Acute poisoning in three African countries: Botswana, South Africa and Uganda

by

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AUTHOR'S DECLARATION

I**, Dr. Ntambwe Malangu**, hereby declare that the thesis hereby submitted to the University of Limpopo, for the degree of **Doctor of Science in Medicine**, has not previously, or currently been, nor will in future be submitted by me for another degree at this or any other university, tertiary institution or examining body; that it is my work in design and execution, and that all material contained herein has been duly acknowledged.

……

Signature

……

Date

DEDICATION

To Nkusu Mushinta Henriette and Malangu Tshibambe for the good genes I inherited from them by the Grace of the Creator of genes, God Almighty, to Whom all the glory!

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LIST OF ABBREVIATIONS AND ACRONYMS

Acronyms	Meaning
AEO	Africa Economic Outlook
ASO	Alcohol selling outlets
BCSO	Botswana central statistics office
DALY	Disability adjusted life-years
DSP	Deliberate self-poisoning
FAO	Food and agriculture organization
HDI	Human development index
INCB	International Narcotics Control Board
LOS	Length of hospital stay
NE	Nations Encyclopaedia
OP	Organophosphate (pesticide)
RSA	Republic of South Africa
SPRC	Suicide Prevention Resource Centre
SSA	Statistics South Africa
UBOS	Uganda Bureau of Statistics
UK	United Kingdom
UNDP	Unites Nations Development Program
UNECA	United Nations Economic Council for Africa
UNODC	United Nations Office of Drugs and Crime
USA	Unites States of America
WEF	World Economic Forum
WHO	World Health Organization
ZAR	South African Rands

SUMMARY

Acute poisoning constitutes one of the main reasons why patients visit emergency departments of hospitals. However, the burden and pattern of acute poisoning in African countries are not well established, hence the need for this study. This study was conducted in order to compare the patterns of acute poisoning in three countries, namely, Botswana, South Africa, and Uganda. Specifically, this study examined the similarities and differences in the patterns of occurrence of acute poisoning based on the sociodemographic characteristics of the victims, the toxic agents involved, and the circumstances of the incidents.

The study was based on six papers published on the topic. Papers I and II about Botswana covered a period of 24 months (January 2004 - December 2005) and six months (January - June 2005) respectively. The data from Uganda, as reported in Paper III, covered a six-month period (January-June 2005); while studies in South Africa, Papers IV to VI, covered respectively six (January-June 2005) and 18 months (January 2000-June 2001). A re-analysis of data from Papers II to IV was conducted after recoding age category and the grouping of toxic agents.

In total, the six Papers reported data on 1780 patients; 54.8% of them were male. The median age was 24 years in Uganda, but as low as 17 years in Botswana and South Africa. In Botswana and South Africa, acute poisoning incidents occurred mostly in children younger than 12 years old, then decreased among teenagers , and increased again among young adults, before decreasing among patients over 30 years old. On the contrary, in Uganda there was that less than 5% of children younger than 12 years who were victims of poisoning. There was an increase in the prevalence of acute poisoning among teenagers and young adults before a decrease occurred among adults over 30 years old. The overall case fatality rate was 2.1%, ranging from 1.4% in Uganda, 2.4% in South Africa, to 2.6% in Botswana.

With regard to similarities across the three countries, it was found that among teenagers, girls committed more deliberate self-poisoning than boys; while in young adults, men committed more self-poisoning than women. With regard to toxic agents, household products were involved in fatal

outcomes in all three countries; while agrichemicals were more involved in deliberate than accidental poisonings; food poisoning affected more females than males.

With regard to disparities across the three countries, the age and gender of the victims, the circumstances of the incidents and the types of toxic agents played a significant role. With regard to gender, the majority of the victims were males in Uganda, females in South Africa; while in Botswana, females and males were affected equally. Among teenagers, the toxic agents most involved in the poisoning incidents were pharmaceuticals in Botswana; household chemicals in South Africa; but agrichemicals in Uganda.

While the majority of incidents happened by accident in Botswana and South Africa, being respectively 76.7% and 59.1%; in Uganda, 64.5% of acute poisoning cases were deliberate self-poisoning. Deliberate self-poisoning was responsible for 50% of deaths in Uganda, 30% in South Africa, but no death in Botswana. The majority of deaths occurred among teenagers in South Africa; in Uganda it was among adults over 30years; while in Botswana, the majority of deaths were distributed almost equally amongst children younger than 12years old and young adults.

Diverse products were involved in fatal outcomes. In South Africa, pharmaceuticals, particularly drugs of abuse, cocaine and marijuana; as well as carbon monoxide, and organophosphates were involved in fatalities. While, in Botswana, the products involved were paraffin, traditional medicines, pharmaceuticals, food poisoning, plants, and snake envenomation. In contrast, in Uganda, alcohol intoxication, organophosphates, carbon monoxide, and some unspecified household products lead to fatalities.

Household chemicals were involved in the deaths of victims in all three countries; but the extent of their involvement differed from country to country. This group of products was responsible of 75% of deaths in Uganda, half of deaths in South Africa, and in a third of deaths in Botswana. Agrichemicals were involved in the deaths of victims in Uganda and South Africa, but not in Botswana. They were involved in a quarter of deaths in Uganda and 10% of deaths in South Africa.

Plants and traditional medicines were involved in two-thirds of the deaths only in Botswana; while pharmaceuticals were involved in 40% of fatal outcomes only in South Africa.

In conclusion, the contextual factors of each country led to a pattern of acute poisoning that showed some similarities with regard to the distribution of deliberate self-poisoning among females, teenagers, and young adult victims. However, there were disparities relating to the differential access to toxic agents, based on the age and gender of the victims. Moreover, though the case fatality rate was similar across the three countries, the distribution of deaths based on age, gender, circumstances of poisoning and types of toxic agents involved differed among the three countries.

These findings suggest that multifaceted interventions should be implemented including policy development, enforcement of the existing legislation, and the establishment of a surveillance mechanism, in-service training of clinicians and revision of treatment guidelines. These interventions should be tailored to meet the specific realities of each country.

CHAPTER 1: INTRODUCTION

1.1 Background

Injury epidemiology is a sub-discipline of epidemiology whose focus is to study the determinants of injuries in the population. It involves the characterization of injury occurrence, identification of risk factors, and the evaluation of injury prevention and management programs (Robertson, 2007). Injury is defined as damage in human tissue resulting from exposure to energy delivered in excess of the threshold that human biological systems can tolerate (Langley and Brenner, 2004). This transfer of energy occurs during exposure to various forms of energy (Duffus et al., 2007).

Exposures may happen in various environments such as the workplace, home, and/ or recreational settings. It is reported that injuries are common and increasing in Sub-Saharan Africa due to the growth of motorized transport, urbanization, expansion of industrial production, and greater availability and access to firearms, chemicals and pharmaceuticals. Hence, a large proportion of the injuries result from road and other traffic accidents, violence, and acute poisonings (Kobusingye, 2001; Bowman et al., 2006; Mariam et al., 2006; Lagarde, 2007; Meel, 2008).

Acute poisoning is an injury in which the toxic effects occur almost immediately, usually within hours from the time of exposure. Uges (2001) reported that poisoning may be accidental, or deliberate. Accidental poisoning may result from error in judgment, carelessness, negligence, or an unexpected situation in the home, or at workplace as in the case of intoxication due to treatment, referred to as 'iatrogenic intoxication" (Hermanns-Clausen et al., 2009; Dart et al., 2009).

In deliberate poisoning, the victim is intoxicated on purpose, either by their own doing, this is called "deliberate self-poisoning", it may be para-suicide or suicide; or at own request, as in euthanasia, or by being the unwitting victim of intoxication orchestrated with criminal intent (Uges, 2001; Trestrail, 2007). Whether the exposure is a single event or a series of events, the term "acute poisoning" is used to denote the fact that the toxic effects appear within 24 hours. The toxic effects range in their severity from the mild to lethal (Persson et al., 1998). It is the concern about the worsening of the health status that compels the victims of acute poisoning and/or his relatives or those assisting her/him to rush to the hospital.

Hence, acute poisoning constitutes one of the main reasons why patients visit emergency departments of hospitals. It is estimated that, every year, acute poisoning directly or indirectly is responsible for more than 1 million episodes of illnesses worldwide (Pillay, 2004). However, the burden and pattern of acute poisoning in African countries are not well established.

1.2 Statement of Purpose

The purpose of the study reported in this thesis was to compare the patterns of acute poisoning in the countries where the original studies were conducted, namely, Botswana, South Africa, and Uganda. In doing so, the study examined the similarities and disparities in the patterns of occurrence of acute poisoning based on the sociodemographic characteristics of the victims, the toxic agents involved, as well as on the circumstances surrounding the incidents.

1.3 Specific objectives of the study

This study sought to:

- Describe the profile of the victims and the patterns of acute poisoning and how they differ among in the three countries
- Describe the most common toxic agents involved in acute poisoning in each country and how do they differ among the three countries
- Determine the proportions of incidents due to accidental and deliberate poisoning and how they differ among the three countries
- Describe the factors that explain the differences or similarities with regard to the patterns of acute poisoning observed in the three countries

1.4 Significance and justification of the study

Several studies have investigated acute poisoning in the three countries contemplated in this study. However, little comparative work has been reported. While individual studies in each country provide data relevant for clinical practice, these studies do not provide enough insights that could be used to learn about the best practices that could be adopted, shared or transferred to other countries with similar problems.

The findings of this study may contribute, firstly, to further the understanding of commonalities and disparities about acute poisoning among the three countries. This understanding may provide a clearer picture of patterns of acute poisoning incidents and the factors that are associated with them across countries in the continent.

Secondly, the findings could assist in identifying significant factors that characterize the similarities and disparities. These identified factors could be useful not only for explaining the disparities among the countries, but also could be targeted for potential interventions at country and regional levels. These interventions should be geared at reducing the occurrence of acute poisoning, its severity, and/or its impact on those that fall its victims.

1.5. Theoretical framework

Exposures to chemicals and biological agents found in the micro- and macro-environments lead to acute and chronic poisonings.

In the macro-environment, the chemicals and biological agents are found in environmental media such as water, foods, soil, and air.

In the micro-environment, these agents are found in the house where people live in the form of household products such as cleaning agents, medicines, insecticides, foods, drinks, ...etc.

Similarly, these agents are found in the workplace as raw materials for instance and in places of entertainment in the form of drugs of abuse, alcoholic drinks, and other harmful products.

In line with the basic tenet of toxicology, exposure to these agents alone does not lead to poisoning; rather the exposure through inhalation, transdermal, injection, or ingestion of amounts at rates beyond the threshold of human tolerance, results in acute poisoning (Holder et al., 2001; Klassen, 2008). Moreover, besides the dose and the dose-response relationship, it is now well recognized that both the exposure and its consequences are greatly influenced by a multitude of factors both within and beyond human control (Porter et al., 2010).

The understanding of how these multiple factors interact to influence the occurrence and severity of injuries including acute poisoning has been significantly advanced as a result of the pioneering work of Dr. William Haddon (1968), who proposed a matrix approach to the study of injury and its consequences.

He built his model based on the classic epidemiologic triad of host, agent, and environment and added a second axis of time sequence to emphasize that the event leading to the injury is separate from the injury itself. This time sequence was divided into three phases: the pre-event, event, and post-event phases.

Factors in the pre-event phase contribute to the likelihood of the potentially injurious event's occurring; factors in the event phase contribute to the likelihood that an injury will actually occur and how severe it will be; and factors in the post-event phase influence the consequences of the injury once it has occurred.

In the case of acute poisoning, the factors in the ‘pre-event phase’ include the whole political, socio-economic, and health system of the country including the extent and degree of enforcement of laws that permit, limit, and control access and use of chemicals. These factors influence the likelihood of the poisoning happening (Fig.1).

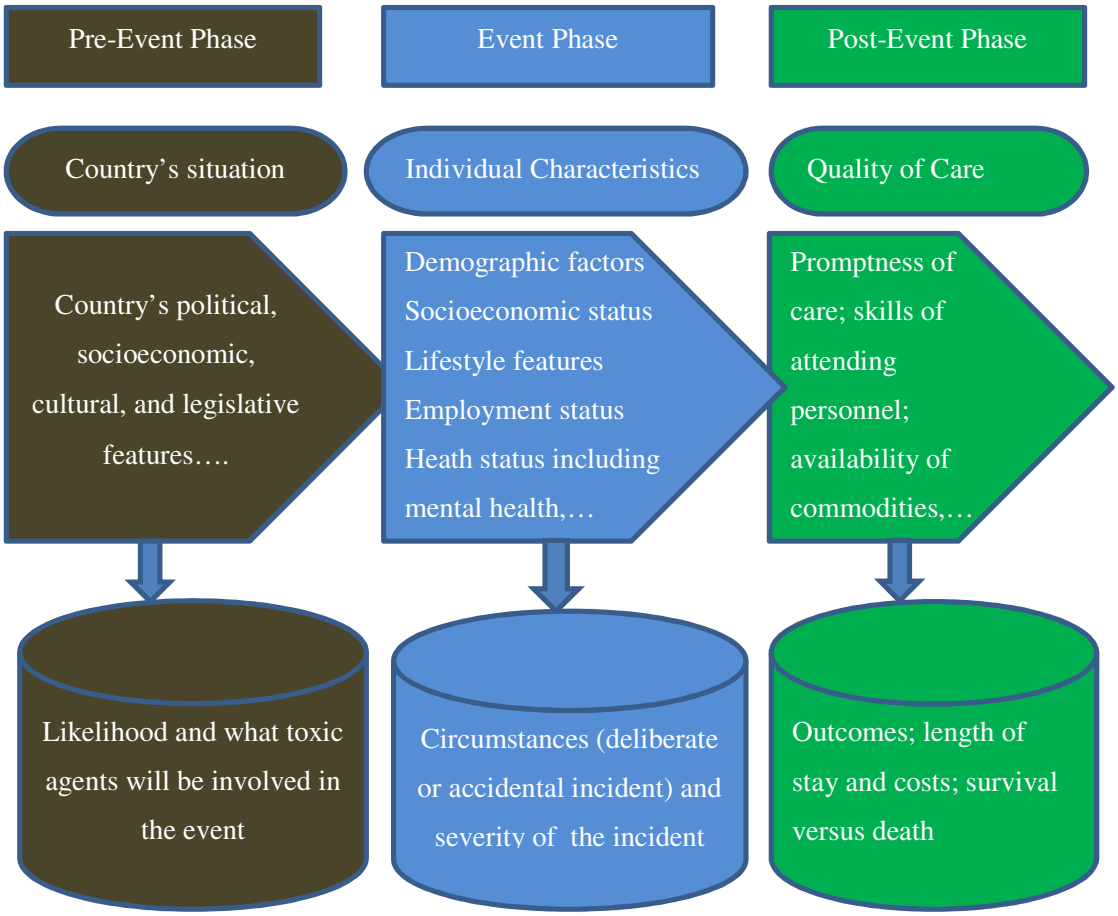


Fig. 1: Factors influencing the occurrence and outcomes of acute poisoning

The factors in the 'event phase' are the personal characteristics of the individuals that fall victims of acute poisoning. These characteristics include their demographic, socioeconomic, and health status such as age, gender, level of education, income, residence, mental status…etc. These factors determine the circumstances that lead to the poisoning whether accidental or deliberate. Together, these factors influence the severity of the poisoning.

The ‘post-event phase’ factors include the quality of care received which is itself influenced by how quick the victim is brought to medical attention, the skills of healthcare providers, the availability of relevant medicines, antidotes, and equipment needed for critical care, …etc. These factors influence the outcomes of the poisoning event, whether the victim will recover without sequel, or will suffer some form of impairment, or will die.

From the above, it is clear that the matrix approach for delineating factors influencing the incidence and severity of injury lays the foundations for injury control.

1.6. Assumptions made

With regard to assumptions, the major assumption made is that the data from the primary studies, as published in Paper I to VI, were accurate. Similarly, it is also assumed that the data sourced from the literature were accurate.

1.7. Components of the thesis

There are six chapters. This subsection ends the introductory Chapter 1. In the following pages, a review of the literature is presented in Chapter 2; Chapter 3 describes the methodologies used in the collection of data, their management and analysis; while the results and their discussions are presented in Chapter 4 and 5 respectively. The last Chapter 6 presents the conclusions and recommendations.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

This chapter begins with a description of the profiles of the countries in which the studies were conducted. This is followed by a review of previous studies about acute poisoning and the factors influencing its prevalence and outcomes. The chapter ends with some concluding remarks.

