KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY

SCHOOL OF MEDICAL SCIENCES

DEPARTMENT OF COMMUNITY HEALTH

‘EARLY DETECTION, PREVENTION, AND RISK FACTORS FOR BURULI ULCER IN THE ATWIMA-NWABIAGYA DISTRICT, GHANA: THE PATIENT’S PERSPECTIVE.’

RAYMOND ASARE

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‘EARLY DETECTION, PREVENTION, AND RISK FACTORS FOR BURULI ULCER IN THE ATWIMA-NWABIAGYA DISTRICT, GHANA: THE PATIENT’S PERSPECTIVE.’

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BY: RAYMOND ASARE

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KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY, KUMASI-GHANA.

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SIGNATURE…… SIGNATURE……

DR. EASMON OTUPIRI DR. ANTHONY EDUSEI

ACADEMIC SUPERVISOR HEAD OF DEPARTMENT

DECLARATION

I hereby declare that, except for references to other people's work which have been duly acknowledged, this work is the result of the original work done by me under supervision.

It has neither in whole or in part submitted for a degree elsewhere.

……..

RAYMOND ASARE

DEDICATION

To my able my, Madam Mary Acquah (Alias Akua Kaya) whose toil has sustained me during the course of my study.

Also to my most loved brothers: Mr.Paul Asare Banahene, Francis Asare, Emmanuel Asare Rev.Ben Fokuo and Atta Osei.

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This work would not have been accomplished had it not been the exclusive power and authority of the Creator of Heavens, Earth and Sea with its fullness-the infinite and unseen God.

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DEFINITION OF TERMS

Educational level: The highest educational standard left off.

Direct costs:The costs of services provided during the period of hospitalization. These included the costs of hospitalization, surgery, daily wound dressing and miscellaneous expenses.

Deforming sequelae: Restriction placed on one's ability to flex any of the joints of the limbs, amputation and/or move freely as a result of worst complications of the Buruli ulcer disease.

Contracture deformity: The inability to bend or straighten any of the body joints as a result of Buruli ulcer infection.

LIST OF ABBREVIATIONS/ACRONYMS

BCG	Bacille Calmette Guerin
GBUI	Global Buruli Ulcer Initiative
BU	Buruli ulcer
WHA	World Health Assembly
WHO	World Health Organization
AFB	Acid-fast bacilli
PCR	Polymerase chain reaction

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ABSTRACT

Mycobacterium ulcerans is an environmental pathogen that is commonly associated water with and soil. In humans, *M. ulcerans* causes an ulcerative skin known as Buruli ulcer in Africa and Bairnsdale in southern Australia. Within the African sub-region, *M. ulcerans* is the third most common mycobacteriosis after Tuberculosis and Leprosy and principally affects remote rural African communities.

A cross-sectional survey was conducted with 200 Buruli ulcer patients in Atwima-Nwabiagya district of Ashanti region of Ghana.

People of all socio-economic class and all age groups are affected. However, adults more than 40 years old are affected most with the disease. Again, the disease is associated with occupational status in buruli-endemic regions; thus farmers are mostly affected in buruli-endemic regions.

Farmers were the most hard hit with the Buruli ulcer disease.. The factor to explain this phenomenon might be the fact that, farmers are more exposed to *M. ulcerans* virtue of their day to day farming activities.

Working close to rivers and lakes are established to be one of the risk factors in buruli-endemic regions. Still further, farming and illiteracy posed as risk factors for the development of Buruli ulcer disease in buruli-endemic regions.

General developmental improvements on the lives of people who dwell in deprived and remote areas of buruli ulcer endemic regions were tagged as some of the primary preventive measures.

In conclusion, injuries, insects' bites, nakedness and contaminated water were established to be some of the principal risk factors for Buruli ulcer in buruli-endemic regions.

CHAPTER ONE

1.0 INTRODUCTION

1.1 BACKGROUND INFORMATION

Buruli ulcer is the most common name of the *M. ulcerans* infection. It has also been referred to as Bairnsdale, Searles, and Kumusi ulcer and "The Mysterious Disease", depending on the geographic region where it was historically reported (Meyers 1974).

Mycobacterium ulcerans is an environmental pathogen that is commonly associated with water and soil (Ross et al., 1997; Hayman 1991). In humans, *Mycobacterium ulcerans* causes an ulcerative skin disease known as Buruli ulcer (BU) in Africa and Bairnsdale in southeastern Australia. Although BU is usually regarded as a disease of subtropical climates, a slowly increasing number of cases have been recorded in temperate southeastern Australia over the past fifteen years (Asiedu, 1998). In sub-Saharan African countries such as La Cote d'Ivoire (Marston et al., 1995), Benin (Johnson et al., 2005) and Ghana (Amofa et al., 2002) are endemic for BU and has been responsible for considerable suffering and disability, and the disease has become more common than Tuberculosis and Leprosy in some highly BU-endemic regions (Debacker et al., 2004). Although the mode of *Mycobacterium ulcerans* transmission is unknown, epidemiologic evidence suggests that transmission occurs through being in close proximity to slow-moving waters contaminated with the bacteria (Hayman 1991; Aiga et al., 2004). Previous case-control studies have reported an increased risk for BU for those who regularly swim or wade through rivers (Raghunathan et al., 2005) and those who farm near BU-endemic region's main rivers (Ross et al., 1997). More recently, results from laboratory experiments have suggested a new hypothesis that aquatic insects, fishes and

plants may be reservoirs for *Mycobacterium ulcerans* (Marsollier et al., 2002) and that the aquatic insects may even be mechanical transmitters to humans (Portaels et al., 1990; Marsollier et al., 2005). BU which is also known as Bairnsdale (Alsop et al., 1972), Daintree ulcer (Johnson et al., 2005) in Australia is an emerging disease of the skin and soft tissues with potential to cause a scarring and disability (Johnson et al., 2005).

BU occurs in more than thirty countries worldwide, but it affects principally children in the Sub-Saharan Africa, where it is now more common than Tuberculosis and Leprosy in some regions (Debacker et al., 2005). The disease occurs in people of all ages, races and socioeconomic classes who live and/or visit BU-endemic areas, but the precise mode of transmission is unknown. Furthermore, studies from disease-endemic areas in Africa have reported that farming activities near rivers (Marston et al., 1995) and swimming in rivers or marshes (Aiga et al., 2004) may be risk for BU; bites from contaminated water bugs may transmit the infection.

Although the first report of BU from Africa dates back to 1897,when Sir Albert Cook described cases of chronic ulceration in Uganda, the first definitive description of *M. ulcerans* was published in 1948 (MacCallum et al., 1948).

Buruli ulcer caused by *Mycobacterium ulcerans*, is characterized by deep and necrotizing skin lesions, mostly on the arms and legs (Asiedu et al., 2002) which is third most common mycobacterial condition after tuberculosis and leprosy and mainly affects remote rural African communities (Stientra et al.,2002). It begins with a painless nodule or papule in the skin and, without appropriate therapy, causes massive skin ulceration, which often results in grossly deforming sequelae (Marsollier et al., 2003). *Mycobacterium ulcerans* disease, commonly called Buruli ulcer (BU) is an emerging

infectious disease in West Africa (Asiedu et al., 2002; Debacker et al., 2004). BU is endemic in Africa, particularly in West African countries. The disease is also endemic outside Africa, but remains uncommon in non-African countries. In sub-Saharan Africa more than 70% of all patients are children. Individuals, 60 years or older, are also at increased risk of BU (Amofa et al., 2002).Several forms of BU exist; large chronic ulceration (indurate plaque) of the skin is the most frequent manifestations of the disease (Asiedu et al., 2002) and bones are sometimes involved (Portaels et al., 1998).

In Africa, countries between latitudes 10 degrees north and south seemed to be prone for the disease transmission (McCallum 1948). BU is currently endemic in the following West African countries: Benin, Ghana, Cote d'Ivoire, Nigeria, Liberia, Sierra Leone, Guinea, and Togo. Some countries are also affected in Central Africa (Angola, Cameroon, Congo, Democratic Republic of Congo, Equatorial Guinea, Gabon and Sudan) and in other regions (Uganda in East Africa and Malawi in Southern Africa). Neighbouring countries of above-named are potentially endemic for BU: Burkina Faso, Burundi, Central Africa Republic, Chad, Ethiopia, Kenya, Mali, Rwanda, Tanzania, and Zambia. The cumulative number of cases in the WHO African Region exceeded 40,000 in 2004.

The mode of transmission remains illusive and speculative, but abrasions of the dermis and minor skin trauma after contact with contaminated water, soil or vegetation could be likely routes of entry. There is preliminary report on possible transmission by insects (Portaels et al., 1999). Aquatic insects, other aquatic invertebrates and fish could be reservoirs or intermediate hosts of *M. ulcerans*.

