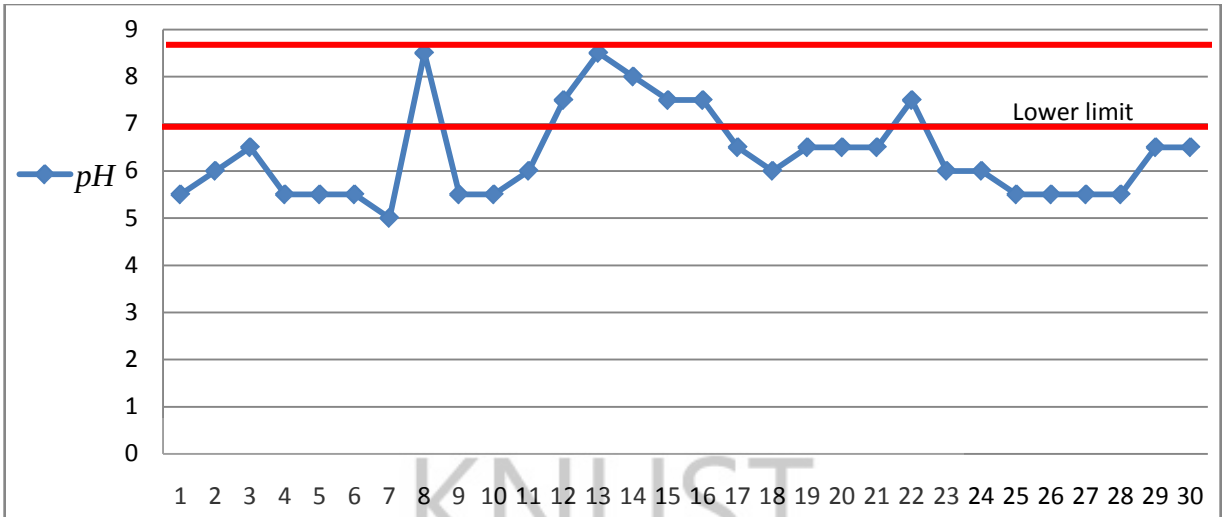


Figure 4.13(a): Values for pH

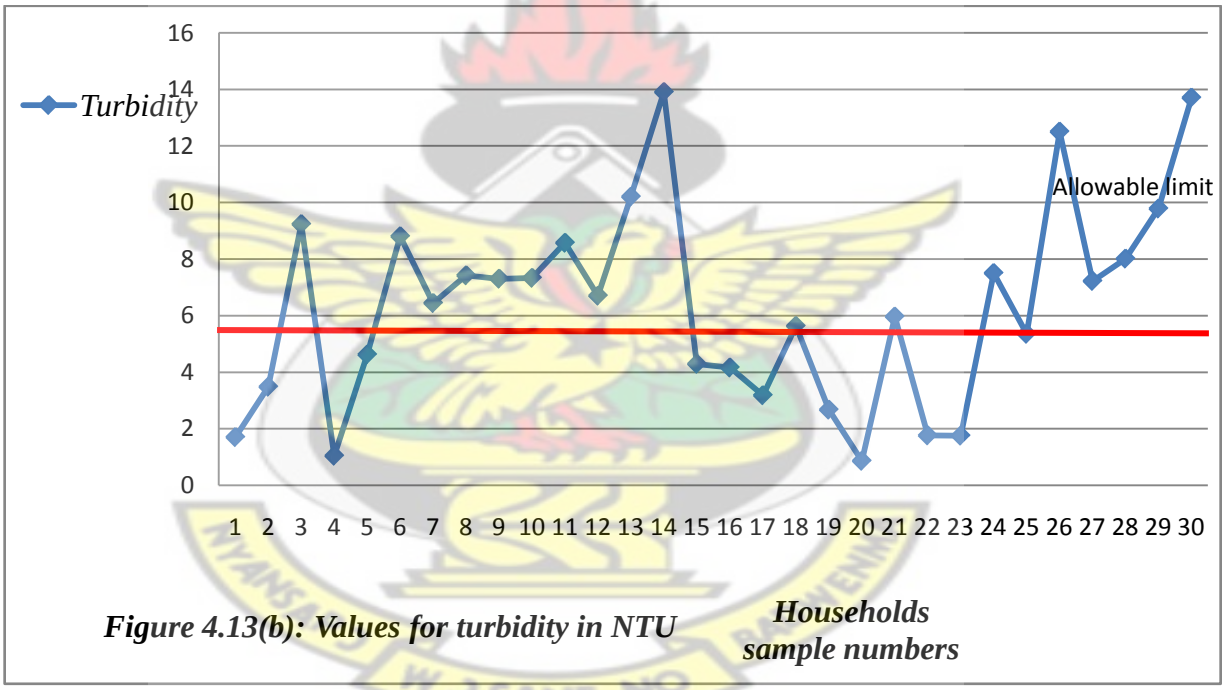


Figure 4.13(b): Values for turbidity in NTU

Turbidity is a value that shows the extent to which water loses its transparency due to the existence of dissolved/suspended particulates. The more total suspended solids (TSS) in the water, the muddier it seems and the higher the turbidity. The key effect is purely aesthetic; no one enjoys the look of filthy water. To effectively disinfect drinking water, turbidity must be removed since suspended particles are sources of attachment by heavy metals and other toxins. Results from the analysis showed that, eleven samples representing 36.7% had

turbidity values below 5NTU (Nephelometric Turbidity Units), the maximum allowable limit set by Ghana Standards Board and that the majority of the samples had suspended particles. As shown in Figure 4.13(b), the highest value obtained in this study was 13.90NTU whilst sample from one household recorded a low value of 0.86NTU.

