UNIVERSITY FOR DEVELOPMENT STUDIES

THE BURDEN OF SNAKEBITES IN FIVE SELECTED HOSPITALS IN NORTHERN GHANA

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FEBRUARY 2021

DECLARATION

Students Declaration:

I hereby declare that this thesis is the result of my own original work and that no part of it has been presented for another degree in this University or elsewhere:

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I hereby declare that the preparation and presentation of the thesis were supervised in accordance with the guidelines on supervision of dissertation/ thesis laid down by the University for Development Studies.

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Name: Professor Juventus Benogle Ziem

DEDICATION

This thesis is dedicated to my lovely wife and children

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ABSTRACT

Snakebites, common in Sub Saharan Africa, Asia, the Caribbean and the Pacific areas are major setbacks that affect agricultural activities in developing countries. Morbidity and mortality from snake envenoming are a serious public health concern in these areas particularly among the poor and rural peasant farmers. This study investigated the burden and management of snakebites in five selected hospitals in the northern part of Ghana.

From January 2017 to December 2019, the number of snakebites reported to 5 hospitals selected from the Northeast-, Northern- and Savannah-regions of Ghana was reviewed from the District Health Information Management System (DHIMS). Additional clinical information on the victims who reported and were managed at these hospitals was obtained from patients' folders at the hospital level.

In all, a total of 1,577 snakebite episodes reported to the five health facilities were reviewed of which ECG hospital in Kpandai recorded the majority of 33.2% (524) of the snakebites. The age group of 11-20 years was the most affected with males constituting 66.0% of the snakebite victims. While 43.4% of the victims were farmers, 33.8% were pupils or students. Annually, the incidence of snakebites was 81.8 snakebites per 100,000 population in 2017, 92 bites per 100,000 in 2018 and 76 bites per 100,000 persons in 2019. Of the 3,135 vials of ASV distributed among the five hospitals over the period, 91.4% of the patients actually received the ASV as part of their treatment at the hospital level whereas an additional 40% of them receive the ASV from sources other than the hospitals.

In conclusion the burden of snakebite envenoming is very high in the 5 selected hospitals in the three Northern regions of Ghana studied between 2017 and 2019.

At the community level, the Ghana heath service through the village volunteers should promote the use of protective garments by farmers to reduce the incidence of snakebites and also to ensure that there is continuous and equitable distribution of the anti-snake venom to all health facilities in the area.

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ADR	-	Adverse Drug Reaction
ASV	-	Anti-Snake Venom
CHAG	-	Christian Health Association of Ghana
DALYS	-	Disability Adjusted Life Years
DAMA	-	Discharged Against Medical Advice
DHMS	-	District Health Information Management System
ECG	-	Evangelical Church of Ghana
GBD	-	Global Burden of Disease
GHS	-	Ghana Health Service
KZN	-	KwaZulu Natal
MPH	-	Masters in Public Health
NTD	-	Neglected Tropical Diseases
OPD	-	Out Patient Department
QA	-	Quality Assurance
RMS	-	Regional Medical Stores
SBE	-	Snakebite Envenoming
SPSS	-	Statistical Package for Social Sciences
TMP	-	Traditional Medicine Practitioner
TTH	-	Tamale Teaching Hospital
UDS	-	University for Development Studies
USA	-	United States of America
WHO	-	World Health Organization
YLD	-	Years Lived with Disability
YLL	-	Years of Lives Lost

CHAPTER ONE (1)

INTRODUCTION

1.1 Background

It is a well-established fact that snake bites are common in Sub Saharan Africa, Asia and the Caribbean as well as the Pacific areas (Gutiérrez et al., 2013). More than 95% of morbidity and mortality from snake bites occur in tropical and/or developing countries (Chippaux, 2017). Morbidity and mortality from snake envenoming are a serious public health concern in these areas particularly among the poor and rural peasant farmers (Harrison et al., 2009). Despite this, inhabitants in these areas have poor access to health services, which are mostly under resourced if available, and in some instances, a scarcity of antivenom, which is the only specific treatment for snake envenoming (Kasturiratne et al., 2008).

Snake bites and envenoming were included in the World Health Organization (WHO) list of neglected Tropical Diseases (NTDs) in 2009, but was not incorporated into the globally coordinated efforts to reduce the impact of this NTD compared to other NTDs caused by helminthes for instance (Gutiérrez et al., 2013). Not receiving the due attention it deserves, snakebite was subsequently removed from the NTD list in 2013 (Sharma et al., 2004). Through advocacy, the WHO re-listed snakebites in the category A of the Neglected Tropical Diseases in June 2017 (Chippaux, 2017).

About 5.4 million snake bites occur worldwide each year, resulting in 1.8 to 2.7 million cases of envenoming (Kasturiratne et al., 2008; WHO, 2018a). Apart from the numerous deaths that result from this, others suffer injuries that leave them disabled for the rest of their lives**.** Because the morbidity and mortality affect the young, the working population, and the reproductive age groups, snakebites are a burden in Sub Saharan Africa, Asia, the Caribbean, and all areas where the bites are common (Gutiérrez et al., 2013).

Despite the enormity and the challenges that snake bites and envenomation posts, there is no reliable data on the true state of the burden of the disease.

The available data usually is limited to few rural populations where snake bites are common, thus making it difficult to get the true global burden of the disease. The most reliable data on snakebites and envenoming are found in few developed countries where the snakebites are few, and this can under estimate the true global burden and impact of the problem

A recent study estimated over 314,000 bites, 7,300 deaths and nearly 6000 amputations occurring annually in sub-Saharan Africa (SSA) (Habib et al., 2015). Another researcher estimated about 8000 amputations are thought to be performed every year in Africa alone as a result of snake bike envenomation (Gutiérrez et al., 2013). A mortality rate of 0.5–5.9/100,000 persons per year was estimated to be occurring in the West African sub-region alone (Kasturiratne et al., 2008).

A secondary data analysis on snake bites in the Western Region of Ghana between 2006 and 2010 revealed a total of 7,275 snakebite cases with 12 deaths, reported in various districts across the Western region of Ghana (Mensah et al., 2016).

A retrospective study on management of snakebites and envenoming in Tamale Teaching Hospital (TTH) in the Northern Region of Ghana revealed that there were 192 cases of snakebite reported to TTH between January 2016 and June 30th 2018. Out of this, there were three (3) snake bite related deaths and 49 people discharged home with various forms of complications (Yakubu et al., 2018).

As in any public health intervention, a reliable data is essential for planning health care resources (like antivenom), drawing up guidelines for training medical staff on management of snake bites and their associated complications (Kasturiratne et al., 2008).

1.2. Problem Statement

Records from some hospitals in the region show that snakebites are a common phenomenon in the Northern regions with its associated cost of treatment, high morbidity, as well as high mortality. Unfortunately, there is no comprehensive study to assess the true burden of the disease in this area. Health workers have been reporting shortage of the anti-snake venom on annual bases and this is largely due to lack of accurate data for planning to facilitate proper acquisition and fare distribution of the antivenom.

A study by Habib, A.G., et al to estimate the impact of snake bite morbidity and mortality using Disability Adjusted Life Years (DALYS) metrics for all the countries in West Africa including Ghana, showed that Ghana had an estimated public health burden of Snakebite Envenoming (SBE) of 22,243 DALYS, second only to Nigeria with an estimated DALYS of 137,105. Notwithstanding these estimates, the SBE remains under estimated in the West African sub region, resulting in resource allocation to deal with the burden being not commensurate (Habib et al., 2015).

The effects of snakebites and envenoming are grievous in many fronts involving the individual, the family, the community and the society in general. In other words, it has economic impact on the nation as well. At the individual level as found by Yakubu and his colleagues, most of the snakebite victims managed at the Tamale Teaching Hospital were young men with almost 60% of them aged below 30 years. These victims were also mostly farmers (46%) from poor rural communities. The average number of days spent in the hospital to receive treatment in this study was 4 days with a range of 1-19 days (Yakubu et al., 2018). Others put it at 15 days of incapacity (Alirol et al., 2010). This means the individual will not be available to attend to his farm for at least fifteen days even if the recovery is complete at the end of hospital stay.

Complication rate from snake envenoming is high, leading to disabilities (WHO, 2018b), and this will further contribute to longer absence from work. Snakebite victims are mostly agricultural workers from rural communities in the world including the Sub Saharan African countries where poverty is also very high (Harrison et al., 2009). The farming here involves crude methods that employ a lot of manpower which unfortunately predisposes them to the snakes. Absenteeism from farm work as a result of the hospitalization and complication will thus worsen their poverty.

The implication is that the family of the victim may likely run into difficulties producing enough food to feed on. The other impact on the immediate family is that their treasures will be used to pay for the hospital bills and buy anti-snake venom in case there is none in the health care facility.

In assessing the economic impact of snake bites and envenoming in Nepal, the mean out-of-pocket expenditure for caring for a snake bite patient was put at 69 U.S. dollars in South Eastern Nepal (Alirol et al., 2010).

In Yakubu A., S. and colleagues' study, the average number of ASV vials used per patient in TTH was 8.4. The 'black market' price for a vial of ASV is GHC 350 local Ghanaian currency or US$ 66. Estimates for out-of-pocket payment for an anti-snake venom per a patient managed at TTH in the Northern region will therefore come to GHC 2,800.00 (US$528). Many people are not able to afford this since the poverty levels are high here according to the Ghana statistical service (Wambile et al., 2017).

Identifying the population most vulnerable at sub national level to the effects and severe outcome of snake bite envenoming is important for planning and deploying current and future treatment for this neglected tropical disease (Longbottom et al., 2018). this study will look at the burden in selected hospitals in Northern Ghana to corroborate this impression and to get the true institutional burden of this disease in the region to contribute to policy planning. This will help to prevent frequent stockouts that will warrant patients buying the ASV from the black market.

1.3 Justification

There is paucity of reliable data on the true burden of snakebites and envenoming in the Northern part of Ghana for proper planning to deal with the problem. This results in reported frequent shortages and mal distribution of anti-snake venom in the Region in recent past (2016 to 2017 annual reports of NR RMS reference).

Yahaya et al conducted a hospital data review over a 10-year period in Savelugu hospital but that didn't point out the real annual incidence of snakebite envenoming in that facility because the 10 years data was lumped together. A lot of the records were not available to them because of the time lapse between the hospital attendance by the patients and the time of the research ((Musah et al., 2019).

Another study done in this locality by Yakubu et al was a data review in one hospital looking at the epidemiology and management of snakebites in the Teaching hospital in Tamale. The area covered was not wide enough compared with the current study which looks at hospitals in each ecological zone with the highest number of reported snakebites.

Objective information is therefore needed to assess the burden of snake bites at least in the hospitals in the region as a whole so that proper planning can be done to avoid the annual ritual of shortage of antivenom.

Availability of data from our study will also indicate the true amounts of antivenom required in this area to attract support from the government and its development partners to deal with the problem comprehensively.

1.4 Research Questions

1. What is the incidence of snakebites in the selected hospitals in Northern Ghana under this study?
2. What is the rate of envenomation among snakebite patients in the selected hospitals in Northern Ghana?
3. Which group of people in the Northern Regions (NRs) is at risk of snakebites?
4. What intervention is provided to snakebite victims before hospital attendance?
5. What is the outcome of snakebites management in the selected hospitals of the Northern Region under this study?

1.4.1. General Objective

To determine the burden of snakebites on the 5 selected hospitals in Northern Ghana between January 2017 and December 2019

1.4.2. Specific Objectives

1. To determine the incidence of snakebites in the 5 selected hospitals in Northern Ghana from January 2017 to December 2019
2. To determine the rate of envenoming among the reported snakebite patients in the 5 selected hospitals in Northern Ghana between January 2017 and December 2019
3. To establish the group, including the occupation of people at risk of snakebite in Northern Ghana

4. To assess the pre-hospital management and availability of ASV in the 5 selected hospitals and its influence on case management and outcome.
5. To assess the outcome of reported snake bites in the 5 selected hospitals in the Northern regions of Ghana between January 2017 and December 2019

1.5. Significance of the Study

Worldwide, there are estimated 4.5 to 5.4 million snakebites annually, with an annual snakebite envenomation accounting for up to 2.7 million reported. There are also approximately 100,000 fatalities annually from snakebite envenoming (WHO, 2018a). Since 2009, snakebite envenomation has been classified as a very important ‘neglected tropical disease’ by the World Health Organization. Despite this emerging awareness, limited efforts have been made towards addressing the serious public health implications of snakebites, particularly in sub-Saharan Africa, where baseline epidemiological data remain incomplete. In Ghana, snakebite envenomation are said to cause many deaths in hundreds and injuries in thousands (Habib et al., 2015). Other developing tropical countries across sub-Saharan Africa represents an epitome example of this ‘neglected tropical disease’. The study will therefore seek to uncover the burden of snake bite envenomation and present data collected from selected hospitals over a period of 3-year and applying different methodologies and techniques to arrive at findings which will inform policy direction. The study highlights thee many interrelated factors involving both snakes and human behaviour in particular that are responsible for the past and current high snakebite burdens recorded. In conclusion, these findings will support increased and concerted efforts from both local authorities and state institutions such as the Ghana Health Service as well as the Christian Health Association of Ghana, to help prioritise and address the seeming crisis and neglect for snakebite cases in the country.

1.6. Conceptual and theoretical framework

The study considered the conceptual and theoretical framework as key in determining the actual relationship and associations with respect to the independent and dependent variables. The study identified snakebite envenomation and outcome of the snakebite case as the dependent variables of interest where the figure 1.1 shows clearly the relationship and linkages that exists between the independent variables and dependents variables.

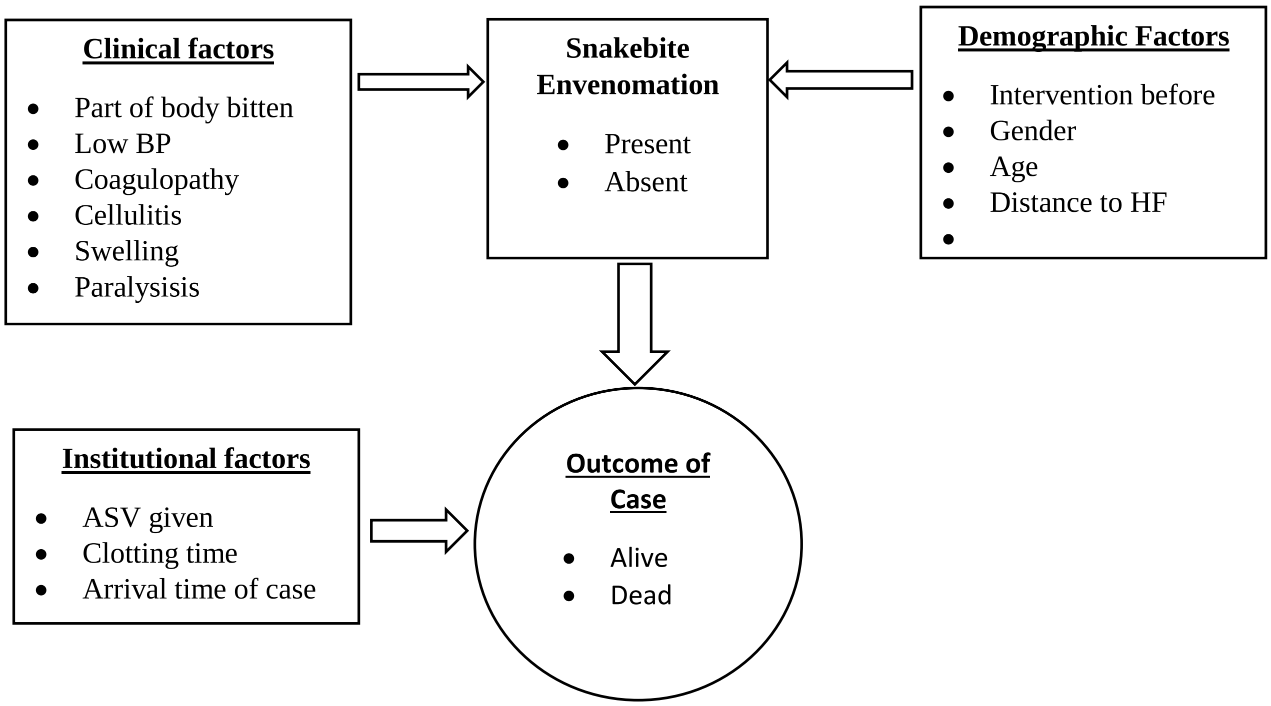


Figure 1.1: Conceptual framework of the study

The absence or presence of snakebite envenomation will affect the outcome of the case of snakebite in the hospital. If present, could cause severe complication and lead to death of patient and vice-versa.

The presence of certain clinical signs and symptoms such as coagulopathy, cellulitis, swelling, paralysis, and low blood pressure (BP) at arrival of the case could suggest whether envenomation occurred or not. Figure 1.1 illustrates clearly the relationship and impact of the demographic and other cardinal clinical factors on the outcome of snakebite envenomation. Intervention given before taking patient to the health facility, distance to the health facility, age, and gender of the patient could influence the outcome of snakebite envenomation.

Lastly, the outcome of the snakebite will also depend heavily on the measures put in place at the arrival of case as well as interventions given to the patient to understand the extent of severity of the case. For instance, the ability of the health facility to determine the clotting time of blood is very essential to the outcome of the case since prolonged clotting times accounts for higher risk of losing the patient. Also, the ASV given and the amounts given has a direct impact on the case of snakebite outcome.

1.7. Limitations of the Study

The study was limited and challenged in various steps taken by the research team to uncover these findings. Some of these challenges and bottlenecks encountered during the study period are;

i. The study was not under any form of external funding which put a lot of burden and financial stress on the researcher as the research was financed solely by the researcher.

ii. Folder retrieval for snake bite cases from the selected facilities was difficult due to poor record keeping by the hospitals where the study was carried out. Mostly it was difficult to retrieve majority of the earlier years.

iii. Some vital data indicators expected to be in the retrieved folders could not be found and this was a shortfall to the study.

iv. Inadequate time frame for the study was a key challenge to the entirety of the process of completing the study hence delayed some aspects of the processes. E.g data collection period was a key challenge to be able to retrieve all necessary folders and information.

1.8. Definition of Key Terms

Envenomation: snakebite with signs and symptoms suggestive of injection of snake venom into the body system of the victim

Venom: complex polypeptide toxin within the body and glands of venomous snakes

Burden of disease: the morbidity and mortality of a disease as well as the economic and social stress the disease brings to bear on society

Snakebite: physical injury caused by the snake through the insertion of its fangs into the body of the victim

Health facility: a physical space or building where health services are rendered by trained health professionals

Coagulopathy: defect in the ability of blood to clot normally due to dysfuntion of the clotting factors

Cellulitis: inflammation of the subcutaneous tissue

Paralysis: dysfunction of the motor nerves of a person leading to inability to move a part or parts of the body controlled by the defective motor nerves

Bleeding: loosing blood as a result of trauma, clotting defect, or abrasion of blood vessels

Clotting time: the time it takes for a blood drawn from a patient to form a clot

Swelling: expansion of body tissues and organs as a result of inflammation or presence of an enlarged organ

Anti-snake venom: an antidote prepared in the laboratory to bind to and counteract the effect of snake venom

1.9. Organization of the Study

The study is structured into six chapters where each chapter deals with concise and detailed presentation of the outcome of the burden of snakebite in northern Ghana. Chapter one covers the introduction of the study, which comprises the background of the study, the problem statement, research questions, research objectives, limitation of the study, and conceptual framework of the study.