The disease is commonly associated with communities with aquatic ecosystems and recent outbreaks in especially West Africa could be related to the natural ecosystem.

The increasing numbers of some soft (tilapia) farms could create a germ tank (Eddyani et al., 2004). In Ghana, increased fish farming and irrigation could be added risk factors.

Trauma is the most frequent means by which *M. ulcerans* is introduced into the human body from the contaminated surface of the skin. Contamination of the skin may result from direct exposure to stagnant water, insect bite, aerosols (Portaels et al.,1999).

In sub-Saharan Africa more than 70% of all patients are children. Individuals who are 60 years or older are also at increased risk of BU. Recently, aquatic insects have been considered potential 'vectors' of *M. ulcerans*. Contamination of the skin may result from direct exposure to stagnant water, insect bite, aerosols (Hyman 1991).

Currently, excisional surgery with or without skin grafting remains the recommended therapy for BU. There have been anecdotal accounts of successful antibiotic therapy of early lesions. A number of prospective therapeutic drug trials are presently underway and some are promising. The use of protected sources of water for domestic purposes reduces exposure to *M. ulcerans*. Contaminated sources and consequently may reduce prevalence rates of BU. Since BU was declared an emerging disease in 1998; much effort has been invested in research. Some aspects, however, remain unclear and thus require much more investigation, including reservoir(s) and mode(s) of transmission, risk factors, optimal management and preventive tools.

Better strategies for early diagnosis and effective therapy compatible with the socioeconomic structures of BU endemic areas, should be developed. A multidisciplinary

approach and productive cooperation between scientists and health professionals remain indispensable for the improvement of BU control worldwide.

Because of local immunosuppressive properties of mycolactone, or perhaps as a result of other unknown mechanisms, the disease progresses without pain and fever, which may partly explain why those affected oftentimes, do not seek prompt treatment. However, without treatment, massive ulcers result, with the classical, undermined borders. Sometimes, bone is affected causing gross deformities. Other conditions that may mimic BU include: tropical phagedemic ulcers (tropical ulcers), leishmaniasis particularly in South America, onchocerciasis nodules and fungal skin infections (WHA, 2004).

The disease has emerged dramatically in West Africa (van der Werf et al., 1999). Prevalence rates in endemic districts in Ghana are reported up to 150 per 100,000 persons (Amofa et al., 2002). The mode of transmission is unclear but aquatic insects, notably *Naucorida* spp may serve as a vector of *Mycobacterium ulcerans* (Marsollier et al., 2002). According to the clinical case definition of the World Health Organisation, the preulcerative stage includes nodule, plaque, or oedema. In the ulcerative stage, skin ulcers with typically undermined edges can be clinically differentiated from other skin disorders. Later, a granulomatous healing response occurs and fibrosis, scarring, and calcification and contractures with permanent disabilities may result (Stientra et al., 2001).

In La Cote d'Ivoire, approximately 24,000 cases have been recorded between 1978 and 2006. In Benin, nearly 7000 cases have also been recorded between 1989 and 2006; In Ghana, more than 11,000 cases have been reported since 1993 (Amofa et al., 2002).

In Nigeria, infections have occurred among Caucasians living on the campus of the University of Ibadan after 1965 (Oluwasanmi, 1975) when small streams flowing through the campus were dammed to make an artificial lake. The first case reported in Cote d'Ivoire was a 7-year-old French boy beside Lake Kossou (Perrudiani, 1980), an artificial lake in the centre of the country. In Liberia, cases have been reported in the north of the country following the introduction of swamp rice field to replace an upland one (Portaels et al., 1998). Focal outbreaks have followed flooding, human migration (Uganda Buruli Group 1971) and man made topographical modifications –dams and resorts. In Benin for example, the disease prevalence in areas with environmental changes is about180 per 100,000 populations, whereas in those without environmental changes it is about 20 per 100,000 (Portaels, 1998).

Marsollier et al., (2003) demonstrated experimentally that *M. ulcerans* could survive and multiply exclusively within the salivary glands of aquatic bugs (*Naucoris cimcoides*) and the insects were able to transmit *M.ulcerans* to mice. Trauma is probably the most frequent means by which M. ulcerans is introduced into the skin from surface contamination. The initial trauma can be as slight as hypodermic needle puncture or as severe as gunshot or exploding land mine wounds (Meyers et al 1974). Epidemiological evidence has not clearly supported person-to-person transmission, for example, in Cote d'Ivoire (Marston et al 1995). Some villages in the Daloa region have rates as high as 16%. In Amansie West district in Ghana, a rate of 22% has been reported (Amofa et al., 1995).

1.2 PROBLEM STATEMENT

Buruli ulcer, caused by *M. ulcerans* is one of the most neglected but treatable tropical diseases. Infection leads to extensive destruction of skin and soft tissues with the formation of large ulcers usually on body extremities. Patients who are not treated early suffer long-term functional disabilities such as restriction of joint movement as well as the obvious cosmetic problem. Early diagnosis and treatment are vital in preventing such disabilities. The incidence of BU in Western African countries is among the highest in the world (Asiedu et al., 2000; Lagarrigue et al., 2002).

According to the national case search for Buruli ulcer conducted by Amofa et al., (2002), the overall crude national prevalence rate of active lesions was 20.7 per 100,000 persons but the rate was 150.8 per 100,000 in the most disease-endemic district.

The economic cost of Buruli ulcer has not been studied. One recent study on the economic and social cost of Buruli ulcer in Amansie west district of Ghana shows that the impact is high (Asiedu et al., 1998).

Based on the available data on 102 cases of Buruli ulcer treated at the district hospital in Ghana between 1994 and 1996, the average hospitalization was 130 days and the average total treatment cost(include hospitalization, surgery, laboratory tests, daily wound dressing, drugs and miscellaneous costs) per person was estimated at USDollars783.

About 70% of those affected by BU are children under 15 years old. The direct consequence for children is two-fold. First, prolonged morbidity often leads to serious disruption of school or even discontinuation of schooling. Second, complications such as amputations and contracture deformities are frequent, and children disabled by the

disease would not be able to work on the field. These children would grow into adulthood and become a serious burden to the society.

The full social impact of BU on women has yet to be ascertained. First, studies on the social consequences of tuberculosis in Pakistan indicates that, this disease may lead to stigmatization, social isolation, diminished marriage prospects, divorce, most particularly in women (Liefoogbe et al., 1995). Buruli ulcer with its physical and cosmetic problems could have similar repercussions. Second, the role of women in rural communities is enormous. They are involved in income-generating activities. These could be reduced considerably if they are left with permanent disabilities as a result of the disease. Such disabilities could potentially limit their ability to execute activities such as trading, farming, food preparation, obtaining water and breastfeeding. The inability to perform these tasks could negatively reduce their income-generating potential, health and welfare of their children.

From the aforementioned deliberations, there is an increased need to determine the cost-benefit analysis of detecting BU early, determine the risk factors for BU and finally determine the primary preventive and control measures of BU in the Atwima-Nwabiagya where the disease is highly endemic.

1.3 RATIONALE OF THE STUDY

Buruli ulcer remains a priority health problem in Ghana and continues to be a common disease and also one of the key causes of morbidity seen in the health facilities within the Atwima-Nwabiagya District of Ashanti Region of Ghana. According to the Sector Wide Indicators for the year 2006, the District spent as much as ¢84,509,700 on the treatment

of Buruli ulcer only in the year 2005.This amount spent constituted the highest percentage of all the expenditures in the treatment of diseases.

The Buruli ulcer disease remains a burden socially, medically and economically among the populace in the Atwima-Nwabiagya district in general but the burden is heavier in children in their teens than are adults. The immunosuppressant occurring in most oftentimes children below fifteen years old puts a heavy toll on them when they experience this neglected but treatable disease. Within every quarter of the year, the ten topmost health problems registered by the district health facility, Buruli ulcer constitutes about 17.0%. This figure is enormous as far as the burden of BU is concerned (Health Information Manual Report, 2006).

Research has been done to ascertain the reasons for low turnout rates of Buruli ulcer patients to health posts, in certain sub-districts, and the reasons for increased *Mycobacterium ulcerans* disease cases, in some areas among others; However ,no research has been done on Buruli ulcer in terms of early detection, risk factors, risk factors and its prevention and, recommendations were made based on the findings, to combat the burden of Buruli ulcer.

1.4 RESEARCH QUESTIONS

The study attempts to address the following questions:

- What are the primary preventive measures of BU?
- What are the control measures of Buruli ulcer?
- What are the risk factors for BU?

- What is the mortality and morbidity pattern of BU?