2.2 Brief overview on the three countries

2.2.1 Botswana

a. Geographic situation

Botswana is a landlocked country in Southern Africa. It is bordered by South Africa, Namibia and Zimbabwe. Its capital city is Gaborone.

Fig.2: Administrative map of Botswana

b. Population

As shown below, Botswana's population was estimated at 1.58 million in July 2000, and is expected to reach 2 million by 2030. With regard to ethnic grouping, Botswana is one of the few countries in sub-Saharan Africa with a fairly homogeneous ethnic background. The Tswana make up the majority of the population. It is estimated that Tswana (or Setswana) are 79%, Kalanga 11%, and white 7%.

Other ethnic groups include the San people (also known as Basarwa, Khwe, or Bushmen) who make 3% of the total. At independence in 1966 only 3 % of the population lived in urban areas, but by 2008, this figure had risen to 60 %. The majority of the population, about 61.8% is 15-64 years old; while children under 14 years old and the elderly aged over 65 years old are respectively 34.3% and 3.9% (CIA, 2010; NE, 2010).

c. Politics

Botswana is one of the best managed countries in Africa. Elections are held on a regular basis and are deemed free and fair. Since independence, four presidents have successfully succeeded each other. The National Assembly elects the country's President for a concurrent term of office, and the President appoints the Vice-President. It is reported that Botswana was one of the African countries where no events indicating civil unrest occurred in 2009 (CIA, 2010: AEO, 2010).

d. Economy and industrial development

Botswana is a has maintained one of the world's highest economic growth rates since independence in 1966, though growth fell below 5% in 2007-08, and turned sharply negative in 2009, with industry falling nearly 30%. Its economy is one of the strongest in Africa due largely to abundant diamond resources coupled with sound macroeconomic policies. Botswana is the world's biggest diamond producer in the world. Its mining industry, particularly diamonds, contributes over 35% of Botswana's GDP. Though agriculture in Botswana is mainly in the form of subsistence farming; beef exports are an important source of revenue for the country. However, because

subsistence farm products and livestock are primarily raised for local consumption and are not sold in the formal market, the value of this production is not included in the gross domestic product or formal employment figures. Agricultural employment is estimated at 15.6% of the formal workforce (CIA, 2010).

e. Socioeconomic situation

The distribution of income is among the most unequal in the world, the unemployment rate is very high, the infrastructure is inadequate and the electrification rate is just 39%. In addition, the economy is too dependent on the mining sector, which employs just 3.8% of the paid workforce.

Consequently, one of the major challenges for human development in Botswana remains poverty. Based on 1996 figures from the Central Statistical Office, the poorest 40 % of the population received 12 % of total income, the middle 40 % had 29 % and the richest 20 % had 59 %. This is an important factor in causing and perpetuating poverty (BCSO, 2009). The high unemployment rate is due partly to the decline of the agricultural sector as a source of employment and partly to the constraints of a largely undiversified economy that is highly dependent on mining, with less attention given to other sectors. Since the mining sector has limited capacity to absorb workers, overall unemployment remains high, particularly when economic growth is less than robust. However, the unemployment rate declined from 21.5% in 1996 to 17.5% in 2008 (AEO, 2010).

2.2.2 South Africa

a. Geographic situation

South Africa is situated at the southern tip of Africa forming part of the Southern Africa region and is bordered by Namibia, Botswana, Zimbabwe, Mozambique and Swaziland. There are nine provinces: Gauteng, Western Cape, Kwazulu-Natal, Eastern Cape, Northern Cape, Limpopo, Mpumalanga, Free State and the North West. Pretoria is the executive capital and Cape Town the legislative capital. Other major cities include Johannesburg, Durban, Port Elizabeth, Bloemfontein and East London.

The country's climate varies from province to province. The Western Cape experiences a Mediterranean climate and the interior has a semi-desert climate with cold, dry winters and summer rainfall. Kwazulu-Natal has a subtropical climate with humid conditions.

Fig.3: Administrative map of South Africa

b. Population

The last official census taken in South Africa in 1996 revealed a population 40,582,573 people. In 2001, estimates were that the population of South Africa has grown to 43,586,097. As of July 2010, it is estimated that the population has reached 50 million (SSA, 2010). The population of South Africa can be divided into the following main racial groups: Africans (blacks), whites, coloreds (mixed-race descendants of early white settlers and indigenous people), and Asians. It is reported that the Khoisan, followed by Bantu tribes migrating from the Central Africa, first inhabited the country. The population of South Africa is young, with 32 % of people between the age of 0 and 14, 63 % between 15 and 64, and only 5 % over the age of 65 (CIA, 2010; NE, 2010)

c. Politics

South Africa is also one of the few stable democratic republics in Africa. Since the first comprehensive elections in 1994, four presidents have successfully succeeded each other. The National Assembly elects the country's president for a concurrent term of office, and the president appoints the vice-president. For more than 15 years, the African National Congress (ANC) has managed to win the majority of votes each time; so the four transitions of powers have been within the ANC itself (AEO, 2010; NE, 2010)

d. Economy and industrial development

South Africa is one of stable economies on the African continent. Since1994, particularly, the country's economy has grown rapidly. Its geographical position provides an ideal gateway to Sub-Saharan Africa (WEF, 2000). The most important contributors to the economy include the mining sector, manufacturing and agriculture. Most economic activity takes place in Gauteng where most mining occurs. South Africa's mineral wealth is found in its diverse and extensive geological formations.

The Witwatersrand Basin contains a considerable portion of the world's gold reserves, and yields most of South Africa's gold outputs. Because of this large reserve base, South Africa is one of the world's leading producers of these commodities (CIA, 2010; NE, 2010; Naude and Kleynhans, 1999). The South African mining industry has become a world leader in developing deep-level mining technology as was recently shown during the rescue operations to the trapped miners in Chile (Froetschel, 2010).

Besides mining, manufacturing, financial services and banking sectors have shown significant growth in recent years. Agriculture contributes 4% to the country's GDP and consists largely of cattle and sheep farming with only 13% of land used for growing crops. Maize is most widely grown followed by wheat, oats, sugar cane and sunflowers (Du Toit and Jacobs, 1995; Ginsberg, 1998; Naude and Kleynhans, 1999; Edwards and Alves, 2010; AEO, 2010)

e. Socioeconomic situation

Due to South Africa's history of apartheid, a period when blacks were oppressed both politically and economically, the country's poverty and wealth profile is highly skewed. In fact, South Africa has one of the most unequal distributions of wealth and income in the world. It is reported that 40 % of the households with the lowest income in South Africa earn less than 6 % of total income, while the 10 % with the highest income earn more. The average income of the top-earning 20 % of the households is 45 times that of the bottom earning 20%.

However, the situation seems to be improving due to the implementation of Black Economic Empowerment policy and other measures of redress (UNECA, 2010; Bond, 2000; CIA, 2010; Whiteford et al., 1995; WEFA, 2006). Poverty in South Africa is primarily a feature of the historically disadvantaged population. Many households still have unsatisfactory access to clean water, energy, health care and education. It is estimated that 39% of the population is vulnerable to food insecurity (CIA, 2010; NE, 2010). South Africa is also characterized by large-scale unemployment in the formal sector of the economy that requires high skills that are scarce among the majority of the youth. At the end of 2009, 24.3% of the population, mainly black youth, were unemployed. When a broader definition of unemployment is used the rate is about 40% (AEO, 2010)

2.2.3 Uganda

a. Geography

Uganda is a landlocked independent republic with a democratic government which lies between the Democratic Republic of Congo and Kenya. It is a landlocked state in Eastern Africa, that has an area of 236,040 square kilometers and a total land boundary of 2,698 kilometers (CIA, 2010).

Fig.4: Administrative map of Uganda

b. Population

The Ugandan population is primarily of African descent, consisting of thirteen principal ethnic groups. Asians and Europeans make up about 1% of the population. Uganda's population is very young, its median age is 15.0years, the birth rate is 47.84 per 1,000 people, 50.0% of the population is under 15years old, 20.1% is between 25 and 44 and 2.1% are 65years and older.

Ugandan population has continued to grow over a period of time. It increased from 9.5 million by 1970 to 24.2 million in 2002; the projected 2010 mid-year population is estimated to be 31.8 million s. It is worth noting that more than half of Ugandan population (51%) is female (UBOS, 2010; CIA, 2010).

c. Politics

Like most African countries, the territory known as Uganda was an arbitrary creation of the European colonial powers. The borders cut across and brought together a whole range of ethnic and linguistic groups. Since gaining independence from Britain in 1962, the history of Uganda's politics and government falls into 4 broad periods. Prime Minister Milton Obote, who later became the self-appointed executive president, led the first period. The second period began in 1971 and ended in 1979 when Idi Amin who ousted Obote from government, was overthrown. The third broad period after Amin's defeat saw a string of 3 limited and short-term governments followed, led by President Binaisa, and President Lule, respectively; then in 1980, President Obote was reinstated.

The fourth period began when Yoweri Museveni took state power in 1986, and he is still President to date despite indications of discontent clearly illustrated by a series of violent insurgencies by dissident groups such as Joseph Kony's Lord's Resistance Army in the north and the Allied Democratic Forces (ADF) in the southwest (Ocan, 1994; Museveni, 1997; NE, 2010).

d. Economy and industrial development

Uganda is a lower-income country but has been one of Africa’s recent success stories with its ground-breaking accomplishments against HIV/AIDS and reports of robust economic growth. The economy grew at an annual rate of 7.6% between 1999 and 2008. This economic success resulted from the implementation of economic reforms. Agriculture is one of the country’s main industry sectors, employing 80% of Uganda's workforce, and made up 31.4% of the country’s GDP in 2002 that totalled US$5.9 billion. The main agricultural crops that are cultivated are cassava, sweet potatoes, plantains, millet, sorghum, corn and pulses. Industry and services made up 22.7% and 45.9% of GDP respectively (Belshaw and Lawrence, 1999; NE, 2010; CIA, 2010; WB, 2010).

The main export commodities include animal feed, cereals, copper, cotton, dairy products, fish, hides and skins, nuts and well-established cash crops such as coffee, tea, and tobacco.The main import commodities include chemical products, clothing, machinery metal and metal products, various petroleum products and pharmaceuticals (Fox and Liebenthal, 2006; CIA, 2010; Datta-Mitra, 2001).

e. Socioeconomic situation

With an average GDP per capita of US$332 in 1998, Uganda was one of the poor countries in the world with a wide disparity of the ownership of the means of production that is reflected by vast inequalities in the distribution of income. The poorest 20% of the country controls only 6.6% of the wealth, whereas the richest 20% control 46.1% of national wealth. In fact, 51.5% of the population lives on less than US$1.25 a day, and the majority of this limited income (63%) is spent on food (WB, 2010).

Unemployment is serious, since existing data indicate that there are just 8,000 jobs for the 390,000 students who finish tertiary education each year. At the end of 2008, the government estimated the unemployment rate for college graduates to be 36% (Lamont, 1995; Jamal, 1999; CIA, 2010; AEO, 2009; UNECA, 2010).

2.2.4. Health and human development profiles of the three countries

2.2.4.1. Health profiles

2.2.4.1.1. The concept of Burden of Diseases

A country's burden of disease refers to the assessment of mortality, morbidity, injuries, disabilities and other risk factors specific to that country. Murray and Lopez (1996) introduced a standardized method for quantifying disease burden in a way that facilitates international comparisons. They introduced the following metrics in the methodology:

- The disability-adjusted life-years (DALYs), an incidence-based measure quantifying the health gap between a population's actual health status and a specified norm or reference. DALYs for a disease or an injury are calculated as the sum of the years of life lost (YLL) due to premature death in the population and the years lost due to disability (YLD) for incident cases of the disease.
- The YLL is calculated from the number of deaths at each age multiplied by a global standard life expectancy of the age at which death occurs.
- YLD for a particular cause in a particular time period is estimated as follows:

YLD = number of incident cases in that period × average duration of the disease × disability weight. The disability weight reflects the severity of the disease on a scale from 0 (perfect health) to 1 (death).

The most recent disability weights used for global burden of disease DALY estimates are available in a publication by Mathers et al. (2006). In addition, calculations of YLD includes a 3% time discounting and non-uniform age weights that give less weight to years lived at young and older ages, as suggested by WHO (2004). Using discounting and age weights, a death in infancy corresponds to 33 DALYs, and deaths at ages 5–20 years to around 36 DALYs.

2.2.4.1.2. Burden of diseases and injuries in the three countries

Based on data submitted to WHO for the year 2004 as updated by February 2009, Botswana, South Africa, and Uganda show a similar pattern of a quadruple disease burden made of communicable diseases mainly infectious diseases, non-communicable diseases, HIV/AIDS, and injuries as shown in Table 1.

With regard to infectious and parasitic diseases, while Botswana has the highest burden of HIV/AIDS, it suffers from lesser burden for Malaria and TB. South Africa has the highest TB burden of the three; while Uganda has the highest Malaria burden.

With regard to non-communicable diseases, the three countries share similar burden with South Africa being only slightly more affected than the others with regard to endocrine disorders, diabetes, cardiovascular, digestive, respiratory, and genito-urinary diseases. In contrast, Botswana seems to have a higher burden of congenital anomalies. The burden of diseases such as sense organ disorders, oral health conditions, skin diseases, and others are similar.

With regard to injuries, it is important to note that acute poisoning is one of the injuries that affect the three countries. Because of lack of robust surveillance systems, the data reported below do not reflect the actual extent of the problem of poisoning. However, based on data reported to WHO by individual countries, it seems that Uganda suffers the highest burden of unintentional injuries particularly poisonings. It seems that South Africa leads the other two countries with regard to deliberate injuries, namely self-inflicted injuries and violence; while Uganda has the highest burden of injuries due to war. With regard to drowning injuries, Botswana bears more burden than the other two countries.

Table 1: Age standardized DALYs of the three countries based on WHO 2004 data

	Age Standardized DALYs					
Country	***Botswana***		***South Africa***		***Uganda***	
Diseases entities	***DALYs***	***%***	***DALYs***	***%***	***DALYs***	***%***
All Causes	53,389	100.00	46,237	100.00	48,408	100.0
Communicable diseases	*38,586*	72.27	*26,298*	*49.26*	*29,981*	*56.16*
Infectious and parasitic diseases	32,483	***60.84***	22,646	***42.42***	22,336	***41.84***
Tuberculosis	1,063	**1.99**	2,484	**4.65**	2,213	**4.14**
HIV/AIDS	28,307	**53.02**	18,210	**34.11**	12,634	**23.66**
Malaria	41	**0.08**	13	**0.02**	2,592	**4.85**
Respiratory infections	1,825	**3.42**	956	**1.79**	2,581	**4.83**
Maternal conditions	878	**1.64**	715	**1.34**	1,965	**3.68**
Perinatal conditions	2,868	**5.37**	1,105	**2.07**	2,155	**4.04**
Nutritional deficiencies	532	1.00	876	1.64	945	**1.77**
Noncommunicable diseases	*11,686*	***21.89***	*15,154*	***28.38***	*13,358*	***25.02***
Malignant neoplasms	958	**1.79**	1,503	**2.82**	1,256	**2.35**
Other neoplasms	37	0.07	59	0.11	46	0.09
Diabetes mellitus	405	0.76	839	**1.57**	439	0.82
Endocrine disorders	406	0.76	569	**1.07**	460	0.86
Neuropsychiatric conditions	2,430	**4.55**	2,727	**5.11**	2,550	**4.78**
Sense organ diseases	2,153	4.03	2,154	4.03	2,149	4.03
Cardiovascular diseases	2,330	**4.36**	3,559	**6.67**	3,070	**5.75**
Respiratory diseases	898	**1.68**	1,358	**2.54**	1,119	**2.10**
Digestive diseases	611	1.15	936	**1.75**	833	1.56
Genitourinary diseases	272	0.51	427	**0.80**	352	0.66
Skin diseases	151	0.28	165	0.31	157	0.29
Musculoskeletal diseases	475	0.89	489	0.92	481	0.90
Congenital anomalies	463	**0.87**	270	0.51	349	0.65
Oral conditions	97	0.18	100	0.19	98	0.18
All Injuries	3,117.92	***5.84***	4,785.24	***8.96***	5,069.12	***9.49***
Unintentional injuries	2,200.54	4.12	2,205.73	4.13	2,826.00	**5.29**
Road traffic accidents	714.14	1.34	1,138.44	**2.13**	1,021.54	1.91
Poisonings	118.59	0.22	29.93	0.06	281.99	**0.53**
Falls	102.80	0.19	103.54	0.19	132.65	**0.25**
Fires	169.44	0.32	248.02	**0.46**	215.44	0.40
Drownings	239.81	**0.45**	77.02	0.14	222.50	0.42
Other unintentional injuries	855.76	1.60	608.77	1.14	951.88	**1.78**
Intentional Injuries	917.38	1.72	2,579.51	**4.83**	2,243.12	4.20
Self-inflicted injuries	180.58	0.34	359.16	**0.67**	234.68	0.44
Violence	665.89	1.25	2,030.82	**3.80**	1,033.58	1.94
War	70.91	0.13	179.70	0.34	974.85	**1.83**

2.2.4.2. Human development index

The recent summary data on the human development index (HDI) are shown in the following table.