On the other hand, chapter two reveals empirical study findings of the true burden of snakebite in the world, Africa, and Ghana precisely, the types of snakes found in the sub-Saharan region, risk factors association to snakebite, Venom and envenomation of snakes, and ASV and treatments given to snakebite victims.

More to that, chapter three basically deals with the scope and area of the study, study design adopted to carry out the investigation, type of data to collect, study population to consider, inclusion and exclusion criterion, and type of data analysis used to uncover the results and findings.

Chapter four details the findings and results, which is presented in forms of tables, graphs and diagrams for easy interpretation and understanding. The chapter uncovers the findings from the data collected over the period of time.

Chapter five explains and discusses the outcome of the findings unveiled in chapter four. It relates the findings and results to public health implication of the outcomes and results.

Lastly, chapter six gives the conclusion and decisive recommendations of the study where it bases its recommendations and conclusion on the discussion of the study outcomes and findings.

CHAPTER TWO (2)

LITERATURE REVIEW

2.1. Introduction

Snakebite and envenomation are a common occupational disease that affects mainly the population involved in manual farm work. It is very common in the South East Asia and South Saharan Africa where a lot of the population are engaged in farming activities. Snakebites are also common in other parts of the world but the common thing is that, it is the manual and mainly rural farm workers who bear the heavy brunt of the venomous snakebites. Mortality and morbidity of snakebites affect the lives of these people and their families. Because the population at risk is quiet young, the economic impact of the disease is great.

It is a challenge so far to get a true estimate of the burden of snake envenoming worldwide. Hospital data alone may not reflect the true burden of snakebites because a considerable proportion of people with asymptomatic bites may not seek treatment at hospitals; in some settings, snakebite victims may preferentially attend traditional healers (Kasturiratne, Wickremasinghe, De Silva, et al., 2008).

Most of the snakes have the ability to inject venom into their victims through the fangs. Snake venoms contain toxins that are rich in protein and peptide that have specificity for a wide range of body tissue receptors and thus making it a challenge for drug design (Warrell, 2010).

The behaviour of snakebite victims immediately after the bite is significant in determining the outcome of their encounter. Many treatment methods are tried during the pre-hospital management of the condition. For instance in Nigeria, it was found by Habib and his colleagues that, most snakebite victims attempted at least one first aid measure after the bite, including occlusion of blood flow by application of tourniquet, application or drinking concoctions, making incisions at the bite site, application of the black- or suction-stone at the bite site (Habib, 2013).

Albert Calmette introduced serum antivenom use for the treatment of envenoming in 1895 and this was accepted quickly. The Anti-Snake Venom (ASV) or Antivenin has been the main stay of treatment of snake envenoming because it is the only antidote for snake venom so far (Warrell, 2010). The ASV is produce by injecting specific snake antigen into an animal that results in hyper- immunoglobinaemia in the animal such as a horse. It is the hyper immune globulin that is extracted to make the specific ASV.

2.2 Biology and Behaviour of Snakes

There are more than 3,400 species of snakes also known as serpent, suborder; serpentes (Musah et al., 2019). Snakes are reptiles classified among lizards but distinguished by their limbless condition and elongated body and tail, after undergoing structural reduction, simplification, loss as well as specialization. All snakes do not have external limbs unlike other lizards or reptiles, they also do not have mobile eyelids and neither do they have open external ears. They have elongated visceral or internal organs with a greatly reduced or entirely loss left lung. Snakes have increased number of vertebrae in their vertebral column, a tracheal lung in the neck and a venom conducting system for conquering their prey.

Most of the snake species have the ability to inject or inoculate venom, using their fangs, or venom secreted by their oral gland. These are Caenophidia families Viperidae (vipers, adders, pit vipers, and mocassins), Elapidae (cobras, mambas, kraits, coral snakes, Australasian venomous snakes, and sea snakes), Atractaspididae (burrowing asps), and Colubridae sensu lato.

Even though all snakes are predators, not all of them are harmful. Out of the over 3000 species of snakes, only about 300 of them are venomous and 200 of these are of medical importance. It is the venomous snakes that give the bad impression to all snakes; hence they are misunderstood and often maligned, primarily out of ignorance about their true nature and position in the natural world. (*snake | Classification, Facts, & Types | Britannica*, n.d.). The distribution of venomous snakes is wide and ranges between latitudes 50°N and 50°S in the western hemisphere and 65°N (Scandinavia) and 50°S in the eastern hemisphere (Warrell, 2010).

Within the WHO Guidelines on production, control and regulation of snake antivenom immunoglobulins, two major categories of venomous snake species have been considered to aid in assessing the relative risk of each species (*WHO, 2008*).

Category 1: Highest medical importance: These are considered highly venomous snakes that are common or widespread and cause numerous snakebites, resulting in high levels of morbidity, disability or mortality.

Category 2: Secondary medical importance**:** They are highly venomous snakes capable of causing morbidity, disability or death, for which exact epidemiological or clinical data may be lacking; and/or are less frequently implicated (due to their activity cycles, behavior, habitat preferences or occurrence in areas remote to large human populations) (WHO Guidelines for the Production, Control and Regulation of Snake Antivenom Immunoglobulins).

Venomous snakes of greatest medical importance in each of four geographic zones are outlined in tables 1 & 2, adapted from the WHO Guidelines for the Production, Control and Regulation of Snake Antivenom Immunoglobulins. The bases for the listing are considered on 2 main reasons;

- The snakes are very wide spread there and are the common cause of snake bite envenomation related morbidity, disability and mortality in the respective geographic area,
- They are species which cause major and life-threatening envenoming responsive to antivenom, but are not common causes of bites (*WHO, 2008*).

A retrospective study among patients with snake bite reported at the Tamale Teaching hospital, Ghana, in 2016 and 2017 showed that the offending snake was positively identified as a viper (Yakubu et al., 2019).

2.3 Environmental and Sociodemographic risk factors for Snakebites.

Humans encounter snakes mainly during their work in the field either as farmers or animal rangers. It is difficult generally to truly understand the intentions of a snake and therefore most snakes are deemed to be dangerous to man and are thus killed on sight. Snakes attack their prey either for food or for self-defense when it realizes that its life is in danger. The commonest part of the human body that is bitten by snakes is the lower limb followed by the hands (Musah et al., 2019) (Rahman et al., 2010) . This is a true reflection on the occupation of the victims of snakebites and envenoming. The victims either will trample over the snake unknowingly or will handle snake with grass or crops during farming activities (Rahman et al., 2010).

In a Participatory rural appraisal session in three communities in Kyaukse and Madaya townships of Mandalay Division of Myanmar, to reflect on what the community saw as problems they faced. All community participants in the discussions and appraisals acknowledged that snakebite was a problem in their communities. Walking to or from farms or working on farms were the activities associated with snakebite, particularly early in the morning and in the evening (Schioldann et al., 2018).

The timing of the snakebite also reflects the relationship between the bite and the activities of the victims. In the same participatory rural appraisal using focus group discussion in Myamar, it was found that June-July and October-November, which are the harvest times in those communities, were the periods associated with higher incidence of snakebite (Schioldann et al., 2018).

In another retrospective study of snakebite and deaths in 5 Rural hospitals from ten blocks of Paschim Medinipur district in West Bengal in India, it was demonstrated that, most snake bites occurred between the early morning hours and 4 pm (Sarkhel et al., 2017). This is said to be the period people are normally engaged in farming activities, thus exposing them to snake bites.

A cross sectional study was conducted by Yahaya Musah and his colleagues between December 2008 and May 2009 in the seven most populated communities in the Savelugu Nanton District of Northern Region of Ghana. they found that about 93% of respondents in this study had encountered snakes in their lifetime with 8% actually been bitten by snakes irrespective of envenomation or hospitalization (Musah et al., 2019).

Majority (65%) of the bites occurred in their farms, while others had their bites in the bush. Snake encounters were predominant during afternoon (50%) and morning (40%) hours. The predominant season for the encounters with the snakes was during the rainy season where about 72% of the encounters occurred (Musah et al., 2019).

The lower limbs (legs and feet; ~65%) and upper limbs (arms and hands; ~34%) were the most frequent body parts bitten by the snakes (Musah et al., 2019).

With respect to gender and age grouping of the snake encounters and envenoming, Musah et al found that males dominated in number of reported cases, whereas the females constituted relatively fewer cases in the youngest age group (2.7%) but 4-8 times more in the two older groups. The 15-44 years group dominated in about half of all reported cases of snakebites for both males and females.

Sumana Sarkhela and colleagues analyzed a hospital based retrospective data of snakebite and deaths from 2012 to 2016 in Paschim Medinipur District of West Bengal, India. They found that 62% of snakebites were males. In terms of age wise distribution of the bites, the age bracket of the majority of the snake bite victims were in the 21–45 years group (Sarkhel et al., 2017).

There was also a cross sectional study by Rahman R, Faiz MA and their colleagues in rural Bangladesh to establish the annual incidence of snake bites and patient health seeking behaviour after the bite. Their findings were similar to the other studies above. For instance, they found that the active population was at a higher risk of snakebite as majority of the snakebite victims were of a younger age. The male to female ratio was similar among the victims. The monsoon season which spans from June to October was found to be the peak season of the snake bites. This is the season of vibrant agricultural activities and most rural dwellers are on their farms. Snake activities also increase during this season in the hot weather and monsoon's rain. They further established that the lower limbs were the commonest body part bitten by the snakes and the bites mostly occurred whilst the people were engaged in their farming activities (Rahman et al., 2010)

A hospital record based retrospective descriptive study at the Tamale Teaching Hospital in Northern Region of Ghana, looked at the clinical and epidemiological characteristics of snakebite victims. All confirmed snakebite cases recorded in the Teaching Hospital between

January 2016 and December 2017 were included in the study. Relevant demographic and clinical information were extracted from patient folders and analyzed.

They found that close to three-quarters (71.5%) of snakebite victims were between 11 and 40 years of age and more than half (52.1%) of the victims of snakebite were farmers or herdsmen. The interesting revelation of this study was that Student/pupils constituted 30.3% of the cases of snake bite, forming the second largest group of snakebite victims (Yakubu1 et al., 2019). As a retrospective study, the exact time of the bite occurrence could not be obtained in all patient folders. Among those with available information on the time of the bite, a significant proportion of the bites (39.3%) occurred between the hours of 4 pm and 8 pm. majority (73.9%) of the bites occurred outdoors while the victims were working on the farm or walking in the bush. The lower limbs were the body part most affected (71.4%) among the snake bite victims (Yakubu et al., 2019).

2.4 Snake venom

Snake venom consists of aggregation of protein and peptide toxins in a complex manner. The variation and type of venom depend on the type of snake and even within species (WHO, 2018a). Snake venom can be classified into haemotoxic, neurotoxic, necrotoxic, cardio toxic, and nephro-toxic. The most dangerous African snake species have two types of venom: the cobras and mambas possess the neurotoxic venom and the vipers –including the oscillated carpet viper (which is common in the savannah), carry the haemorrhagic and necrotic type of venom. Effects of envenomation will therefore include haemorrhage and prolonged disruption of haemostasis, neuromuscular paralysis, tissue necrosis, myolysis (muscle degeneration), cardio toxicity, acute kidney injury, thrombosis, and hypovolaemic shock.

Envenomation from the cobras and mambas usually cause respiratory paralysis, which can kill the victim by asphyxia between 1 and 6 hours after the bite. The vipers on the other hand induce oedema and necrosis in the limbs together with haemorrhage, which can be fatal in just a few days

2.4.1. Envenoming by snakes

Not all snakebites result in envenoming: some snakes are non-venomous and venomous snakes do not always inject venom during a bite. About 50–55% of all snakebites result in envenoming (WHO, 2018a) .

The snake venom injection during the biting process has significant morbidity and mortality implications, depending on the type of snake and the venom it carries, and the amount of venom injected. There is paucity of literature differentiating snake bite with and without envenoming, making it difficult for the estimation of the total number of snakebites in various regions (Kasturiratne, Wickremasinghe, de Silva, et al., 2008).

Snakebite varies geographically and seasonally, in addition to it being mainly a rural tropical phenomenon with diverse and poor health seeking behaviour which all contribute to the difficulties faced when studying its epidemiology. In spite of this, it is suggested in Asia for instance that envenomed bites constitute between 12% and 50% of the total number of bites (Darryl et al., 2016; Kasturiratne, Wickremasinghe, de Silva, et al., 2008)

Limited data are from North and Latin America indicates that 56% of snake bites in Brazil for instance is caused by nonvenomous snakes whereas the American Association of Poison Control Centers data suggest that the total number of snakebites is about three times that of venomous bites. In India and Pakistan, the most complete data suggest that envenomed bites constitute 18% and 30% of the total, respectively (Kasturiratne, Wickremasinghe, de Silva, et al., 2008)

The few African studies also show similar variation in the proportion of envenoming among snakebites. It was put at 19% in Kenya and between 45% and 87% respectively in two studies in West Africa (Kasturiratne, Wickremasinghe, De Silva, et al., 2008)

To give an indication of the total number of bites, Kasturiratne Wickremasinghe and their colleagues in a meta-analysis assumed that the total number of snakebites would be two to three times the number of envenoming. This led to their conclusion that 1,200,000 to 5,500,000 snakebites may occur globally per year (Kasturiratne, Wickremasinghe, de Silva, et al., 2008).

2.5 Treatment Seeking Behaviour of Snake Bite Victims

According to Iliyasu G, Tiamiyu AB, Daiyab FM, and their colleagues in a quantitative descriptive study to explore the causes and influence of delay, distance and time taken to access care on snakebite outcomes in Nigeria, their findings included that predicting the outcome of a snakebite depends largely on time to access care following the bite. They found that the shorter the time the better the prognosis. There is a 2% chance of a higher poor prognosis associated with every hour of delay in seeking care after a snakebite (Iliyasu et al., 2015). Delay in initiating antivenom is also associated with development of complications (Alirol et al., 2010).

Yahaya Musah, Evans P.K. Ameade and their colleagues between December 2008 and May 2009 conducted a cross-sectional study on the Epidemiology, ecology and human perceptions of snakebites in Savelugu/Nanton District of northern Ghana. They conducted interviews of selected residents and Traditional Medicine Practitioners (TMP) of the 7 most populous communities in the District as well as retrospective review of 10 prior years' records of snakebite cases at the District hospital.

Findings of the study included high patronage of the services of TMPs for snakebite treatment, home treatment or are untreated, which they attributed mainly to low educational level and income, limited access to orthodox medical facilities and high costs or lack of sufficient and effective antivenom administration (Musah et al., 2019).

The study relied mainly on the recollection or memory capacity of the respondents, which couldn't give the accurate annual incidence of snakebites in the District. Not all of them had personal encounters with snakebites and thus reasons given for the health seeking behavior of people after snakebite was largely subjective.

The study was limited to sampled areas in one District in Northern Region of Ghana and therefore cannot be extrapolated to represent the perspective in the entire region.

In Tamale Teaching Hospital in the Northern Region of Ghana, it was found that close to a third of snake bite victims between January 2016 and December 2017 presented to the hospital for care between 3 to 6 hours of the bite. It was also found that about 11% of the victims actually presented within 2 hours of the bite to the hospital for care. While this was commendable on the part of these victims, local herbal medicine application to the bite site was a common initial intervention of the victims before hospital attendance. This was found in the case of about 38% of the victims. The benefit of early presentation to the hospital reflected in the average number of days spent in the hospital by the victims in this study (4.7 days), fewer complications (13.4%), and no associated mortality. About 96 % of patients who presented to the hospital in this study received anti venom and this might have impacted on the good recovery rate (Yakubu1 et al., 2019).

Respondents in a rapid rural appraisal study in three communities in villages in Kyaukse and Madaya townships of Mandalay Division in Myanmar gave varied reasons for their choice of treatment after a snakebite encounter. Those respondents who were community non-health worker participants cited high cost of hospital treatment for management of snakebites, non-accessibility of health care facilities, and attitude of health care staff when they go there, non-availability of ASV at the health centres. Instead, they preferred treatment with traditional medicine practitioners and local Monks because of the strong traditional belief systems there.

Participants who were health care workers on the other hand did not believe in the effectiveness of the traditional medicine practitioners and the local Monks. They stated that people go to these places because of cost of treatment at the health centres.

They maintained that if there was enough medicine available at the centres, most people would report straight there and not to a traditional practitioner, despite strong community belief in traditional healing for snakebite (Schioldann et al., 2018).

The limitation of this study was that the research was limited to three communities only, and the perspectives about cost, transport, effectiveness of biomedical care could be area specific and thus cannot be generalized.

Several first aid or alternative treatments have been used to offer treatment to snakebite victims before transporting to hospitals or continuing the same treatment by the traditional medicine practitioners. Some of these methods are practiced at different parts of the world with different rationalizations. In a meta-analysis, a study in Bangladesh showed that 98% of snake bite victims used tourniquets around the bite site whilst in Nepal it was 90%. In Bangladesh, 28% of envenomed victims had incisions made at and around the bite site. In Northwest India, incision and drainage were practiced by 20% of patients (Alirol et al., 2010)

To study the impact of snake bites and determinants of fatal outcomes in Southeastern Nepal, Sanjib K. Sharma and his colleagues carried out a community-based survey in December 2001 in five Village Development Committees in that region of Nepal. Among their findings were that the presence of sign(s) of envenoming, an initial visit to a traditional healer and a lack of available transport were all statistically associated with an increased risk of death. The delay before transport was statistically significantly longer for victims with a fatal outcome than for survivors (Sharma et al., 2004).

In a study to evaluate the impact of clinical management of snake bite victims at the Tamale Teaching Hospital in the Northern Region of Ghana, it was found that at least a third of the victims resorted to traditional and mostly ineffective means of treatment initially. This resulted in a delay in reporting to the hospital with an average time from the snake bite to hospital arrival being 8 hours with a range of 20 minutes to 130 days (Yakubu et al., 2018). Out of 192 cases in this study, there were 3 deaths due to snake envenoming and a quarter of them (49 patients) were discharged home with complications (Yakubu et al., 2018).

One limitation of the study was that the adverse outcomes including the fatal cases were not directly linked to the delay in hospital attendance or the use of the traditional and other first aid measures. The average length of stay on admission in the hospital was found to be 4.7 days with a range of 1-19 days but again the study didn't do sub group analysis to relate the longer duration of stay to complications from the delay in hospital attendance.

2.5.1 Management of Snakebites (antivenom)

The principle of treatment of snake envenoming by anti-snake venom (ASV) is based on immunology. This immunotherapy is the most specific therapy for most snake species all over the world. The ASV is obtained from extraction of plasma of previously immunized animals mostly horses and processed for use in human snake envenomed victims. The type of ASV depend on whether the animal was immunized with venom from a single species or multiple species of snakes, thus we have monovalent and polyvalent ASV respectively. Manufacturers however prefer to produce more of polyvalent ASV despite the fact that data available indicates that the monovalent antivenom are more efficacious. This is because it is difficult for clinicians to clinically identify the species of snake that has bitten the victim coupled with the fact that there is currently no rapid diagnostic tool to aid in the diagnosis of the species of snake. It is therefore economically prudent to manufacture the polyvalent form of AS (Alirol et al., 2010; *Neglected Diseases*, 2006).