1.5 RESEARCH OBJECTIVES

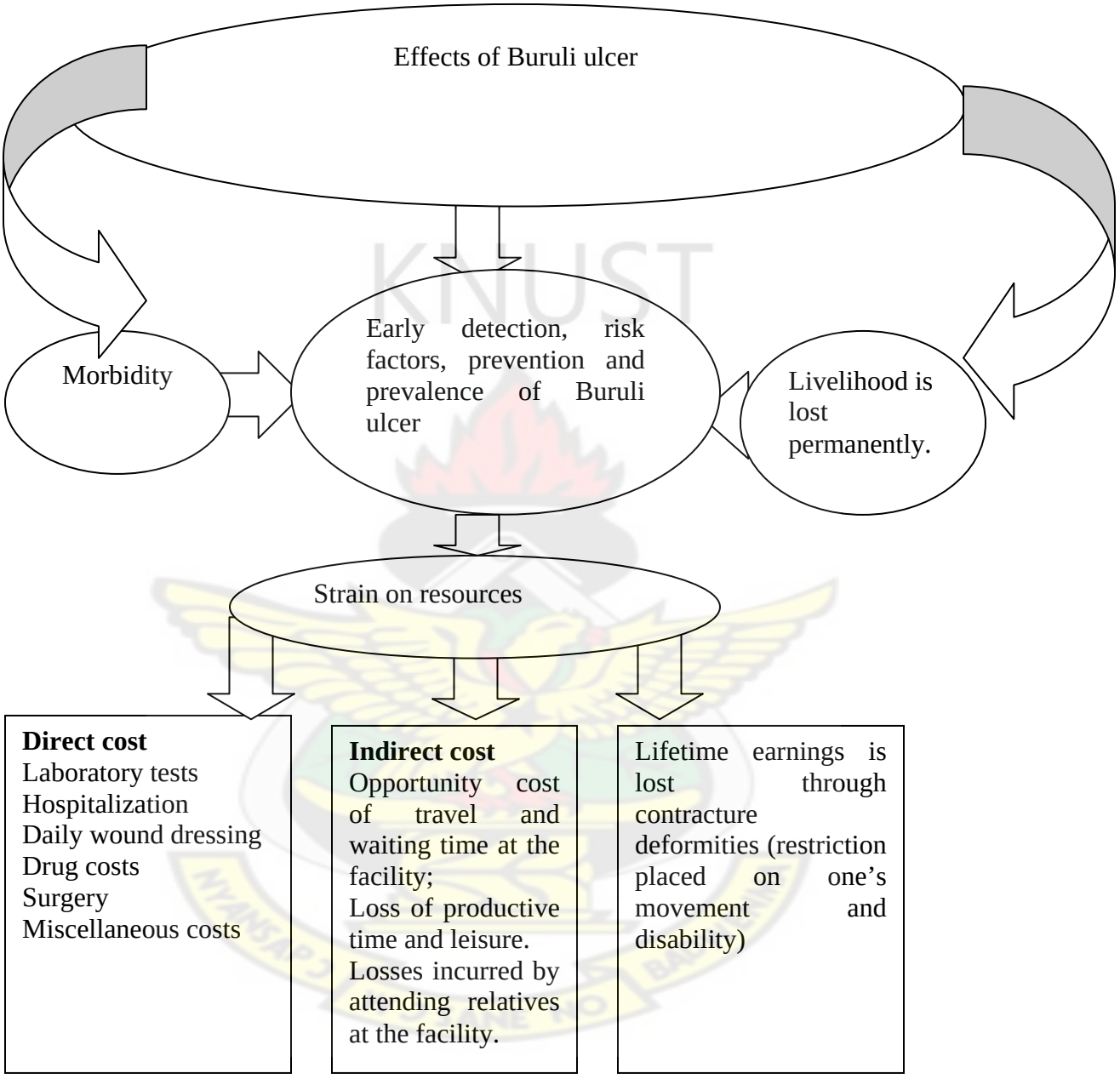
1.5.1 General Objective

To identify the principal ways of reducing the risk factors for developing the Buruli ulcer disease in the Atwima-Nwabiagya District.

1.5.2 Specific Objectives of the Study

- Determine the primary preventive measures for the BU disease.
- Determine the control measures of *M. ulcerans* disease.
- Determine the risk factors of *M. ulcerans* disease.
- Determine the morbidity and mortality pattern of the BU disease.

Figure 1.6: Conceptual framework



Source: Author's own construction using data from Global Buruli Ulcer Initiative, 2000

6.1 EXPLANATION TO THE CONCEPTUAL FRAMEWORK

There are five main sections in the above figure **1.6** with the central one showing the main topic. The three others represent the economic effects of the disease, then the two health effects. Morbidity associated with the disease may lead to consumption of resources. The cost involved can be direct, indirect or even lifetime earnings. The direct cost refers to the direct pocket money spent on treatment of diseases, indirect cost on the other hand is the opportunity cost of travel, waiting at the health facility and loss of productive time. Lastly, loss of lifetime earnings through contracture deformities, disabilities, and disfigurement etc.

1.7 PROFILE OF THE STUDY AREA

1.7.1 Geographical Location

The District lies approximately on latitude 6^{o} 75^{I} N and between longitude 1^{o} 45^{I} and 2^{I} 00^{o} W. It is situated in the western part of the region and shares boundaries with Ahafo Ano South and Atwima- Mponua Districts (to the west), Offinso District (to the North),Amansie west and Bosomtwe-Atwima –Kwanwoma Districts (to the South),Kumasi Metropolis and Kwabre District (to the East). It has an area of 294.84 km square.

The District lies within the wet semi-equatorial zone marked by double maxim rainfall ranging from 170 cm and 185 cm per annum. The major rainfall season is mid-March to

July and minor season is between September and mid-November. The rainfall is not distributed throughout the year.

The District has a mean relative humidity of about 87-91 percent. The lowest humidity usually occurs in February/April when they are between 83-87 in the morning and 48-67 in the afternoon.

1.7.2 Economic Activities

The economy of Atwima- Nwabiagya District has been categorized into Agriculture, Industry, Trading and Services. Agriculture employs about 50.76% of the labour force followed by industrial sector which employs about 17.41% of the labour force. Petty trading also employs about 14.41% of the labour force.

The service sector comprising transportation, hairdressing, hospitality among others employs about 17.40% of the labour force.

1.7.3 Health Services

The District has one (1) Hospital, four (4) Health centres, four (4) Clinics, six (6) Maternity homes, and forty (40) trained traditional birth attendants. The Hospital is located at Nkawie-Toase. The District has a population of 129,375 with an annual growth rate of 3% according to the 2000 Population and Housing Census.

Table 1.1 Health facilities in the District

Serial number	Centre	Location
1.	Nkawie-Toase District Hospital	Nkawie-Toase
2.	Akropong Health Centre	Akropong
3.	Barekese Health Centre	Barekese
4.	Asuofua Health Centre	Asuofua
5.	Abuakwa Health Centre	Abuakwa
6.	Toase Clinic	Toase
7.	Nana Frema Maternity Home	Adankwame
8.	Nyama Maternity Home	Achiase
9.	Akropong Maternity Home	Akropong
10.	God is able Maternity Home	Sepaase
11.	Antwi's Maternity Home	Koforidua
12.	Maakro Clinic	Maakro

Source: (District Health Profile, 2002)

1.8 Scope of the study

Buruli ulcer, a debilitating disease is the third most common mycobacteriosis in humans after tuberculosis and leprosy. The disease is currently known to be endemic in the following countries in West Africa., Thus Benin, La Cote d'Ivoire, Ghana, Guinea, Liberia, Nigeria, Sierra Leone and Togo. The governments of these heavily affected countries have recognized the gravity of this disease in terms of social-economic costs, besides its public health importance, and have initiated actions to fight this problem.

The study highlights on the following:

- Primary preventive measures of Buruli ulcer.
- Control measures of Buruli ulcer.
- Risk factors for developing the BU disease.
- Mortality and morbidity pattern of Buruli ulcer.

1.9 Organization of the report

Chapter one deals with the background information, problem statement, rationale of the study, research objectives and questions, explanation to the conceptual framework, geographical location, economic activities, health services and facilities, and scope of the work.

Chapter two deals with primary preventive and control measures of BU, risk factors for BU, morbidity and mortality pattern of BU. Chapter three also deals with the study design and type, data collection techniques and tools, study population, sample size and sampling techniques, study variables, data handling and storage, ethical considerations, assumptions and limitations of the study.