The pH is a numerical representation that specifies the extent to which water is acidic. Its size range between 0 (strong acid) and 14 (strong alkali), with 7 being neutral. The water quality regulations specify that the pH of drinking water should be between 6.5(lower limit) and 8.5(upper limit). From the study, the pH ranged between 5.0 and 8.5 and 14 samples representing 46.7% fell within the GSB guidelines (i.e. 6.5- 8.5). When the pH of water is too low, it can dissolve elements that build up in metal pipes and this may bring about diseases.

4.7.2Total Coliform and E. coli

In testing the microbial quality of water, it is difficult to analyse the numerous pathogenic species that may be present, each of which requires a specific and technically difficult analysis. The difficulties and complex nature of tests involved therefore makes it impractical to test for bacteria directly and instead, indicator organisms are used. Indicator organisms are bacteria whose presence in water signals the presence of pathogens. Indicator organisms are usually not pathogenic but are "present in water when other pathogens are present and absent when pathogens are absent" (HACH, 2003). Total coliform, faecal coliform, and E. coli are all indicators of drinking water quality. In this study, testing for total coliform was followed by that for E. coli.WHO (2004) suggests that it may be useful to classify drinking water systems into categories that are predefined depending on the risks associated with the drinking water, the order of priorities placed, and the local circumstance, by using the percentage of samples which tested negative for E.coli or thermotolerant bacteria.

TABLE 4.10: CATEGORIZATION OF DRINKING WATER SYSTEMS BASED ON COMPLIANCE WITH PERFORMANCE AND SAFETY TARGETS

Percentage (%) of samples negative to E. coli or *thermotolerant*bacteria			
	Population Size		
Quality of water	< 5,000	5,000 – 100,000	> 100,000
Excellent	90	95	99
Good	80	90	95
Fair	70	85	90
Poor	60	80	85

Source: WHO, 2004

An example of such a classification is shown in Table 4.10. A typical deduction from the table is as follows; the water quality of a community is said to be Excellent only if it has population less than 5,000people and as many as 90% of the water samples tested negative to *E.coli* or *thermotolerant* bacteria. Also, according to Ali (1996), a negative test for E.coli in water samples does not imply that E. coli is entirely absent in the sample. This is because; E. coli is likely to be detected only when there is bacteria activity in the sample. Bacteria activity also depends on the season in which the testing was done since it increases in the rainy season. In this study, 27 out of the 30 samples representing 90% tested negative for E. coli with the least value of 40 colonies per 100ml and a maximum of 100 colonies per 100ml. The testing was done between June and August 2007. This was due to the availability of the BGL company laboratory free to student research at that time and also lack of funding for the test to be done elsewhere at a fee.

The water quality tests were conducted for baseline purposes only in this study and as such not very comprehensive. But the results give an immediate overview or a good snapshot of the water quality situation in the study area and as such very vital to the study. The main aim of the water quality test was to trigger further study in the area in order to complete and document the water quality situation of the Wassa West District. As shown in Figure 4.14, colony counts termed TNTC were not represented. Moreover, due to the large values involved

a log scale was used and as such certain small figures may not appear. (Refer to the tabulated results given in Table 4.11 for the complete results).