Successful treatment of snake envenoming is depended on the ability of the immunoglobulin to bind and effectively remove the snake venom from the body tissues. This is very well achieved in terms of restoration of haemostasis and cardiovascular function. In restoring respiratory paralysis and neurotoxicity, anti-snake venom is not very effective and this sometimes results in excessive administration of ASV. Another shortcoming of the use of ASV is the geographical variation of snake species and thus potent ASV in one region may be ineffective in another part of a country or the world (Alirol et al., 2010; Harrison et al., 2009; *Neglected Diseases*, 2006; Warrell, 2010; WHO, 2018a).

Adjunctive therapy is very critical in saving lives and reducing or preventing complications due to snake envenoming. Antivenom is only very effective in neutralizing snake venom that is extracellular and therefore accessible. Once the venom sequesters into the intracellular space, the ASV cannot act on it and the tissue damage can still go on. Successful treatment will therefore include giving adequate dose of antivenom plus cardiorespiratory and/or fluid resuscitation; airway intubation; mechanical ventilation; haemodialysis; wound debridement, reconstructive surgery antibiotics, anti-tetanus, physiotherapy and other rehabilitation services when needed (WHO, 2018b)

Availability and accessibility of effective antivenom is a major challenge affecting snakebite management. Many countries procure and supply antivenom free of charge to their citizens but the availability is usually not regular and the quality of ASV procured is questionable most of the time in these countries. There are many of the antivenom available that have not been subjected to preclinical trials for their effectiveness as ASV but find themselves in the market particularly in Sub Saharan Africa and Asia. This is partly due to weak product standardization and regulation in some of the countries in these regions (Alirol et al., n.d.; WHO, 2018a).

In an article published in the British Medical Journal in 2015 by David Williams and colleagues and titled Snake bite: a global failure to act costs thousands of lives each year states that the replacement of an effective antivenom in Ghana with a completely untested alternative resulted in an increase of snake bite case fatality from 1.8% to 12.1% within a year. Also in Chad, the use of unsafe, ineffective antivenom resulted in snake bite case fatality increasing from 2.3% with the use of one antivenom to 15.3% with a new antivenom (Williams, 2015)

This unfortunate situation plays to the disadvantage of good and very credible product manufacturing companies who cannot compete with these cheap products in the market, thus crowding them out of business in the developing countries where the demand is high. Many of them end up stopping the manufacturing of ASV and rendering them bankrupt (Alirol et al., 2010; WHO, 2018a).

2.5.2 Adverse Drug Reactions (ADRs) to ASV

Adverse reactions are common but many of them are mild such as pruritus and urticaria but others are serious such as anaphylactic reactions, late serum-sickness-type reactions, attributable to damage by immune complexes and pyrogenic reactions due to contamination with endotoxin during manufacture. A study in India indicates that up to 80% of patients treated with ASV experience one form of ADR or another but with no fatalities reported. Severe symptoms such as bronchospasm, angiooedema, and hypotension occur in only about 5-10% of reactions associated with antivenom ADRs (Alirol et al., 2010; Warrell, 2010).

Incorrect assessment of the risks verses the benefit of ASV to a patient will lead to unnecessary administration of the antivenom to patients who do not need it such as those with dry bites or snake species that are not neutralized by the particular ASV. These predispose the patients to adverse reactions. Conversely, a seriously envenomed patient may be denied treatment with an antivenom because of exaggerated fear of ADRs, leading to fatality or complications (Warrell, 2010). Adverse drug reaction to antivenom can efficiently be treated with antihistamines, corticosteroids and adrenalin.

The practice of prophylactic use of these antidotes have not been proven to be effective and thus the best means of preventing ADRs is dependent on the dose, route and speed of administration, and the quality of refinement of the product. The patient should also be observed for at least 2 hours after administration of the antivenom for early signs of ADR and antihistamines given as early as possible (Warrell, 2010).

2.6.Cost of snakebite treatment in KZN

The cost per vial of polyvalent antivenom from KZN central pharmacy data during the study period was approximately **$80.** This means the cost of the 840 vials supplied per annum in KZN was **$67,200**. The average number of antivenom used per patient from the study was 4.9 vials or approximately 5 vials. Therefore, the antivenom cost per patient receiving antivenom was **$400**.

The daily hospital admission cost for a snakebite patient was not readily available during the study period. They therefore used a surrogate daily hospital admission cost for trauma patient in KZN which was estimated to be **$243** per patient per day. The average number of days spent on admission for snakebite patients in KZN was 3-7.6 days before being discharged. Using these values, a crude estimate of a single snakebite admission ranged from **$703 to $1780** (Darryl et al., 2016).

The total cost of snakebite admissions in KZN, based on the low and high hospital stay and the estimated 1680 snakebite admissions, equals a low estimate of **$1,156,930** and a high estimate of **$2,827,848.** Added to this cost is the total cost of antivenom per year **($67,200)** bringing the total cost of snakebite treatment in KZN during the study period to a range of **$1,224,130 to $2,895,048** (Darryl et al., 2016).

The researchers used antivenom ratio in this study because there was a reliable supply of the antivenom from the provincial medical stores to all public hospitals. This cannot be said to be the case in many public hospitals in other developing countries such as Ghana. There is eratic supply of antivenom and many a times the patients have to buy the antivenom from the open market. This method cannot therefore be applicable universally to determine the incidence of snakebites and for that matter the burden of snakebites in many of these countries.

Another short coming of this method is the use of cost of trauma related admission to determine the hospital admission cost for snakebites with the explanation that snakebites are injuries as well. the admission cost is likely on the higher side.

2.61Burden of snake envenoming on health service delivery

Estimation of the total number of snakebites including bites by nonvenomous snakes or bites by a venomous snake that do not because envenoming may pose a burden on health systems. Snakebite commonly is a problem of the rural poor who are mostly subsistence farmers and herdsmen whose health seeking behavior is mostly the traditional medical system. Getting data from such cases to estimate the burden of snakebite envenoming is often a challenge because the record keeping of these systems are different. This is contributing largely to the under estimation of snakebites as a serious problem that deserves more attention than it is currently receiving. In spite of the readmission of snakebites into the fold of Neglected tropical diseases of serious concern by the WHO in 2017, it is yet to receive a comparative attention and resource allocation compared to other NTDs.

Global health resource allocation is often based on Disability-Adjusted Life Years (DALYs), and other socioeconomic markers rather than on the number of patients and deaths. Attempts by many renounced writers to give the true burden of snake bites globally has been fraught with many challenges including lack of accurate data on snake bites and envenoming in many regions. The most referenced work of Kasturiratne A, Wickremasinghe and their colleagues on estimation of the global burden of snakebites cannot be avoided when one attempts to write on the burden of snakebites in any part of the world. Their attempt to estimate the global burden of snakebites involved meta-analysis and modelling based on regional estimates of envenoming and deaths due to snakebites. Their focus was to estimate snakebite envenoming, since that causes most of the burden of snakebite such as antivenom requirement, hospitalization including intensive care unit service, surgery, management of complications of snakebite, and sometimes death.

They derived their estimated number of snake envenoming from the national or regional estimates from the respective National Health Service data where applicable and came to a conclusion that at least 421,000 envenoming and 20,000 deaths occur worldwide from snakebite annually, but may be as high as 1,841,000 envenoming and 94,000 deaths.

It is difficult to estimate the total number of snakebites both with and without envenoming due to the scarcity of literature that differentiates the two and variation in the distribution of venomous snakes in the regions. To address this, Kastruratne and his colleagues made an assumption that the total number of snakebites would be two to three times the number of envenoming. This means the 421,000 to 1,841,000 envenoming may be equivalent to 1,200,000 to 5,500,000 total snakebites occurring globally per annum. This extrapolation is simplistic but not uniformly applicable globally since data are lacking and variable in many countries. For instance, Brazil in Latin America according to their analysis had about 56% of snakebites in that country being due to non-venomous bites. In Kenya, it was reported that venomous bites constituted about 19% while in West Africa, 2 separate studies in 2 different countries indicated 45% and 86% of the snakebites were due to venomous snakes respectively. This suggests that there are many factors that influence the relationship between the total number of snake bites and envenoming (Kasturiratne, Wickremasinghe, de Silva, et al., 2008).

Their model found that the top three regions of the world with highest cases of envenomed snakebites were South Asia (121,000), South East Asia (111,000), and South East African region (43000). Estimation of total snakebites for these regions also means for example that South Asia had about 363,000 snakebites per annum, South East Asia 333,000 bites per annum and South East Africa 129000 bites per annum.

Drilling down to the respective regions, it was realized that one or two countries were the drivers in the number of envenoming and hence total number of snakebites for each region. For instance, India had the most envenoming at 81,000 per year. Sri Lanka (33,000), Viet Nam (30,000), Brazil (30,000), Mexico (28,000), and Nepal (20,000). This is one of the shortcomings of their model because there were instances where some countries didn't have any data and for that matter estimated envenoming from other countries in that region was used to estimate the average number of envenoming for all countries. For example, snakebite is known to be an important public health problem in eastern sub-Saharan Africa, but data were available for only one country in that region which was used to estimate the number of envenoming for all countries in Eastern Sub Saharan Africa. This definitely would not give a true representation for the number of envenoming in that region. This was also a challenge in countries with large geographical areas and population such as Russia and China where relatively small changes in the incidence rates could lead to considerable differences in the estimation of the total burden in terms of the number of envenoming and deaths.

In South Africa, Daryl Wood and his colleagues tried to estimate the burden of snakebites on public hospitals in the Kwazulu Natal (KZN) Province by the use of a crude invalidated formula. They used the antivenom ratio in 6 sampled public hospitals to determine the burden of snakebites in the province. In other words, they calculated the proportion of patients administered antivenom out of the total number of patients who reported with snakebites in those hospitals. The ratio was used to generalize for all the hospitals in the province and extrapolated for public health hospitals in the rest of the region.

The KZN central pharmacy supplied 1680 SAIMR polyvalent antivenom vials to 56 hospitals, representing 78% of all public hospitals during 2012 and 2013. This gave an annual average number of vials used in KZN during this period to be 840. The average number of vials used per patient receiving antivenom was 4.9. The average antivenom ratio calculated from the 6 sample sites was 0.12 or 12%. All the 56 hospitals that treated snakebites with antivenom had the formula applied to their data, and the results were extrapolated to each district and KZN as a whole.

An estimated annual total of 1680 snakebite admissions (both envenomed and non-envenomed) were made to the hospitals in 2012 and 2013.Thus the estimated number of patients who received antivenom was 202, being 12% of the estimated annual incidence of 1680 snakebite admissions (Darryl et al., 2016).

2.7 The Burden of Snakebite Envenoming (SBE) In West Africa

In estimating the burden of SBE in the 16 West African Countries, Habib A G and his colleagues used a meta-analysis based on indexed, non-indexed or grey literature and conference proceedings over the preceding 40 years. The pooled incidence rates, amputation rates and mortality rates were obtained and applied to the population size to derive the mortality and amputation estimates. The annual number of snakebite related deaths and mean age at time of envenoming was obtained from the analysis and from the literature for each country in West Africa. The corresponding Years of Life Lost (YLL) was derived for each of the countries, following the methodology outlined in the GBD 2015. The standard loss function in this latest global burden of disease review is based on projected frontier period life expectancy at birth for Japan and South Korea in the year 2050 estimated at 91.9 years and is not discounted (WHO, 2017). They thus, defined the YLL due to SBE in each country as 91.9 years minus the mean age at the time of envenoming. In spite of the challenges of incomplete data in some countries in West Africa, they made an assumption that SBE occurs in the 25–29 year age bracket in most of the countries in the sub region and applied the standard loss function that corresponds to the this age bracket for all countries which came to 64.6 years on the average (Habib et al., 2015). They then multiplied the number of SBE related deaths in each country by 64.6 years to calculate the YLL.

The meta-analysis showed that the most common disability associated with SBE in the West African Sub region was amputation of the affected limbs. To estimate the Years of Life Lived with Disability (YLD) in West Africa therefore, they multiplied the number of amputations by the respective disability weight of 0.13 and applying this disability weight for the remainder of undiscounted local life expectancy. In this age group, the remaining local life expectancies for the 16 countries ranged from 37 years in Sierra Leone to 45 years in Ghana and Senegal (Habib et al., 2015). The sum of YLL and YLD then defined the total DALY burden for each country.

They came to a conclusion that SBE is associated with 319,874 DALYs annually in the 16 West African countries. The bulk of the burden of SBE in the West African study was due to early mortality as YLL constituted 290,275 DALYs as against 29,599 DALYs due to YLD. Nigeria had the highest estimated local public health burden associated with SBE since it had 43% of the total burden or 137,105 DALYs followed by Ghana 22,243 DALYs, Burkina Faso 21,283 DALYs, Niger 18,833 DALYs and Cameroun 18,690 DALYs. The lowest public health burden was estimated for Guinea Bissau at 1,699 DALYs or 0.5% of the total burden (Habib et al., 2015).

These findings revealed that In WA, SBE is an important killer and most of the DALYs (over 90%) obtained from early deaths. the analysis has however been conservative since only amputation was used as the main disability. The limitations of this study is the non-availability of data on SBE in many countries in the sub region to be part of the calculation or estimation of the DALYs. This led to a lot of extrapolations and assumptions. For instance, the average age of envenomation for some countries could not be obtained and figures from other countries had to be used to extrapolate and this can affect the accuracy of the calculations since each country has different geographic and demographic characteristics.

2.7.1 Burden of snakebite in Northern Ghana

In a study to estimate the burden of snakebites on the people of the Savanna ecological zone in Ghana, Yahaya Musah and his colleagues conducted a cross sectional survey in a respondent interview in Savelugu and Nanton Districts in the Northern of Ghana over a six-month period between December 2008 and January 2009. They interviewed up to 1000 inhabitants including Traditional Medicine Practitioners (TMP), and records review of snakebite patients in the District hospital who attended hospital over the preceding 10 years from 1999 to 2008.

Their findings included that up to 93% of respondents have encountered snakes before in their lifetime, and about 8% of them claimed to actually have been bitten by snakes before. They also established that a vast majority of people with snakebites do report to the TMPs rather than the hospital. Based on these findings they conservatively estimated a snakebite prevalence of 6%, with a mortality rate of 3% in the study area. Translating this to estimate the annual snake bites gave a total of 7,500 snakebite incidences and 200 deaths for the District with a population of about 130,000 in 2008 (Musah et al., 2019). These findings were based on the memory recollection of the respondents and therefore cannot represent figures for 2008 alone. Even with a conservative assumption that their recollection ability was up to the preceding 10 years will mean an annual estimate of 750 snakebites with 20 deaths per year in the District.

The records review of snake bite incidence in the District hospital for a 10 year period on the other hand gave an average of 46.6 reported snake bite cases per annum (Musah et al., 2019). Conservatively, the annual incidence of snakebites in the district per the hospital records was therefore about 50 cases per year. Granted that hospital reporting rate for snakebites in the district is 50%, it will mean that the incidence of snakebites in the district is about 100 cases per year compared to 750 by the correspondent interview of people in the same District over the same period of time. This makes the hospital data to be near the reality than the community survey data.

CHAPTER THREE

METHODOLOGY

3.1 Study Area

The study was conducted in 5 selected hospitals located in the Northern, North East, and Savanna Regions of Ghana. These regions form part of the Northern Ghana with a total land size 70,384 sq.km (27,000sq.mls) and represents 29% of the total landmass of Ghana.

Collectively, there are about 29 administrative districts with 17 hospitals and 7 polyclinics located across the 3 regions. Five of the hospitals belong to Christian Health Association of Ghana (CHAG). However, eight of the districts in the regions are without hospitals, which means there is no medical doctor in those districts and patients who need hospital care will have to be referred to other districts with hospitals to receive the medical service.

The region lies in the savanna ecological zone of Ghana and West Africa and has 2 major seasons; the rainy season and the dry season. The rainy season starts from May to October each year but the peak wettest months are August to October. The Harmattan follows the rainy season and starts from November to March each year where the dry North-East monsoon winds blow with dust from the Sahara Desert.

The vegetation cover is that of savanna grassland with moderate forest in some areas. Shea trees grow naturally in the region and bears fruits (Shea nuts) between May –June where women go to pick them manually early in the morning which exposes them to the hazards of snake bites).

Until 2019, the three regions collectively formed the Northern region with an estimated population of 2,993,889 persons (1,471,475 males and 1,522,414 females) according to the Ghana Statistical Service projection from the 2010 population and housing Census. The main occupation of the people in the area is agriculture, employing over 50% of the population in peasant farming. Cattle rearing also employ some other people who take the animals on free-range bases to graze in the fields throughout the year.

The round 7 of the Ghana Living Standard survey conducted by the Ghana Statistical service in 2016/2017 revealed that these 3 regions are among the poorest regions in Ghana. According to the survey then Northern and Upper East regions saw an increase in poverty rate among the population between 2012 and 2016 with 61% of the population in the 3 Northern regions being poor. It also revealed that 26% of Ghana's poor people live in the 3 Northern Regions (Wambile et al., 2017).