Chapter four also deals with age group and educational levels of respondents, religions, occupational and marital status, sex, water sources, stage of ulcer before visiting the hospital, stance on whether rainy season favours the development of Buruli ulcer, parts affected with the condition, persons infected with the condition per household, period of onset of condition to ulceration, primary preventive measures of BU condition, risk factors for BU condition, brief description of physical signs of BU on the body of respondents, reasons why respondents did not report to hospital upon developing the condition,

Chapter five deals with the primary preventive measures of BU, risk factors, mortality and morbidity pattern of BU and control measures of Buruli ulcer.

Lastly, chapter six highlights on the conclusions and recommendations.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 PRIMARY PREVENTIVE MEASURES FOR BURULI ULCER

Some of the principal risk factors are: contact with stagnant water, wearing clothes that do not cover all the body during farming activities and lack of recourse to antiseptic solutions when any care is given to skin wounds (Amofa et al., 1995). The protective factors described are the use of mosquito screens, regular washing clothes, correct care of skin wounds with antiseptic solutions (Stientra et al., 2002).

That clothing provides protection against BU as reported in La Cote d'Ivoire (Marston et al., 1995).

Programmes for provision of protected water for drinking and domestic use would have the greatest effect on control of Buruli ulcer of areas endemic for Buruli ulcer. This effect could be accomplished by drilling wells. Appropriate educational programmes that promote behavioural changes could also reduce the frequency of Buruli ulcer cases (Asiedu et al., 1998).

The use of soap for washing was found to decrease the risk of BU as in Ghanaian study (Debacker et al., 2006) and treating injuries with soap or antiseptic powder also seemed protective.

Immunity to infection can be boosted by vaccination if available. The use of Bacille Calmette Guerin (BCG) might offer some protection against BU (Uganda Buruli Group, 1971) but the short duration of BCG protection would require repeated vaccination target at the population at risk group.

2.2 CONTROL MEASURES OF BURULI ULCER

Until recently, chemotherapy has been considered ineffective (van der Werf et al., 2003). However, it has been postulated without evidence that antimicrobial agents fail to penetrate the lesions of Buruli ulcers of the extensive necrosis (Etuaful et al., 2005). Recent studies have demonstrated that both moxifloxacin, a newer fluoroquinolone, and diarylquinoline, exhibit powerful bactericidal activity against *M. ulcerans*(Andries eta al.,2005;Blumberg et al.,2003).

Creams generating topical nitrogen oxide promoted healing in one small study, and nitric oxide killed *M. ulcerans in vitro*(Phillips et al., 2004;Phillips et al.,2004).

Access to surgery in rural tropical areas is highly problematic; the focus is shifting to the treatment with rifampicin and streptomycin combined with much smaller surgical intervention. Years of *in vitro* and animal model studies have established this chemotherapeutic combination of rifampicin and streptomycin as the most effective way of killing the *M.ulcerans* and more recent work shows that the organism can be killed in human tissue by the treatment combination for at least eight weeks(Dega et al.,2002;Etuaful et al.,2004).

2.3- RISK FACTORS FOR BURULI ULCER

Direct contact with the environment appears to be a universal risk factor for acquisition of BU. Some other risk factors are contact with contaminated stagnant water and walking in marshes. Studies from Buruli-endemic regions in Africa have reported that farming near rivers (Marston et al 1995) and swimming in marshes or rivers (Aiga, 2000) may be risk factors for BU; bites from contaminated water bugs may transmit the

infection. Contact with contaminated stagnant water, wearing clothes that do not cover all the body parts during farming activities and lack of recourse to antiseptic solutions when any care is given to skin wounds (Debacker et al., 2006).

It is established from studies that BU is associated with age, place of residence, and water sources for all persons and that BU was associated with Bacille Calmette Guerin (BCG) scar in persons ≥ 5 years old(Aiga et al.,2004).

In accordance with previous studies (WHO 2005; Amofa et al 1993; Debacker et al., 2004), the risk for BU was higher in children < 15 years old. Children 3-4 years old had an increased risk for BU if they used unprotected water and lived in Buruli-endemic areas. That clothing provides protection against BU has already been reported in Cote d'Ivoire (Marston et al.,1995). In Africa, infants ≤1year of age are often protected by clothes, bonnets. At approximately 1-2 years of age, children begin to walk and play in dirt near their homes, and those 3-4 years of age are more independent and roam freely in the environment, usually scantily clothed, which increases exposure to contaminated environment. The use of unprotected water increases BU risk, especially in children <5 years old. These associations have been previously reported (Aiga et al 2004; Uganda Buruli Group 1971). Materials from swamps, ponds, or river regions may contaminate skin surfaces with *Mycobacterium ulcerans* which result in introduction of the causative agent into the skin when it is broken by trauma or insect bites (Portaels et al 1999; Meyer et al., 1974).

Children 5-14 years old and persons >49 years old were at higher risk for BU. Their attire and contact with environmental sources of *Mycobacterium ulcerans* may be relevant

factor. Elderly persons through repeated episodes of exposure to *Mycobacterium ulcerans* may acquire latent infections that are reactivated by age related immunosuppression.

Although adults 15-49 years old are frequently exposed to wetland, their risk for BU was lower, which suggests acquired resistance to the disease. It is speculated that this resistance may be related to acquired specific immunity or to cross-immunity from other mycobacterioses (Smith, 1970).

Men >59 years old in Zou had a higher risk for BU than women, but men and women in the <59-years-old group were equally at risk (Debacker et al., 2004).

Previous case-control studies have reported an increased risk for BU for those who regularly swim or wade through rivers (Aiga et al 2004; Raghunathan et al 2005) and those who farm near a Buruli-endemic town's main rivers (Marston et al 1995). More recently, results from laboratory experiments have suggested a new hypothesis that aquatic insects, fish, and plants may be reservoirs for *Mycobacterium ulcerans* disease (Portaels et al 1999; Marsollier et al 2004) and that aquatic insects may even be involved in the transmission to humans (Portael et al., 1999; Marsollier et al., 2002).

Case-control studies have identified the use use of unprotected water from swamps (Debacker et al.,2006; Pouillot et al., 2007) and rivers (Raghunathan et al.,2005;Aiga et al.,2004) particularly systems that have been heavily impacted by agricultural land use within surrounding catchments(Debacker et al.,2004) as risk factors for Buruli ulcer disease.

In addition, an impaired immune system, potentially as a result of exposure to soil or water enriched with naturally occurring elements or anthropogenic contaminants, is also a risk factor for Buruli ulcer disease (Stientra et al., 2001). For example, Duker et

al.,(2004) demonstrated spatial relationships between Buruli ulcer prevalence and arsenic (an immunosuppressant agent) in Amansie West District of Ghana. Specifically, Duker et al.,(2004) found that the mean Buruli ulcer prevalence was higher in arsenic-enriched drainages and farmlands compared to areas elsewhere in the district.

2.4 MORBIDITY AND MORTALITY PATTERN OF BU

Buruli ulcer has mortality rate of 2% globally (WHO, 2004). However, it is a significant source of morbidity and socioeconomic burden. All countries along the Gulf of Guinea are affected. Global prevalence rates available at country levels are variable, ranging from 2-22% in some communities endemic for BU (Amofa, 1995). In La Cote d'Ivoire, approximately 15,000 cases have been reported since 1978 where up to 16% of the populations in some villages are affected. There are 5 major endemic regions in La Cote d'Ivoire: Bondoukou, Bouake, Daloa, Danane and Yamoussoukro. A national survey conducted at the end of 1997 revealed that the disease is found in all regions except the departments of Boundiali and Tengrela in the north of the La Cote d'Ivoire. Some 5641 cases were reported between 1995 and 1997, 1351 cases in 1999 and 562 cases in 2001(Weekly Epidemiological Record, 2004).

In Benin, 4000 buruli cases have been recorded since 1989. Benin reported 567 cases in 1999, 416 cases in 2000 and 478 cases in 2001(Weekly Epidemiological Record, 2004). The majority of new cases are found in the Antlantique, Coastal, Oueme, Mono, Plateau, Zou and Hills regions.

In Ghana, (6000 recorded cases in a national survey in 1999) up to 22% of villages are affected in some heavily endemic areas (Debacker et al., 2004). The most endemic areas

include the Ashanti and Central regions with prevalence rate of 20.1 to 60.0 per 100,000 populations; followed by Greater Accra, Eastern and Western Regions with prevalence rate of 15.1 to 20.0. Brong Ahafo and Upper East Regions both have a prevalence rate of 10.1 to 15.0. The regions of lowest prevalence (7.0 to 10.0 per 100, 000) include Upper West, Volta and Northern (Weekly Epidemiological Record, 2004).