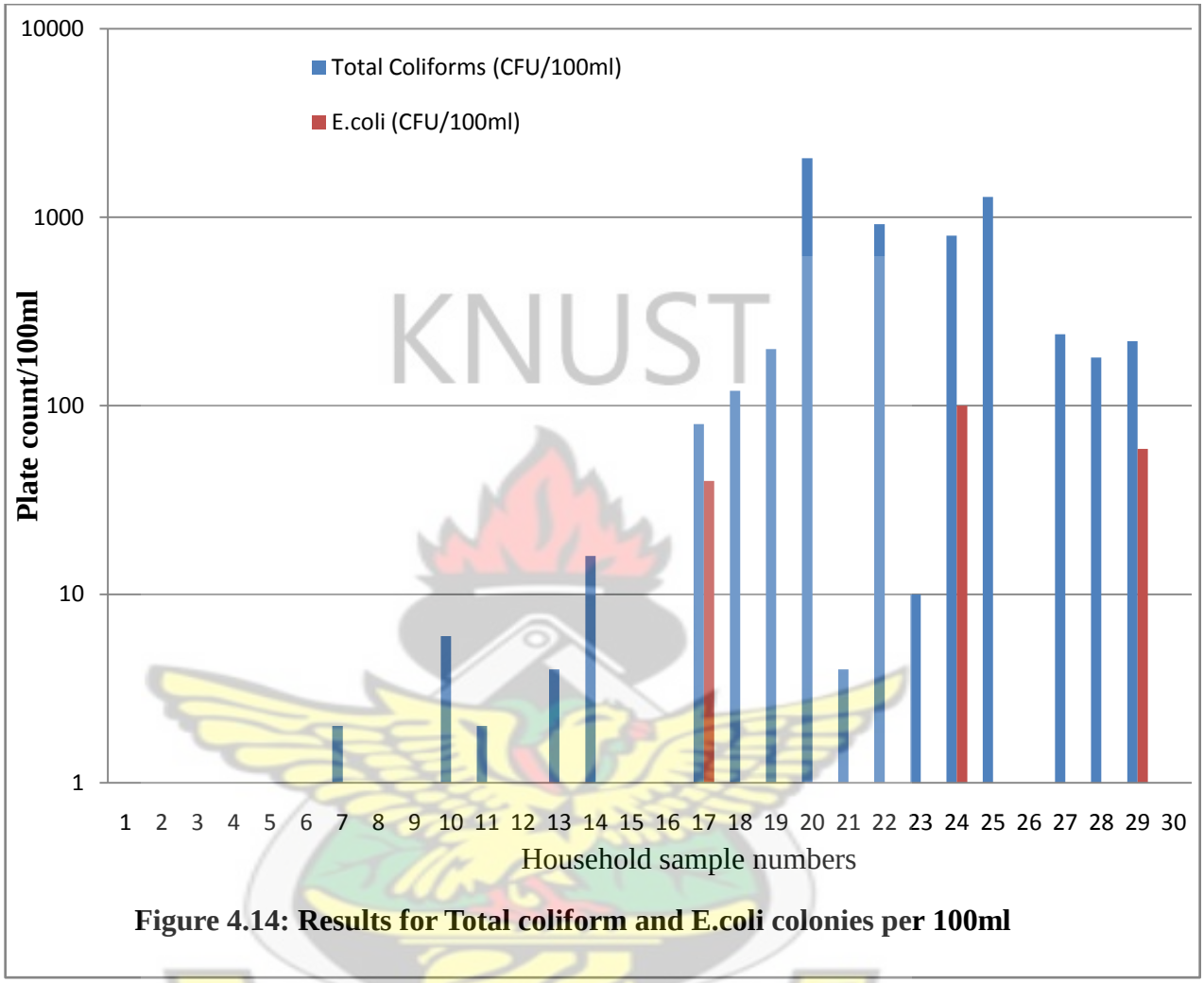


Figure 4.14: Results for Total coliform and E.coli colonies per 100ml

Table 4.11: WATER QUALITY RESULTS

Sample No.	Total Coliforms (CFU/100ml)	E.coli (CFU/100ml)	Turbidity (NTU)	PH
1	0	0	1.70	5.5
2	0	0	3.48	6.0
3	0	0	9.23	6.5
4	0	0	1.04	5.5
5	0	0	4.62	5.5
6	0	0	8.80	5.5
7	2	0	6.44	5.0
8	0	0	7.42	8.5
9	0	0	7.30	5.5
10	6	0	7.33	5.5
11	2	0	8.57	6.0
12	1	0	6.70	7.5
13	4	0	10.20	8.5
14	16	0	13.90	8.0
15	0	0	4.29	7.5
16	0	0	4.16	7.5
17	80	40	3.18	6.5
18	120	0	5.63	6.0
19	200	0	2.67	6.5
20	2060	0	0.86	6.5
21	4	0	5.96	6.5
22	920	0	1.76	7.5
23	10	0	1.75	6.0
24	800	100	7.50	6.0
25	1280	0	5.35	5.5
26	TNTC	0	12.50	5.5
26	240	0	7.22	5.5
28	180	0	8.01	5.5
29	220	59	9.78	6.5
30	TNTC	0	13.70	6.5

WHO (1993) acknowledges that environmental conditions in various countries differ from each other, especially in warm countries there are millions of harmless bacteria. Thus, the allowable levels of bacteriological quality may be higher than the international guideline values. Just like the WHO standards, the GSB regulation stipulate that no E.coli or thermotolerant bacteria should be detected in a 100ml sample of water. Results from the laboratory analysis showed that 20 samples representing 66.7% tested positive for Total

coliform. Out of the 20 samples that tested positive for Total coliform, the least count was 1 CFU/100ml and the maximum countable colony was 2060 colonies per 100ml of water. Two samples had coliform population too numerous to count and was labelled TNTC. Based on the WHO guidelines (Table 4.10), the water quality in the study area can be said to be poor. This deduction could,however,be misleading and should be read with caution since the total of 30 samples may not be representative enough despite the fact that the study area has documented evidence of water related diseases (Appendix D).

4.8Hypothesis testing using Pearson correlation

In order to investigate and describe the strength and directions of the relationships between variables, the SPSS software was used to obtain Pearson's product-moment correlation coefficient values. The strength of the relationships depended on the suggestions by Cohen (1988) based on the following guidelines in Table 4.12.

TABLE 4.12: GUIDELINES ESTABLISHING STRENGTH OF CORRELATIONS

Pearson's product moment correlation, r	Strength of relationship
r = 0.10 to r = 0.29 or r = - 0.10 to r = - 0.29	Small
r = 0.30 to r = 0.49 or r = - 0.30 to r = - 0.49	Medium
r = 0.50 to r = 1.0 or r = - 0.50 to r = - 1.0	Large

Source: (Cohen, 1988)

The coefficient of determination (r^2) was also obtained from the scatter plots and converted to percentages to give an idea about the variance shared between variables.

4.8.1The educational attainment of infant caretaker and the occurrence of diarrhoea

It was hypothesized that:

H_O: Occurrence of infant diarrhoea in the household is independent of the formal educational attainment of child caretakers.

H_1: Occurrence of infant diarrhoea in the household depends on the formal educational attainment of the child caretakers.

Pearson product moment correlation analysis was used to test this hypothesis at 99% confidence level. The result is shown in Table 4.13.

TABLE 4.13: PEARSON CORRELATION RESULT FOR EDUCATION LEVEL OF INFANT CARETAKER AND OCCURRENCE OF DIARRHEA IN THE HOUSEHOLD

		Occurrence of infant diarrhea in the household
Education attainment of caretaker	Pearson Correlation	0.064
	Sig. (2-tailed)	0.582
	N	77

Pearson correlation value of 0.064 is approximately equal to 0.1 and this shows that there is a weak or no significant relationship between the occurrence of infant diarrhoea in the households and the educational attainment of the child caretaker. The null hypothesis is upheld in this case. Since caretaker educational attainment and occurrence of infant diarrhoea are both categorical data, a cross table is used to identify the relationship.