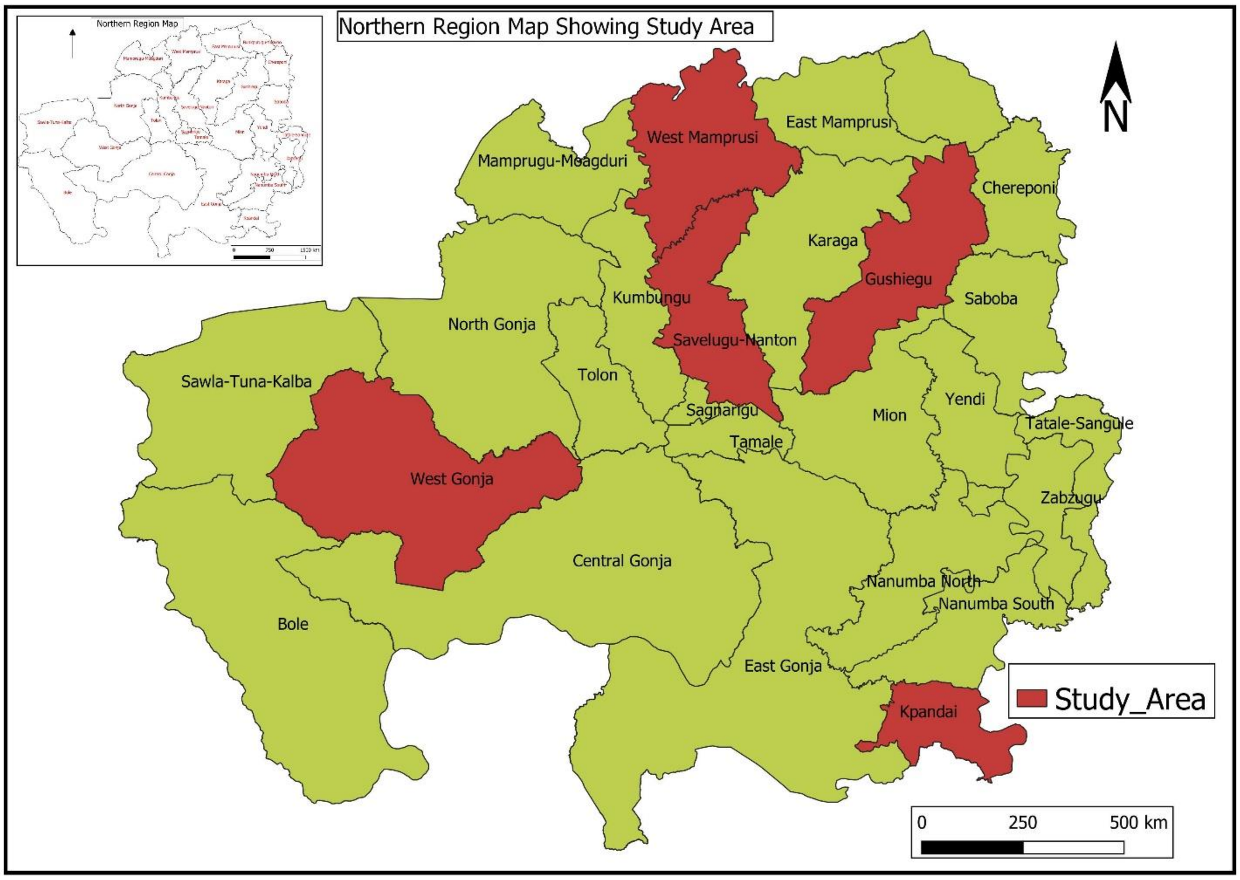


Figure 3.1: map of Northern Region Showing the study areas

3.2. Study type and design

This study is a retrospective study that involved records review of secondary hospital data on reported snakebites in 5 selected hospitals in the North East, Savanna and Northern regions of Ghana. Aggregated data on incidence of reported snakebites per the selected hospital and their respective districts within the period of January 2017 to December 2019 was extracted from the District Health Information Management System (DHIMS). The quantity of anti-snake venom supplied from the Northern Regional Medical Stores (RMS) which serves the three regions over the three years was obtained.

The study design chosen was appropriate for this study because time and resources constraints will not permit a prospective study design. The availability of established aggregated data in the DHIMS makes it possible to predetermine the number of snakebites reported by each hospital. the specific patient information regarding snakebite management could therefore be retrieved from their folders in the respective hospitals.

Study population

The study population is the population of all the Districts where the selected hospitals for the study are located.

Sample population

The sample population for our study consist of all patients who attended the selected hospitals during the period of the study

Sampling unit

The sampling unit consist of all patients who attended the selected hospitals over the three years period due to snakebites

3.3. Inclusion and exclusion criteria

3.3.1. Inclusion criteria

All folders of patients who attended any of the 5 selected hospitals Northern Ghana between January 2017 and December 2019 due to a snake bite irrespective of the age, sex, or envenomation status of the patient.

All snakebite Patients data reported and captured in the DHIMS platform in respect of the 3 years under study

3.3.2. Exclusion criteria

- Folders of unconfirmed snake bite patients who attended the selected health facilities.

  Folders of snakebite patients who attended the 5 selected hospitals before 1st January 2017 and after 31st December 2019.

3.4. Sampling technique

Based on logistics and time constraints, 5 health facilities were selected for the study; 3 facilities from the Northern region and 1 each from Northeast and Savanna regions. The selection was based on proportionate population size, geographic location of the facility and the number of reported snakebites as reported by the DHIMS. Thus the hospital with the highest number of reported snakebites in the DHIMS for each zone was selected to represent the zone. Once a facility was selected, snakebite patients' folders were retrieved to extract information using a tool designed for this study (refer to the tool). The region of the health facilities, the number of facility and their district is shown by table 3.1.

Table 3.1 study sites

Region	No. of Facilities	Facility name(s)
North-East	1	Walewale District hospital
Northern	3	Saveligu District Hospital
		Gusheigu District Hospital
		ECG hospital Kpandai
Savannah	1	West Gonja District Hospital, Damongo

3.5 Data collection tool

A structured questionnaire was designed to collect data on the patients and their management in the selected hospitals under the study. The questions were based on the objectives of the study. the first part had to do with information on the selected hospital. The second part had to do with data on the demography of the snakebite patients who were managed in the hospitals. **The third part** sort to obtain information on events following the bite upto the decision taken in the hospital after consultation. Part 4 requests information on management in the hospital upto outcome of the hospital admission

3.6. Variables

Outcome variables (dependent variables) such as incidence rate, envenoming rate, anti-snake venom administration, blood transfusion, complications (cellulitis, sepsis, amputation, adverse drug reaction etc.), discharge home and death were measured.

Exposure variables (independent variables) such as age, gender, religion, address, distance to hospital, occupation, part of body bitten, time interval between snakebite and hospital attendance were measured.

3.7. Quality control

For Quality Assurance (QA) purposes, the data collection tool was pre-tested using folders of snakebite patients managed at the Tamale Teaching Hospital. This was done during the training of the data collection team and all the necessary bottlenecks were straightened. Another QA measure was the use of names and other demographic information of all snakebite patients as recorded in the hospital registers over the study period, to retrieve their folders for data extraction. This avoided selection of patient folders, which did not meet the inclusion criteria.

3.8. Data Collection Process

3.8.1. Review of data from the DHIMs

The annual incidence of reported snakebites in the selected hospitals in the Northeast, Savannah and the Northern Regions over the study period was retrieved from the DHIMS. The DHIMS is a ministry of health/Ghana Health Service data base portal where service data is stored. It is available online to all those with log in credentials to input, edit and extract data depending on the level of operation of the individual. This information became the bases for which patient folders were sought in the hospitals.

3.8.2. Review of folders from the hospital

Consulting room registers, outpatient Department (OPD) registers as well as ward admission and discharges registers for 2017 to 2019 were used to retrieve folders of patients who reported for care at the hospitals on account of snakebites. The tool used for the data collection was a questionnaire designed to capture all the relevant information needed to meet the objectives of the study. The questionnaire was converted into an electronic format KoBoCollect v1.27.3, which enabled real time data collection and transmission. Health information officers in the 5 sampled hospitals were trained on the app in a one-day orientation and deployed to their hospitals to collect the data. The training enabled them to collect and transmit the completed questionnaires in real time to the host server via the internet.

The quantity of anti-snake venom in vials supplied to each of the selected hospitals per each of the years under study was obtained from the Northern Regional medical stores. This enabled the comparison of the caseload of snakebites in the study facilities to the volume or amount of ASV received over the study period.

3.9. Ethical considerations

No ethical clearance was obtained, however, written Permission was obtained from the management of the selected health facilities through the Regional Director of Health Services for Northern Region who is the official custodian of the data in the hospitals

3.10. Data analysis and presentation methods

The data gathered was exported to Microsoft office professional plus 2016 (Excel) which was cleaned, validated**,** and further exported to the Statistical Package for Social Sciences software version 26 (SPSS, V26.0) for analysis. The data was analyzed and presented in forms of graphs, tables and charts for easy understanding and interpretation. Furthermore, chi-squared test of association was employed to determine the influence of factors on snake bite envenomation and its associated outcomes. More to that, the Phi and Cramers V statistics was adopted to determine the strength of the association between the independent variables and the dependent variable.

3.11. Limitations of the study

The major limitation encountered during the study was poor records keeping by the hospitals selected for the study. There were many patients registered as snakebite patients in the hospital attendance registers but their folders could not be trace anywhere in the hospital. This affected the ability of the research team to meet the target sample size envisaged for the respective facilities.

The second major limitation is the fact that the data obtained was only a hospital based study where only patients with snakebites who reported there for care is captured. Information on other patients who did not attend hospital for their snakebite management is not part of this data. It therefore affected calculation of incidence of snakebites in the districts concerned.

3.12. Plan for dissemination of results

The results of this research will first be submitted to the University for Development Studies (UDS) as partial fulfilment of obtaining a Master's in Public Health (MPH) degree. The findings will later be presented at a review meeting of the Northern Regional Health directorate to enable them appreciate the burden of snakebites in the region, and particularly to expose the challenges of data inconsistences and poor record keeping in the various hospitals in the region. Subsequently the findings will be published in a reputable peer reviewed journal in collaboration with the UDS.

CHAPTER FOUR (4)

RESULTS

4.1. Annual occurrence of reported snakebites

From the year 2017 to 2019, a total of 1,577 snakebite episodes reported to the five health facilities included in the study. Of this, majority of snakebites, 524 (33.2%) were reported by the ECG hospital in Kpandai and the least of 1.7% (112) was reported by the Gushegu hospital. Majority (580) of the bites occurred in the year 2018 compared to 493 bites in 2019 giving an average incidence of 526 snakebite cases per annum over the 3-year period. Refer to table 4.1 for the number of snakebite episodes reported in the 5 hospitals over the 3-year period.

Table 4.1: Annual reported cases of snakebites by the study hospitals in the DHIMS

Hospital	2017	2018	2019	Total	%Total
Damongo	94	101	82	277	17.6
ECG Kpandai	177	202	145	524	33.2
Gushegu	45	56	11	112	7.1
Savelugu	132	152	146	430	27.3
Walewale	56	69	109	234	14.8
Total	**504**	**580**	**493**	**1577**	**100**

Source: *Field Survey, 2020*

Snake bite incidence calculated from the catchment population of the health facilities included in the study showed the annual mean incidence of bites to be 83.3 per 100,000 of the population. Year by year, the incidence varied from the least of 76.0 per 100,000.00 in 2019, to 92.0 per 100,000.00 in 2018 (table 4.2).

With respect to the hospitals, ECG, Kpandai hospital, reported the highest incidence of bites and the least was reported by Gushegu hospital over the period. All facilities reported increase in snakebite incidence from 2017 to 2018. However, there was decrease in incidence from 2018 to 2019 for all facilities except that of Walewale hospital where incidence increased.

Table 4.2: Annual incidence of reported snakebite in DHIMS per facility/District

Year	**Hospital**	**Number of snakebites** (X)	**Population at risk** (Y)	**Annual incidence of snakebites** (X/Y*100,000)
2017	Damongo	94	49,348	190.0
	ECG Kpandai	177	128,621	140.0
	Gushegu	45	131,528	30.0
	Savelugu	132	163,693	80.0
	West Mamprusi	56	143,233	40.0
	Total	**504**	**616,423**	**81.8**
2018	Damongo	101	50,504	200.0
	ECG Kpandai	202	131,602	150.0
	Gushegu	56	134,599	40.0
	Savelugu	152	167,491	90.0
	West Mamprusi	69	146,561	50.0
	Total	**580**	**630,757**	**92.0**
2019	Damongo	82	51,716	16.0
	ECG Kpandai	145	134,715	11.0
	Gushegu	11	137,772	8.0
	Savelugu	146	171,457	90.0
	West Mamprusi	109	150,011	70.0
	Total	**493**	**645,671**	**76.0**

Source: *Field Survey, 2020*

Table 4.2 gives the details of the incidence of reported snakebites in each hospital per the population of the District in which the hospital is located. The combined incidence for the selected hospitals for 2017 was 81.8 per 100000 population. That of 2019 and 2019 were 92/100000 and 76/100000 population respectively.

Table 4.3: Folder Retrieval and enrollment into the study

Hospital	Number of snakebites reported in DHIMS	Number of folders retrieved in the hospitals	%Folders retrieved
Damongo	277	275	99.3
ECG Kpandai	524	179	34.2
Gushegu	112	162	144.6
Savelugu	430	105	24.4
Walewale	234	284	121.4
Totals	**1577**	**1,005**	**63.7%**

Source: *Field Survey, 2020*

Table 4.3 gives the summary of outpatient morbidity data on snakebites reported in the study hospitals for the three years. In all, 63.8% of the expected folders were retrieved for the study. Almost all the folders expected in Damongo hospital for the study were retrieved (99.3%) for analysis. In the Gushegu and Walewale hospitals, there were more snakebites occurrences over the years than was reported by the routine health service data (DHIMS) whereas in the case of the ECG hospital in Kpandai and Savelugu hospitals only 34.2% and 24.4% of the folders could be retrieved respectively.

4.2. Sociodemographic information of patients in the study

Table 4.4: Age and gender grouping of patients in the study

	Variables	Frequency	Percentage	Cum. Percent
Age Group of victims	1-10	161	16.0	16
	11-20	307	30.5	46.5
	21-30	230	22.9	69.4
	31-40	152	15.1	84.5
	41-50	88	8.7	93.2
	51-60	35	3.5	96.7
	60+	33	3.4	100.0
	Total	**1006**	**100.0**	
Gender	Male	665	66.1	66.1
	Female	341	33.9	100.0
	Total	**1006**	**100**	

Source: *Field Survey, 2020*

It can be seen from table 4.3 that the peak age for the snake bite victims under this study ranged from 11 to 30 years as this age range constituted over 50% of the victims across the three years. It is however clear that the modal age range at risk of snakebite is 11-20. The median age range for risk of snakebites is 31 to 40 years. The age group with the least risk of snakebite is the 60 and above year olds.

The data here shows that males constitute 66.1% of the study participants.

Table **4.5: Occupation of the patients**

Occupation	Damongo Hospital	ECG, Kpandai	Gushegu Hospital	Savelugu Municipal Hospital	Walewale Hospital	Grand Total	%
Farmer/Farming	120	122	49	65	121	473	47.3%
Herdsmen	40	1	1	0	8	50	5.0%
Petty trader	5	5	0	1	4	15	1.6%
Pupil/Student	93	39	73	36	90	331	33.2%
Unemployed	19	15	39	3	52	128	12.9%
Sub Total	275	179	162	105	275	996	100%

Source: *Field Survey, 2020*

Table 4.5 shows the occupation of the snakebite victims studied in the 5 hospitals. It is clear that the leading occupation of the snakebite victims is farming (47.3%), followed by pupils/students who formed 33.2%.. The unemployed group is the 3rd highest vulnerable group of people at risk of snake bites (12.9%). The least group of people at risk of snakebites are the petty traders who constituted only 1.6% of the total snakebite cases over the 3 years.

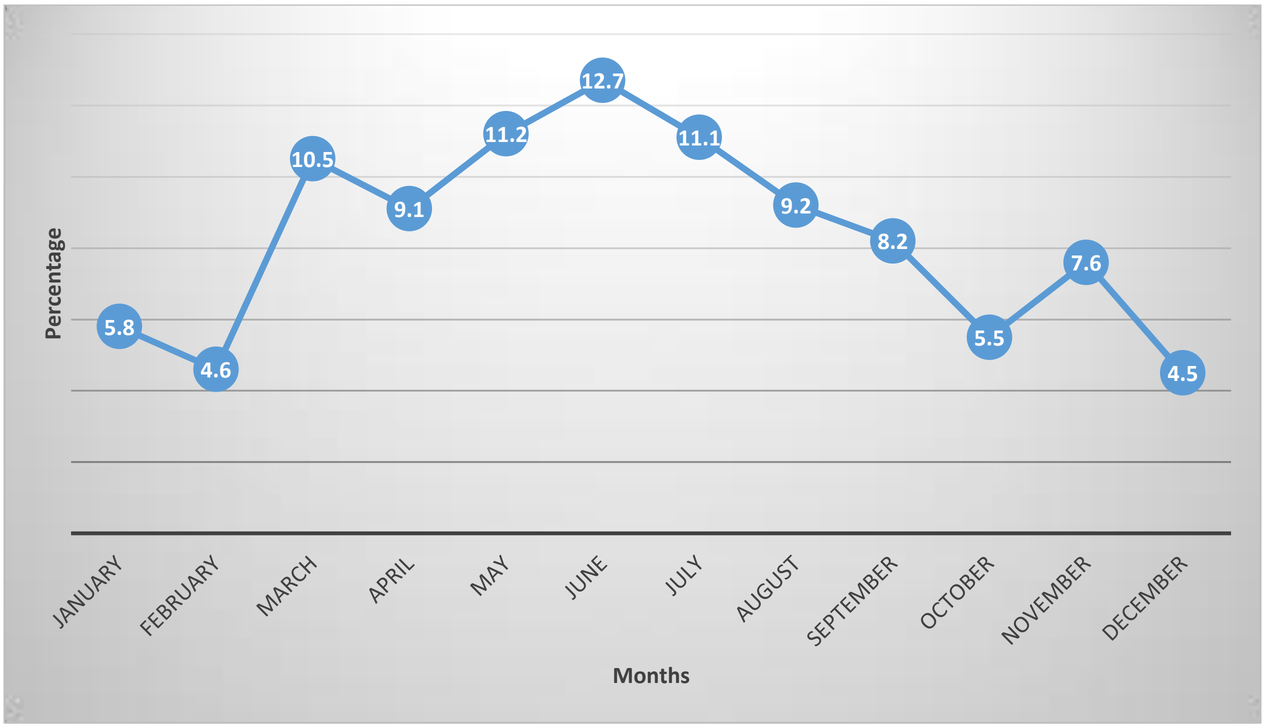
Table 4.6: Religion of the patient

Name of the Hospital/Religion	Christian	Muslim	Total
Damongo Hospital	76	199	175
ECG, Kpandai	123	56	179
Gushegu Hospital	85	77	162
Savelugu Municipal Hospital	5	100	105
Walewale Hospital	39	245	284
Grand Total	328	677	1005
Percentage (%)	32.6%	67.4%	100%

Source: *Field Survey, 2020*

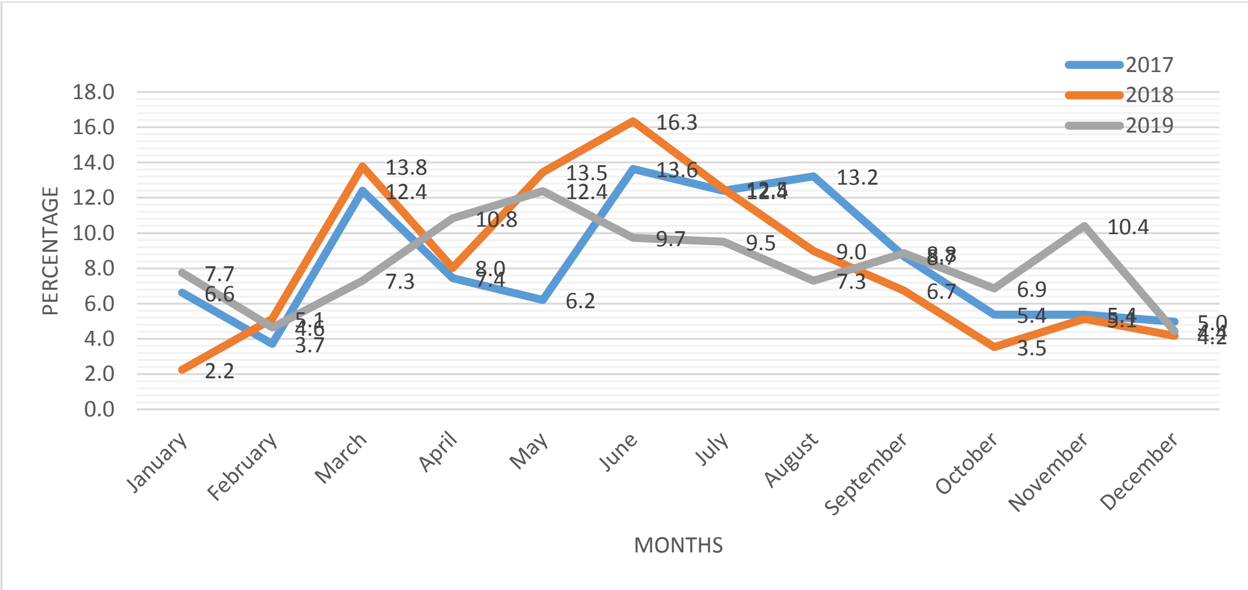
On religious affiliation of the snakebite victims under the study, Islam was the predominant religion among them as Muslims constituted 67.4% of the snakebite victims. Christians formed 32.6% of snakebite victims in the study. Specifically, Christianity was the dominant religion among snakebite victims in Gushegu and Kpandai Hospitals while in Damongo, Savelugu, and Walewale had more Muslims among their snakebite patients

4.3. Trends of snake bite cases from 2017 to 2019



Source: Field Survey, 2020

Figure 4.1: Trend of total reported snakebites in percentage points per month



Source: *Field Survey, 2020*

Figure 4.2: Annual trend of reported snakebites per month

Figure 4.1 shows the aggregate monthly trend of reported snakebite cases for the three years under study. From the figures, snakebites increase from March to September each year with the peak month being June, Figure 4.2 on the other hand shows monthly trend per each year for the 3 years

4.3. Categories of cases of snakebite victims

Table 4.7: Part of body bitten by snake

Part of the body bitten by the snake	Damongo Hospital	ECG, Kpandai	Gushegu Hospital	Savelugu Municipal Hospital	Walewale Hospital	Grand Total	Percentage (%)
Hands	68	36	31	25	73	233	23.3%
Chest	1	0	0	0	0	1	0.1%
Head	0	0	0	0	1	1	0.1%
Stomach	0	0	0	0	1	1	0.1%
Legs	197	127	119	52	184	679	67.8%
Unknown	9	16	8	28	25	86	8.6%
Sub Total	275	179	158	105	284	1001	100%

Source: *Field Survey, 2020*

Table 4.7 shows the part of the body bitten by the snakes as recorded in the patient folders. It is noted that the legs or lower limbs are the body part commonly bitten by snakes with a response rate of about 67.8% on the average. The next body part most bitten by the venomous creatures is the hand. However, about n=86, 8.6% of the folders reviewed had no information on the body part bitten by the snake.