Table 2: Selected indicators of HDI as per Human Development Report 2010

HDI Rank	Country	HDI	Life Expentancy at birth	Expected Years of Schooling	Mean years of schooling	GNI per capita in USD (2008)
Medium Human Development						
98	Botswana	0.63	55.50	12.40	8.90	13204.00
110	South Africa	0.59	52.00	13.40	8.20	9812.00
Low Human Development						
143	Uganda	0.42	54.10	10.40	4.70	1224.00

Botswana and South Africa are classified in "medium human development", while Uganda is in the "low human development" category. The low ranking of Uganda (143 of 179 nations) is due to the existence of widespread poverty as well as inadequate health and education systems that cannot accommodate a rapidly growing population (UNDP, 2010). From Table 2, it can be seen that the mean years of schooling in Uganda in about half of what it is in Botswana and South Africa. It seems that many people in Uganda, which has the majority of its population made of youths, do not complete even half of the expected 10 years of schooling.

Moreover, the discrepancy between the gross national income (GNI) per capita of Uganda is very low compared to both Botswana and South Africa. It remains low even when compared to the Sub-Saharan Africa average of USD 2,050. This explains partly the high level of poverty experienced in Uganda. Hence, the majority of people in Uganda may be categorized in the lower socioeconomic status (UBOS, 2010). However, even though Uganda is behind Botswana and South Africa on the overall index, the life expectancy of its population is similar to that of Botswana and slightly higher than South Africa.

2.3 Overview on previous studies on acute poisoning

2.3.1 Introduction

In the following pages, a review of relevant studies is undertaken starting from the concept of acute poisoning, and ending with perspectives of the management and outcomes of acute poisoning.

2.3.2 The concept of acute poisoning

The Global Burden of Disease (GBD) Group has established that injuries contribute approximately 10% to global mortality and 12% to global morbidity worldwide (Murray and Lopez, 1996; Mathers and Lonar, 2006; WHO, 2008). In the countries under review, WHO estimates that injuries are responsible of 2.2%, 3.3%, and 5.0% of children deaths, respectively in Uganda, Botswana and South Africa (WHO, 2006). Among the injuries, acute poisoning constitutes a separate entity discussed below.

Acute poisoning results from exposures to toxic agents that may lead to harmful effects based on the reaction of the body to these agents. Exposures may be through ingestion, transdermal, injection, or inhalation. The resulting effects of the exposure may be localized, or generalized; they may also be topical or systemic. At the core, the adverse functional or morphological changes observed upon clinical, gross or histopathological examinations are almost invariably a consequence of biochemical lesions (Beriche et al., 2010; Zampagni et al., 2010). This means that, in general, toxicity arises from interaction with molecular sites leading to derangement of the biochemical processes involved in the normal function and regulation of the cells, tissues, organs and systems of the body. Hence it is the overloading of the biochemical processes beyond their capacity to adapt that leads ultimately to cell, tissue, or organ injury; whether the substance involved is a nutrient, endogenous metabolite, or a xenobiotic, meaning, any substance foreign to the body (Tarloff and Wallace, 2007).

Various primary biochemical mechanisms may be involved in the occurrence of a toxic response, although their detailed discussion is beyond the scope of this review. However, it is important to note that a single chemical may produce toxicity by more than one mechanism.

In addition, an action via one mechanism may increase toxicity mediated by another mechanism, for instance, an overload of metabolic pathways could lead to a disproportionately increased interactions with endogenous non-specific receptors, and the resulting reversible reactions may trigger other competitive or non-competitive reactions. This is why it is difficult to predict the range of toxic effects of any substance ingested in an overdose situation. Several authors have described diverse mechanisms of toxicity (Gillette et al., 1974; Kaplowitz, 2002; Lee, 2003; Ansari et al., 2004; Masubuchi and Horie, 2007; Obinaju, 2009; Grattagliano et al., 2009). Some of these mechanisms include:

- Depletion of protective pools;
- Displacement from carrier proteins;
- Induction of germ cell mutations ;
- Induction and/ or overload of specific enzymes;
- Inhibition of specific enzymes: competitive or non-competitive;
- Interaction with endogenous receptors: specific and non-specific;

Hence, in most cases, the detailed mechanism of poisoning is unknown, but the time between the exposure and the elucidation of the resulting toxic effects determines whether an exposure is acute or chronic. In an acute toxicity or poisoning, the effects occur almost immediately after an exposure. Whether the effects follow a single dose or a series of doses or exposures, when the effects appear within 24 hours, this is termed “acute poisoning” (Klaassen, 2008).

Moreover, the exposures may be deliberate or accidental. Deliberate exposures occur when the victims expose themselves to toxic agents with the intention to harm themselves or to seek attention from the people close to them. These exposures result in suicide or parasuicide depending on whether the victim had or did not have actual intention to die (Hatzitolios et al., 2001). A parasuicidal patient is defined as one who ‘deliberately ingested a substance in excess of the prescribed or generally recognized therapeutic dosage range and which is aimed at realizing changes which the subject desired via the actual or expected physical consequences’ (Schmidtke, 1997).

However, whether the victims dies or not, deliberate self-poisoning (DSP) is a serious public health issue for several reasons. These include the draining of financial resources from the healthcare system and households, the loss of working times as relatives have to look after the victims, the increase in the use of health commodities in treating the victim, and the emotional burden it leaves to all involved.

Furthermore, other deliberate exposures result from actions or gestures taken by other people in order to harm the victims. In this case the resulting poisoning incident is often criminal although it can be emotional for instance in case of a lover's revenge or attention-seeking tactics (Camber, 2011). Several motives can lead to criminal poisoning. These include but not limited to the desire to benefit financially, get political power, to end the miserable life of a loved one, to eliminate an enemy, to terrorize, to steal, to get attention as in the case of *Munchausen Syndrome by Proxy*, or to perform sexual assault or rape (Douglas et al., 1992; Levin and Sheridan, 1995; Trestrail, 2007). Many investigators have reported on drug-facilitated sexual assaults where a variety of prescription and drugs of abuse have been used (Kesterer and Uges, 1992; Richard et al., 1996).

With regard to accidental poisoning, it is reported that several social and demographic factors such as the socioeconomic status, age and gender of people influence the occurrence of acute poisoning cases (Nhachi and Kasilo, 2006; Izuora and Adeoye, 2001). The above review shows that acute poisoning is complex and multi-factorial as discussed below.

2.3.3 Prevalence and risk factors of acute poisoning

The prevalence of acute poisoning in the general population is unknown because of lack of population-based studies. However, prevalence of acute poisoning in patients attending health facilities has been determined as well as the factors associated with such incidents. Several studies have reported the prevalence of acute poisoning calculated on the basis of all patients that were diagnosed with 'poisoning' or on the basis on a single toxic agent involved in of a confirmed poisoning event. Because the diagnosis is usually based on the patients or relatives reports, with little confirmation by laboratory findings, the accuracy of prevalence figures is limited. There is a further limitation due to the fact that a large portion of patients or those accompanying them are unable to state exactly the nature, type, or the name of the toxic agents involved particularly in case of attempted suicide.

Hence, due the limitations stated above, it is often not practical to conduct laboratory investigations when it is not clear what chemicals should be targeted for the investigation.

In clinical practice, the anamnesis provides the basis for the diagnosis of acute poisoning. Several studies have reported the prevalence of acute poisoning based on the number of people attending the emergency departments, and /or people admitted in the hospital wards with a diagnosis of acute poisoning. The figures reported vary widely with the size of the denominator used. Hence, studies from some countries in Europe, particularly, in Greece, reported that acute poisonings represent up to 2.4 % of the overall admissions in a medical department, and 0.7% of all emergency admissions (Ozköse and Ayoglu, 1999; Akbaba, 2007). In the UK, it is estimated that 5-10% of patients seen at Emergency departments are victims of poisoning (Greene et al., 2005). In Middle East and Asia, figures as high as 42%, and as low as 1.5%, 3.4% and 3.9% have been reported respectively in Iran, Palestine, China, and India (Abdollahi et al., 1997; Lall et al., 2003; Sawalha et al., 2010; Jayashree and Singhi, 2010; Sin-Man et al., 2010; Shadnia et al., 2007). While in Africa, reported estimates range from 1.2% in Togo to 9.1% -11% in South Africa (Balme et al., 2010; Tsolenyanu et al., 2009; Ibekwe et al., 2007; Reed and Conrandie, 1997).

Published studies report not only the prevalence but also the types of toxic agents involved in these incidents. Hence, with regard to studies reporting acute poisoning due to a single type of toxic agent, pesticides seem to be the most reported agents. Acute pesticide poisoning is a major public health problem worldwide, following the intensification of agriculture and the promotion of agrichemicals in low and middle-income countries. Hence, deliberate self-poisoning involving these chemicals have been reported in many countries such as Zimbabwe, Nigeria, Ethiopia, Iran, Israel, India, China, Trinidad and Tobago, Guyana, as well as in Greece and Turkey (Akang et al., 1994; Ozköse and Ayoglu, 1999; Sawalha et al., 2010; Jayashree and Singhi, 2010; Shadnia et al., 2007).

The promotion of these chemicals in improving agricultural outputs has led to the easy availability of highly toxic pesticides in the homes of farming communities. Hence, paraquat, for instance, has been reported in poisoning incidents in many countries including Brazil, Fiji, Guadeloupe, Korea, Guinea, Mexico, Reunion, Singapore, Sri Lanka, Suriname, Taiwan, Thailand, and Western Samoa (Chan et al., 1982; Ram and Roa, 1983; Wong and Ng, 1984; Haynes, 1987; Perriens et al., 1989; Forget, 1991; Tinoco et al., 1993; Lee et al., 1995; Bowles, 1995; Tinoco-Ojanguren, 1998). More studies from Asia have documented that self-poisoning with pesticides is one of the most predominant means of suicide. For example, in China, Sri Lanka and Malaysia more than 60% of all suicides in rural areas are performed using pesticides (Eddleston, 2000; Gunnell et al., 2007; Konradsen et al., 2007). In contrast, in the United Kingdom, acetaminophen or paracetamol is the drug most widely reported as being used in deliberate self-poisoning (Hawton et al, 1996; Hawton and Harriss, 2006; Hawton and Harriss, 2008).

With regard to studies reporting multiple toxic agents involved in acute incidents, Kobayashi and Fukushima (2008) reported one of the most dramatic. In this incident, a victim committed suicidal poisoning and died from hydrogen sulfide produced by mixing a liquid bath essence containing sulfur and a toilet bowl cleaner containing hydrochloric acid. Several studies have reported incidents involving alcohol and drugs of abuse; alcohol and pharmaceuticals, and even pesticides with alcohol and pharmaceuticals as well as a combination of several medicines being involved in suicides (Desalew et al., 2011; Joubert and Mathibe, 1989; Joubert, 1990).

Nordentoft (2007) reported on risk of suicide attempt and suicide in the short-term, medium-term and long-term follow-up of persons who attempted suicide. The findings were that the risk of repetition in short- and medium-term follow-up studies was approximately 16 %, with lower risk among "first-evers" compared to repeaters. Nordentoft (2007) reported also that the risk factors for attempted suicide were previous suicide attempt, alcohol and drug abuse, depression, schizophrenia, previous inpatient treatment, unemployment, frequent change of residential address, hostility, and loneliness. Moreover, he stated that the predictors of successful suicide were male gender, increasing age, previous suicide attempt, alcohol and substance abuse, mental illness, as well as ongoing or previous psychiatric treatment.

Several other authors have reported similar findings (Cassidy et al., 2008). The factors reported as associated with para- and suicide include being lonely, unemployed, being in interpersonal conflicts, failed or failing relationships, mental illness, ill health and substance abuse, especially alcohol (Joubert and Mathibe, 1989; Schapira et al., 2001; Lifshitz and Gayrilov, 2002; Camidge et al., 2003; Watson et al., 2003; Desalew, 2011). A systematic review study by Fliege et al. (2009) reported that deliberate self-harm may occur at all ages, yet adolescents and young adults are at a higher risk. From the same authors, they reported that that there is an association between current self-harm behaviour and a history of childhood sexual abuse as well as negative emotions such as anxiety, depression, and aggressiveness. These findings concur with reports from Africa, in particular, by Kinyanda and co-workers (2005) who reported that negative life-events including mental disorders are associated with suicide attempts in Uganda.

Indeed, besides pesticides, other toxic agents such as pharmaceuticals are involved in acute poisoning. Both prescription and non-prescription medicines have been used throughout the world for self-poisoning mainly in urban areas. The most commonly used medicines are central nervous system-acting drugs such as antipsychotics, antidepressants, barbiturates, and benzodiazepines; followed by analgesics mainly paracetamol; anti-epileptic drugs such as carbamazepine; antiseptics and disinfectants; antimalarial drugs such as chloroquine and others (Eddleston, 2000; Lamminpaa, 1991). Cases of poisoning with medicines have been reported from several countries including South Africa (Ndiaye et al., 1983; Meeran and Jacobs, 1993; Joubert and Mathibe, 1989). Paracetamol has been reported as the most used medicine in suicidal poisoning among teenagers since it is easily found in the homes (Hawton and Harriss, 2008).

With regard to household products and chemicals, the most commonly involved toxic agents are paraffin, cleaning agents such as bleach and cetrimide, acids and bases used for drain cleaning, shampoos and soaps, disinfectants such as potassium permanganate and creosote; cigarettes, insecticides and rodenticides used in the homes (Eddleston, 2000; Joubert, 1990). This group of products illustrates the diversity of toxic chemicals that can potentially be involved in acute poisoning incidents.

However, this diversity in itself does not explain why different groups of people are victims of poisoning with a particular toxic agent. Rather, the sum of factors that lead to exposures to specific toxic agents explains why some toxic agents would be involved in poisoning incidents. For instance, paraffin, a common household product, is mainly involved in incidents with younger children in South Africa, particularly in those who live in informal settlements and in rural areas because it is in these settings where paraffin is used as the main source of energy for domestic use. Reed and Conradie (1997) reported that children younger than five years of age admitted with the diagnosis of paraffin poisoning represented 9.1% of total ward admissions for this age group at Shongwe Hospital, in South Africa.

Hence, the presence of the diverse products in the households and the way in which they are stored, influence the probability of occurrence of an acute poisoning incident (Butchart et al., 2000; Burrows et al., 2010). When implicated in accidental poisoning, household chemicals are often used in small quantities thereby resulting in minor or mild acute poisoning cases. On the contrary, when they are used in deliberate self-poisoning, these products can be ingested or inhaled at excessive doses that may lead to life-threatening or fatal outcomes (Chan et al., 1995; Yusuf et al., 2000; Akbaba, 2007). Among products that are available in households, foods also lead to poisoning.

With regard to food poisoning, it is one of the common categories of acute poisoning but due to the lack of effective surveillance systems, its incidence is not well established. Moreover, food poisoning is often confused with food allergy and food adverse effects, which are respectively an immune-mediated reaction, and a clinically abnormal response, attributed to an exposure to a food or food additive (Anderson, 1986). A study conducted by Ravel et al. (2009) in Canada reported that, overall, 6,908 food-borne outbreaks occurred from 1976 through 2005, but the offending agent and the food vehicle carrying it were identified in about one-third of these outbreaks. A detailed analysis of these outbreaks showed the following distribution of micro-organisms and types of foods involved: salmonellosis in 29% of cases associated with fresh produces, 15% with poultry, and 15% with meat other than poultry, pork, and beef. While campylobacteriosis was found in 56% of cases associated with poultry and 22% with dairy products other than milk; and *Escherichia coli* infection was present in 37% of cases associated with beef, 23% with cooked multi-ingredient dishes, and 11% with meat other than beef, poultry, and pork.