Concerning Guinea, the main endemic area is in the Forest region (Districts of Lola, Youmou and N'Zerekore). A survey conducted in 1999 in the above named region estimated the prevalence rate of 9.8 per 100,000 populations in Youmou and 155 per 100,000 populations in N'Zerekore (Weekly Epidemiological Record, 2004).

Concerning Gabon, the first 2 cases from this country were described in 1961.A further 23 cases were described in 1986(Weekly Epidemiological Record, 2004).

CHAPTER THREE

3.0 METHODOLOGY

3.1 STUDY DESIGN AND TYPE

The study was a cross-sectional survey with an exploratory design. The study was conducted in the public health facility in the Atwima-Nwabiagya district of Ashanti region.

A total of 200 Buruli ulcer patients were included in the sample. The Buruli patients were randomly selected from among those who were receiving medical treatment in the district health facility.

3.2 DATA COLLECTION TECHNIQUES AND TOOLS

The study used primary data only. The study used a questionnaire as the main data collection tool and person-to-person interviews were conducted. Observation using a check list was used to ensure that the lesion s reported were indeed Buruli ulcer lesions.

A series of questions were asked about respondents' attitudes towards and perception of Buruli ulcer, what they did when they realized they had the disease, distance to the health facility, knowledge of the symptoms of Buruli ulcer disease and the like.

3.3 STUDY POPULATION

The study population was laboratory diagnosed Buruli ulcer patients receiving medical treatment at the district health facility in the Atwima-Nwabiagya district.

3.4 SAMPLE SIZE AND SAMPLING TECHNIQUE

A total of 200 laboratory confirmed Buruli ulcer patients were included in the sample for the study. The Buruli ulcer patients were selected randomly from among those who were receiving medical treatment in the health facility.

The sample size was calculated using the formula; $N=z^2pq/d^2$ where N=sample size, z=confidence level, p=proportion of persons with the risk factor, q=proportion of persons without the risk factor, i.e. q= 1-p, d = precision. d= 7%, z= 95 %=≥ 1.96, p = 50%, q= 1-0.5 => 0.5. $N= (1.96)^2(0.5)\ (0.5)/\ (0.07)^2= 196$.

Twice a week during the study period, about 50 Buruli ulcer patients reported to the district health facility for a review. A simple random of 30 patients were selected. The numbers on a currency note were used to randomly select 30 Buruli patients from the pile of identity cards reported for a review and also new cases included in the selection. The identity cards picked formed part of the sample and the selected patients interviewed accordingly.

3.5 STUDY VARIABLES

Table 3.1 Study variables

No	Variable	Definition	Scale of measurement
1.	Persons affected per household	Persons affected in the same household	Nominal
2.	History of swimming	Persons who have recently swum in any water body	Nominal
3.	History of insect bites	Persons who have suffered insect bite just before they developed the BU disease	Nominal
4.	Risk factors	Patients who are able to cite some practices as risk factors	Nominal
5.	Age bracket	Persons within a specified age category who are highly vulnerable to BU	Ordinal
6.	Gender	The sex which is mostly affected the BU	Nominal
7.	Time of ulceration	Time taken for developed BU to turn into	Nominal
8.	Control of Buruli ulcer	Chemotherapy for the treatment of BU	Nominal

3.6 DATA HANDLING AND STORAGE

With the structured questionnaire, the researcher made sure that the data collected were complete and accurate by checking through the questionnaire after each day's field work. Data collected from the health facility was kept in an envelope, labeled and kept safely for analysis.

3.7 DATA ANALYSIS

The survey data were coded and entered using SPSS 15.0 version used for data analysis. The results have been presented in descriptive statistics showing percentages and frequencies.

3.8 ETHICAL CONSIDERATIONS

Permission was sought from the Department of Community Health, Kwame Nkrumah University of Science and Technology (KNUST) and District Health Directorate of Atwima-Nwabiagya district as well as the management of the health institution. Informed consent was obtained from all the respondents of the survey. The purpose of the study, the methods and eventual use of the study findings were also explained to the Buruli ulcer patients and the health providers.

3.9 LIMITATIONS OF THE STUDY

The health institution has only acid-fast bacilli (AFB) device for the diagnosis of Buruli ulcer cases. Unlike polymerase chain reaction (PCR) which has a specificity of 100%, AFB has less specificity; hence some of the tropical ulcers were mistaken for Buruli ulcer.

CHAPTER FOUR

4.0 RESULTS

4.1 RESPONDENTS WERE SAMPLED ACCORDING TO THEIR SOCIAL AND DEMOGRAPHIC CHARACTERISTICS.

Table 4.1- Age, Educational Status and Religion of respondents

(1) Age group	**Frequency≡200**	**Percent**
< 10 years	41	49.5
11-20 years	40	20.0
21-40 years	20	10.0
>40 years	99	45.5
(2) Educational level	**Frequency**	**Percent**
No formal education	55	27.7
Jss/Mslc./Comm./Tech.	59	29.6
Teacher/Nursing training	74	37.5
Poly./Univ.	12	5.2
(3) Religion	**Frequency**	**Percent**
Christian	157	78.5
Moslem	37	18.5
Traditional	3	1.5
Others	3	1.5

Source: Field data, 2009

Table 4.2: Occupational status of respondents

Occupation	Frequency	Percent
Teacher	10	5.0
Farmer	66	33.0
Trader	31	15.5
Others	93	46.5

Source:Field data,2009

Table 4.3: Marital status and sex of respondents

(4) Marital	**Frequency**	**Percent**
Single	101	50.5
Married	79	39.5
Widowed	15	7.5
Divorced	3	1.5
Separated	2	1.0
(5) Sex	**Frequency**	**Percent**
Male	109	54.5
Female	91	45.5
Total	200	100.0

Source: Field data, 2009.

Of the respondents interviewed 27.6% had no formal education while 37.2 had completed Jss, Middle School Leaving Certificate, and Commercial or Technical school. This high

percentage farming is their occupation. Only 1.5% had tertiary education. Of the respondents interviewed, 78.5% were Christians, 18.5% Moslems, 15.0% Traditionalist whilst 15.0% were pagans.

Of the respondents interviewed, 33.0% were farmers, 5.0% teachers, and 15.5% traders while 46.5% was for others. The "others" ranged from hunters, jobless to construction work.

Farmers were the 2nd highest of the respondents, explaining why people who catch *Mycobacterium ulcerans* condition are most often farmers. Of the respondents, the number who said they were single, married, widowed, divorced and separated were 50.5%,39.5.%, 7.5%, 1.5% and 1.0% respectively. Of all the respondents interviewed, 54.5% were males while 45.5% were females.

4.4 WATER SOURCES OF RESPONDENTS

Table 4.4: Water sources of respondents

Water type	Frequency	Percent
Stream/River	85	42.5
Borehole	65	32.5
Pipe borne	50	25.0

Source :(Field data, 2009)

Of the respondents interviewed, 42.5% said they accessed river or stream, while 32.0% and 25.0% accessed borehole and pipe borne water respectively.

4.5: PRIMARY PREVENTIVE MEASURES OF BU

Table 4.5-Primary prevention of BU condition

Position	Frequency	Percent
Reduction of injury	120	60.0
Hygiene and cleanliness	60	30.0
Attending hospital upon injury	10	5.0
No knowledge	10	5.0

Source: Source :(Field data, 2009)

Of the total respondents, 60.0% claimed that reduction of injuries could be one of the practices of reducing the Buruli ulcer condition. The 2nd highest (30.0%) said hygiene and cleanliness could be a way of reducing the chances of developing the *M .ulcerans* condition.5.0% however emphatically said that prompt hospital attendance upon injury could also reduce the chances of developing the condition. While 5.0% of the respondents also expressed 'no knowledge' of the practices of reducing the condition.

4.6: RESPONDENTS WERE INTERVIEWED ON THE CONTROL MEASURES OF BURULI ULCER

Table 4.6: Control measures of Buruli ulcer

Chemotherapy	Frequency	Percent
Streptomycin-rifampicin	120	60
Diarylquinoline	60	30
No knowledge	20	10

Source: (Field data, 2009).

4.7: RISK FACTORS FOR CONTRACTING MYCOBACTERIUM ULCERANS

Table 4.7- Risk factors for contracting Mycobacterium ulcerans condition

Position	Frequency	Percent
Injury	99	49.5
Insects bites	40	20.0
Nakedness	30	15.0
No knowledge	1	0.5
Contaminated water	30	15.0

Source: Source :(Field data, 2009)

Of the respondents interviewed, 49.5% claimed that the risk factors could be injuries; 20.0% responded that it could be insects' bites; 15.0% responded that it could be exposed skin; 15.0% contaminated water; and lastly, 10.0% claimed that they did not know of the

predisposing factors. The unknown but affirmed predisposing factor was injuries which registered the highest percentage.