Table 4.8: Activity carried out before snakebite

Activity being carried out	Damongo Hospital	ECG, Kpandai	Gushegu Hospital	Savelugu Municipal Hospital	Walewale Hospital	Grand Total	Percentage (%)
At Home	8	1	5	6	5	25	2.5%
Defecating	3	2	4	0	3	12	1.2%
Farming/Farm activities	136	117	61	47	127	488	49%
Herding cattle	2	0	0	0	3	5	0.5%
Hunting in the bush	6	1	0	0	1	8	0.8%
Playing	2	0	0	5	2	9	1.0%
Sleeping/On bed	5	1	1	0	7	14	1.4%
Unknown	96	53	88	31	131	399	40.1%
Walking/On a pathway	6	4	2	16	4	32	3.2%
Swimming/Crossing river	1	0	1	0	1	3	0.3%
Sub Total	**265**	**179**	**162**	**105**	**284**	**995**	**100%**

Source: *Field Survey, 2020*

Table 4.8 shows the activity the snakebite victims were engaged in at the time of the bite. The data in the table indicates that 49% of the victims were engaged in farming activity when they encountered the snakes. In other words, farming activities are shown to be the mostly predisposes people to snake bites in the study facilities and for that matter, the Northern region. In about 40% of the patient records reviewed, there was no information regarding type of activity during the snakebite. Other victims had the snakebites while they were walking on the footpath as was shown in up to 3.2% of the cases. A small number of people (1.2%) were engaged in open defecation while they had the snake bites.

Table 4.9: Intervention given before visiting a health facility

Intervention	Damongo Hospital	ECG, Kpandai	Gushegu Hospital	Savelugu Municipal Hospital	Walewale Hospital	Grand Total	Percentage (%)
Local/Herbal treatment	17	6	7	3	13	46	4.6%
No intervention	258	173	155	100	271	957	95.2%
Self-medication	0	0	0	2	0	2	0.2%
Sub Total	**275**	**179**	**162**	**105**	**284**	**1005**	**100%**

Source: *Field Survey, 2020*

About 95% of the snakebite patients did not receive any form of treatment before going to seek care in the hospital. Up to 4.6% of the victims sought herbal or alternative medical treatment before going to the hospital to seek care as shown in table 4.9.

Table 4.10: Distance from the residence of the victim to the hospital in kilometers

Hospital	**1-10**	**11-20**	**20-30**	**>30**	**Unknown**	**Total**
Damongo hospital	66	25	9	79	96	275
ECG hospital Kpandai	27	28	46	73	5	179
Gushegu hospital	124	24	8	5	2	163
Savelugu hospital	21	2	1	1	80	105
Walewale hospital	71	46	54	95	18	284
Total	309	125	118	252	202	1006
Total Percent	30.7	12.4	11.7	25	20	100

Source: *Field Survey, 2020*

Regarding the distance patients travelled to reach the hospital, varied information was extracted from the data. Table 4.10 shows that 25% of the patients travelled for more than 30 km before reaching the hospital over the 3 years under study. Sub analysis show that a lot more of patients seeking care at Damongo, ECG Kpandai, and Walewale hospitals respectively travelled for more than 30 km before receiving care at the hospital over the 3 years under study. Gushegu hospital seem to have a lot of their patients coming from nearby places (within 10 km radius) to receive care after snakebites over the 3 years of the study period.

Table 4.11: Means of transport to the hospital

Means of transport	Damongo Hospital	ECG, Kpandai	Gushegu Hospital	Savelugu Hospital	Walewale Hospital	Grand Total	Percent (%)
Ambulance	1	0	2	0	2	5	0.5
Motorbike	1	165	119	5	32	322	32.0
Tricycle	1	1	0	2	0	4	0.4
Unknown	271	13	38	98	240	660	65.7
Vehicle	1	0	2	0	11	14	1.4
Sub Total	**275**	**179**	**161**	**105**	**285**	**1005**	**100**

Source: *Field Survey, 2020*

Table 4.11 shows the means of transport the snakebite victims used to get to the various hospitals to seek care. Majority of the patient records reviewed (65.7%) did not state the means of transport that brought the patients to the hospital. Among the 345 folders that had information on the means of transport to the hospital, motor bike was the dominant vehicle that brought patients to the hospitals after snake bites as 93.3% of the victims with known means of transport went to the hospital on motorbikes. Clients going to ECG hospital in Kpandai used mostly motorbikes to get to the hospital in the 3 years under the study (about 99,4%). Gushegu hospital was the next place snakebite victims travelled to on motor bike as 96.7% got to the hospital through motor bikes.

Tricycles being the most predominant rural ambulance in the Northern sector were not utilized in transporting snakebite patients to the hospitals as only 1.1 % of the patients with known means of transport used them in going to the hospitals to seek snakebite care. The national ambulance service equally ferried only 1,4% of the patients.

4.4 Snakebite patient assessment

Table 4.12: Signs of envenomation

Health Facility	No	Yes	Total
Damongo Hospital	31	244	275
ECG, Kpandai	8	171	179
Gushegu Hospital	21	142	163
Savelugu Hospital	10	95	105
Walewale Hospital	34	250	284
Total (%)	104 (10.3)	902 (89.7)	1006 (100)

Source: *Field Survey, 2020*

There are signs to indicate whether snakebite is by a venomous type of snake or whether there was snake venom injection in the process of the snakebite. These signs are bleeding, swelling, cellulitis, and paralysis among others. These signs were assessed in the patient records reviewed.

From table 4.12, some or all these signs of envenomation were present in 89.7% of the patients in the study hospitals.

4.5 Further care at the hospital

Table 4.13: Outcome of Out Patient Department consultation

Facility	Admitted	Detained	Not admit	Total
Damongo Hospital	241	31	3	275
ECG, Kpandai	175	4	0	179
Gushegu Hospital	162	0	1	163
Savelugu Hospital	97	8	0	105
Walewale Hospital	217	67	0	284
Total (%)	**892 (88.7)**	**110 (10.9)**	**4 (0.4)**	**1006 (100)**

Source: *Field Survey, 2020*

Table 4.13 shows the outcome of consultation with a prescriber in the hospitals attended over the 3 years. In all, 88.7% of the patients were admitted for inpatient care in the hospitals whiles about 11% were detained. Four patients were seen at OPD but were not admitted.

Table 4.14: Aggregate Length of stay in the hospital

No of Days	No of Snake bites (N)	% of N
1 – 3	611	68.5
4 – 6	202	22.6
7 – 10	59	6.6
> 10	20	2.3
Total	**892**	**100**

Source: *Field Survey, 2020*

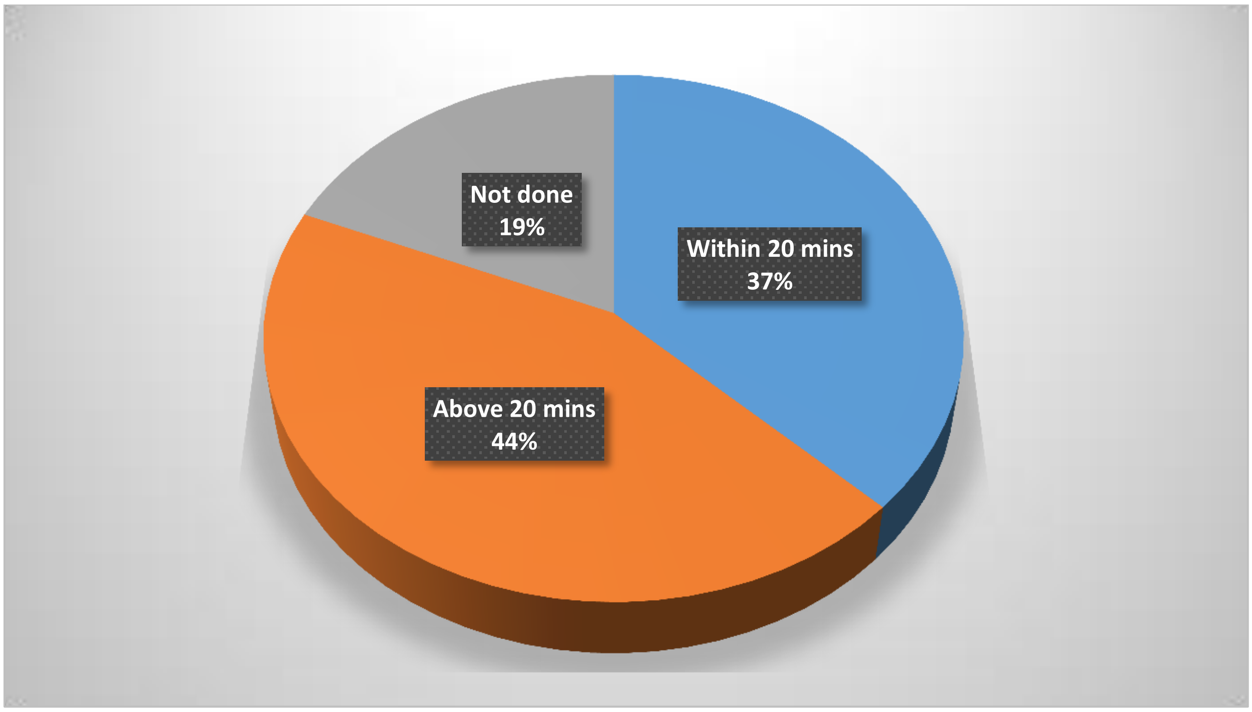
The number of days spent on admission in the hospital is a factor in calculating the financial burden of the disease. This will be in addition to the amount incurred in procuring medicine and other services. With respect to snakebite, the cost of antivenom will be independent of the cost of admission. Table 4.14 shows the aggregate length of stay in the hospital by the snakebite victims after hospital admission. The mean number of days spent in the hospital was 3.4 days with a range of 1->10 days before discharge for the 3 years of the study. In total 892 bites resulted in hospital admission of which 611 (68.5%) and 202 (22.6%) were admitted for 1-3 days and 4.6 days respectively as shown by table 4.15.

Table 4.15: Type of laboratory investigations requested by clinicians

Test Requested	Yes	Percent	No	Percent
Kidney Function Test	12	1.2	994	98.8
Urine R/E	12	.1.2	994	98.8
Clotting Profile	819	81.4	187	18.6
Bedside Clotting time	819	81.4	187	18.6
Blood Grouping	59	5.9	947	94.1
Full Blood Count	326	32.4	680	67.6

Source: *Field Survey, 2020.*

From table 4.15, the predominant laboratory test done was to assess the coagulation status of the patients as 81% of the folders contain information on clotting profile request. The second commonly requested test was full blood count to perhaps assess the haemoglobin status and whether any secondary bacterial infection had occurred by looking at the total and differential white cell count. Blood grouping and cross matching was done in 59 or 5.9% of patients may be as part of preparation to transfuse blood to those who might have needed blood transfusion. Kidney function test was the least investigation done (1.2%) probably due to lack of capacity at these district hospitals under the study.



Source: *Field Survey, 2020*

Figure 4.3: Bedside clotting done for the patients

Figure 4.4 shows the bedside clotting time for cases managed over the 3 years period. It can be seen that 442 or 44% of the cases had delayed clotting time above 20 minutes compared to 37% or 371 of the cases who had their blood clotting within the acceptable range of 20 minutes. The remaining 19% of the cases had no record for blood clotting time in their folders.

Table 4.16 shows the response as to whether the patients received ASV as part of their treatment

Hospital	Total Cases	ASV given	% ASV Given
Damongo Hospital	275	248	90.2
ECG, Kpandai	179	151	84.4
Gushegu Hospital	163	156	95.7
Savelugu Hospital	105	105	100
Walewale Hospital	284	259	91.2
Total	1006	919	91.4

Source: *Field Survey, 2020*

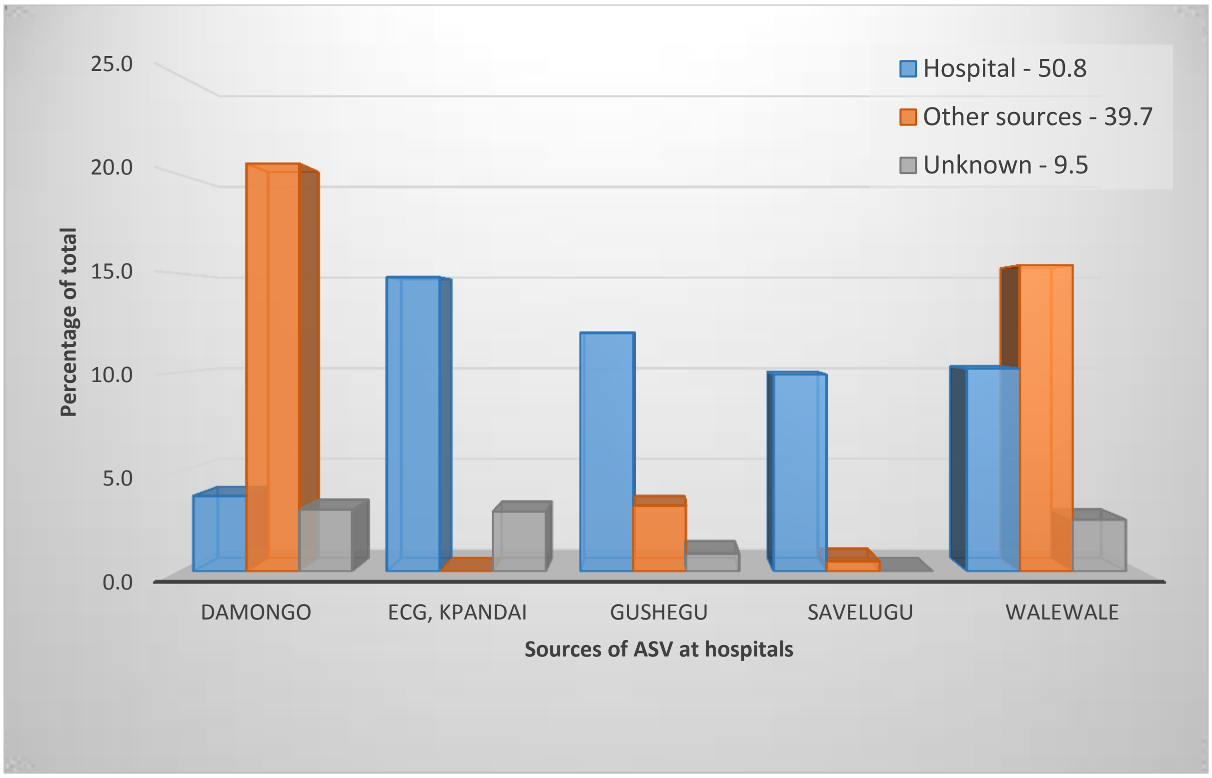
Overall, 91.4% of the patients received ASV as part of their treatment. ASV administration ranges from 84.4% of the total number of patients in ECG Kpandai hospital to 100% of the patients in Savelugu hospital.

Table 4.17: **Specific ASV brand administered**.

ASV Brand	Damongo Hospital	ECG, Kpandai	Gushegu Hospital	Savelugu Municipal Hospital	Walewale Hospital	Grand Total	Percentage (%)
Echis	0	25	0	2	1	28	3%
Monovalent nt	0	0	2	0	2	4	
Polivalent	0	0	0	0	13	13	1.4%
Unknown	275	143	160	10	269	857	93.9%
Vins	0	11	0	0	0	11	1.2%
Sub Total	**275**	**179**	**162**	**12**	**42**	**913**	**100%**

Source: *Field Survey, 2020*

Table 4.17 shows the information of specific ASV brands administered to patients in the study facilities in the respective years. Over 90% of the folders reviewed had no information on the specific type of ASV given to the patients since the prescribers did not document any information on the brand of ASV given. The few ASV brands that were identified in the patient records were Echis identified in 25 folders all in Kpandai ECG hospital in 2018 and 2019. The other brand was Vins identified in 11 patients' folders also only in Kpandai ECG hospital.