TABLE 4.14 CROSS TABULATION OF INFANT DIARRHOEA OCCURRENCE AND CHILD CARETAKER EDUCATION

		Occurrence of infant diarrhoea in the household		Total
		Yes	No	
Education attainment of caretaker	Literate	12 (25.5%)	6 (20.0%)	18
	Illiterate	35 (74.5%)	24 (80.0%)	59
Total		47 (100%)	30 (100%)	77

From Table 4.14,74.5% of caretakers whose infants had diarrhoea were illiterates and strangely too, 80% of those caretakers whose infants were free from diarrhoea were illiterates as well. For the literate caretakers, 25.5% of them had their infants attacked by diarrhoea whilst 20.0% did not experience it at all. This is quite a shocking result because; it was expected that well educated child minders may have a good awareness of infant diarrhoea avoidance. Probably, the relationship between these factors is not linear or might be too complex for this study to accurately determine. Of course, a lot more factors may have to be considered in order to determine such a complex relationship.Several reports (Awasthi*et al.*,

1996 and Brattacharya*et al.*, 1995) recognized poverty, poor sanitation, lack of water supply and overcrowding as factors associated with diarrhoea prevalence in the household. Other factors include early childbirth, short birth intervals, lack of breastfeeding, and malnutrition (Scariati*et al.*, 1997).

4.8.2Household sociocultural demographic factors and the sanitation conditions

It was hypothesized that:

Ho: There is no relationship between households' background factors and the sanitation conditions of the household.

H_1: There is a relationship between households' background factors and the sanitation conditions of the household.

Household characteristics considered essential to the objectives of this study included age of household head, religious affiliation of the head of household, household size and the educational attainment of the household head.

4.8.3Age of household head and the sanitation condition

TABLE 4.15 PEARSON CORRELATION RESULT FOR AGE OF HOUSEHOLD HEAD AND THE SANITATION CONDITION OF THE HOUSEHOLD

		Age of head of household
Sanitation Category	Pearson Correlation	0.456(**)
	Sig. (2-tailed)	0.000
	N	120

***** Correlation is significant at the 0.01 level (2-tailed)***

From Table 4.15, the Pearson correlation value of +0.456 indicates a medium, yet significantly positive relationship between the age of the head of household and the sanitation condition of the household at 99% confidence limit, hence the null hypothesis was rejected. The scatter plot (Figure 4.15) shows that, the sanitation condition of the household improved

tremendously as the age of the head increased and 20.8% is a respectable amount of variance. It may be presumed that as the age of the head of household increases, the heads gain more experience with what happens when good health is compromised (Lau *et al*, 1986).

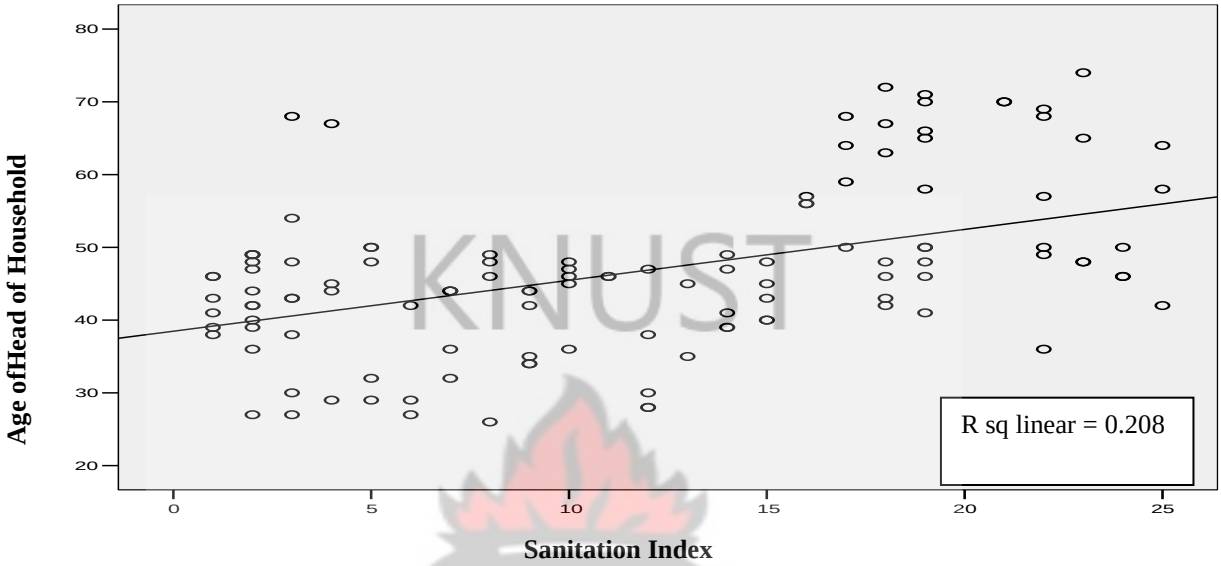


FIGURE 4.15: SCATTER PLOT SHOWING THE RELATIONSHIP BETWEEN THE AGE OF HEAD OF HOUSEHOLD AND THE SANITATION INDEX,

4.8.4Education of head and sanitation condition of household

TABLE 4.16: EDUCATION OF HOUSEHOLD HEADS AND SANITATION CONDITION

		Education attainment of head of the household
Sanitation condition of the household	Pearson Correlation	0.408(**)
	Sig. (2-tailed)	0.000
	N	120

** ***Correlation is significant at the 0.01 level (2-tailed)***

Pearson correlation (*r*) value of +0.408 suggests a medium but positive and significant relationship between the education attainment of the head of a household and the sanitation condition of the household. The null hypothesis was rejected in this case. The result is further explored with cross table as shown in Table 4.17.

TABLE 4.17: CROSS TABLE FOR EDUCATIONAL ATTAINMENT AND THE SANITATION CONDITIONS

		Sanitation condition of the household		Total
		Good	Poor	
Education attainment of head of the household	Literate	25(62.5%)	17(21.3%)	42(35%)
	Illiterate	15(37.5%)	63(78.7%)	78(65%)
Total		40(100%)	80(100%)	120(100%)

From Table 4.17, 25 out of 40respondents who had good sanitation are literate as compared with the mere 15 being illiterate.Only 21.3% of literate heads had poor sanitation as compared to the 78.7% illiterate heads. This shows that there is a high level of poor sanitary practice among inhabitants with no formal education than those with formal education. This result implies that the maximization of gains in sanitation intervention from the provision of better water and toilet amenities can only be obtained when household heads have some formal education. Thus, policies which look to provide better health circumstances exclusively through improvements in sanitation possibly will not accomplish their goals. Instead, integrated programmes and policies which advance the value of facilities equally with education may get the best results. In fact, according to Stephens (1985), education alone without contemporary water or toilet facilities, is more useful than provision of modern facilities in most cases. This result could be the true picture of the problem at Bogoso. Rapid sanitation facility provision without education is not benefiting the community.