4.8: MORBIDITY AND MORTALITY PATTERN OF BU PER HOUSEHOLD OF RESPONDENTS

Table 4.8: Morbidity and mortality pattern due to BU per household of respondents

Persons	Frequency	Percent
One person	79	39.5
≥ Two persons	121	60.5

Source: Source :(Field data, 2009)

Of the total respondents interviewed, 39.5% said they had one person each who was affected per household while 60.5% said they had ≥ two persons affected with the condition per household.

4.9: STAGE OF BURULI ULCER LESION BEFORE VISITING THE HOSPITAL

Table 4.9: Stage of Buruli ulcer iesion before visiting the hospital

Stage	Frequency	Percent
Preulcerative	147	71.5
Ulcerative	57	28.5

Source: Source :(Field data, 2009)

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Of the respondents interviewed, 71.5% reported to the hospital at the preulcerative stage while 28.5% reported at the ulcerative stage.

4.10: RESPONDENTS' STANCE ON WHETHER RAINY SEASON FAVOURS THE DEVELOPMENT OF BURULI ULCER

Table 4.10 Respondents' stance on whether rainy season favours the development of Buruli ulcer

Stance	Frequency	Percent
Strongly agree	27	13.5
No knowledge	167	83.5
Strongly disagree	6	3.0

Source :(Field data, 2009)

Of the respondents interviewed, 23.5% agreed that, rainy season favours the development of BU, 85.5% expressed no knowledge while 3.0% strongly disagreed to the assertion.

4.11: PARTS AFFECTED WITH THE BU CONDITION

Table 4.11: Parts affected with the BU Condition

Part	Frequency	Percent
Lower limb	129	64.5
Upper limb	36	18.0
Others	35	17.5

Source: Source :(Field data, 2009)

Of the respondent interviewed, 64.5% said they developed the condition on the lower limbs whilst 18.5% developed the condition on their upper limbs. Again, 17.5% developed the condition around the neck, thorax, head, genitalia etc. The lower limbs scored the highest because they are the parts which come in contact with pathogen.

4.12: PERIOD OF ONSET OF BU CONDITION TO ULCERATION

Table 4.12-Period of onset of Condition to ulceration

Time	Frequency	Percent
< 1month	193	96.5
2-3 months	6	3.0
≥ 4 months	1	0.5

Source: Source :(Field data, 2009)

Of the total respondents interviewed, 96.6% said that they developed the ulcer in less than 1 month after developing the condition, 3.0% said that it took them between 2-3

months to develop the ulcer after developing the condition while 0.5% developed the ulcer about four months after onset of the condition.

4.13: BRIEF DESCRIPTION OF PHYSICAL SIGNS OF BU ON THE BODY OF RESPONDENTS

Table 4.13- Brief description of physical signs of BU on the body of respondents

Description	Frequency	Percent
Nodule followed by blisters	40	20.0
Pain followed by blisters	36	18.0
Oedema followed by swelling and blisters	59	29.5
Plaque with swelling	25	12.5
Nodule, followed by pain and swelling.	40	20.0

Source: Source :(Field data, 2009).

Of the respondents interviewed, 20.0% developed nodule followed by blisters; 18.0% also claimed they experienced pain followed by blisters; 29.5% also responded that, they developed oedema, followed by swelling and blisters; 12.5% said that they had plaque with swelling; while 20.0% claimed they developed nodule, followed by pain and swelling on the site of infection. Most often, the condition presents itself as a single or a combination of pain, swelling and blisters.

4.14: REASONS WHY RESPONDENTS DID NOT REPORT TO HOSPITAL UPON DEVELOPING THE BU CONDITION

Table 4.14: Reasons why respondents did not report to hospital upon developing the BU condition

Reason	Frequency	Percent
Lacked money for transportation	121	60.5
Fear for surgery	56	28.0
Residence too distant	7	3.5
Others	16	8.0

Source: (Field data, 2009).

Of the respondents, 60.5% said they lacked money for transportation, 28.0% said they feared for surgery, 3.5% claimed their place of residence was too distant to the hospital and 8.0% others. The 'others' ranged from simply ignorance of the condition, fear of surgery to the use of traditional method of healing.

CHAPTER FIVE

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5.0-DISCUSSION

5.1 PRIMARY PREVENTIVE MEASURES OF BURULI ULCER

Of all the respondents sampled and interviewed, 60% claimed that reduction of injuries in Buruli-endemic regions could potentially reduce the risk for Buruli ulcer; this is in full agreement with Amofa et al., (1995).

Furthermore, the second highest (30%) claimed that hygiene and cleanliness is one of the principal ways of preventing the BU disease in Buruli- endemic regions and this assertion is shared by Stientra et al.,(2002) and Debacker et al.,(2006).

The use of BCG offer some protection against BU (Uganda Buruli Group, 1971) but the short duration of BCG protection would require repeated vaccination targeted at the population at risk. Another primary preventive measure is avoidance of contact with the environment. This is obviously difficult to achieve, most especially among farmers in buruli- endemic communities, as they will invariably come into contact with the organism in the environment as they go about their daily farming and other activities. The use of protective clothing to cover the exposed parts of the body may prove beneficial (Marston 1995). Again, the use of soap for washing was found to decrease the risk of BU (Debacker et al., 2006) and treating injuries with antiseptic powder also seemed protective. The principle behind primary prevention of BU is about general hygiene and cleanliness in the Buruli-endemic regions.

Health education on maintaining proper personal and environmental cleanliness, and the proper care of all abrasions and cuts, is also to be encouraged. Prompt treatment of injuries with antiseptic cream may also offer some protection, although this has not been evaluated. Health education should focus on early identification and reporting, so that pre-ulcerative lesions may be excised before they ulcerate. Close collaborative work with the school system and disease control programmes such as those on leprosy, guinea worm, onchocerciasis and yaws could enhance early detection of cases.

Addressing environmental factors is just not easy. Efforts should be made to avoid creating artificial marshy environments through damming of rivers, especially in endemic or nearby communities. Provision of boreholes near where people live will reduce the frequency of contact with the organism in the environment. Buruli ulcer is not just only a medical problem but a developmental one also. Consequently, much effort should be put into the general provision of educational and health facilities.

As most people in Buruli-endemic communities are poor, the need to provide free and/or heavily subsidized services for the management of Buruli ulcer cannot be over-emphasized (Debacker et al., 2004). Otherwise the whole purpose of educating people to report for early excision will be defeated, as they will not be able to access the services even when these are available.

5.2 CONTROL MEASURES OF BURULI ULCER

Out of the total respondents interviewed, 120(60%) and 60(30%) said they were treated with Rifampicin- streptomycin chemotherapy combination and diarylquinoline respectively. The treatment of Buruli ulcer with the said chemotherapy combination is

extremely rewarding and has been confirmed by the work of Dega et al., (2002) and Etuaful et al., (2004).

Furthermore, the use of Diarylaquinoline antibiotic chemotherapy for Buruli ulcer as said by the respondents exhibited powerful bactericidal activity against *M. ulcerans* and this is in full agreement with the work of Andries et al.,(2003) and Blumberg et al.,(2003) independently. Lastly, 20(10%) of the respondents could however not tell the chemotherapy against the Buruli ulcer disease as a result of gross illiteracy.

5.3 RISK FACTORS FOR BU

From the result, of all the respondents sampled and interviewed, about 49.5% 40% claimed that injuries and aquatic insects' bites respectively in Buruli-endemic regions could be potential source of risks for BU; This assertion is shared with Potaels et al.,(1999) and Meyer et al., (1974).

Still further, the third highest (30%) claimed that both nakedness and contaminated water could be potential risk factors for BU development in Buruli-endemic regions and this philosophy is in full agreement with work Debacker et al.,(2006). Direct contact with the environment appears to be a universal risk factor for acquisition of BU Studies from Buruli-endemic regions have reported that farming near rivers (Marston et al 1995) and swimming in marshes or rivers (Aiga et al., 2000) may be risk factors for BU. Bites from contaminated water bugs may transmit the infection. Contact with contaminated stagnant water, habitual exposed body during farming have been reported as risk factors for the acquisition of BU as reported by Debacker et al., (2006).

In accordance with previous studies (WHO 2005; Amofa et al 1993; Debacker et al., 2004), the risk for BU was higher in children less than 15 years old. Moreover, Buruli ulcer development is associated with educational and occupational status of respondents in buruli- endemic regions. Thus farmers and the uneducated are mostly affected with the disease in buruli-endemic regions

5.4 MORTALITY AND MORBIDITY PATTERN OF BU

Though BU oftentimes registers a low and/or no mortality rate, it is a significant source of morbidity and economic burden in Burli-endemic regions and this philosophy is shared by WHO (2004). Of the respondents sampled and interviewed, about 39.9% reported that one person affected with BU within each household whilst 60.1% reported that ≥two persons were affected with the BU disease.