Source: *Field Survey, 2020*

Figure 4.4: Sources of ASV administered to the patients in percentage of total

Figure 4.4 shows the source of ASV administered to the patients during their admission in the various hospitals over the 3 years in an aggregated format. About 51% of the patients obtained the ASV from the hospital and almost 40% obtained from sources other than the hospital. It is noted that majority of the patients who procured the ASV outside the hospital were seen in Damongo and Walewale hospitals. These patients probably bought them from the open market

Table 4.18: Number of vials of ASV supplied from the northern regional medical stores

FACILITY NAME	2017		2018		2019		Totals	
	Snakebites	ASV vials supplied	Snakebites	ASV vials supplied	Snakebites	ASV vials supplied	Total snakebites 3 years	Total ASV supplied for the 3 years
Damongo Hospital	94	90	101	10	82	0	277	100
ECG Hospital, Kpandai	177	120	202	210	145	110	524	440
Gushegu Hospital	45	0	56	170	11	100	112	270
Savelugu Hospital	132	335	152	400	146	200	430	935
Walewale Hospital	56	640	69	740	109	10	234	1390
Total	**504**	**1185**	**580**	**1530**	**493**	**420**	**1577**	**3135**

Source: *Field Survey, 2020*

It can be seen from table 4.18 that Damongo hospital had the least number of vials (100) of ASV supplied to them over the 3 years under study against a total of 277 reported snakebites. They received no ASV from the regional medical stores in 2019. Walewale hospital on the other hand, had the largest amount of ASV (1390 vials) supplied to the facility over the 3 years under study, against a total of 224 reported snakebites. Savelugu hospital also received substantial amount of ASV supplied especially in 2017 and 2018 where they received 335 and 400 vials respectively against 132 and 152 reported snakebites respectively. ECG Kpandai had the highest number of reported snakebites of 524 and received 440 vials of ASV over the same period.

Table 4.19: Other drugs given as part of the snakebite management

Name of Drug	Damongo Hospital	ECG, Kpandai	Gushegu Hospital	Savelugu Municipal Hospital	Walewale Hospital	Grand Total
A/A P'mol Iron III Multivitamin	1	0	0	0	0	1
Amoxicillin anti tetanus brufen	0	1	0	0	0	1
Amoxiclav	0	0	1	0	0	1
Amoxiclav ATS Hydrocortison	1	0	0	0	0	1
ATS Amoxiclav	1	0	0	0	0	1
* FFP(3units)	1	0	0	0	0	1
Benzyl Penicillin Vit K	1	0	0	0	0	1
Amixiclav Paracetamol	0	0	0	1	0	1
Total	12	0	0	1	0	13

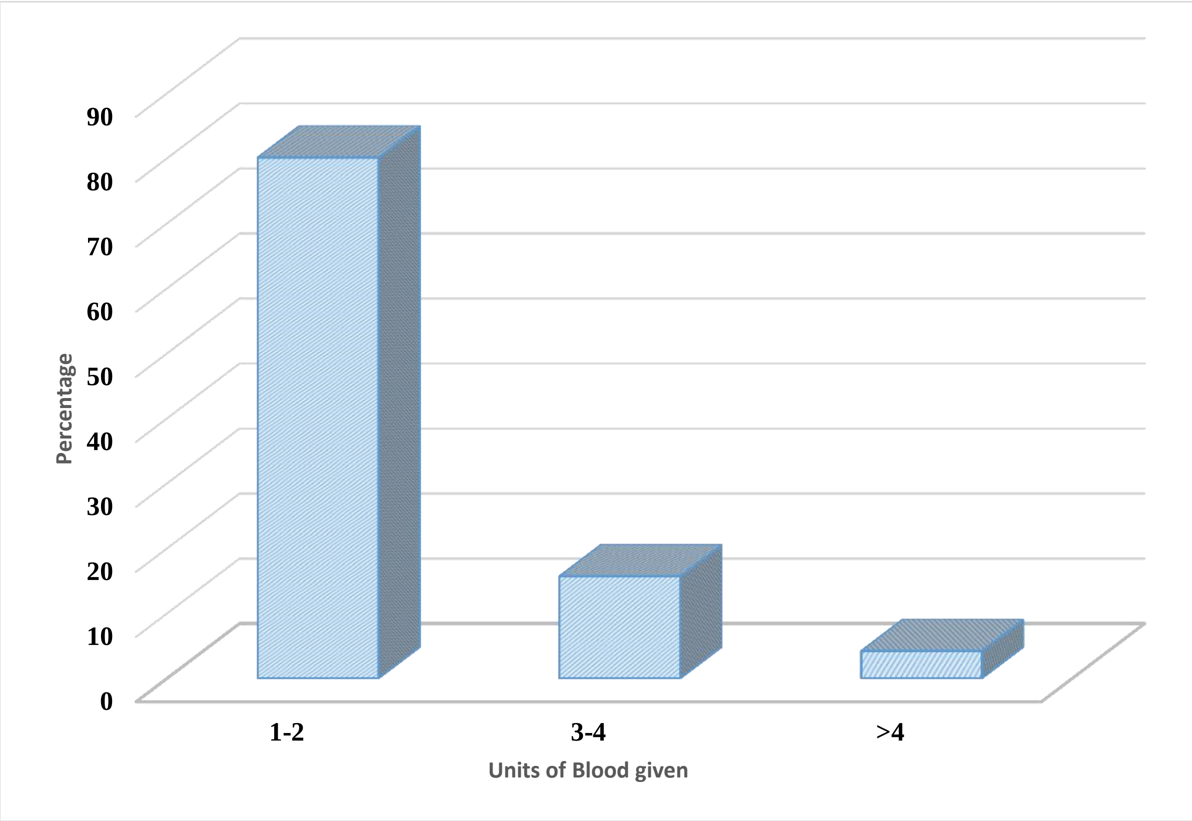
Table 4.19 looks at the other drugs given as part of the snakebite management. Amoxicillin clavulanate was relatively common among the treatment protocols of the hospitals. Damongo hospital was consistent in the administration of antibiotic amoxicillin clavulanate among others.

Table 4.20: Blood transfusion done

Year	2017				2018				2019			
Blood Transfusion	Yes	No	Don't know	Sub Total	Yes	No	Don't know	Sub Total	Yes	No	Don't know	Sub Total
Damongo Hospital	21	58	0	79	18	73	0	91	21	82	0	103
ECG, Kpandai	1	13	0	14	3	13	0	16	6	142	1	149
Gushegu Hospital	10	41	0	51	12	45	0	57	5	48	0	53
Savelugu Municipal Hospital	0	0	0	0	15	47	0	62	11	32	0	43
Walewale Hospital	17	80	1	98	18	69	1	88	8	89	0	97
Grand Total	49	192	1	242	66	247	1	314	51	393	1	445
Percentage (%)	20.0	79.0	0.0	100	21.0	79.0	0.0	100	11.0	88.0	0.0	100

Bleeding is one of the complications of snakebite envenoming as shown in figure 4.7 and significant bleeding can lead to acute anaemia that will require blood transfusion. Overall, 166 patients (16.5%) received blood transfusion as part of their treatment over the 3 years under study. The number of blood recipients varied from year to year. Table 4.20 shows that 20% of the snakebite patients received blood transfusion among the hospitals under study in 2017 with the exception of Savelugu that didn’t have data. In 2018 it was 21% but almost halved in 2019 to 11%. In 2017, Damongo hospital transfused a little over a quarter (26.6%) of their snakebite patients similar to 2019 where 21 out of 103 patients (20.3%) had blood transfusion as part of their treatment.

Gushegu hospital also did significant blood transfusions in 2017 where a 20% of their patients with snakebite received blood transfusion similar to 2018 where 22% of their patients were haemotransfused. The trend is similar in all the other hospitals except Kpandai ECG hospital that had the least number of haemotransfusions done over the 3 years under study, where blood transfusion was done in less than 1% of their patients with snakebite.



Source: *Field Survey, 2020*

Figure 4.5: Cumulative number of units of blood given over the 3 years

Figure 4.5 summarizes the cumulative units of blood transfused in the study facilities of the 3 years of study. Most patients received a maximum of 2 units of blood.

Table 4.24 shows the number of units of blood received by the patients with snakebite in the various hospitals. In all, 169 units of blood was transfused to patients in the 5 facilities during the study period. More than a 3rd of the patients (41%) received just one unit of blood. Another 39.1% of the patients received 2 units of blood during the study period. In other words, 80.5% of the patients received between 1 to 2 units of blood as part of their treatment.

One patient in Damongo hospital received up to 6 units of blood. One patient and 2 patients received 5 units of blood transfusion in ECG Kpandai and Savelugu hospitals respectively in 2018.

The trend in 2019 was similar to that of 2017 in all the hospitals under study. A total of 98 units of blood was transfused to snakebite patients in the 5 hospitals. In all 82% of the patients received between 1 to 2 units of blood on the average in all the hospitals under the study.

Table 4.21: Nature of blood received by patients from the health facilities

Hospital	Fresh Blood	Stored Blood	Unknown	Total
Damongo Hospital	56	1	3	60
ECG, Kpandai	8	0	2	10
Gushegu Hospital	16	10	1	27
Savelugu Hospital	24	0	2	26
Walewale Hospital	37	1	5	43
Total	**141**	**12**	**13**	**166**
Percentage of total	**84.9**	**7.2**	**7.8**	**100**

Source: *Field Survey, 2020.*

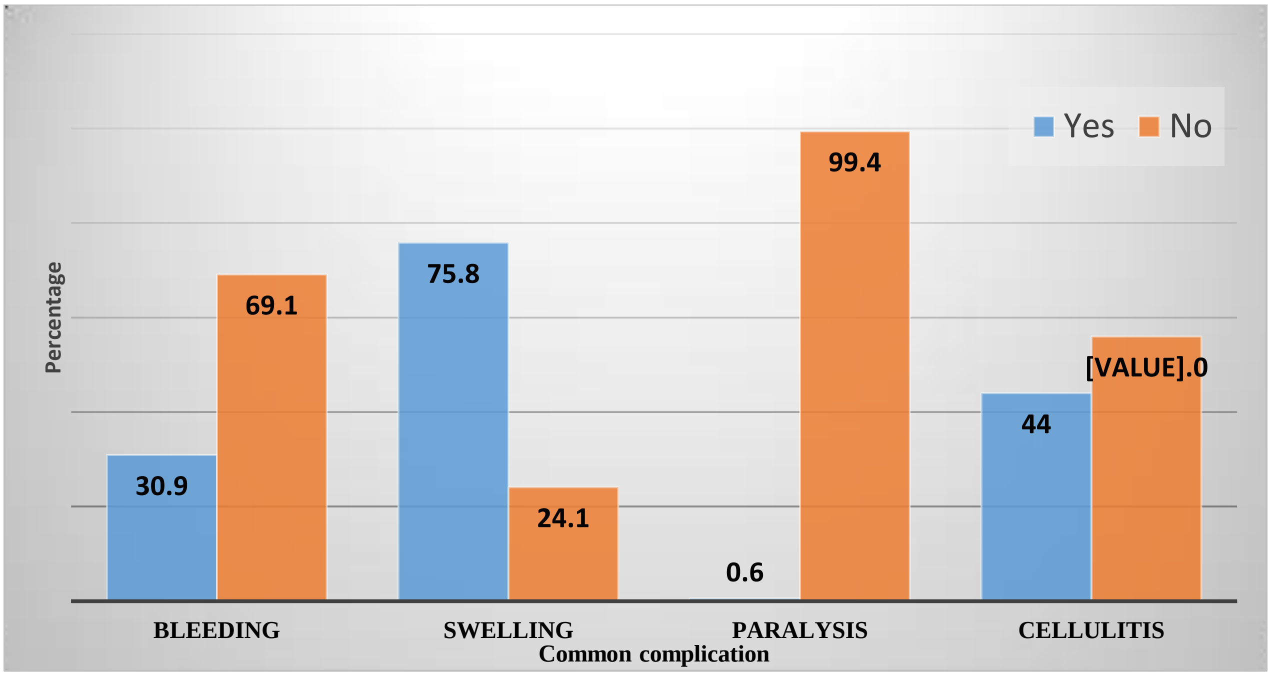
Table 4.21 denotes the nature of blood received by cases seen over the period 2017 to 2019. It was clearly indicated that, majority (84.9%) of the cases received fresh blood whiles few (7.2%) received stored blood. It was however unclear for 7.8% of the cases whether the blood was fresh or stored due to inadequate information in their folders.

Table 4.22: Adverse drug reaction to ASV among the patients admitted

Year	**2017**				**2018**				**2019**			
Complications	Yes	No	Unkn	Sub Total	Yes	No	Unkn	Sub Total	Yes	No	Unkn	Sub Total
Damongo Hospital	0	21	58	79	2	16	73	91	0	21	84	105
ECG, Kpandai	0	1	13	14	0	3	13	16	0	6	143	149
Gushegu Hospital	0	10	41	51	0	12	45	57	0	5	49	54
Savelugu Hospital	0	0	0	0	0	15	47	62	0	11	32	43
Walewale Hospital	0	17	81	98	1	17	70	88	1	7	90	98
Grand Total	0	49	193	242	3	63	248	314	1	50	398	449
Percentage (%)	0.0	20.0	80.0	100	1.0	20.0	79.0	100	0.0	11.0	89.0	100

Source: *Field Survey, 2020.*

Information regarding adverse drug reaction (ADR) among the patients managed in the study hospitals was largely unavailable in the patient records reviewed by the data enumerators for the study as shown in table 4.22. An average of 83% of patient records did not contain such information. There was clear indication of no complication in only 20% of records reviewed for 2017 and 2018, same was 11% in 2019.



Source: *Field Survey, 2020.*

Figure 4.6: Common Complications associated with snakebites

Figure 4.6 shows cumulative complications documented among patients after the snake bite. It is indicated that 30.9% of the cases experienced bleeding compared to paralysis, which were few (0.6%).

Swelling occurred in 75.8% of the patients compared to cellulitis which was documented among 44.0% of the patients.

4.6 Outcome of hospital admission

Table 4.23: Outcome of the hospital admission

Outcome	Damongo Hospital	ECG, Kpandai	Gushegu Hospital	Savelugu Municipal Hospital	Walewale Hospital	Grand Total	Percentage (%)
Absconded	3	2	0	1	6	12	1.2%
DAMA	7	10	7	8	23	55	5.5%
Died	1	0	0	1	3	5	0.5%
Discharged home	255	165	152	95	252	919	91.6%
Referred	7	2	3	0	0	12	1.2%
Sub Total	273	179	162	105	284	1003	100%

Source: *Field Survey, 2020.*

Table 4.23 indicates the outcome of hospital admission among the snakebite patients admitted into the various hospitals under the study. A total of 974 patients (97%) were discharged home after hospital admission and treatment for snakebites among the hospitals in the study. Nine hundred and nineteen (919) of the patients (91.6%) recovered fully and were discharged home by the hospital protocol. Another 55 patients or 5.5% of the patients were discharged home after the patients asked for Discharged against Medical Advice (DAMA). There were 5 deaths over the 3 years of study, giving a case fatality rate of 0.5%. Twelve (12) patients (0.12%) absconded from the hospital before being discharged. Majority of the absconders were on admission at Damongo and Walewale hospitals respectively.

Table 4.24: Factors that influence snakebite envenomation

Factors		Envenomation Yes	Envenomation No	X^2 value / Phi value	Risk Estimate	Confidence Interval Lower bound	Confidence Interval Upper bound
Bleeding	Yes	31.0	0.0	.000	1.529	1.458	1.605
	No	58.6	10.3	.228			
Swelling	Yes	75.9	0.0	.000	6.536	5.606	7.621
	No	13.7	10.3	.603			
Paralysis	Yes	0.6	0.0	.404	1.007	1.001	1.012
	No	89.1	10.3	.026			
Low Blood Pressure	Yes	0.8	0.0	.335	1.009	1.003	1.015
	No	88.9	10.3	.030			
Coagulopathy	Yes	42.5	2.0	.000	3.792	2.289	6.283
	No	47.1	8.3	.173			
Cellulitis	Yes	44.0	0.0	.000	1.965	1.843	2.095
	No	45.6	10.3	.301			
Intervention before	Yes	4.5	0.4	.608	1.313	0.462	3.727
	No	85.2	9.9	.016			
Gender	Male	59.2	6.9	.956	0.988	0.643	1.518
	Female	30.4	3.5	.002			
Part of body bitten	Leg	61.8	5.7				
	Hand	21.3	1.9				
	Stomach	0.1	0.0	.000	-	-	-
	Head	0.1	0.0	.215			
	Chest	0.2	0.0				
	Unknown	6.2	2.8				
Distance to Health facility	1 – 10 km	27.1	3.6	.418	-	-	-
	11 – 20 km	11.4	1.0	.070			

	21 – 30 km	10.2	1.5				
	Above 30 km	22.3	2.9				
	Unknown	18.6	1.4				

Source: *Field Survey, 2020*

Table 4.24 presents the factors that are associated with or influence the outcome of snake bite among the victims over the period under review. From the table, swelling (X^2=0.000; V=0.603) is statistically significant with a strong positive relationship or association with envenomation. It is over 6.5 times likely to occur in patients with snakebite envenoming. Other indicators of envenoming such as bleeding (X^2=0.000; V=0.228), coagulopathy (X^2=0.000; V=0.173), cellulitis (X^2=0.000; phi=0.301), and part of the body bitten (X^2=0.000; V=0.215) had statistically significant positive phi-values.

Bleeding with an odds ratio of 1.529, indicate that those patients who had bleeding after a snakebite have 1.529 times chances of snakebite envenomation compared to those without bleeding. Patients who had coagulopathy had a 3.792 chance of having envenomation than a patient who did not experience any form of coagulopathy. It is also clear from the table that patients who developed cellulitis had 1.965 chance of having envenomation more than a patient with snake bite without cellulitis.

It is also worth noting that bleeding and part of the body bitten by the snake had a statistically significant positive but weak relationship. Cellulitis on the other hand, had a statistically significant positive and moderate relationship.

Paralysis (X^2=0.404; V=0.026), low blood pressure (X^2=0.335; V=0.030), intervention given before going to the health facility (X^2=0.608; V=0.016), gender of the victim (X^2=0.956;

V=0.002), and distance from home to the health facility (X^2=0.418; V=0.070) had no statistically significant association and with no or negligible relationship.

Table 4.25: Cross tabulation between outcome of snakebite and ASV administration

Indicator		ASV Given		Total
		No	Yes	
Fatal Outcome	No	87	914	1001
	Yes	0	5	5
	Total	87	919	1006
	% of Total	8.6	91.4	100.0

Source: *Field Survey, 2020.*

Table 4.25 is a cross tabulation of the outcome of snakebite cases and ASV status. It can be seen that majority of patients (90.9%) who received ASV as part of their treatment were discharged home alive whiles 0.5% of them died on admission. It is worth noting that 8.6% of the patients did not receive ASV but were all discharged home alive.in other words, all the 5 patients who died received ASV as part of their treatment.

Table 4.26: **Chi-square test of association of ASV given and outcome**

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.476[a]	1	.490		
Continuity Correction[b]	.000	1	1.000		
Likelihood Ratio	.907	1	.341		
Fisher's Exact Test				1.000	.636
Nominal * Nominal	.022		.490		
Phi & Cramer's V	.022		.490		
N of Valid Cases	1006				

Source: *Field Survey, 2020.*

Table 4.26 presents the chi-squared test of association between outcome and ASV given. It is indicated that there is no statistically significant (X^2=0.476; p=0.490) association between outcome and the ASV given. Phi and Cramer's V of 0.022 denotes a weak and positive correlation but statistically insignificant.