The above report attests that bacteria are the most common agents involved in food poisoning; but other micro-organisms such as norovirus and rotavirus as well as parasites such as *Gardia spp*, and C*yclosporidium spp* can also be involved (Herwaldt and Beach, 1997; AMA, 2004). The main reason why bacteria predominate is that they have the ability to grow in the foods. Even when bacteria do not grow in the food itself, they may be carried by the food such as in the case of dysentery. It is important to note that most foods carry microorganisms; but some foods are more prone in being potential carriers of food poisoning microorganisms (Varma et al., 2007). These foods are principally raw meat, poultry, milk, and seafood.

Food-poisoning organisms are often associated with the gut of humans, animals, and birds. Therefore, any food contaminated with faeces has the potential to cause food poisoning (Hedican et al., 2010). Since water is a component of most foods and drinks, if it is contaminated it became a major source of illnesses and food poisoning (Batz et al., 2005; Miller et al., 2008; Koepke et al., 2008). Furthermore, some toxic agents found in the foodstuffs can also cause food poisoning such as in the case of mushroom toxins, or Ciguatera poisoning that result from eating fish that contain toxins produced by a marine alga called *Gambierdiscus toxicus*. Pesticide food poisoning can also occur if recently treated and unwashed fruits or vegetables that are contaminated with pesticides are eaten (Schantz, 1989; Morgan and Fenwick, 1990; Herwaldt and Beach, 1997; Noah, 2009).

With regard to acute poisoning due to plants and traditional medicines, they have been reported as major causes of hospital admissions in some African countries including Nigeria, South Africa, and Zimbabwe (Kadiri et al., 1999; Foukaridis et al., 1994; Kasilo and Nhachi, 1992). A10-year retrospective study describing the pattern of hospital admissions due to poisoning in Zimbabwe reported that traditional medicines were responsible for 22.9% of cases of acute poisoning. Poisoning from plants is due to their toxic constituents, mainly alkaloids, but also taxanes, glucosides, saponins, flavonoids, and other compounds. Historically plants containing alkaloids such as aconitine, strychnine, and others have been used in criminal poisoning (Trestrail, 2007).

Moreover, many traditional medicines especially in the tropical regions of Africa contain plants or plant materials that can produce renal toxicity. One such medicine is the traditional remedy in South Africa called "Impila" that is made from the roots of the plant, *Callilepis laureola.* It is used to treat a number of heath conditions, but it is reported as causing hepatic and renal toxicity (Stewart et al., 2002). Elsewhere, there have been reports of acute renal failure in individuals ingesting wild mushrooms containing the nephrotoxic "orellanine" (Mount et al., 2002); and a case report of acute renal failure was reported in a patient with systemic lupus erythematous taking *Uncaria tomentosa,* the popular Peruvian herb cat's claw (Hileps et al., 1997).

While the use of traditional medicines is associated with health beliefs, its poisoning incidents are believed to result from overdosing due to lack of standardized dosing in traditional medicine practice. In contrast, poisoning by plant materials is often associated with children's explorative nature (Becharat et al., 2008). In adults, there have been reports of plant poisoning due to confusion of edible legumes with their look-alike toxic species. An outbreak occurred in Cambodia due to the confusion of the edible *Melientha suavis* with *Urobotrya siamensis*, both plants from the Opiliaceae family (Tourdjman et al., 2009). In other instances, plant poisoning occurred due the deliberate acts of suicide based on local knowledge of the toxic effects of the plants. In Asia, cases of deliberate ingestion of yellow oleander seeds (*Thevetia peruviana*), known as "lucky nuts," had been reported in Sri Lanka, where this plant is frequently used for self-poisoning, with a case fatality rate of untreated patients ranging between 5 and 10% (Eddleston et al., 2000). In other settings, accidental plant poisoning incidents have been reported after people consumed teas brewed from plant parts or after consuming leaves, flowers, or seeds from toxic plants (Dickstein and Kunkel, 1980; Bain, 1985; Meda et al., 1999; Joskow et al., 2006). Besides poisoning from ingestions, biting can also lead to poisoning.

With regard to acute poisoning due to bites, it is known that biting exposures can be from insects, animals, and humans. Reliable statistics are not available for most biting incidents since they are not usually notifiable conditions in many countries. Moreover, victims of insect biting exposures do not often require hospital care or seek medical care; except when the situation is immediately serious as when anaphylactic shock ensues following a bee stinging of a hypersensible person. Anaphylactic shock is the most notable immediate risk associated with insect exposures whether it was insect saliva, venom, body parts, excretions, or secretions (Hoffman, 1981; Hill et al., 2005).

Notwithstanding allergy, diseases may be transmitted by insect bites (Busvine, 1993). These include for instance Lyme disease, transmitted by ticks; and malaria, transmitted by mosquitoes, as well as other conditions (Voigt, 2008; Rodriguez et al., 2009). Because the resulting infections or diseases may produce a mild to severe acute and / or chronic illness, especially in paediatric patients and tourists, clinicians should always take the necessary measures when managing such victims (Lane and Crosskey, 1993; Hill et al., 2005; Goddard, 1996; Goddard and de Shazo, 2009). In terms of the burden of incidents, a study in Zimbabwe, found that 1.5% of hospital admissions were related to insect exposure, including both bites and stings. The majority of these were due to arachnids (Nhachi and Kasilo, 1993). In Tunisia, Bouaziz et al. (2008), reported on 951 cases of scorpion bites incidents.

With regard to animals, the most common bites are snakes and dogs' bites. Snakebites cause considerable death and injury worldwide and pose an important yet neglected threat to public health. A recent study that pooled data from 227 countries showed that 421,000 envenomings and 20,000 related deaths occur worldwide from snakebites annually. It is estimated that India has the highest annual envenomings and deaths of 81,000, and 11,000 respectively (Kasturiratne et al., 2009). Cases of snakebites have been reported in many countries including Botswana, Kenya and South Africa (Coetzer and Tilbury, 1982; Coombs et al., 1997; Malangu, 2007a Malangu, 2007b). It is known that snakebites are more common in tropical regions and in areas that are primarily agricultural (Chippaux, 1998).

Two major families of snakes account for most envenomation incidents in humans; they are the elapid and the viper families. A study from Sri Lanka reported that the majority of 97 snakes identified were vipers, while the twelve were cobras and kraits. The same study reported that the majority of envenomings happened during harvest periods, with one death out of 303 cases treated at heath facilities (Whitehall et al., 2007). A recent study from Turkey attests that the majority of snake envenomation was also due to the *Vipera ammodytes species*. Of the 79 cases described in the study, no deaths occurred (Al et al., 2010). Besides people living in agrarian conditions, people involved in outdoor activities are also at risk for snake bite and should take precautionary measures such as wearing long boots or long baggy trousers and thick socks to act as a barrier in case of an unsuspected attack (Auerbach, 2001; Bentur et al., 2008).

With regard to dogs and cats bites, data from Australia show that although bite injuries account for 1% of emergency department visits; dog bites are the most common representing 80-90% of cases that affect mainly children aged 5-9 years old, particularly boys (Weiss et al, 1998). Between 4 and 25% of dog bite wounds become infected; and the factors that may increase the risk of infection include deeper wounds, puncture injuries, crush wounds and wounds on the hands (Goldstein, 1992; Smith et al., 2000). Hence, dog bites may lead to fatalities. In USA, it has been reported that over 300 deaths due to dog bites occurred between 1979 and 1996; while in Canada, 28 fatalities were reported between 1990 and 2007; and five in New Zealand in 2004 (Healey, 2007; Raghavan, 2008; Shields et al., 2009). Moreover, besides injuries and fatalities, dog bites can also transmit rabies as reported by a study from Tanzania (Hampson et al., 2008). With regard to cat bites, they occur particularly in women and in the elderly. A large proportion of cat bites are puncture wounds that present an increased risk of infection (Goldstein, 1992; Smith et al., 2000).

Finally, human bite wounds account for 2-3% of bite presentations in Australia; reliable data from other countries are not available. These injuries are commonly infected with bacteria from the human oropharyngeal flora. Therefore, admission to hospital for intravenous antibiotic therapy is usually required (Medeiros and Saconato, 2001).

2.3.4 Management and outcomes of acute poisoning

Both, preventive and curative interventions are implemented to address and manage the problem of acute poisoning and its victims.

2.3.4.1 Preventive interventions

Acute poisoning as a health condition deserves to be targeted for preventive interventions. From the review presented above, it is clear that though there are many factors involved in the occurrence of acute poisoning, it is possible to retain some key risk factors that can lead to defining a "high-risk" group. For acute poisoning, the youth, from teenagers to young adults, particularly those with any psychiatric or psychological disorder, those with history of child abuse, and those who are addicted to any substance, constitute a high-risk group for para- and suicide (Kinyanda et al., 2005; Nordentoft, 2007; Hawton and Harriss, 2008; Fliege et al., 2009). In contrast, it is harder to define a similar grouping based on known risk factors for accidental and criminal poisonings at population level; though it is possible to do so in workplace settings (Graves et al., 1991; Ayres et al., 1996). Thus, the two public health strategies, namely, individual-centred or 'high risk strategy', and the population-centred or 'population strategy', need to be operationalized in order to address acute poisoning (Rose, 2001).

In order to reduce the morbidity and mortality, multiple approaches ought to be implemented. Based on the population strategy, these include legislative measures, public educational programs, and establishment of poison or toxicological information centers and services (Hung et al., 2008). Reports from England and Sri Lanka have shown that legislative measures that restricted access to toxic agents resulted in a decrease in mortality associated with the targeted agents (Krietman, 1976; Gunnell et al., 2000; man et a., 2005; Manuweera et al., 2008).

Based on high-risk strategy, managerial decisions at facilities' level can be implemented such as assessment of poisoning cases with clinical psychometric tools, or referral of deliberate poisoning cases to a psychologist or psychiatrist, specific educational programs for limited households or communities. In this respect, health facilities-based interventions after admission for self-harm have become popular in an attempt to reduce repetition. However, there are conflicting reports about

their success. One meta-analysis concluded that there was insufficient evidence to recommend any of the specific interventions as a means to reduce further harmful behavior (Hawton et al., 1998; van der Sande, 1997). In contrast, a recent meta-analysis concluded that home safety education provided in a clinical setting or at home, together with the provision of safety equipment is effective in increasing a range of safety practices (Kendrick et al, 2007). Yet, in Sri Lanka an intervention aimed at assisting a farming community to improve the storage of pesticides, resulted in participants opting to keep the safe storage boxes containing pesticides at their homes rather than in the field, thereby increasing the risk of their accessibility and use in poisoning incidents (Konradsen et al., 2007). Clearly, there is still some uncertainty with regard to the level of success of various preventive interventions.

2.3.4.2 Curative measures

Because serious clinical toxic effects occur in less than 5% of poisoned patients, identifying patients that require immediate care is paramount to a successful management of victims of acute poisoning. Patients in need of immediate care include those suffering from cardiac arrests, respiratory distress, hypotension, arrhythmia, seizures, agitation, hypoglycemia, and those with body temperature over 39^0C (Greene et al., 2005).

Strategies or treatment options include supportive care, gut decontamination using activated charcoal, increasing drug elimination through multi-dose activated charcoal or urine alkalinisation with sodium bicarbonate, or charcoal hemo-perfusion; use of specific antidotes, use of medicines to prevent complications of poisoning, and induction of vomiting where applicable (Greene et al., 2005;Baselt, 2002;Thakore and Murphy, 2002; Karim et al., 2001).

As noted above, it is clear that once the dose absorbed or otherwise consumed overwhelms the victim threshold of tolerance, the toxic effects manifest; hence, it is the patients' clinical status upon arrival at a health facility or at the time when medical assistance is provided that determines, among others, the outcome of acute poisoning. Studies in Europe have reported that, though the status of patients upon arrival is generally good, serious symptoms such as unconsciousness, insufficient ventilation necessitating intubation, convulsions or hypotension, were recorded in 15% of cases in Finland for instance (Lapatto-Reiniluoto et al., 1998); while 29% of patients were semi-

comatose or comatose in a study from Croatia (Prkacin et al., 2001). Such patients with poor prognosis have less chance for better outcomes.

2.3.4.3 Outcomes of acute poisoning

The mortality rate of acute poisoning varies across settings, and is determined by many factor such as the poisonous substance's inherent toxicity and the amounts consumed, the treatment instituted, and various patients and health systems' factors. These factors include the skills of the attending health care workers, the time lapse between the poisoning and the provision of first aid or medical care, the extent and number of vital functions affected. It is also reported that the availability of antidotes and required equipment affect the treatment given (Shadnia et al., 2003).

Published case fatality rates of poisoning incidents range from as low as less than 1% in Germany to up to 3.9% in Spain, Greece, Hong Kong and Turkey. But, fatality rates have been reported to be as high as 8% in Sri Lanka, 9.6% in elderly Chinese, and 15.4% in India (Pinar and Fowler, 1993; Chan et al, 1994; Cabo et al., 1993; Goksu et al., 2002; Ravindra, 2002; Afshari et al., 2004; Seydaoglu et al., 2005; Ramesha et al., 2009; Hu et al., 2010).

With regard to the relationship between the fatal outcomes and specific groups of toxic agents, agrichemicals particularly organophosphate pesticides continue to be responsible for the majority of deaths in most deliberate self-poisoning cases in many developing countries (Gunnell et al., 2007). For instance, in Zimbabwe, a case fatality of 15% was reported, and the main agents associated with fatality were, in descending order, pesticides, traditional medicines, and pharmaceuticals (Nhachi and Kasilo, 1992). In South Korea, of the 25,360 deaths due to poisoning between 1996 and 2005, pesticides were responsible for 58.3% of fatalities (Lee et al., 2009); while in South Africa, a recent study reported a case fatality rate of 2% due to pesticide poisoning (Balme et al., 2010).

2.4 Concluding remarks

Botswana, and South Africa are at a similar level of human development index; Uganda is lagging behind them. There are some disparities with regard to the structure of the populations, the socioeconomic situation, and the level of infrastructure development including the complexity of industries driving the economy of each country. The major similarity across the three countries is that they all suffer from a quadruple burden of diseases and injuries, although one of the four components differs from country to country.

Data on injuries experienced by the three countries show more suffering resulting from war and poisonings in Uganda; while violence and self-inflicted injuries are more prevalent in South Africa. The other three main burdens of diseases are HIV/AIDS, communicable, and non-communicable diseases. Botswana suffers the highest burden of HIV/AIDS among the three countries.

The literature review has shown that acute poisoning is a common and multi-faceted phenomenon because of the wide range of toxic agents that can potentially be involved in poisoning incidents, and the multitude of other factors that influence it. These include the country's socio-political, economical, and cultural features that affect the individual behaviors and circumstances leading to acute poisoning. Hence, it is not surprising that several interventions have been implemented with varying levels of success, and that the outcomes of acute poisoning vary widely from settings to settings.

CHAPTER 3: METHODS

3.1 Introduction

This chapter describes the processes implemented in order to conduct this study. It starts by describing briefly the design of this study, then proceeds to explain the re-analysis undertaken, and ends with some notes on the literature review conducted.

3.2. Design of the study

This was an ecological study conducted with the purpose of examining similarities and disparities in the patterns of acute poisoning across the three countries (Morgenstern, 1995). The comparison was based on the data from the six papers included in this thesis. Papers I and II about Botswana covered a period of 24months (January 2004 - December 2005) and six months (January - June 2005) respectively. The data from Uganda, as reported in Paper III, covered a six-months period (January-June 2005); while studies in South Africa, Papers IV to VI, covered respectively six (January-June 2005) and 18months (January 2000-June 2001).

3.3 Settings of the studies

The facilities in Uganda were two major hospitals situated in the Capital City, Kampala. One of the hospitals was a referral tertiary institution. In South Africa, the eight hospitals were the studies were conducted were distributed as follows: four hospitals were situated in each of the two provinces, Gauteng and Kwazulu-Natal; two of the four hospitals in Kwazulu-Natal were in rural areas; while two of the four hospitals in Gauteng were in peri-urban areas. In Botswana, studies were conducted at two major hospitals situated in the large urban areas of Gaborone and Francistown as well as at four hospitals situated in three health districts, namely, Gaborone, Kgatleng, and South-East. The last two districts were situated in rural areas.