Not only is Buruli ulcer a burden economically, socially and medically but developmentally in the District of Atwima-Nwabiagya in general. The burden is heavier among adults than people in their teens. The immunosuppression occurring in children puts a hefty toll on them when they experience this developmental health problem. The data obtained from the Records and Statistical Department of the District Health Directorate of Atwima-Nwabiagya revealed the following morbidity and mortality pattern for the years 2004 to 2008. In the year 2004, the grand total for top ten morbidity was 48,099 out of which Buruli ulcer accounted for 160(0.33%) of the grand total for the year. The morbidity due to BU for 2004 indicated that, for the total outpatient attendance of 48,099, children below the age twenty years accounted for 90(0.19%) whilst adults constituted 47,939(99.75%).

Furthermore, during the years 2005 and 2006, the grand total morbidity for top ten was 37,717 and 58,169 out of which BU accounted for 137(0.36%) and 112(0.19%) respectively. Still further, the years 2007 and 2008 also registered grand total morbidity for top ten as 39,719 and 40,691 of which morbidity due to BU constituted 40(0.10%) and 133(0.33%) respectively.

According to the medical statistics from the District Health Directorate, almost all freshly developed Buruli ulcer cases reporting to the Nkawie- Toase Government health facility were treated on outpatient basis whilst patients with extensive lesions were admitted at the District Hospital for hospitalization to enable surgery and grafting to be performed to eliminate possible complications associated with maltreatment of the extensive lesions.

No death due to BU was recorded since the 2004 to date.

However, contractures and sequelae due to BU super abound according to statistics from the District Health Directorate, 2008.

CHAPTER SIX

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 CONCLUSIONS

The WHO Global Buruli Ulcer Initiative has been instrumental in developing and providing materials that have been used to improve early detection and interventions. Despite the progress registered in recent years, major gaps still remain unabridged. The reservoirs of *Mycobacterium ulcerans*, its mode of transmission to humans and immunopathogenesis are still poorly understood. Current treatment options discourage patients from reporting early; and no available treatment can prevent recurrence. Improved treatment options would encourage patients who currently present late; afraid of mutilating surgery, reluctant to seek treatment outside their own communities, and unable to cope with protracted, expensive hospitalization. There is an increased need for better understanding of this devastating disease.

Buruli ulcer development is associated with educational and occupational status of respondents in buruli- endemic regions.

General cleanliness and hygiene was identified as one of the proven ways of reducing the risk for developing the Buruli ulcer disease. This finding is in confirmation with the work conducted by Debacker et al., (2006), and Marston et al., (1995).

Urbanization, potentially by providing access to protected water sources, may reduce the likelihood of becoming infected with Buruli ulcer disease. Villages located at low

elevations may have higher Buruli ulcer disease prevalence rates in buruli-endemic regions due to their close spatial proximity to high risk environments. In addition, forest land cover and drainage basins with variable wetness patterns may be important for providing suitable growth conditions for *M. ulcerans*, influencing the distribution and abundance of vectors or mediating vector-human interactions.

6.2 RECOMMENDATIONS

Buruli ulcer is not just only medical problem but developmental one also. The below recommendations would be helpful when adopted.

First, to the Government of Ghana,

- The treatment of the disease should be free of charge in accordance with the final resolution of the Yamoussoukro Conference, and patients and health care providers should be made of this package.
- Treatment of the disease should be decentralized as much as practicable, by providing various levels of the health care system, dressing materials and other logistics to ensure effective treatment of the affected.
- Agogo hospital should be used to teach the Buruli disease in the nursing school and to train medical doctors in the surgical management of the disease.
- The Noguchi memorial institute for medical research should be contracted for the possibility of collaborating with other centres in Buruli ulcer research activities.

Second, to the District Health Directorate,

- Surveys should be conducted to assess the extent and distribution of the disease and set up ongoing surveillance.
- It should put into operation an effective screening programme for Buruli cases in endemic districts to reduce and/or eliminate the usual associated cosmetic complications.

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APPENDICES

A QUESTIONNAIRE FOR HOUSEHOLD SURVEY ON

EARLY DETECTION, PREVENTION AND RISK FACTORS FOR MYCOBACTERIUM ULCERANS.

INFORMATION FOR RESPONDENTS: This questionnaire seeks to gather information on the dynamics of Buruli ulcer infection and Mycobacterium ulcerans; genuine responses are required from you the respondents because the results of the data will greatly help arrest the burden of BU on the people.

Section A Identification

Respondent's Serial number

Date of Interview

Name/ID of Questionnaire Administrator

Section B (Personal Data)

1) What is your age category?

< 10 years [ ] 1

10- 20 years [ ] 2

21- 40 years [ ] 3

>40 years [ ] 4

2) What is your highest educational level?

No formal education [ ] 1

Kindergarten/Nursery [ ] 2

JSS/ MSLC/Technical/ Commercial [ ] 3

Tr. Training/Nursing Training [ ] 4

Polytechnic /Varsity [ ] 5

3) What is your religion?

Christianity [ ] 1

Islam [ ] 2

Traditional [ ] 3

Others. Please specify …….

4) What is your occupation?

Teacher [ ] 1

Farmer [ ] 2

Trader [ ] 3

Others .Please specify ……

5) Marital status?

Single [ ] 1

Married [ ] 2

Widowed [ ] 3

Divorced [ ] 4

Separated [ ] 5

6) Sex?

Male [ ] 1

Female [ ] 2

Section C (**Risk factors for the development of BU)**

7) Are you infected with the disease?

Yes [ ] 1

No [ ] 2

8) Which of the below water sources do you regularly access?

Well/Stream/River [ ] 1

Borehole [ ] 2

Pipe borne [ ] 3

Others .Please specify. …….

9) Have you ever swum in streams, lakes or rivers?

Yes [ ] 1

No [ ] 2

If yes,

10) were you having any cuts/wounds /sores?

Yes [ ] 1

No [ ] 2

11) In your mind's eye, what practices precipitate one getting infected with the condition?

State your view here

……

……

12) On which of the below geographical sites have you been farming?

Close to rivers/lakes/stream [ ] 1

On mountains [ ] 2

On plain fields [ ] 3

.

Section D (Working diagnostic tool for early detection of BU)

13) Have you ever had BU?

Yes [ ] 1

No [ ] 2

If **yes**

14) Did you notice any physical signs on your body in the early development of BU before there were symptomatic conditions?

Yes [ ] 1

No [ ] 2

If yes

15) Briefly describe the signs

……

……

16) Can you give a time range from the onset of the condition to the time of ulceration/lesions?

Yes [ ] 1

No [ ] 2

17) If **yes**, tick the appropriate option.

≤ 1month [ ] 1

2-3 months [ ] 2

4-5 months [ ] 3

> 5 months [ ] 4

18) At what stage of the BU infection did you report to the hospital?

Pre-ulcerative [ ] 1

Ulcerative [ ] 2

19) Why didn't you report to the hospital on seeing the symptoms?

For fear of amputation [ ] 1

For lack of money for transportation [ ] 2

Place being too distant to the hospital [ ] 3

Others .Please specify ……

……

……

Section E (Prevalence rate of BU since 01/01/08)

20) How many persons are infected in your household with the BU condition since 01/01/08? ……

21) How many are females? ……

.

22) Which parts of the body are affected with the disease?

…….....

……

23) Which sex is most affected? Male [ ] 1

Female [ ] 2

24) What do you think might be some of the predisposing factors for contracting BU?

.....