Table 4.27: **Cross tabulation between gender of victim and outcome of case**

		Gender		Total
		Female	Male	
Outcome of case	Survived	339	662	1001
	Dead	2	3	5
	Total	341	665	1006
	% of Total	33.9	66.1	100.0

Source: *Field Survey, 2020.*

Table 4.27 shows the cross tabulation of outcome of the snakebite against the gender of the victim. It shows that 99.5% of the victims survived comprising 65.8% males and 33.7% females. Out of the total of 5 (0.5%) of the cases who died on admission, 3 of them were males whiles 2 were females.

Table 4.28. Chi square estimates of Gender based risk of snakebite

	Value	95% Confidence Interval	
		Lower	Upper
Odds Ratio for Outcome 1 (No / Ye)	.768	.128	4.619
For cohort Gender = Female	.847	.288	2.486
For cohort Gender = Male	1.102	.538	2.258
N of Valid Cases	1006		

Source: *Field Survey, 2020.*

Table 4.28 demonstrates the risk estimate of outcome of the case and the gender of the patient or case. It is evident from the odds ratio that female snakebite patients have a lower risk of 0.847 likelihood of dying compared to males.

Table 4.29: Cross tabulation of outcome of case and intervention taken before hospital attendance

		Intervention given		Total
		No	Yes	
Outcome of case	Survived	952	49	1001
	Dead	3	2	5
	Total	957	49	1006
	% of Total	95.1	4.9	100.0

Source: *Field Survey, 2020.*

Table 4.29 represents the cross tabulation between outcome of the case and intervention given before going to the health facility for treatment. Majority of the cases (94.6%) who survived and discharged home did not receive any form of intervention before reporting to the health facility whiles few (4.9%) had some form of intervention before reporting to the health facility. Amongst the cases 0.5% died during management of the cases at the health facility. Out of those who died, 60.0% received some form of intervention before reporting to the health facility while 40.0% did not.

Table 4.30: Risk estimates of the association between outcome of case and intervention given before

Risk Estimates	Value	95% Confidence Interval	
		Lower	Upper
Odds ratio for outcome (Dead/ Alive)	.854	.831	.909
For cohort Intervention = Yes	1.065	1.012	1.205
For cohort Intervention = No	.951	.938	.965
N of Valid Cases	1006		

Table 4.30 represents the risk estimates specifically the odds ratio of outcome of case and intervention given. It shows that patients who did not receive any form of intervention before going to the health facility for management have a lesser risk of 0.854 likelihood of dying from the snake bite compared to those who received some form of first aid.

Table 4.31: Shows the cross tabulation of outcome of case and clotting time

		Clotted within 20 minutes		Total
		No	Yes	
Outcome	Survived	558	443	1001
	Dead	5	0	5
	Total	558	448	1006
	% of Total	55.5	44.5	100.0

Table 4.31 is a cross tabulation of outcome of the case and bedside clotting time of the patients' blood. It can be seen that 99.5% of the patients survived comprising 55.5% of those whose blood clotted after 20 minutes and 44% of those whose bedside clotting time was within 20 minutes. The blood of all the 5 patients who died did not clot in 20 minutes at the bedside.

Table 4.32 shows the chi-squared test of association between outcome of the case and clotting time of blood of patient. It is realized that there is a statistically significant (X^2=6.259, $p < 0.05$) association between outcome of case and clotting time of the blood of patients. Notwithstanding that, a phi value of 0.079 indicates a weak and positive association.

Table 4.32: The chi-squared test of association between outcome and clotting time

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	6.259[a]	1	.012		
Continuity Correction[b]	4.205	1	.040		
Likelihood Ratio	8.121	1	.004		
Fisher's Exact Test				.017	.017
Phi	.079		.012		
Cramer's V	.079		.012		
N of Valid Cases	1006				

Table 4.33: Shows the risk estimates of the independent and dependent variables

	Value	95% Confidence Interval	
		Lower	Upper
Odds ratio for Outcome (Dead/ Alive)	1.780	1.641	2.213
For cohort Coagulopathy = Yes	.443	.413	.474
For cohort Coagulopathy = No	.241	.110	.391
N of Valid Cases	1006		

Table 4.33 represents the risk estimates of the outcome of case and clotting time of the patient. It can be seen through the odds ratio that the outcome of the case with bedside clotting time more

than 20 minutes is 1.780 likelihood of dying on admission compared to those whose blood clotted in less than 20 minutes.

Table 4.34: Cross tabulation of outcome of case and appropriate time of arrival at the hospital

		Appropriate time		Total
		No	Yes	
Outcome 1	Survived	144	857	1001
	Dead	3	2	5
	Total	147	859	1006
	% of Total	14.6	85.4	100.0

Source: *Field Survey, 2020.*

Table 4.34 represents the cross tabulation of the outcome of the case and the appropriate time of arrival at the health facility for treatment. It is evident that 3 out of the 5 patients who died reported late to the hospitals for treatment. However, 2 patients out of the 5 deceased, actually reported to the hospitals early enough despite.

Table 4.39 below on the other hand, denotes the chi-squared test of association between the outcome of the case and appropriate time of arrival of the patient at the health facility. The table indicates that there is a statistically significant ($X^2=8.297$, $p < 0.05$) association between the outcome of the case and arrival time of patient at the health facility. The strength of the association denoted as 0.091 however means it is a weak association.

Table 4.35: Chi-square test of association between outcome of case and appropriate time of arrival

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	8.297[a]	1	.004		
Continuity Correction[b]	5.043	1	.025		
Likelihood Ratio	5.483	1	.019		
Fisher's Exact Test				.024	.024
Phi	.091			.004	
Cramer's V	.091			.004	
N of Valid Cases	1006				

Source: *Field Survey, 2020.*

Table 4.36: Risk estimates of the outcome and times of arrival of case

	Value	95% Confidence Interval	
		Lower	Upper
Odds Ratio for Outcome 1 (Dead / Survive)	.112	.019	.676
For cohort Appropriate time = No	.240	.115	.498
For cohort Appropriate time = Yes	2.140	.731	6.264
N of Valid Cases	1006		

Source: *Field Survey, 2020.*

Table 4.36 denotes the risk estimates for the outcome of case and appropriate time of arrival of case at the health facility. What this means is that the patients who were brought to the health facility on time had a lesser chance of dying (0.112) compared to those who arrived at the facility late.

Table 4.37: **cross tabulation of outcome of case and part of body bitten**

		Outcome of case		Total
		Survived	Dead	
Part of the body bitten by the snake	Chest	2	0	2
	Hand	232	1	233
	Head	1	0	1
	Legs	677	2	679
	Stomach	1	0	1
	Unknown	88	2	90
	Total	1001	5	1006
	% of Total	99.5	0.5	100.0

Source: *Field Survey, 2020.*

Table 4.37 describes the cross tabulation of outcome of the case and part of the body bitten by the snake. Out of the 5 victims who died 1 of them had the snakebite on the hand, 2 had it on their legs, and the part of the body bitten is not known in the last 2.

Table 4.38: Chi-square test of association of the dependent and independent variable

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	6.021[a]	5	.304
Likelihood Ratio	3.634	5	.603
Phi	.077		.304
Cramer's V	.077		.304
N of Valid Cases	1006		

Source: *Field Survey, 2020.*

Table 4.41 represents the chi-square test of association of the outcome of the case as the dependent variable and part of body bitten by snake as independent variable of interest. It was indicated that there is no statistically significant ($X^2 = 6.021$, $p > 0.05$) association between the outcome of case and part of body bitten.

CHAPTER FIVE (5)
DISCUSSION

The effects of snakebites and envenoming are grievous in many fronts involving the individual, the family, the community and the society in general. In other words, it has economic impact on the nation as a whole.

There is a gap on reliable data on the true burden of snakebites and envenoming in the Northern part of Ghana for proper planning to deal with the problem. This results in reported frequent shortages and mal distribution of anti-snake venom in the Region in recent past (2016 to 2017 annual reports of NR RMS reference).

. Findings in this study will help to prevent the frequent shortages that usually warrant patients buying the ASV of questionable quality from the black market at exorbitant prices.

The main objective of this study was to determine the burden of snakebites in the selected health facilities in the region over the study period January 2017 to December 2019.

The outpatient morbidity data recorded in the District Health Information Management System (DHIMS) for the 5 selected hospitals for the 3 years of the study indicated that there were 1577 episodes of reported snakebite cases in those hospitals. A 3rd of this number were reported by the ECG Hospital in Kpandai. The probable reason for this distribution is the fact that being a CHAG hospital, ECG hospital had access to supplementary anti-snake venom from the church and this resulted in many victims of snakebites reporting to that facility where anti snake venom can be accessed. Furthermore, the ECG hospitals serve inhabitants of a typical transitional Savannah-Forest zone, which is ideal habitat for snakes.

Some of the patients who patronize this facility come from outside the district and Northern region just because they are sure of receiving ASV in the facility. This finding is corroborated by a non-published long essay submitted by Sonlaar k. k., to the University of Ghana in partial fulfillment for a master degree in June 2019. In that report, it was revealed that 15 out of 54 sampled snakebite patients who reported at the ECG hospital in Kpandai were not residents in the Kpandai District (Sonlaar 2019).

The Kpandai District hospital is in the same town and about 600 meters away from the ECG hospital but the total number of snakebite cases recorded by the District hospital over the same 3 years period was 73. The annual reporting was 15, 28 and 30 for 2017, 2018 and 2019 respectively (GHS DHIMS 2 2017-2019). This is because the district hospital usually receives ASV only from the regional medical stores, which are usually not enough, compared to the ECG hospital. Over the 3 years under review, the ECG hospital in Kpandai received a total of 440 vials of ASV from the regional medical stores (regional medical stores ASV ledger 2017-2019) against 540 cases managed. The pattern of reported snakebite cases across the facilities corresponds to the supply of ASV to these facilities from the RMS. In 2019, the ASV supply to all the hospitals was lower than the previous year. Walewale had a lot more ASV supplied in 2018 than the previous year therefore they might have had more ASV in 2019. This observation thus lends credence to the earlier observation that snakebite victims report to facilities where ASV is available for them. Therefore, the number of patients with snakebite reporting to the hospitals reduced in 2019 because there was a short of supply of ASV in that year compared to the previous year.

Snakebites occurred in a consistent pattern over the three years regarding the months of occurrence. We found that snakebite incidence increases progressively from March to September each year and declined thereafter. The month with the highest number of snakebites in each year is June. This pattern of occurrence of snakebites is consistent with the economic activities in the Northern region. Farming being the dominant occupation with the highest risk of snakebites, it is expected that the number of snakebites will increase relative to the increase in the activities related to farming. Farming in the region starts in May/June every year. This is the time for clearing and tilling the land as well as planting. There will therefore be increased in exposure of the people to the snakes. Women also go for sheanut picking at this time and are exposed to the snakes as well. Children who are students/pupils accompany their parents to the farm at weekends during the planting season and are thus exposed to the snakes. The young children also go for hunting expedition during this time for game and are thus exposed to snakes

The combined incidence of snakebites for the selected hospitals for 2017 was 81.8 per 100000 population. That of 2018 and 2019 were 92/100000 and 76/100000 population respectively.

The incidence slows down from October because there are intense rains at this time of the year. Most farming activities are done by this time and farmers wait for the rains to subside at the end of October for harvesting to start in November. This again account for the peak of snakebite incidence in November each year as the farmers again is exposed to the snakes during the harvesting periods.

In a participatory rural appraisal using focus group discussion in Myamar, it was found that June-July and October-November, which are the harvest times in those communities, were the periods associated with higher incidence of snakebite (Schioldann et al., 2018).

A cross sectional study was conducted by Rahman R, Faiz MA and their colleagues in rural Bangladesh to establish the annual incidence of snake bites and patient health seeking behaviour.

They established that the monsoon season, which spans from June to October was found to be the peak season of the snake bites. This is the season of vibrant agricultural activities and most rural dwellers are on their farms. Snake activities also increases during this season because of the hot weather and monsoon's rain (Rahman et al., 2010).

In the study by Sharma et al, majority of the snakebites (68%) occur in the rainy season when agricultural activities engage a lot of the farmers (Sharma et al., 2004). In a hospital based epidemiological study on snakebite in West Bengal, it was found that about 34% of the snake bites occurred from June to September each year (Sarkhel et al., 2017).

The incidence of snakebites for Western region of Ghana was 82.8 per 100,000 population in 2009 (Mensah et al., 2016) which is close to the incidence from our study.

Farming was the leading occupation among the snakebite victims as they constituted 47.3% of all the snakebite victims. The second leading group of people were pupils or students who formed 33.2% of the snakebite victims. The least occupation at risk of snakebite was petty trading who constituted only 1.6% of the snakebite patient population.

This finding is consistent with what Yakubu et al found in their study to look at the clinical and epidemiological characteristics of snake bite victims in Tamale Teaching hospital in Northern Region of Ghana. They found that more than half (52.1%) of the victims of snakebite victims were farmers or herdsmen. They also found that Student/pupils constituted 30.3% of the cases of snakebite victims, forming the second largest group of people at risk of snakebite (Yakubu1 et al., 2019). This study and ours basically look at the population from the same area of the country, with similar sociocultural characteristics and economic dynamics. Yahaya Musah and his colleagues also in Northern region found 65% of the snakebite victims to be farmers (Musah et al., 2019). In South Eastern Asia, it was found that agricultural workers constituted 44% of snakebite victims followed by students (25%), then housewife (23%) (Sharma et al., 2004).

In terms of rate of envenomation among the snakebite victims, we recognized that not all snakebites are from venomous snakes and not all bites from venomous snake species result in envenomation. Our study showed that 892 out of the 1006 patients or 88.7% were found to have signs and symptoms suggestive of snakebite envenoming and were admitted at the hospital after assessment at the OPD. The remaining patients were either detained for a while and discharged or sent home after the initial assessment. The most common signs suggestive of snakebite envenoming were bleeding (31% of the patients), swelling (66.3%), cellulitis (44.4%), and paralysis (0.2%).

There is paucity of literature differentiating snake bite with and without envenoming, making it difficult for the estimation of the total number of snakebites in various regions of the world. The few African studies show a variation in the proportion of envenoming among snakebites. It was put at 19% in Kenya and between 45% and 87% respectively in two studies in West Africa, which is closed to our findings (Kasturiratne, Wickremasinghe, De Silva, et al., 2008)

In Asia, envenomed bites were found to constitute between 12% and 50% of the total number of snakebites (Kasturiratne, Wickremasinghe, de Silva, et al., 2008). Specifically in Nepal, half of the snake bites (52%) in a study by Sanjib et al had signs of probable envenoming (Sharma et al., 2004). Limited data from North and Latin America indicates that 56% of snake bites in Brazil is caused by nonvenomous snakes whereas the American Association of Poison Control Centers data suggest that the total number of snakebites is about three times that of venomous bites. In India and Pakistan, the most complete data suggest that envenomed bites constitute 18% and 30% of the total snakebites respectively (Kasturiratne, Wickremasinghe, de Silva, et al., 2008).

Identification of the type of snake is very critical in successful treatment of a snakebite since the anti-snake venoms are produced specific to the species. This therefore allows for optimal clinical management, since clinicians are allowed to choose the appropriate treatment, anticipate complications, and therefore to improve prognosis. As a retrospective study, patients were not available to describe the type of snake that bit them. This has reflected in the data in this study where over 90% of folders reviewed did not contain information on the type of snakebite. Carpet viper was recorded to be responsible for less than 2.0%, of snakebites in the study hospitals. The best method to ascertain the type of snake that bit a patient is to do a prospective study as Iliyasu G and his colleagues found in Nigeria. Their study was at the Kaltungo hospital at the Gombe state in Nigeria where carpet viper was responsible for about 76.0% of the 399 patients enrolled into the study (Iliyasu et al., 2015)

Sanjib et al found in a study on the impact of snakebite and determinants of fatal outcome in South-eastern Asia found that cobras formed 58% of the snakes identified followed by water snake in 24%. Pit viper was responsible for 25 of the bites (Sharma et al., 2004). In Tamale Teaching hospital in the Northern Region, carpet viper was the identified snake specie in 11.5% of the snakebites in the study of Yakubu et al when they did a retrospective study evaluating the management of snakebites in that hospital (Yakubu et al., 2018).

On the body part bitten by the snakes our study revealed that the legs or lower limbs are the body part commonly bitten by snakes. The leg was the part bitten in 67.8% of the cases that had information on the part bitten recorded in the folders. The next most affected body part is the hand which was involved in 23% of the cases on the average. These findings are consistent with that of other studies that showed that the lower limb is the most affected body part bitten by snakes (Musah et al., 2019; Rahman et al., 2010; Yakubu et al., 2018). In their review on snakebite in South Asia, Alirol et al found that 60%–80% of bites occur on the foot, ankle, or leg (Alirol et al., 2010)

The legs and hands are the common body parts bitten by snakes because farming, which is the predominant occupation of majority of snakebite victims involves the use of hands and legs. Other victims who may not necessarily be farmers trample on the snakes while walking on foot paths or the street. In terms of prognosis of patients bitten by the snake, we found that there is no statistically significant association between the outcome of snakebite case and part of the body bitten ($X^2 = 6.021$, $p > 0.05$).

Regarding interventions or treatment received before going to the hospital, about 95% of the patients in our study didn't receive any form of pre-hospital treatment. An average of 4.6% (3%-6%) received herbal medicine before going to the hospital. The findings further showed that patients who did not receive any form of intervention before going to the health facility for management have a lesser risk of dying (likelihood ratio of 0.854) from the snake bite compared to those who received some form of first aid before going to the hospital.

This finding shows a positive health seeking behaviour of the snakebite victims when we compare our finding with other similar studies. For instance, in Myanmar, traditional medicine is either used before hospital attendance or after hospital attendance by majority of the people. Others don't go to hospital at all but patronizes the traditional healers. Some of their traditional medicine practitioners include the monks who do not use herbs but prayers and incantations. Others use the black stone and some use herbs (Schioldann et al., 2018).

In Kaltungo hospital in the Gombe State of Nigeria, 45.8% of snakebite victims used black stone as a form of first aid, another 33.8% of the snakebite victims applied traditional concoction to the bite site. Some 19% ingested concoctions while 21% made incisions at the bite site. In the same study, only 19% of the patients reported to hospital for care without any form of local remedy as first aid (Habila, 2014). In Nepal, majority of the patients chose hospital as their first point of call when they had snakebite as only 22% of the victims initially consulted a traditional healer (Sharma et al., 2004).

Yahaya Musah and colleagues also found rather high patronage of the traditional medicine by snakebite victims in Savelugu Nanton district which has one of our study facilities. Also in Tamale Teaching hospital in the Northern, 38% of the snakebite victims who presented there for care between 2016 and 2018 applied herbal anti-snake medicine before reporting to the hospital (Yakubu et al., 2018).

Being a retrospective study involving record review, information was not found in some folders because some of the patients were either not asked about the use of alternative medicine before hospital attendance or the information regarding that was not recorded by the care givers in the hospitals. The other reason is that the patients believed that ASV is the best treatment for snakebites and so their first point of call was the hospital. Most people would report to hospital for snakebite treatment if there is ASV, and not to a traditional practitioner, despite strong community belief in traditional healing for snakebite (Schioldann et al., 2018). At the Kaltungo hospital in Nigeria, patients chose the hospital treatment for their snakebite due to several reasons such as Need for faster healing, Effectiveness of treatment, and Cheaper cost of treatment (Habila, 2014)

The specific antidote for a snakebite envenoming is the ASV specifically produced with particular species of snakes taken into consideration.