3.4 Data collection procedures

All papers described the data collection tools as a pre-tested data collection form. For Papers II to IV, the field workers were Masters of Public Health students who filled these forms by extracting data from patients' records. For Paper I, Paper V, and Paper IV, nurses extracted and filled in data collection forms.

The demographic and clinical variables collected from the patients' records included the age, and gender of the victims of poisoning; the names and types of poisoning agent, the circumstances of poisoning, whether accidental or deliberate; the outcomes of the incident, whether the patients survived, or died. In some studies, data on the prescribed drugs and related drug use indicators were extracted; as well as the length of stay in the hospital. This information was used to calculate the costs of treatment based on the fee applied per hospital bed.

The details of the toxic agent ingested were determined from the records reviewed. It is known that this information was originally from the histories related by the patient or relatives, the hospital transfer letter, or from the bottle/packaging, showing the details of the product ingested when it was brought along by the patient or those accompanying him/ her. When the exact name of the toxic agent was not available, it was recorded as "unspecified' in the patients' records. Papers V and IV reported on the treatments prescribed and related costs.

3.5 Data analysis

In line with the objectives of the study, a re-analysis of data was undertaken. This was necessary in order to make comparisons based on similarly pre-defined age groups and types or groups of toxic agents. Of the six Papers, three had data collected during the same period (January to June 2005); had used similar a similar data collection tool; and were thus comparable. These were Papers II to IV. Therefore, one dataset made of the original individual datasheets for Paper II, III, and IV, was constituted. Some variables were recoded as explained below. Four pre-defined age groups were considered: 0-12years, 13-19years, 20 to 30years, and over 30years. Similarly, toxic agents were re-coded in six groups: household products, pharmaceuticals, agrichemicals, plants and traditional medicines, food poisoning, animal and insect bites.

The household products group included all unspecified toxic agents, and diverse products likely to be found in the house such as paraffin, cleaning agents, soaps, ..etc. Though pharmaceuticals can also be found in the house, they are usually reported in their own group. During the recoding, this group included primarily identified medicines such as paracetamol; unspecified medicines overdoses; and few cases of named drugs of abuse such as cocaine, and marijuana.

Plants and traditional medicines were grouped together since they were few cases of each group, and it is known that most traditional medicines are made of plants or herbs. Animal and insects bites constituted a group usually referred to as "natural toxins". It included snake, dog, and human bites for animals; as well as bee, spider, and scorpion stings for insects.

The coding for gender, circumstances, outcomes remained the same as follows: gender was dichotomized into "female" and" male"; circumstances as "accidental" versus "deliberate"; and outcomes as 'died" or "survived". Data were analyzed based on their types. Categorical data were analyzed and summarized as proportions. For numerical data, descriptive statistics were calculated, namely, the mean, median, ..etc. The case fatality was defined as the proportion of deaths over the number of people poisoned. Odds ratios (ORs) and the 95%confidence intervals (CIs) of the proportions of deaths were calculated using OpenEpi (Dean et al., 2010).

The Pearson Chi-square test and the Fisher's Exact Test were used to estimate *P* values for differences between groups, based on whether the counts on any cell was more or less than 5. The *P* values of less than 0.05 were considered as statistically significant (Altman, 1999).

3.6 Ethical considerations

Ethical approval for the conduct of the original studies was obtained from the Ethics Committees of the University of Limpopo (Medunsa-Campus). In addition, provincial Ethics Committees and institutional Ethics Committees or managers gave their permission where applicable. This information is reported in all six papers.

3.7 Notes on the literature review

Since this study is based on published papers, there was a need for a review of relevant and recent literature in order to contextualize the reported results and highlight the problem of acute poisoning in the three countries. For this purpose, electronic searches of PubMed, Google Scholar, Science Direct, Highwire, BiomedCentral, AJOL, and specific journals' websites were conducted, as well as searches of references from articles found from primary searches. The relevant papers identified have been included in the discussions in Chapters 2 and 5 respectively.

CHAPTER 4: RESULTS

4.1 Introduction

In the following pages, the results from the re-analysis and the results from the published papers are presented in an integrated manner in order to establish the similarities and differences on the patterns of acute poisoning in the three countries, namely, Botswana, South Africa, and Uganda. Papers are referred by their Roman numerals. The presentation of findings starts with the demographic characteristics of patients, and ends with results on the outcomes of acute poisoning.

4.2 Demographic characteristics of victims of acute poisoning

In total, the six Papers reported data on 1780 patients; 54.8% were male. Based on a subset of 815 patients data included in the re-analysis, the tables and figures constituted are shown below.

4.2.1. Age characteristics of the victims of acute poisoning

Fig.1. shows the age distribution of the 815 patients from the three countries.

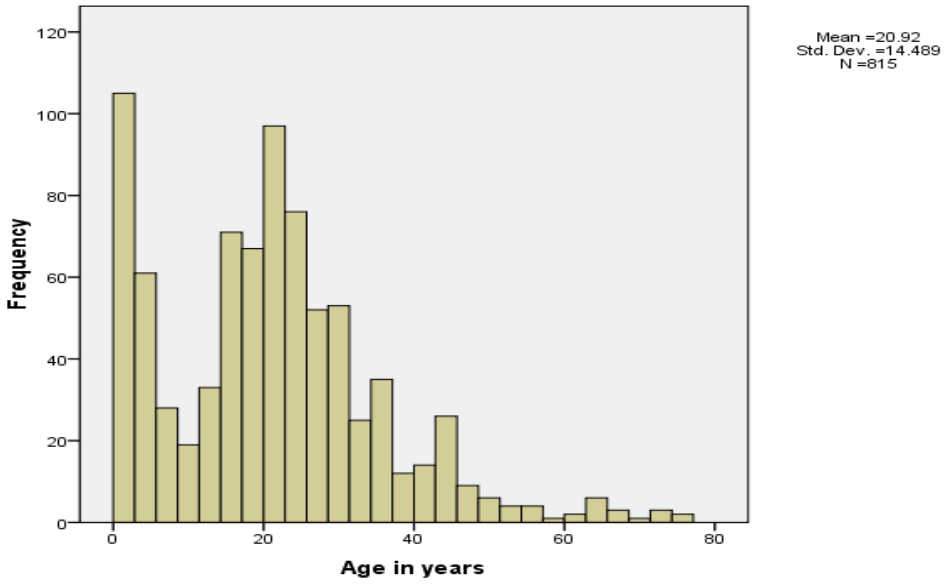


Fig.5: Age distribution pattern of victims of acute poisoning from the three countries

Their mean age was 20.9 ± 14.5years. Fig. 5 shows two peaks in the frequency distribution of the age of victims; a peak among patients 5years and younger; another one, among those 20years old.

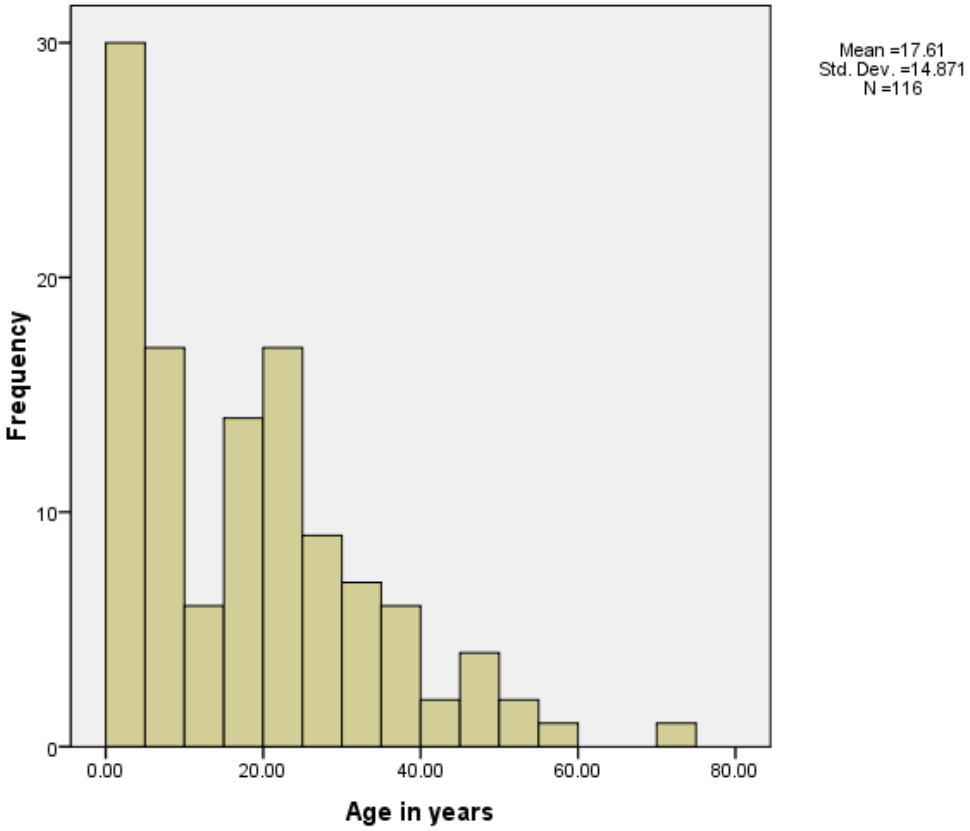


Fig.6: Age distribution patterns of victims of acute poisoning in Botswana

In Botswana, the frequencies of poisoning were highest among children less than 5years, then dropped before starting to increase during teenage period and peaking again during the early young adult stage, then started to decrease from age 40. With regard to pre-defined age categories, there were 53 cases among children younger than 12years old, 15 cases among teenagers, 28 cases among young adults, and 20 cases among adults over 30years old.

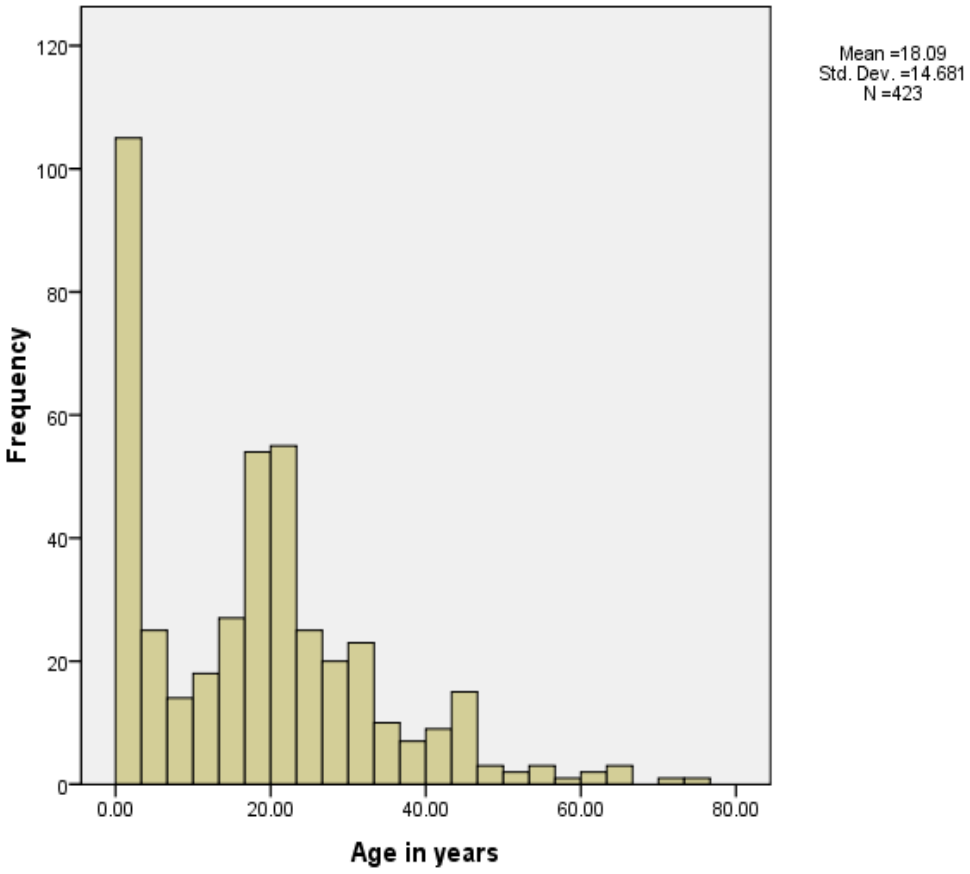


Fig.7: Age distribution pattern of victims of acute poisoning in South Africa

In South Africa, the frequencies of poisoning were highest among children less than 5years, then dropped sharply before starting to increase during early teenage period and peaking again during late teenage period and early young adult stage, then started to decrease dramatically until old age.

With regard to pre-defined age categories, there were 153 cases among children younger than 12years old, 89 cases among teenagers, 109 cases among young adults, and 72 cases among adults aged over 30years old.

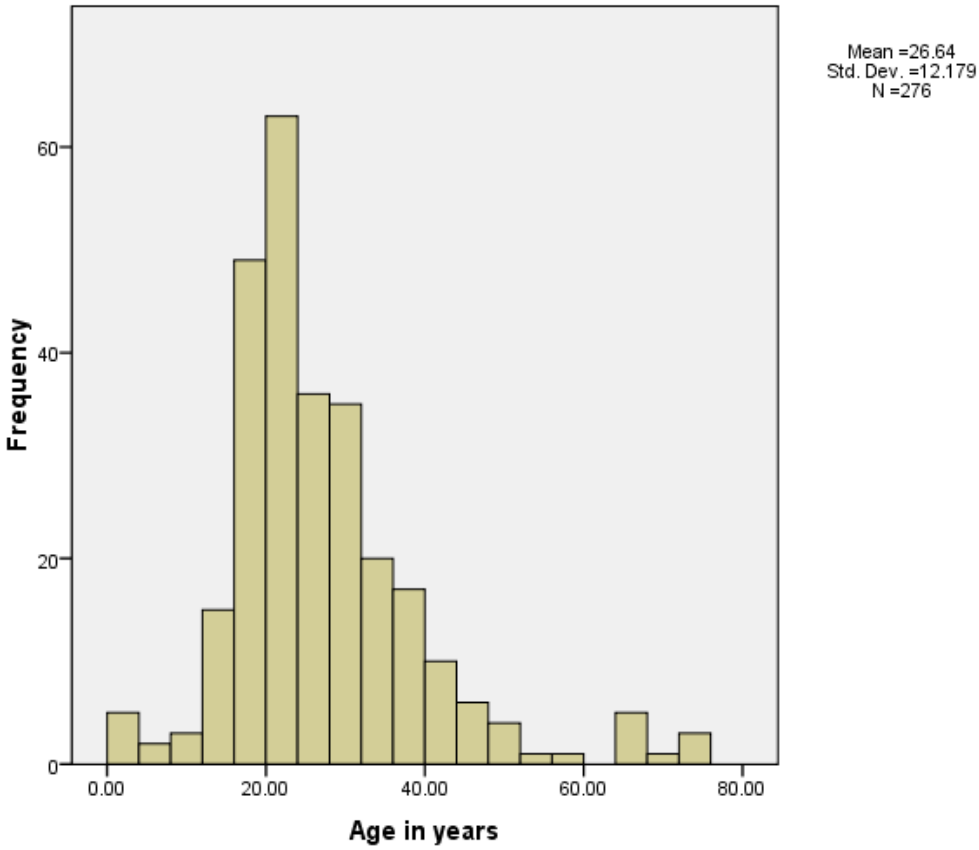


Fig.8: Age distribution pattern of acute poisoning victims in Uganda

In Uganda, the frequencies of poisoning were lowest among children, then started to increase during late teenage period and peaked sharply among those aged 20 to 30years old, before starting to decrease particularly after age 40.

With regard to pre-defined age categories, there were 13 cases among children younger than 12years old, 61 cases among teenagers, 132 cases among young adults, and 70 cases among adults aged over 30years old. The minimum age of the victims of acute poisoning in the three countries was less than 12 months. The youngest child was 3months old from South Africa.

As shown in Fig.9, while the mean and median ages were similar in Botswana and South Africa, the values of these parameters were much higher in Uganda.