4.8.5Household size and sanitation conditions

TABLE 4.18: PEARSON CORRELATION RESULT FOR FAMILY SIZE AND SANITATION CONDITION

		The number of persons living in the household
Sanitation Category	Pearson Correlation	-0.469(**)
	Sig. (2-tailed)	0.000
	N	120

***** Correlation is significant at the 0.01 level (2-tailed)***

The Pearson correlation (at 0.01significance level) value of -0.469 indicates a medium negative, yet significant relationship between the size of the family living in the household and the sanitation conditions of the household. The direction can best be described by the scatter plot (Figure 4.16)since sanitation index and family size are both continuous data sets.

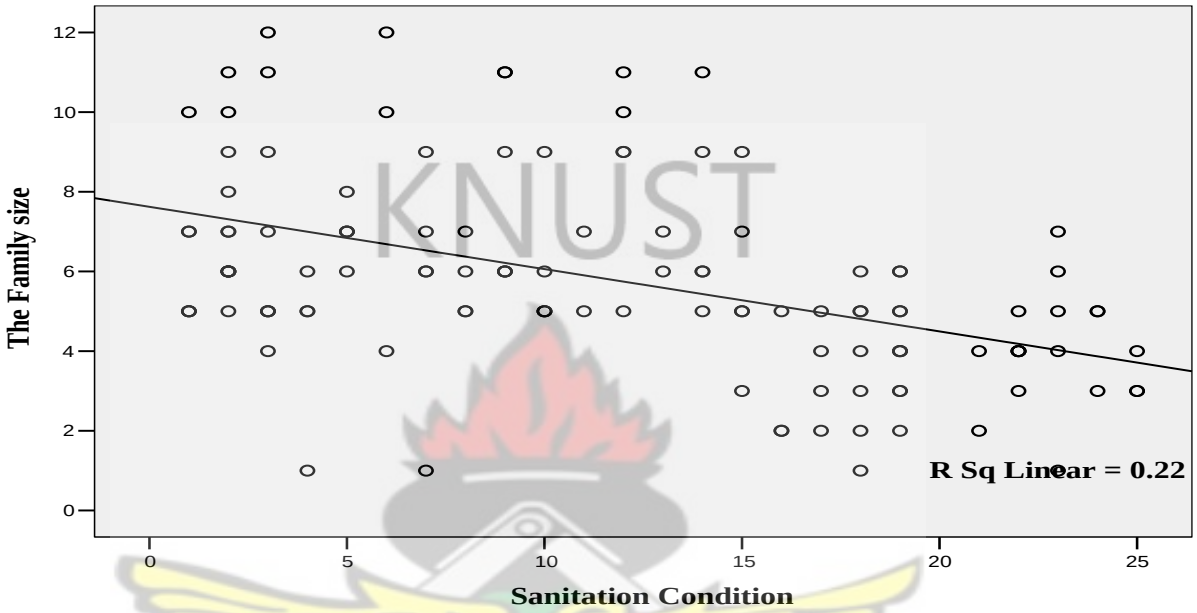


FIGURE 4.16: SCATTER DIAGRAM SHOWING THE RELATIONSHIP BETWEEN FAMILY SIZE AND SANITATION CONDITION OF HOUSEHOLD

From the scatter plot (Figure 4.16), the index of sanitation increased as the family size decreased. The R^2linearvalue shows that the variables shared 22% of their variance which is a respectable value. The implication is that, sanitation conditions deteriorate with overcrowding in the household. With large family size (averagely 6) there is the likelihood of members generating more waste which in turn creates problems of sanitation and hygiene in the households. The null hypothesis is not valid and as such was rejected in this case.

4.8.6Religious Affiliation of Heads of Household and the Sanitation Conditions

TABLE 4.19: PEARSON CORRELATION RESULT FOR RELIGIOUS AFFILIATION OF HOUSEHOLD HEAD AND THE SANITATION CONDITION OF THE HOUSEHOLD

		Religion of head of household
Sanitation condition of the household	Pearson Correlation	0.413(**)
	Sig. (2-tailed)	0.000
	N	120

***** Correlation is significant at the 0.01 level (2-tailed)***

From Table 4.19, Pearson product moment correlation value of +0.413 at 99% confidence level showed a significant positive relationship between the religious affiliation of the head of household and the sanitation conditions of the household. The resulting cross table is as shown by Table 4.20.