However over 90% of the folders reviewed had no information on the specific type of ASV given to the patients since the prescribers did not document any information on the brand of ASV given A shortcoming of the use of ASV is the geographical variation of snake species and thus potent ASV in one region may be ineffective in another part of a country or the world (Alirol et al., 2010; Harrison et al., 2009; *Neglected Diseases*, 2006; Warrell, 2010; WHO, 2018) It is therefore economically prudent for manufacturers to manufacture the polyvalent form of ASV (Alirol et al., 2010; *Neglected Diseases*, 2006). The use of Polyvalent ASV also enhances the prescriber's chance of treating the unknown snake specie successfully with it.

We found that 91.4% of the patients in our study received ASV as part of their treatment. We however found no statistically significant association (X2=0.476; p=0.490) between administration of ASV and outcome of the patients. There was a weak and positive correlation between the outcome of a case and ASV administration but statistically insignificant. (Phi and Cramer's V of 0.022). All the 5 patients in this study who died received ASV as part of their treatment. This might be due to either late reporting to the hospital by the patient or inadequate amount of ASV was administered.

In Tamale Teaching hospital, up to 94.8% of patients with snakebite envenoming received ASV as part of their treatment (Yakubu et al., 2018). All the 1633 patients in a hospital based epidemiological study in Paschim, West Bengal, India, received ASV as part of their treatment (Sarkhel et al., 2017).

The government of Ghana supplies polyvalent ASV to hospitals through the various Regional Medical Stores (RMS) in the country to administer to patients free of charge. Our findings however revealed that about 40% of the snakebite patients obtained the ASV from sources other than the hospital. The potency and safety of such medicines usually are questionable. In other words, 40% of the patients actually bought the ASV administered to them from outside the hospital supply system. This simply means the ASV supplied from the RMS was available for only 60% of the patients. A similar finding was made at Kaltungo hospital in Nigeria where 46.5% of the snakebite victims reported that they paid for the antivenom given to them during their treatment (Habila, 2014).

There were discrepancies in the distribution of ASV supplied to the hospitals from the RMS as some hospitals received far less and others got fairly more. The case of Damongo and Walewale hospitals are clear examples. Damongo hospital had the least amount (100 vials) of ASV supplied from the RMS over the 3 years against a total of 277 reported snakebites. In fact, they received no ASV at all from the regional medical stores in 2019. Walewale hospital on the other hand, took delivery of the largest amount of ASV (1390 vials) over the 3 years under study from the regional medical stores, against the total of 261 reported cases of snakebites.

The number of ASV vials received by each patient could not be obtained but in the study by Yakubu et al at the Tamale Teaching hospital, the average amount of ASV administered was approximately 8 vials per patient and in KwaZulu Natal province in South Africa, an average of 5 vials were administered per patient (Darryl et al., 2016; Yakubu et al., 2018).

Granted that each patient in Walewale received 5 vials as in South Africa, then the ASV supplied them could take care of up to 278 clients against a total of 261 reported snakebites. Evidence from our study shows that in Walewale hospital, 155 snakebite patients bought their own ASV.

If on the other hand they received 8 vials as in the case of Tamale, the amount of ASV received from the medical stores could take care of only 174 patients, this will thus justify the 155 patients buying the ASV from other sources. The ASV supplied to Damongo hospital could take care of only 13 to 20 patients, against 277 patients seen over the period. Our study revealed that at least 206 patients in Damongo hospital got the ASV from other sources and thus probably bought it from the open market over the period. These findings corroborated what Habila and colleagues found at the Kaltungo hospital in Nigeria where 48% of patients in the study reported that antivenom was not always available at the General Hospital (Habila, 2014).

The cost per a vial of ASV at the open market in Ghana ranges from GHC350 to GHC 500.00. This is equivalent to US$50.00 to US$83.00 at the dollar cedi exchange rate of 1:6. In this case, it cost each of the patients who bought ASV in this study, GHC 1,750.00 to GHC2, 500.00 or US$250 to US$415.00 for ASV alone. This amount is not affordable for most patients who come from the Northern regions where majority of poor people in Ghana are found, according to the latest Ghana living standard survey (Wambile et al., 2017). The implication is that some people will seek treatment at the traditional medicine practitioners, resulting in deaths and complications. Patients will also travel far outside their districts to hospitals that have ASV in adequate stocks. A typical case in point is the ECG hospital in Kpandai which always has ASV compared to its counterpart, the District hospital. This results in the former admitting and treating more snakebite patients than the district hospital. Some of the patients who attend ECG hospital travel from other districts and regions for snakebite management simply because the facility receives ASV from additional sources including the church that established the hospital.

In South Africa, the cost of ASV was US$80 per vial and therefore the total average cost of ASV per patient was found to be US$400.00. At the Kaltungo hospital in Nigeria, the cost of ASV to patients who bought it was US $136 (Habila, 2014).

A total of 3,135 vials of ASV was distributed to the five hospitals under this study over the three years under review. The total number of patients actually seen in these five hospitals was 1577. If each patient was to receive a minimum average of 5 vials per treatment, the ASV supplied by the RMS would take care of only 627 or 40% of the patients who needed the ASV. The required amount of ASV for these five hospitals over the three years period would have been 7,885 vials.

Going by the open market prices, the 3135 vials supplied from the RMS cost the government of Ghana between GHC1.097, 250.00 to GHC1, 567,500.00 to provide ASV to the 5 facilities under the study. In dollar terms the cost of ASV supplied to the 5 facilities stood at US$182,875.00 to US$261,250.00. If the required amount of ASV was to be supplied, it would cost GHC2, 759,750.00 to GHC3, 942500.00 or US$ 459,958 to US$657,083 by the prevailing market price.

Blood transfusion is a major part of treatment of snakebites especially in areas where the predominant type of snakes is the carpet viper. Carpet viper envenoming causes coagulopathy and can lead to severe bleeding that led to anaemia requiring blood transfusion. In the middle belt of Ghana, 39% of patients in a study exhibited coagulopathy by laboratory finding (Punguyire et al., 2013). Among patients in Tamale Teaching hospital, carpet viper was identified as the commonest type of snake responsible for the snakebites reported in 2016 and 2017. Among their patients, up to 84.9% had coagulopathy as part of manifestations of envenomation from snakebite. Our findings show that up to 324 units of blood was transfused among 166 snakebite patients seen in the 5 hospitals under study. A total of 67 or 40.4% of the blood recipients were transfused 1 unit of blood, 132 or 79.5% of the patients received 2 units of blood.

The number of days spent on admission in the hospital is a factor in calculating the financial burden of the disease. This is calculated in addition to the amount spent in procuring medicine and other services. With respect to snakebite, the cost of antivenom will be independent of the cost of admission. Our study shows that the average number of days spent in the hospital was 3.4 days (range of 1- >10 days). Since hospital bills are not calculated per hour, the bill for a patient who spent 3.4 days will be calculated against 4 days. In the District hospitals in the Northern Region, the daily admission service charge is GHC50.00 exclusive of medications, laboratory investigations, blood transfusion and any other procedure carried out on the patient. The processing fee of a unit of blood for transfusion is GHC33.00, in addition the patient relatives will have to bleed and replace the blood borrowed (Regional Fincial Monitoring Reports, 2017 to 2019 Northern Regional Health Directorate).

The finding on the average number of days spent is consistent with what was found among snakebite patients managed in Tamale Teaching Hospital around the same time of our study. Their patients spent an average of 4.7 days on admission with a range of 1-19 days (Yakubu et al., 2018). The average number of days spent on admission for snakebite patients in KwaZulu Natal in South Africa was 3-7.6 days before being discharged (Darryl et al., 2016). In Paschim Medinipur District of West Bengal, the mean duration of stay of all patients at the hospital was 8.5 ± 2.2 days (Sarkhel et al., 2017).

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The policy of the Ghana blood transfusion service regarding transfusion of blood is that the patient pays for the procession fees and subsequently get donors to replace the amount of blood borrowed. The processing fee for each unit of blood in Ghana as at November 2020 is GHC33.00. Thus, in all, the patients who received blood transfusion during their treatment of snakebite incurred additional cost of GHC33.00 to GHC66.00 for those who received 1 and 2 units respectively. Adverse blood transfusion reaction and its management is another risk and cost incurred by the patients.

On the outcome of the snakebite patients admitted to the hospital, a total of 974 patients (97%) were discharged home after hospital admission and treatment for snakebites among the hospitals in the study. Nine hundred and nineteen (919) of the patients (91.4%) recovered fully and were discharged home by the hospital protocol. Another 55 patients or 5.5% of the patients were discharged home after the patients asked for Discharged against Medical Advice (DaMA). There were 5 deaths over the 3 years of study, giving a case fatality rate of 0.5%. Twelve (12) patients (0.12%) absconded from the hospital before being discharged. Majority of the absconders were on admission at Damongo and Walewale hospitals respectively.

The case fatality rate in this study is similar to findings in the Western Region of Ghana where case fatality rate on secondary data analysis on snakebites in the DHIMS was 0.7% but in Tamale Teaching hospital it was 1.6% (Mensah et al., 2016; Yakubu et al., 2018). In Western Nepal, Sharma and his colleagues found case fatality to be as high as 27% in a retrospective study on the impact of snakebites and determinants of fatal outcome. This was said to be so because there are a lot of venomous snake species there (Sharma et al., 2004). In rural Bangladesh, the opposite was observed where only 1 out of 98 patients in a study *on the annual incidence of snakebites* in that country. This gave a case fatality of 1%, and the reason for this was that most snakebites there are due to non-venomous snakebites (Rahman et al., 2010). Iliyasu and fellow researchers found a case fatality of 1.5% in rural Nigeria when they assessed the effect of distance on the outcome of snakebites (Iliyasu et al., 2015).

There were no reported cases of complications such as amputations etc. in the records that we reviewed. The type of complications seen were prolonged hospital stay for more than 7 days in 79 patients or 7.9%, and coagulopathy needing blood transfusion in 166 patients (16.5%). In Tamale Teaching hospital forty-nine (25.5%) patients were discharged home with complications. In Nigeria, 74 out of 399 snakebite patients had poor outcomes in a study. The types of complications developed were prolonged length of hospital stay for >7 days in 37 patients, amputations in 4, coagulopathy needing blood transfusion in 15, gangrene in 8,and loss of consciousness/ intracerebral hemorrhage in 4 (Iliyasu et al., 2015).

For the weaknesses of this study, the missing folders in the study affected the sample size of this study. This study was expected to review the records of 1577 patients who had snakebites over the period under review in the 5 hospitals but only about 63.8% of the folders were found. This study has exposed the weaknesses in the filing and retrieval system in our hospitals. Some of the reasons given were lack of physical space in the hospitals to file the folders. Teviu, et al in an operational research to enhance patient folder filing system in a District hospital in Ghana in 2012 found a number of factors contributing to misfiling of patient folders. These include lack of physical space in the hospital records unit, the bulky nature of the folders, staff indexing and filing errors due to lack of training for the support staff at the records unit, use of same folder filing systems for inpatients and outpatient services, and patients carrying their folders home without permission (Teviu et al., 2012). Damongo hospital is an exception where almost all the patient folders were retrieved because they have adopted a robust e-folder filing and retrieval system in that hospital.

The folders were filed but could not be retrieved and others were taken to an unknown location as in the case of 2017 folders for Savelugu hospital.

Being a retrospective study, information as to the type of snake, the brand, cost of ASV purchased by patients, and other vital information needed from the patients could not be found in the patient records. The study lacks a community survey component to give the actual number of snakebites for the entire population in the respective districts as well as the true burden of the condition for the entire region.

CHAPTER SIX (6)

6.0. CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

The annual incidence of snakebites was 81.1/100000, 92/100,000, and 76/100,000 for 2017, 2018, and 2019 respectively for all the five hospitals in this study. The incidence of snakebites was highest in Damongo hospital serving the West Gonja District, and lowest in the Gushegu hospital serving the Gushegu District.

The rate of envenomation among the snakebite patients in this study was 88.6%. The commonest indication of snakebite envenoming was swelling which was present in 66.3% of the patients. Bleeding and cellulitis were present in 31% and 445 of the patients respectively.

The age range 11-20 years is the age range at highest risk of snakebite. Males are at a much higher risk of being bitten by snakes compared to females. Farmers and pupils/students have higher risk of snakebite compared to the general population. Traders on the other hand have the least risk of snakebites and envenomation

The hospital was the first point of call for up to 95% of the patients under this study. Only 4.6% applied herbal medicine before going to the hospital.

Up to 91.4% of the patients in our study received ASV as part of their treatment, about 40% of the patients bought the ASV administered to them from outside the hospital supply system. About 16.5% of the patients in this study received blood transfusion as a result of bleeding due to coagulopathy from the SBE.

A total of 3,135 vials of ASV was distributed to the five hospitals under this study over the three years under review. This quantity of ASV supplied from the RMS was available for only 60% of the patients since the other 40% bought the ASV.

A total of 974 patients (97%) were discharged home after hospital admission and treatment including 55 or 5.5% who were discharged against medical advice. There were 5 deaths over the 3 years under study, giving a case fatality rate of 0.5%. The most common complications seen were prolonged hospital stay for more than 7 days, coagulopathy needing blood transfusion, and paralysis in 2 patients.

In conclusion the burden of snakebite envenoming is very high in the 5 selected hospitals in the Northern Ghana studied between 2017 and 2019.

6.2 Recommendation

1. A prospective study of this nature complemented by a community survey on snakebites will help to gather more information from the patients and the community to give the true incidence of snakebites in the Districts under the study and thus will reflect the true burden of snakebites in the Regions.
2. Farmers should be educated by the agricultural extension workers on the dangers of snakes and advise them to wear protective boots and hand gloves to prevent snakebites. Also, Students/pupils should be prevented their parents and guardians from going for hunting or at least wear protective clothing before going to the bush.
3. The ministry of health/Ghana Health Service must step up the quantity of ASV they procure for the country and the various regional directors of health service to ensure

equitable distribution of the ASV to all hospitals based on the number of snakebites reported in the DHIMS.

4. The community health nurses, traditional and religious leaders should educate the public to report early to the hospital when they are bitten by snakes in order to prevent complications
5. A second look at the folder filing and retrieval system in the hospitals should be considered. This calls for a refresher training of the medical record staff by the regional and district directors of health service as a short-term measure while steps are taken to migrate to electronic medical records system

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APPENDIX 1

THE BURDEN OF SNAKE BITES IN NORTHERN REGION

DATA COLLECTION TOOL **Case No**
……………………......................

This questionnaire is to be completed per each patient folder/record retrieved from this hospital

1. NAME OF THE HOSPITAL………………………………………………………………………………………..
2. Name of the patient………………………………………………………………………
3. Folder number ……………………………………………………………….
4. Age of patient in years ………………………………………………………..
5. Sex of the patient: ☐ Male ☐ Female
6. Address of patient …………………………………………………………………………………………………..
7. Occupation of patient………………………………………………………………………………………………
8. Religion of the patient…………………………………………………………………………………………….
9. Date of snake bite ……………………………………………………………………………………………….
10. Type of snake (if known)…………………………………………………………………………………………..
11. Part of the body bitten by the snake……………………………………………………………………………

12. What was the victim doing when s(he) had the bite?

……….

……

13. What was done for the patient before coming to hospital?

………

………

14. Means of transport to the hospital………………………………………………………………………………………

15. Distance from the residence of the victim to this hospital in kilometers……………………………………..

16. Date of admission …….

17. Date of discharge/transfer/death …………………………………………………………………………………………..

18. Number of days spent in this hospital …………………………………………………………………………………….

19. Signs of envenomation ………………………………………………………………………………………………………..

……….

20. How was envenoming confirmed?

…………………………………………………………………………………………………

…………

21. Results of laboratory tests done

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………

22. ASV given? ☐ Yes ☐ No ☐ Don't know

23. Specify brand of ASV (if Known)

24. If yes number of vials given

…………………………………………………………………………………………………

…………

25. Source of ASV? ☐ hospital ☐ private pharmacy/drugs store ☐ from a staff ☐ don't know

26. Average cost of ASV (GHC……………………………………)

27. Other drugs given

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

………..

28. Blood transfusion done? ☐ Yes ☐ No ☐ Don't know

29. If yes number of units given ……………………………………………………………….

30. Complications? ☐ Yes ☐ No

31. If yes, state the type of complication

…………………………………………………………………………………………………

……………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………..

32. Outcome of the admission

☐ Discharged home ☐ referred
☐ died

APPENDIX 2

THREE-YEAR TREND OF SNAKE BITES BY HOSPITALS NORTHERN REGION

SNO	Northern Region Name of Hospital	2017	2018	2019
1	Assemblies of God	46	94	0
2	Bimbilla	40	16	45
3	ECG	177	202	145
4	Gushiegu	45	56	11
5	Karaga	0	0	3
6	Kings Medical Centre	0	11	2
7	Kpandai	15	28	30
8	Savelugu	132	152	146
9	Tamale Central	42	64	35
10	Tamale SDA	1	2	0
11	Tamale Teaching	1	0	0
12	Tamale West	34	12	26
13	Tatale Polyclinic	41	73	71
14	Yendi	29	37	6
15	Zabzugu	106	107	133
	Northern Region	709	854	653

SNO	Savannah Region Name of the Hospital	2017	2018	2019
1	Bole	51	88	27
2	Buipe Polyclinic	18	24	23
3	Damongo	94	101	82
4	Holistic Medicare	83	137	178
5	Salaga	42	43	56
6	Sawla Polyclinc	14	30	64
	Savannah Region	302	423	430

SNO	North East Region			
	Name of the Hospital	2017	2018	2019
1	Baptist	18	13	72
2	Binde	59	40	11
3	Chereponi Government	6	4	1
4	Janga Polyclinic	11	4	11
5	Walewale	56	69	109
	North East Region	150	130	204

APPENDIX 3

file

GHANA HEALTH SERVICE

OUR CORE VALUES:
1. People-Centered
2. Professionalism
3. Team work
4. Innovation
5. Discipline
6. Integrity

My Ref GHS/NR/..18...0/57
Your Ref. No:..................

Reg. Health Directorate
P. O. Box 99
Tamale
Northern Region
Tel:(233) 3720 22912
Fax:(233) 3720 22777
E-mail: rdhs.nr@ghsmail.org
19/02/2020

PERMISSION GRANTED TO COLLECT DATA FROM YOUR FACILITY

This is to inform you that permission has been granted to **Dr Braimah B Abubakari** to collect and analyze secondary data from your facility to address his topic ***institutional burden of snake bites in Northern Region between January 2017 and December 2019.*** He is pursuing a Master of public health (MPH) at the University for Development Studies. The theses work is part of the requirements for completing the MPH course. The data collection is proposed to take place between February 2020 and April 2020. I entreat you to give him or his data collectors the necessary support they need from your institution.

Dr John Bertson Eleeza

Regional Director of Health Service

The Medical Superintendent:

1. Savelugu Municipal Hospital
2. West Gonja District Hospital
3. Yendi Municipal Hospital
4. ECG Hospital Kpandai
5. Gushegu Municipal Hospital
6. Wale Wale Hospital