25) In your opinion, what practices can help reduce the chances of getting infected with BU? By

……

……

……

Stage of buruli ulcer before visiting the hospital

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Preulcerative	143	71.5	71.5	71.5
	Ulcerative	49	24.5	24.5	96.0
	3.00	2	1.0	1.0	97.0
	4.00	6	3.0	3.0	100.0
	Total	200	100.0	100.0	

Age of respondents

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	<10 years	99	49.5	49.5	49.5
	11-20 years	40	20.0	20.0	69.5
	21-40 years	20	10.0	10.0	79.5
	>41 years	41	20.5	20.5	100.0
	Total	200	100.0	100.0	

Whether or not rainy season favours Buruli Ulcer development

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	40	20.0	20.0	20.0
	Female	123	61.5	61.5	81.5
	no knowledge	32	16.0	16.0	97.5
	4.00	5	2.5	2.5	100.0
	Total	200	100.0	100.0	

Stage of buruli ulcer before visiting the hospital

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Preulcerative	143	71.5	71.5	71.5
	Ulcerative	49	24.5	24.5	96.0
	3.00	2	1.0	1.0	97.0
	4.00	6	3.0	3.0	100.0
	Total	200	100.0	100.0	

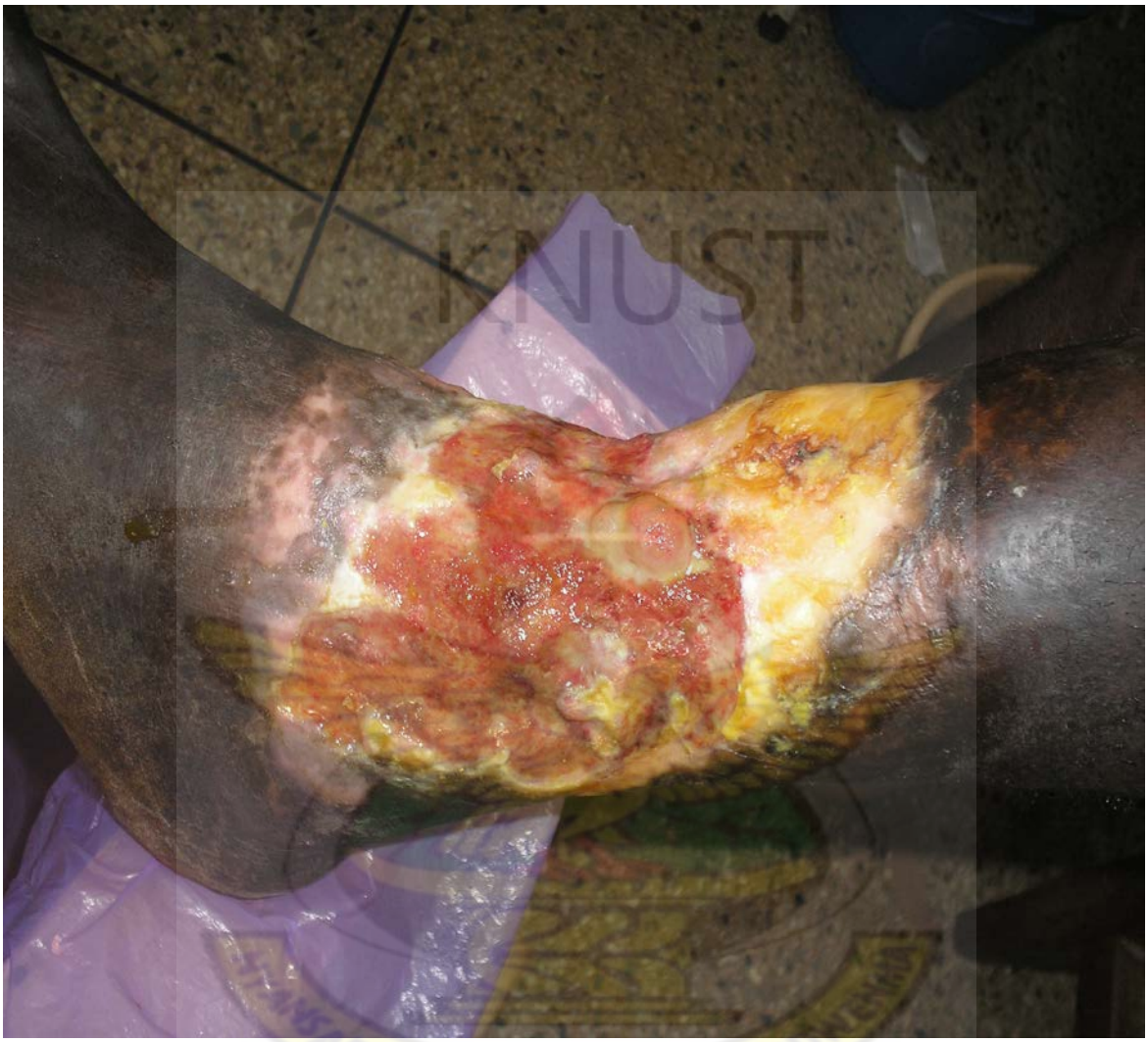
Parts affected with the condition

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	.00	2	1.0	1.0	1.0
	lower limbs	127	63.5	63.5	64.5
	upper limbs	36	18.0	18.0	82.5
	Others	31	15.5	15.5	98.0
	4.00	4	2.0	2.0	100.0
	Total	200	100.0	100.0	

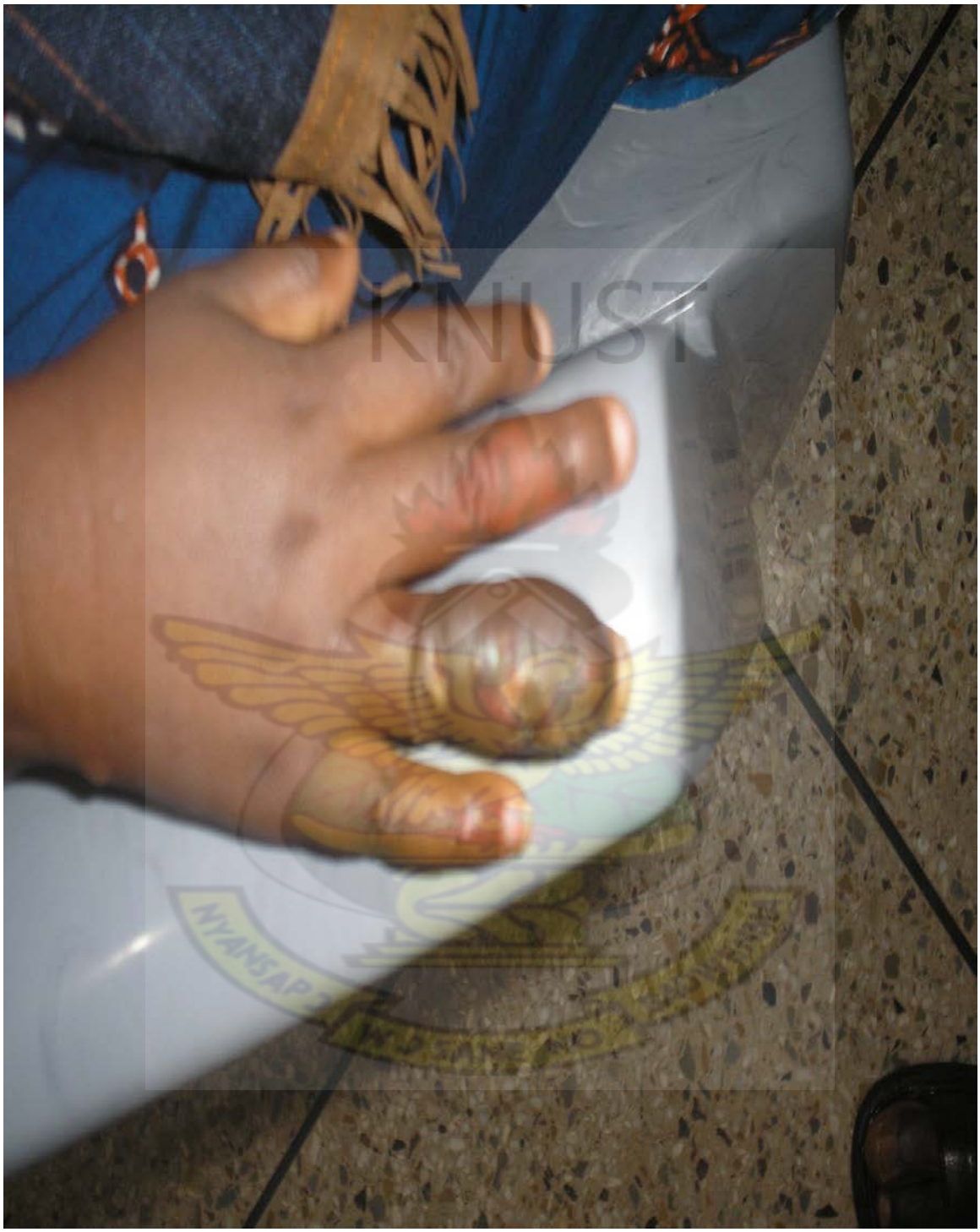
Females infected per household

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	.00	47	23.5	23.5	23.5
	one female	114	57.0	57.0	80.5
	two females	33	16.5	16.5	97.0
	three or more females	2	1.0	1.0	98.0
	4.00	3	1.5	1.5	99.5
	6.00	1	.5	.5	100.0
	Total	200	100.0	100.0	

3 Month old Buruli lesion



1Month old Buruli lesion



4 Month old Buruli for both lesions

MAP OF ATWIMA-NWABIAGYA DISTRICT