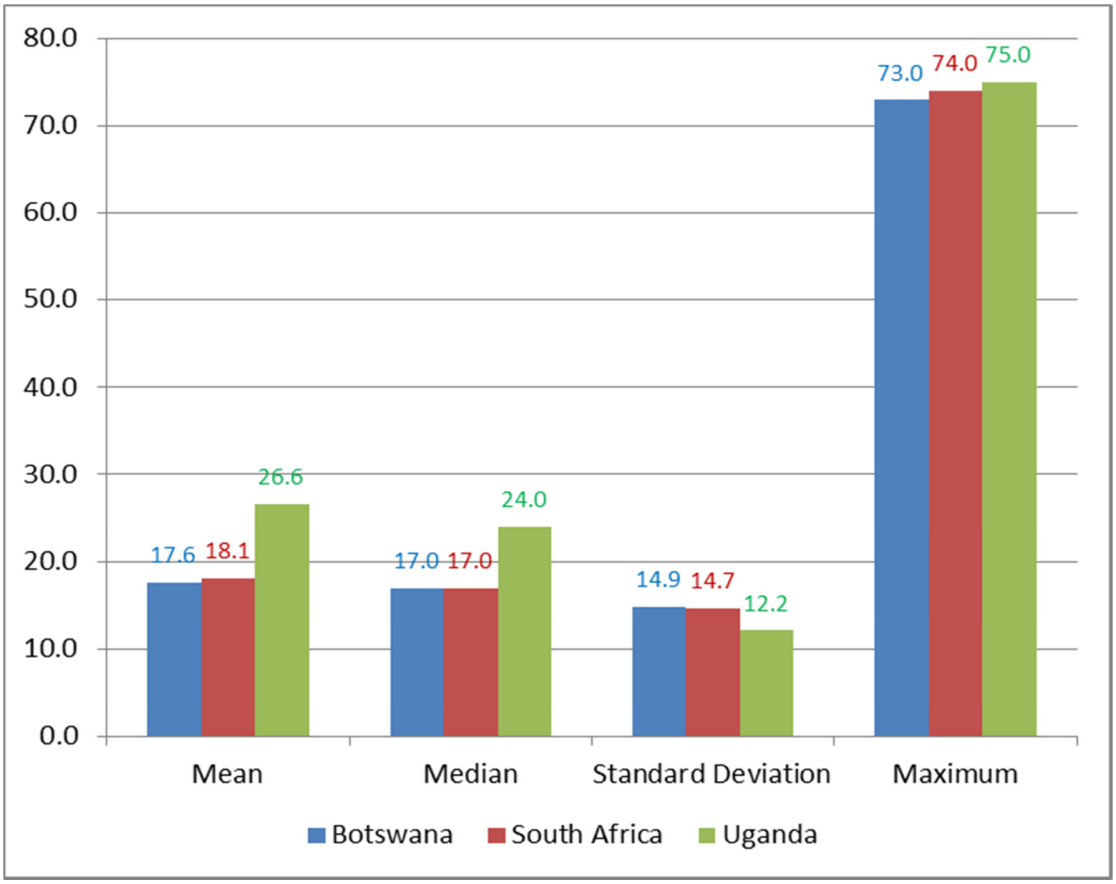


Fig.9: Age parameters of victims of acute poisoning from the three countries

The median age was 24years in Uganda versus 17years in Botswana and South Africa. However, the maximum age of the victims was similar in the three countries; the oldest victim of acute poisoning was 82years old from Botswana as reported in Paper I.

The frequencies of acute poisoning in relation to the age category of the victims are shown in Fig.10.

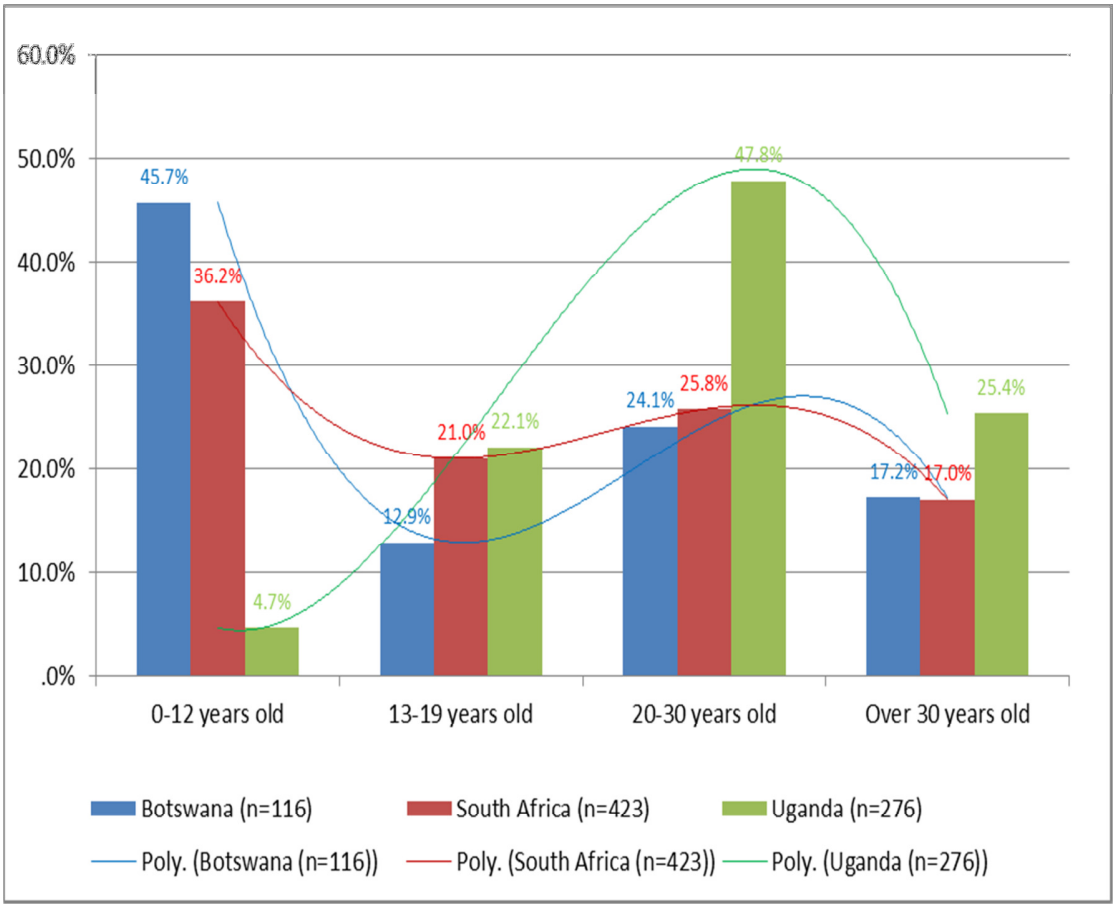


Fig.10: Acute poisoning per age category in the three countries

The above figure shows two dissimilar patterns, a bimodal pattern for Botswana and South Africa, and a single peak pattern for Uganda. In Botswana and South Africa, acute poisoning incidents occurred most in children younger than 12years old, then decreased among teenagers, increased among young adults before decreasing among patients over 30years old.

In contrast, the situation in Uganda differed in that less than 5% of children younger than 12years were victims of poisoning; and that there was an increase among teenagers and young adults before a decrease could be noticed among those over 30years old.

From Paper VI, which was about children from a rural community in South Africa, children aged one to 3years were the most affected; the median age of victims in this sample was 3years old.

4.2.2. Distribution by gender

Acute poisoning was distributed differently across the three countries with regard to gender.

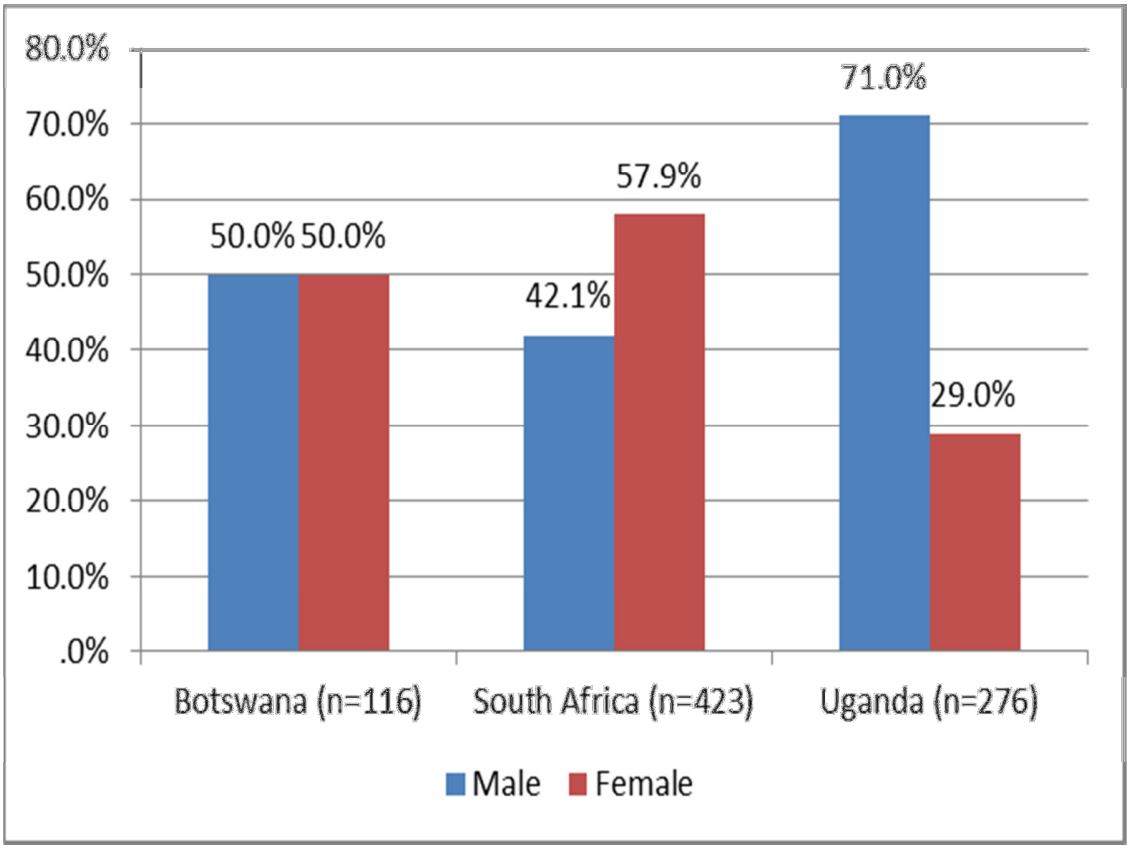


Fig.11: Acute poisoning per gender in the three countries

Fig.11 shows that acute poisoning affected victims differently based on the gender; in Botswana male and female victims were affected equally; although data from Paper I show that males were slightly more affected than females (51.4% males versus 48.6% females).

In South Africa, female patients were significantly more affected than males; except in children where males were more significantly affected than females ($p<0.05$) as reported in Paper VI. Meanwhile in Uganda, males were significantly more affected than females ($p=0.001$).

4.2.3. Age category and gender characteristics

Based on age category and gender of the victims, there were differences within each country and across the three countries as shown in the following figure.

Table 3: Acute poisoning per age category and gender

Country	Gender	Age category			
		0-12 years old	13-19 years old	20-30 years old	over 30 years old
Botswana (n=116)	Male	49.1%	20.0%	53.6%	**70.0%**
	Female	50.9%	**80.0%**	46.4%	30.0%
	Total	100.0%	100.0%	100.0%	100.0%
South Africa (n=423)	Male	55.6%	25.8%	38.5%	38.9%
	Female	44.4%	**74.2%**	**61.5%**	**61.1%**
	Total	100.0%	100.0%	100.0%	100.0%
Uganda (n=276)	Male	**61.5%**	**60.7%**	**75.0%**	**74.3%**
	Female	38.5%	39.3%	25.0%	25.7%
	Total	100.0%	100.0%	100.0%	100.0%

Across the three countries, among teenagers, more females (over 60%) than males were victims of acute poisoning. In Uganda, male patients constituted the majority of victims in all age categories. In South Africa, female patients were the most affected by acute poisoning from teenage period to adulthood. However, in children younger than 12years old, South African boys were most affected than their female counterparts.

In contrast, in Botswana, the proportions of acute poisoning shifted in each age category; there was similar distribution in boys and girls younger than 12years, but females were significantly more victims than males during teenage period ($p=0.01$), while males were the most significantly affected in adults aged over 30years ($p=0.01$). This trend among older patients was consistent in Botswana as data in Paper I showed a similar pattern.

4.2.4. Racial characteristics of victims of acute poisoning

Although data from Botswana and Uganda did report cases of acute poisoning in other racial groupings, data from South Africa showed that though the majority of victims were of Black African, 7.8% and 0.9% were respectively Caucasians and Asians. Of the 33 Caucasians, 57.5% were females.

4.3 Circumstances and toxic agents involved in acute poisoning

4.3.1. Circumstances of acute poisoning

Exposure to poisonous products occurred mainly through ingestion, but some occurred through dermal contact or transdermal injection, and few through inhalation as reported in Paper I. Transdermal exposure occurred in cases of animals such as snake envenomation or insects bites; while inhalation occurred in case of carbon monoxide poisoning. Acute poisoning occurred either accidentally or deliberately as shown in the following figure.

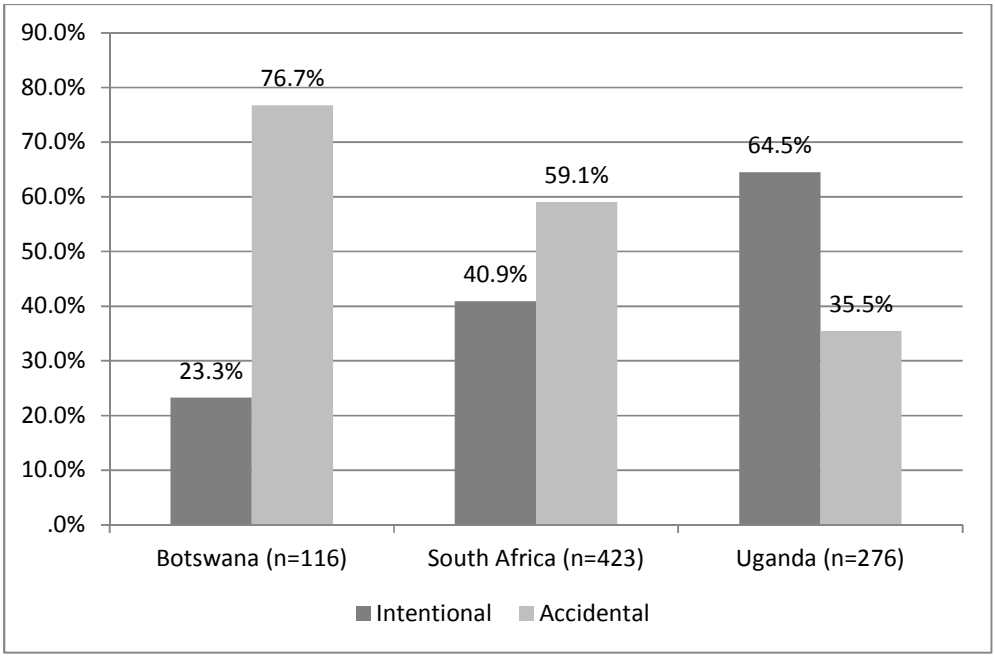


Fig.12: Circumstances of acute poisoning

In Botswana and South Africa, the majority of incidents occurred accidentally, being respectively 76.7% and 59.1%; in Uganda, 64.5% of cases were deliberate or deliberate self-poisoning (DSP).

Nevertheless, the above distribution varied with age and gender. With regard to age, as shown in Table 4, all incidents of acute poisoning in children younger than 12years old in Botswana were accidental; in South Africa and Uganda, some smaller proportions of incidents (5.9% and 7.7% respectively) were deliberate in this age group.