TABLE 4.20: CROSS TABULATION FOR RELIGION OF HEAD AND SANITATION CONDITION

		Sanitation condition of the household		Total
		Good	Poor	
Religion of head of household	Traditional	23(57.5%)	15(18.7%)	38(31.7%)
	Christian	14(35%)	37(46.3%)	51(42.5%)
	Moslem	3(7.5%)	28(35%)	31(25.8%)
Total		40(100%)	80(100%)	120(100%)

From Table 4.20, 23 representing 57.5% of the 40 households who had good sanitation were Traditional worshipers as compared to 35% for Christians and 7.5% for Moslems. Only 18.7% of Traditional believers had poor sanitation out of the 80 respondents with poor sanitation as compared with 46.3% for Christians and 35% for Moslems. This means that of the three major religions in the sampled households, the Traditionalist households had better sanitation conditions than Christians and Moslems, and Christians had better sanitation in their households than Moslems did. The converse statement of the null hypothesis is valid and hence the null hypothesis was rejected. Even though traditionalist households are mostly

illiterate, there are informal learning systems in various cultures, which sometimes ensure that individual behaviour elicits responses from the environment.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

Water is a unique natural resource, since it is essential for the survival of all forms of life. Access to water and sanitation is a fundamental need for the poor, and therefore should be an essential component of efforts to alleviate poverty. The study community has been affected by mining, forestry and agricultural activities for over 120 years (BGL EIS, 2005). Because of this development, the local environment has been subject to varying degrees of degradation. Moreover, there is high incidence of hygiene and sanitation related illnesses in the area. The study found that there was a problem of poor housing structures which is also a cause of insect breeding since most of the houses in the study area are built with earth. The main findings of the study are as stated below:

1) There was no significant relationship between the occurrence of infant diarrhoea in the households and the educational attainment of the child caretakers so the study refuted that factor.Most child caretakers in the study area are women. Most of these caretakers had no formal education, making it difficult for them to positively engage and teach the children proper hygiene and sanitary practices and thus preventing the occurrence of infant diarrhoea.
2) Household background variables like age of head of household, family size, religious affiliation of head of household and educational attainment of the head of household had relationship with the sanitation conditions in the household. It was found from the study that as the age of the head of the household increased, there was improvement in the sanitation conditions of the household. However, the sanitation conditions of the households deteriorated as the number of people living in the household increased. It was

also found that in houses where the religion of the head of household was Traditional, sanitation conditions were better than those of a Christian head and this household also had better sanitation conditions than that with a Moslem head of household. The study also showed that educated heads had better sanitation conditions than that of households with illiterate heads. This implies that, sanitation intervention programmes cannot progress without adequate formal education.

3) The pH of stored drinking water of households in the study area was within the guidelines of both the GSB and the WHO with some few samples going below the least limit of 6.5. Majority of samples contained suspended particles as shown by the high values of turbidity and also the bacteriological quality was bad since 66.7% tested positive for Total coliform and 10% tested positive for E. coli.

5.2Conclusion

It was evident from the study that household factors like family size, age of head, the educational attainment and the religion of the head of household had significant relation with the sanitation conditions of the household. Majority of caretakers of children were illiterate and yet did not attend child healthcare programmes.

Most houses in the study area are built with mud. Earth is the most used material for floor construction. Besides the use of straw, corrugated sheets are the most used material for roofing in the community. The use of low quality materials for walls, floors and roofs makes the houses easy for insect vector and pest attacks and thereby, increase the chances of sanitation related diseases occurring in these houses. There could also be huge building maintenance cost at least in terms of time, since birds and rodents create holes and make nest on the roofs and the floor if inferior materials are used which becomes a burden on the household.The supply of sanitation facilities like household toilets and rubbish dumps was inadequate and there was extensive use of the bush as place of convenience and indiscriminate

disposal of rubbish. Sanitation conditions in the households of the sampled areas were generally poor since modes of disposal of household waste were not as safe to guarantee an improvement in the health of the people living in those communities.

The gender of the heads of household was predominantly male and the proportion of male heads of household was higher than the national average. Furthermore, it was observed in the sampled district that the women were always engaged in petty trading and subsistence farming when they were not doing anything at home. A physical observation of drinking water storage containers in the sampled households revealed that most of the respondents did not cover their water storage containers. Majority of the households dipped cups and bottles into the container to fetch water for use. From these ways of collecting water, foreign materials can be introduced easily into the containers anytime water is collected as these cups and jugs might not be clean enough. This attitude towards water usage makes the respondents much prone to water borne diseases since majority of the inhabitants use water from unprotected surface water sources.

5.3Recommendations

The following actions are strongly recommended as the way forward for lessening the poor sanitation situation in the sampled communities so as to improve the health of the people and reduce the incidence of diarrhoeal diseases.It is suggested at the end of this study that a thorough investigation into the effects of sanitation conditions on water quality of households be undertaken in the sampled communities. Such study must be done using a larger sample size and with more sensitive laboratory techniques for determining bacteriological quality, for example the multiple tube fermentation method using 10 tubes or the 3M™ Petrifilm™ test.It is also suggested that a study comprising the determination of water quality at source, when in transit and in storage be undertaken to determine where exactly contamination occurs and factors responsible for the contamination. Furthermore, it is suggested that a detailed study of

simple and cheaper water treatments methods, especially, the potential of using solar disinfection to treat water be undertaken.

5.4Suggested intervention actions

The following actions are also recommended to the agencies involved as a way forward for any intervention policy formulation in order to find a sustainable solution to the health and sanitation problem in the study area. These agencies include the Local Area Council, the District Assembly, NGOs, Community Water and Sanitation Agency, Educational institutions, Ministry of Information and the Environmental Health Division of the MOH.

- **Promotionof community participation in sanitation improvement programmes**

An effective sanitation improvement intervention programme must be implemented as soon as possible by the Local Area Council to help solve the problem. Any intervention programme must promote community level participation and also strengthen social learning capacity among community members. It is very important to sustain community level networks and local social ties in the implementation of behaviour change programmes. Studies concerning HIV/AIDS prevention in Sub-Saharan Africa, offer insight into potentially useful interaction methods for improving water and sanitation messages. In Uganda for example, the prevalence of HIV/AIDS was reduced from between 15-21% in the early 1990's to 4-10% by 2003. The strategy used included earning the support of local leaders, teaming up with religious and traditional healers, performing widespread observation, face-to-face community awareness raising, and intentionally promoting fear arousal (Green *et al*., 2006). Another assessment of the Uganda's case brings to light the importance of personal means of communication, as against impersonal radio and newspaper campaigns (Low-Beer and Stoneburner, 2003).