Table 4: Circumstances of acute poisoning per age category

Country	Circumstances	Age category			
		0-12 years old	13-19 years old	20-30 years old	over 30 years old
Botswana (n=116)	Intentional		46.7%	53.6%	25.0%
	Accidental	100.0%	53.3%	46.4%	**75.0%**
	Total	100.0%	100.0%	100.0%	100.0%
South Africa (n=423)	Intentional	5.9%	**62.9%**	**63.3%**	**54.2%**
	Accidental	94.1%	37.1%	36.7%	45.8%
	Total	100.0%	100.0%	100.0%	100.0%
Uganda (n=276)	Intentional	7.7%	**67.2%**	**71.2%**	**60.0%**
	Accidental	92.3%	32.8%	28.8%	40.0%
	Total	100.0%	100.0%	100.0%	100.0%

Table 4 shows a similarity across the three countries about the circumstances of the poisoning incident; in all three countries, the majority (over 50%) of young adults were victims of intentional or deliberate self-poisoning. This trend was seen also in teenagers and adults over 30years from South Africa and Uganda.

With regard to gender, DSP was significantly higher in females than males in Botswana and South Africa ($p<0.05$), but there was no such difference in Uganda as shown in Table 5.

Table 5: Circumstances of acute poisoning by gender

Country	Gender	Gender	
		Male	Female
Botswana (n=116)	Intentional	13.8%	**32.8%**
	Accidental	86.2%	67.2%
	Total	100.0%	100.0%
South Africa (n=423)	Intentional	30.9%	**48.2%**
	Accidental	69.1%	51.8%
	Total	100.0%	100.0%
Uganda (n=276)	Intentional	64.8%	63.8%
	Accidental	35.2%	36.3%
	Total	100.0%	100.0%

In Botswana and South Africa, females were significantly more victims of deliberate self-poisoning than males ($p<0.05$); in Uganda, there was no difference relating to the circumstances within gender; but males were significantly more victims of intentional poisoning than females ($p<0.01$).

The results of a further analysis including the age category of those who were affected by deliberate poisoning are shown in Table 6.

Table 6: Patients who committed DSP per age category and gender

Age category	Botswana (n=27)		South Africa (n=173)		Uganda (n=178)	
	Male	*Female*	*Male*	*Female*	*Male*	*Female*
0-12years old	0%	0%	3.6%	**5.9%**	.0%	**2.0%**
13-19years old	25.0%	**26.3%**	18.2%	**39.0%**	17.3%	**37.3%**
20-30years old	**62.5%**	52.6%	**45.5%**	37.3%	**58.3%**	39.2%
Over 30years old	12.5%	**21.1%**	**32.7%**	17.8%	**24.4%**	21.6%
Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Across the three countries, female victims committed more DSP than males among teenagers, particularly in South Africa and Uganda where the difference was statistically significant ($p<0.05$). This was again the case among children younger than 12years old; females were more victims of DSP than males in South Africa and Uganda.

On the contrary, across the three countries, young adult male victims committed significantly more DSP than their female counterparts. Yet, among adults over 30years old, there was a disparity across the countries in that, contrary to South Africa and Uganda, in Botswana female victims committed DSP significantly more than males.

4.3.2. Toxic agents involved in acute poisoning

The combined frequencies of toxic agents are shown in Table 7.

Table 7: Overall distribution of toxic agents

Toxic Agents	Percent
Household products (n=376)	46.1%
Agrichemicals (n=153)	18.8%
Pharmaceuticals (n=114)	14.0%
Animal and insect bites (n=106)	13.0%
Food poisoning (n=37)	4.5%
Plants and Traditional medicines (n=29)	3.6%
	0.0%
Total (n=815)	100.0%

Overall, in descending order, the most common toxic agents involved in poisoning incidents in the three countries were household products, agrichemicals, pharmaceuticals, animal and insect bites, food poisoning, as well as plants and traditional medicines.

As shown in Fig.13, household products were involved in the majority of acute poisoning incidents in all three countries. The products most commonly involved were acetone, aluminium phosphate, creosote, paraffin, carbon monoxide, alcohol, acids, soaps, hydrogen peroxide, liquid engine cleaner, vinegar, methylated spirits, sodium hypochlorite, thinners, paints, glues, potassium permanganate, nitroglycol, and diverse unspecified chemicals.

Of the above toxic agents, the most commonly involved household product in the three countries was paraffin. Paper V reported that paraffin poisoning affected significantly children younger than 5years as compared to the older ones ($p<0.001$).

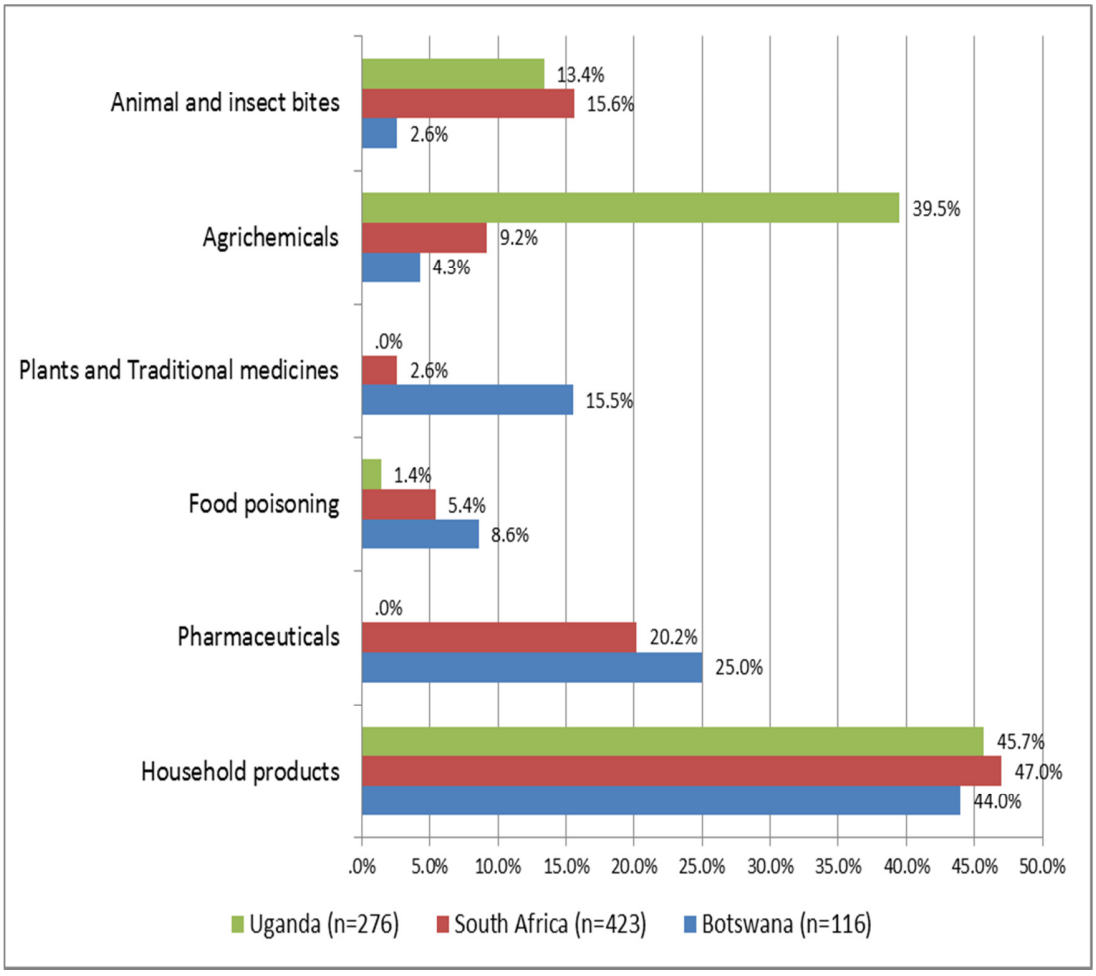


Fig.13: Toxic agents involved in acute poisoning

In the grouping of pharmaceutical products involved in acute poisoning, the following were included: drugs of abuse, non-specified prescription and non-prescription medicines. The range of pharmaceuticals involved was similar between South Africa and Botswana. The following groups of drugs were reported in South Africa: narcotics such as cocaine and cannabis, non-steroidal anti-inflammatory drugs such paracetamol and aspirin, antibiotics such as cotrimoxazole and erythromycin, antimalarial drugs such as chloroquine, anti-epileptic drugs such as carbamazepine, and anti-scabies drugs such as ascabiol were reported in South Africa.

In Botswana, narcotics such as cocaine, non-steroidal anti-inflammatory drugs such as paracetamol and ibuprofen, antibiotics such as amoxicillin, tricyclic antidepressants such as amitriptyline and imipramine, anti-psychotics such as chlorpromazine, and barbiturates such as phenobarbital, dopamine agonists such as bromocriptine, were reported. As reported in Papers I and IV, the most common pharmaceutical product involved in acute poisoning was paracetamol, both in Botswana and South Africa.

The pattern of involvement of various toxic agents differed from country to country. In Botswana, besides household chemicals, pharmaceuticals, plants and traditional medicines were the most involved agents; while in Uganda, agrichemicals were the most involved poisoning agents. Notably, there was no poisoning due to pharmaceuticals, plants and traditional medicines reported in Uganda based on Paper III as shown in Fig.9.

The proportions of those affected by snake envenomation was almost similar between South Africa and Uganda (15.1% South Africa versus 14.1% Uganda); however, though bee stings, spider and scorpion bites were reported in South Africa, no such cases were reported in Uganda. In contrast, scorpion' stings were reported in Botswana among children under 12years old.

Toxic agents affected victims differently depending on their age and gender. With regard to age category, Table 8 shows that household products were the most implicated agents in children younger than 12years of Botswana and South Africa; but in Uganda, snakebites predominated in this age group. Paper I and IV report that in this age group, plants and plant materials such as wild berries were also most involved in Botswana and South Africa.

Paper I and Paper IV report that teenagers were affected by traditional medicines in Botswana and South Africa. Paper VI shows that in South African children, those younger than 5years old were significantly more affected than the older ones by poisoning with pharmaceuticals, paraffin, and agrichemicals. Based on gender, male children were significantly more poisoned than females by pharmaceuticals, paraffin, and plants.

Table 8: Toxic agents involved in acute poisoning per age category

Country	Toxic agents	Age category			
		0-12 years old	13-19 years old	20-30 years old	over 30 years old
Botswana (n=116)	Household products	**58.5%**	33.3%	32.1%	30.0%
	Pharmaceuticals	9.4%	**53.3%**	35.7%	30.0%
	Food poisoning	9.4%	6.7%	7.1%	10.0%
	Plants and traditional medicines	20.8%	.0%	3.6%	30.0%
	Agrichemicals	1.9%	6.7%	**10.7%**	.0%
	Animal and insect bites	.0%	.0%	10.7%	.0%
	Total	100.0%	100.0%	100.0%	100.0%
South Africa (n=423)	Household products	**65.4%**	**34.8%**	**42.2%**	**30.6%**
	Pharmaceuticals	9.8%	**30.3%**	23.9%	23.6%
	Food poisoning	5.9%	4.5%	**7.3%**	2.8%
	Plants and traditional medicines	4.6%	2.2%	.0%	2.8%
	Agrichemicals	4.6%	10.1%	6.4%	**22.2%**
	Animal and insect bites	9.8%	18.0%	20.2%	18.1%
	Total	100.0%	100.0%	100.0%	100.0%
Uganda (n=276)	Household products	38.5%	**41.0%**	**47.0%**	**48.6%**
	Pharmaceuticals	.0%	.0%	.0%	.0%
	Food poisoning	.0%	1.6%	.8%	**2.9%**
	Plants and traditional medicines	.0%	.0%	.0%	.0%
	Agrichemicals	15.4%	**47.5%**	**40.9%**	**34.3%**
	Animal and insect bites	**46.2%**	9.8%	11.4%	14.3%
	Total	100.0%	100.0%	100.0%	100.0%

Moreover, in teenagers, pharmaceutical products were the most involved toxic agents in Botswana and South Africa; while in Uganda, agrichemicals were the most involved in this age group. In young adults, household and agrichemicals were more common in Uganda, while animal and insect bites affected most this group in South Africa.

In adults over 30years old, household products predominated in Uganda, but plants and traditional medicines were more involved in Botswana; while agrichemicals were more common in South African adults of this age group. In the particular case of alcohol poisoning, it is reported in Paper I that there were 41 cases; the majority of them involved people in the age category of 20 to 30years of age in Botswana.

With regard to gender, Table 9 shows that while no poisoning by animal and insect bites was reported in females in Botswana, women were more bitten than men in South Africa and Uganda.

Furthermore, in Botswana and Uganda, household products were significantly more involved in males than in females ($p<0.05$); in South Africa both males and females were affected almost equally.

Table 9: Toxic agents involved in acute poisoning per gender

Country	Toxic agents	Gender	
		Male	Female
Botswana (n=116)	Household products	**51.7%**	36.2%
	Pharmaceuticals	10.3%	**39.7%**
	Food poisoning	6.9%	**10.3%**
	Plants and traditional medicines	**20.7%**	10.3%
	Agrichemicals	**5.2%**	3.4%
	Animal and insect bites	**5.2%**	.0%
	Total	100.0%	100.0%
South Africa (n=423)	Household products	46.6%	**47.3%**
	Pharmaceuticals	**21.9%**	18.8%
	Food poisoning	5.1%	5.7%
	Plants and traditional medicines	2.8%	2.4%
	Agrichemicals	9.0%	9.4%
	Animal and insect bites	14.6%	16.3%
	Total	100.0%	100.0%
Uganda (n=276)	Household products	**51.5%**	31.3%
	Pharmaceuticals	.0%	.0%
	Food poisoning	1.0%	**2.5%**
	Plants and traditional medicines	.0%	.0%
	Agrichemicals	38.8%	**41.3%**
	Animal and insect bites	8.7%	**25.0%**
	Total	100.0%	100.0%

Table 9, shows that pharmaceuticals were more significantly ($p=0.013$) involved in acute incidents of poisoning of female than male patients in Botswana.

For instance, fourteen of the sixteen cases of unspecified medicine-overdose affected the female victims. In contrast, in South Africa, pharmaceuticals were marginally more involved in incidents of males than females. Moreover, of the 12 cases of cocaine poisoning, eight occurred among Caucasians.

With regard to food poisoning, females were more significantly affected than men in the three countries, particularly in Botswana and Uganda. In contrast, poisoning by plants and traditional medicines affected more males than females in Botswana and South Africa. Agrichemicals affected equally males and females in South Africa, but were more involved in poisoning incidents of females in Uganda, while affecting more males in Botswana. In particular, as reported in Paper II, of the twelve cases of alcohol intoxication in Botswana, ten were reported among males. Similarly, six of the eight cases of poisoning by traditional medicines and all three cases of poisoning through drugs of abuse involved male victims.

With regard to the association between toxic agents and circumstances of poisoning, pharmaceuticals were involved in 63% of cases of DSP in Botswana, but were second to household chemicals in South Africa where they were involved in 28.3% of all deliberate incidents. As shown in Table 10, household chemicals were involved in the majority of accidental poisoning incidents in Botswana and Uganda, while in South Africa they accounted for 52.6% cases of DSP.

With regard to agrichemicals, they were more significantly involved DSP in each country ($p<0.001$); being found in 59.6%, 17.3%, and 14.8% of DSP respectively in Uganda, South Africa, and Botswana. Plants and traditional medicines were involved more in accidental incidents than deliberate ones in Botswana and South Africa, but not in Uganda where no case was reported.

Table 10: Toxic agents involved in acute poisoning per circumstances

Country	Toxic agents	Circumstances	
		Intentional	Accidental
Botswana (n=116)	Household products	18.5%	**51.7%**
	Pharmaceuticals	**63.0%**	13.5%
	Food poisoning	.0%	11.2%
	Plants and traditional medicines	3.7%	19.1%
	Agrichemicals	14.8%	1.1%
	Animal and insect bites	.0%	3.4%
	Total	100.0%	100.0%
South Africa (n=423)	Household products	**52.6%**	43.2%
	Pharmaceuticals	28.3%	14.4%
	Food poisoning	1.2%	8.4%
	Plants and traditional medicines	.6%	4.0%
	Agrichemicals	17.3%	3.6%
	Animal and insect bites	.0%	26.4%
	Total	100.0%	100.0%
Uganda (n=276)	Household products	37.6%	**60.2%**
	Pharmaceuticals	.0%	.0%
	Food poisoning	.0%	4.1%
	Plants and traditional medicines	.0%	.0%
	Agrichemicals	**59.6%**	3.1%
	Animal and insect bites	.0%	32.7%
	Total	100.0%	100.0%

In Botswana, the products involved in DSP were in descending order, pharmaceuticals, household products and agrichemicals; in South Africa, household products predominated but were followed by pharmaceuticals, then agrichemicals; while in Uganda, agrichemicals predominated.