- **Mass Health Education**

TheDistrict Assembly and NGOs operating in the area must collaborate and give more attention to educating the people of the community regarding the need to keep their environment clean and cultivate good sanitation and hygiene practices. The messages should be planned based on the community's characteristics and appreciation of health, sanitation and hygiene. As suggested by the PHAST (WHO, 1998),local health clubs and animations must be employed to promote good hygiene routine. Formal education must also be improved in the area to increase educational status so as to achieve improvement in health behaviour. The programme must aim at young heads of households, households with large family size and households whose heads are Christians and Moslems.

- **Sanitation Facilities**

The District Assembly, Community Water and Sanitation Agencies and NGOs should all help the communities to build household toilet facilities and institute better mechanisms of refuse disposal systems at reduced subsidies. This will reduce the risk of contamination of water in the communities. When this is supported by education to change behaviour towards the proper and consistent use of these facilities the incidence of public health diseases may reduce.

- **Formal Education**

Formal education must be promoted across the study area and all its surrounding villages. Some of the resources invested in water and sanitation facility provision must be channelled into formal education promotion. The study has shown that, formal education can positively influence the sanitation conditions of households since household sanitation improved with the educational attainment of the heads of the households. This is based on the fact that a literate person in the study is someone who has had at least six years formal education that is up to primary school in Ghana's education system.

- **Environmental Health Inspection**

It is finally recommended to the Environmental Health Division of the District Assembly and the District Water and Sanitation Committee that the supervision of environmental sanitation in the communities is stepped up with more environmental health officers employed. The prosecution of environmental health offenders should serve as a deterrent to ensure that people behave appropriately with regards to household and community hygiene. They can also be agents of information flow for health education messages in the communities.

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5.6 APPENDICES

APPENDIX A: Interview schedule for the head of household/representative

Household description

A – LOCATION

A1: Cluster Community:……

A2: Household Id number……

B – HOUSEHOLD CHARACTERISTICS

B1: Wall construction

(1) Brick or cement blocks [ ] (2) Stone [ ]

(2) Mud [ ] (4) Raffia [ ]

(6)Other (Specify)……

B2: Floor construction

(1)Tile [ ] (2) Concrete [ ] (3) Earth [ ] (6) Specify other ……

B3: Roof construction

(1)Cement [ ] (2) Mud [ ] (3) Corrugated sheets [ ] (4) Straw [ ]

(6) Other (Specify)……

B4: Children (0-59 months) Living here Yes [ ] No [ ]

B5: Caretakers of children (0-59 months) present Yes [ ] No [ ]

C- SOCIO-CULTURAL BACKGROUND OF HEAD OF THE HOUSEHOLD

1. Gender of head of household (circle one) Male [ ] Female [ ]

2. Age……

3. Marital Status. (1) Married [ ] (2) Single [ ] (8) Other[ ]…….

4. Religion of Head of household……

5. The occupation of the Head of the household……

6. What is the education attainment of the head of household?

(1)No formal schooling [ ] (2) Primary, incomplete [ ] (3) Primary,completed []

(4)Secondary, incomplete [ ] (5) Secondary professional level [ ]

(6) University, incomplete [ ] (7) University, completed [ ] (8) don't know [ ]

D-WASTE DISPOSAL (garbage)

7. What is the main way you dispose of your garbage?

(9) In waste pit/dump site [ ] (10) Random [ ] (11) Burned [ ]

(12)Buried [ ] (13) Composted [ ] (96)Other……

8. If disposed within household, how far is this from the house?

(1) less than 50meters [ ] (2) 51 – 100m[ ] (3) 101 – 150m [ ] (4) more than 150m [ ]

E-WATER USE BEHAVIOUR

9. What is the main source of drinking water for members of this household?

(1) Piped water [ ] (2) Tube well/Borehole (pump) [ ]

(3)Hand dug well [ ] (4) spring [ ]

(5) Rainwater collection [ ] (6) Tanker truck [ ]

(7) Bottled water [ ] (8) Surface water (rivers/lakes) [ ]

(98)Other…….

10. Do you treat your water in any way to make it safe to drink? (1)Yes [ ] (2)No [ ]

11. If yes, what do you usually do to the water to make it safe?

(1) Boil [ ] (2) Add bleach/chlorine [ ] (3) Sieve it through cloth [ ]

(4)Water filter (ceramic, sand) [ ] (5) Solar disinfection [ ]

(6)Sedimentation [ ] (96) Other…… (98)Don't know [ ]

12. How do you remove water from the drinking water container?

(1) Pouring [ ] (2) Dipping [ ] (3) Both pouring and dipping [ ]

(4) Container has a spigot or tap [ ] (96) Other(specify)……

13. What type of containers are these?

(1) Narrow mouthed [ ] (2) Wide mouthed [ ] (3)Both types [ ]

14. Are the containers covered? (1)All are [ ] (2) Some are [ ] (3)None is [ ]

15. Do you have toilet facility inside your household?

(1) Yes[ ] (2) No[ ]

APPENDIX B: **Questionnaire for caretaker of children less than 60 months (5years) in the household**

16. Gender of Caretaker (circle one) (1) Male [ ] (2) Female [ ]

17.Age of Caretaker……

18. Marital Status of caretaker. (1) Married [ ] (2) Single [ ]

19. What is the education attainment of the Caretaker of children under five years old?

(1)No formal schooling [ ] (2) Primary, incomplete [ ] (3) Primary completed[ ]

(4)Secondary, incomplete [ ] (5) Secondary professional level [ ]

(6) University, incomplete [ ] (7) University, completed [ ] (8) don't know [ ]

20. Has the child had diarrhoea during the past 48hours?

(1) Yes [ ] (2) No [ ] (8) Don't know [ ]

21. Do you attend childcare educational (weighing) programmes?

(1) Yes [ ] (2) No [ ]

APPENDIX C: Observational guide
Source: Adopted and modified from the Hygiene Improvement Framework (the joint publication 8, 2004).

OBSERVATIONAL GUIDE

Village……

House number……

The household environment

On approaching the house, observe the presence of the following:

Flies in the compound?	Yes / No
Faeces on the path to the house?	Yes / No
Faeces around the house?	Yes / No
Faeces on the compound?	Yes / No
Animal faeces around house?	Yes / No
Animal faeces in the house?	Yes / No
Is the compound clean (swept)?	Yes / No
Weeds around house?	Yes / No
Is cooked food covered?	Yes / No
Animals running around compound?	Yes / No
Waste water from washing cooked utensils	
Poured in the yard?	Yes / No

For the following items, ask to see and physically inspect before ticking. Add one extra mark after each verification if found in good condition as required by the Joint Publication 8 report.

Unwashed dishes seen?	Yes / No
Is stored water covered?	Yes / No
Any household toilet seen?	Yes / No
Any household waste dump seen?	Yes / No
Faeces seen in the dump?	Yes / No
Soap and water for hand washing seen?	Yes / No
Is waste well kept?	Yes / No

Appendix D: Poor household index estimation using observational guide

Items		**mark**
Flies in the compound?	**Yes** / No	[0]
Faeces on the path to the house?	Yes / **No**	[1]
Faeces around the house?	Yes / **No**	[1]
Faeces on the compound?	Yes / **No**	[1]
Animal faeces around house?	**Yes** / No	[0]
Animal faeces in the house?	**Yes** / No	[0]
Is the compound clean (swept)?	**Yes** / No	[1]
Weeds around house?	**Yes** / No	[1]
Is cooked food covered?	Yes / **No**	[0]
Animals running around compound?	**Yes** / No	[0]
Waste water from washing cooked utensils poured in the yard?	**Yes** / No	[0]

For the following items, ask to see and physically inspect before ticking. Add extra marks after each verification if found in good condition as required by the Joint Publication 8.

		mark	extra mark
Unwashed dishes seen?	Yes / **No**	[1]	[1]
Is stored water covered?	Yes / **No**	[0]	[0]
Remarks: Water storage containers were dirty and uncovered, no extra marks awarded			
Any household toilet seen?	Yes / **No**	[0]	[0]
Any household waste dump seen?	Yes / **No**	[0]	[1]
Faeces seen in the dump?	Yes / **No**	[1]	[1]
Remarks: Household dump not available but extra marks awarded for good waste disposal			
Soap and water for hand washing seen?	Yes / **No**	[0]	[0]
Is waste well kept?	**Yes** / No	[1]	[1]

Average score: 12

Households sanitation index = 12

Since the sanitation index is less than 16, the household had a poor sanitation condition.

Appendix E: Good household index estimation using observational guide

Items		**mark**
Flies in the compound?	Yes / **No**	[1]
Faeces on the path to the house?	Yes / **No**	[1]
Faeces around the house?	Yes / **No**	[1]
Faeces on the compound?	Yes / **No**	[1]
Animal faeces around house?	Yes / **No**	[1]
Animal faeces in the house?	Yes/**No**	[1]
Is the compound clean (swept)?	**Yes** / No	[1]
Weeds around house?	**Yes** / No	[0]
Is cooked food covered?	**Yes** / No	[1]
Animals running around compound?	**Yes** / No	[0]
Waste water from washing cooked utensils poured in the yard?	**Yes**/ No	[0]

For the following items, ask to see and physically inspect before ticking. Add extra marks after each verification if found in good condition as required by the Joint Publication 8.

		mark	extra mark
Unwashed dishes seen?	Yes / **No**	[1]	[1]
Is stored water covered?	**Yes** / No	[1]	[1]
Any household toilet seen?	**Yes** / No	[1]	[0]

Remarks: bucket latrine present in household but not clean inside so no extra marks awarded

Any household waste dump seen?	**Yes** / No	[1]	[1]
Faeces seen in the dump?	Yes / **No**	[1]	[1]

Remarks: Extra marks awarded for good waste disposal and rubbish dump management

Soap and water for hand washing seen?	**Yes** / No	[1]	[1]

Remarks: Liquid soap and container full of rainwater present near toilet entrance, extra marks given

Is waste well kept?	**Yes** / No	[1]	[1]

Average score: 21

Households sanitation index = 21

Since the sanitation index is more than 16, the household had a good sanitation condition.

APPENDIX F: The top ten prevalent diseases in the Wassa West District between 2005 and 2008.

Diseases	2005	2006	2007	2008
Malaria	66,387	95,266	89,617	85,655
Acute respiratory infection	10,548	16,551	15,517	17,517
Skin diseases	3,736	7,328	8,287	8,072
Diarrhoea	7,091	7,060	7,895	7,179
Rheumatism	3,699	6,247	5,565	9,111
Acute eye infection	3,174	4,962	3,656	4,501
Dental caries		3,411	4,320	3,545
Hypertension	2,149	4,302	5,381	6,781
Pregnancy related complication	2,746	4,022	3,809	4,618
Home/occupation related accidents		2,851	3,362	3,046
All other diseases	85,000	71,000	96,000	61,759
Grand total	190,970	224,905	242,418	212,368

Source: Regional Directorate of the Ministry of Health, 2008

Appendix G: Top eight most prevalent diseases in the WassaAmenfi East District between 2006 and 2008.

Diseases	2006	2007	2008
Malaria	3163	4282	13645
Acute respiratory infection	979	1245	1131
Skin diseases	280	504	1296
Diarrhoea	127	176	1651
Acute eye infection	202	1082	1748
Dental caries	23	38	77
Hypertension	402	572	1125
Home/occupation related accidents	54	29	26
Total (excluding other diseases)	5230	7928	20699

Source: Regional Directorate of the Ministry of Health, 2008