4.4 Outcomes of acute poisoning

Unless a short period of medical observation is performed, the management of acute poisoning often requires hospitalization, whose outcomes are the length of stay and the associated costs. If the treatment is successful, the patient would have survived and will be discharged from the hospital. When the treatment is not successful, acute poisoning may lead to death. This outcome is measured as the case fatality rate.

4.4.1. Case fatality rate

Overall, the case fatality rate was 2.1%. The number of patients who died was respectively three, ten, and four, in Botswana, South Africa and Uganda, based on Papers II to IV.

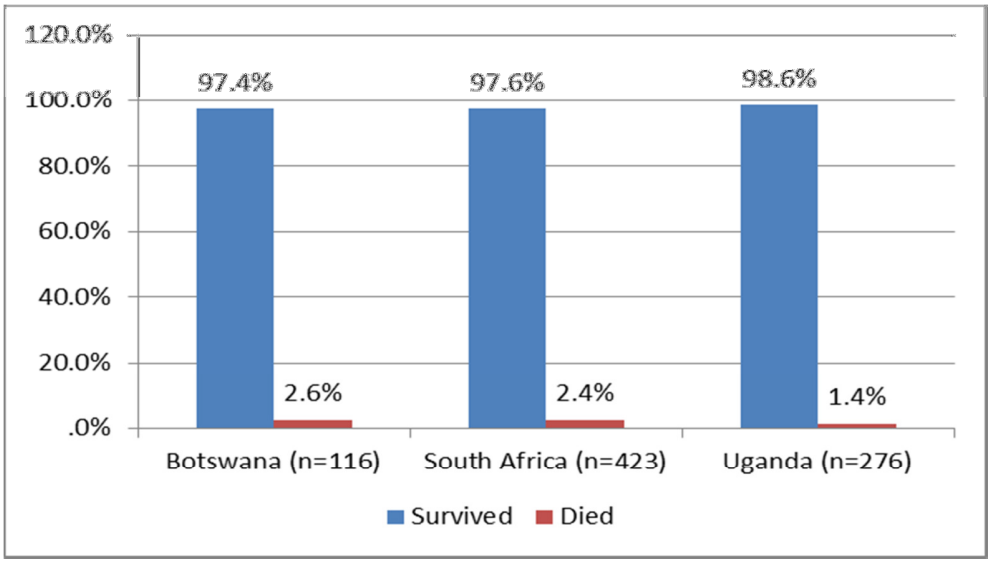


Fig.14: Acute poisoning case fatality rate in the three countries

Paper I reported nine deaths from the 590 cases reviewed from the three districts data of Botswana, a case fatality rate of 1.5%. Clearly, the majority of patients who were victims of acute poisoning survived; among those who died, the demographic profile, the types of toxic agents involved, as well as the circumstances of the poisoning differed from country to country.

Table 11: Case fatality per age category

Country	Survival status	Age category			
		0-12 years old	13-19 years old	20-30 years old	over 30 years old
Botswana (n=116)	Survived	96.2%	100.0%	96.4%	100.0%
	Died	**3.8%**	.0%	**3.6%**	.0%
	Total	100.0%	100.0%	100.0%	100.0%
South Africa (n=423)	Survived	100.0%	91.0%	99.1%	98.6%
	Died	.0%	**9.0%**	.9%	1.4%
	Total	100.0%	100.0%	100.0%	100.0%
Uganda (n=276)	Survived	100.0%	98.4%	99.2%	97.1%
	Died	.0%	1.6%	.8%	**2.9%**
	Total	100.0%	100.0%	100.0%	100.0%

With regard to age category, Table 11 shows that there were differences between countries based on how deaths affected different age categories. There was no death among children younger than 12years old in South Africa and Uganda, but in Botswana, 3.8% of this group died.

Among teenagers, South African teenagers were the most affected as 9% of them died, while no death was reported in Botswana in this group. Amongst young adults, it was in Botswana where more youths died in comparison to South Africa and Uganda, where less than 1% of them died.

Among adults, while no death was reported in Botswana in this category, a case fatality rate of 2.9% and 1.6% was reported respectively in Uganda and South Africa.

Hence, a disparity shown from the above data is that, while the majority of deaths occurred among teenagers in South Africa; in Uganda it was among adults over 30years; but in Botswana, the majority of deaths occurred among children younger than 12years old.

Table 12: Case fatality rate per gender

Country	Survival status	Gender	
		Male	Female
Botswana (n=116)	Survived	100.0%	94.8%
	Died	0%	**5.2%**
	Total	100.0%	100.0%
South Africa (n=423)	Survived	97.2%	97.6%
	Died	2.2%	**2.4%**
	Total	100.0%	100.0%
Uganda (n=276)	Survived	98.5%	98.8%
	Died	**1.5%**	1.2%
	Total	100.0%	100.0%

With regard to gender, Table 12 shows that no male victims of poisoning died in Botswana, but there were slightly more deaths among males than females in Uganda. In females, the case fatality rate was lowest among Ugandan women, followed by South African women, but highest among Botswana women where more than 5% of them died. In South Africa, more female than male victims died from poisoning incidents.

Table 13: Case fatality rate per circumstances of acute poisoning

Country	Survival status	Circumstances	
		Intentional	Accidental
Botswana (n=116)	Survived	100.0%	96.6%
	Died	0%	**3.4%**
	Total	100.0%	100.0%
South Africa (n=423)	Survived	98.3%	97.2%
	Died	1.7%	**2.8%**
	Total	100.0%	100.0%
Uganda (n=276)	Survived	98.9%	98.0%
	Died	1.1%	**2.0%**
	Total	100.0%	100.0%

In all three countries, the majority of deaths occurred in those who were poisoned accidentally; in this group, the case fatality was 2% in Uganda, 2.8% in South Africa and 3.4% in Botswana. In

contrast, among the victims of deliberate self-poisoning, there were fewer deaths. The case fatality ranged from zero in Botswana to 1.7% in South Africa.

Table 14: Characteristics of those who died per age category, gender, and circumstances

Country	Age Category	Intentional		Accidental		*Total*
		Male	*Female*	*Male*	*Female*	
Botswana (= 3)	0-12years old	0.0%	0.0%	0.0%	66.7%	**66.7%**
	13-19years old	0.0%	0.0%	0.0%	0.0%	0.0%
	20-30years old	0.0%	0.0%	0.0%	33.3%	33.3%
	Over 30years old	0.0%	0.0%	0.0%	0.0%	0.0%
	Total	0.0%	0.0%	0.0%	**100.0%**	100.0%
South Africa (n= 10)	0-12years old	0.0%	0.0%	0.0%	0.0%	0.0%
	13-19years old	10.0%	20.0%	30.0%	20.0%	**80.0%**
	20-30years old	0.0%	0.0%	0.0%	10.0%	10.0%
	Over 30years old	0.0%	0.0%	0.0%	10.0%	10.0%
	Total	10.0%	**20.0%**	30.0%	**40.0%**	100.0%
Uganda (n=4)	0-12years old	0.0%	0.0%	0.0%	0.0%	0.0%
	13-19years old	0.0%	0.0%	0.0%	25.0%	25.0%
	20-30years old	25.0%	0.0%	0.0%	0.0%	25.0%
	Over 30years old	25.0%	0.0%	25.0%	0.0%	**50.0%**
	Total	**50.0%**	0.0%	**25.0%**	25.0%	100.0%

As shown in Table 14, in Botswana, all three deaths (100%) occurred among female victims, but 66.7% of them were among children less than 12years old; 33% in young adults. Still in Botswana, data from Paper I showed a similar with the majority of deaths being reported among children younger than 12years. Of the nine patients who died, two deaths each occurred among patients over 30years, two in young adults, one death occurred among teenagers; but, four deaths occurred in children younger than 12years old, representing 44.4% of deaths in this series of data.

In South Africa, 70% of deaths occurred among those poisoned accidentally; among them, there were 20% of adults over 20years old. The majority of those who died were teenagers; of the 80% of teenagers who died, 30% had committed suicide.

Still in South Africa, 60% of deaths were among females. As reported in Paper VI, no fatalities were reported in children younger than 12years old, even in a large sample of 375 children.

Similarly, in Uganda, there was no death among those younger than 12years old; but 50% of deaths occurred in adults over 30years old. There were 25% of deaths respectively in teenagers and young adults. Death affected significantly males as 75% of them died.

Furthermore, in Uganda, 50% of those who died had committed suicide and they were all over 20years old. Of those who died from accidental incident, 25% were female teenagers, and the other 25% were adult males over 30years old.

Hence, the odds of dying from acute poisoning incident were estimated for South Africa and Uganda; since in Botswana, deaths affected only females and those poisoned accidentally, odds ratios could not be calculated. Table 15 and 16 show the results of these calculations.

Table 15: Odd ratios of dying based on the gender of the victims

Country	Gender	Outcomes		Totals
		Died	Survived	
South Africa	Female	6	239	245
	Male	4	174	178
	Totals	10	413	423
	OR=1.09 (0.30, 3.93); 1/OR=0.9 (0.26, 3.29)			
Uganda	Female	1	79	80
	Male	3	193	196
	Totals	4	272	276
	OR=0.81 (0.08, 7.95); 1/OR=1.2 (0.13, 11.98)			

In Uganda, males died 1.2 times more than females but the difference was not statistically significant; on the contrary, in South Africa, females died 1.09 times more often than their male counterparts did but the difference was not also statistically significant.

Table 16: Odd ratios of dying based on the circumstances

Country	Circumstances	Outcomes		Totals
		Died	Survived	
South Africa	Intentional	3	170	173
	Accidental	7	243	250
	Totals	10	413	423
	OR=0.61 (0.16, 2.40); 1/OR=1.6 (0.42, 6.40)			
Uganda	Intentional	2	176	178
	Accidental	2	96	98
	Totals	4	272	276
	OR=0.55 (0.08, 3.93); 1/OR =1.8 (0.25, 13.22)			

In both countries, South Africa and Uganda, victims of accidental poisoning were more likely to die respectively 1.6 times and 1.8 times more often than those poisoned deliberately but the difference was not statistically significant.

The toxic agents that were ingested, and that led to the death of the victims differed from country to country. Even the extent of their involvement was dissimilar. The three deaths in Botswana were two very young girls aged 1 and 2years who died respectively from paraffin and traditional medicine poisoning, while a 28years old woman died also from traditional medicine poisoning. The four deaths in Uganda were as follows: alcohol intoxication was responsible of one death that affected a 75years old man; two men died from DSP, a 42years old man died from organophosphate poisoning, and a 29years old man from an unspecified poison; while a 16years old female died from carbon monoxide poisoning.

In South Africa, those who died were a diverse grouping as shown in Table 17. With regard to pharmaceuticals, it was actually drugs of abuse that were implicated in fatal outcomes. For instance, four deaths occurred among the 12 cases confirmed of cocaine poisoning.

From Paper I, in Botswana, deaths resulted from a variety of toxic agents. Of the nine patients who died, three were poisoned by pharmaceuticals (33.3%), two by traditional medicines (22.2%), two because of food poisoning (22.2%), one by plant poisoning (11.1%), and one due to snake envenomation (11.1%).

Furthermore, based on data from Papers II to IV, Fig.15 shows that there is a disparity with regard to the involvement of toxic agents in fatal poisoning incidents. Plants and traditional medicines were involved in fatal cases only in Botswana, where they were involved in two-thirds of the deaths; while pharmaceuticals were involved in 40% of fatal outcomes only in South Africa. On the contrary, household products were implicated in fatal outcomes in all three countries, though the extent of their involvement varied from country to country. They were involved in three-quarters of deaths in Uganda, half of deaths in South Africa, and in a third of deaths in Botswana.

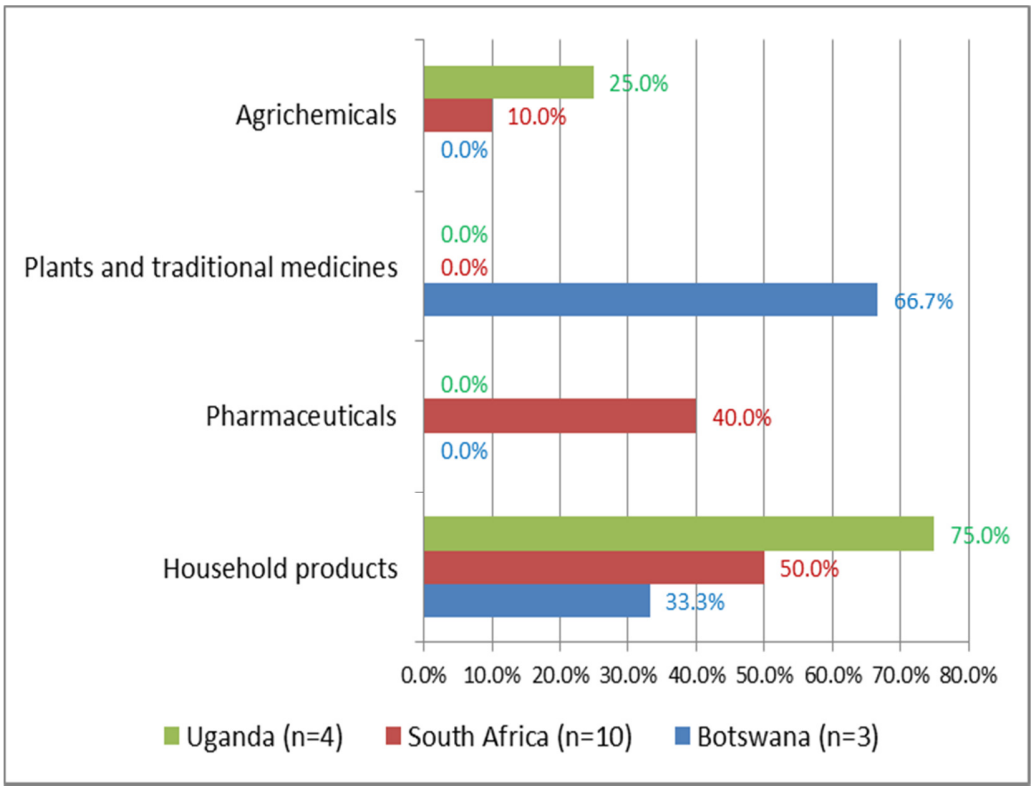


Fig.15: Toxic agents involved in the death of victims of acute poisoning

On the contrary, agrichemicals were involved in the deaths of victims in Uganda and South Africa, but not in Botswana. They were involved in a quarter of deaths in Uganda and 10% of deaths in South Africa.

Table 17: Characteristics of dead victims of acute poisoning in South Africa

Toxic Agents	Age (Years)	Gender	Race	Circumstances
Carbon monoxide				
Victim 1	19.0	Male	Black	Accidental
Victim 2	19.0	Male	Black	Deliberate
Victim 3	26.0	Female	Black	Accidental
Victim 4	74.0	Female	Black	Accidental
Cocaine				
Victim 5	17.0	Female	White	Accidental
Victim 6	17.0	Female	White	Accidental
Cocaine + Marijuana				
Victim 7	14.0	Male	Black	Accidental
Victim 8	14.0	Male	Black	Accidental
Organophosphate				
Victim 9	17.0	Female	Black	Deliberate
Organophosphate + Bleach ®* + Ratex ®**				
Victim 10	17.0	Female	Black	Deliberate

*= contains chlorine **= contains carbamate

The majority of deaths in South Africa affected Blacks (80%), females (60%), teenagers (80%), and victims poisoned accidentally (70%). Carbon monoxide and cocaine were each involved in 40% of deaths, while organophosphates were involved in 20% of deaths.

4.4.2. Length of stay in hospital

Victims of acute poisoning are often hospitalized. The length of hospital stay is influenced by various factors. In South Africa, 70% of the victims of acute poisoning stayed for less than two days with the median duration of stay of 1.9days. Based on gender, the majority of females as compared to males stayed for more than two days (70.1% versus 29.9%). Paper V reported that children affected by paraffin poisoning stayed longer in the hospital, a mean length of stay of 2.5±2days.

Similarly, in Uganda, 79.7% of patients stayed for less than 2days, and the mean length of stay was 2.1days. Paper I reported that in Botswana, the average length of stay differed based on the type of toxic agents. It was two days for patients admitted with poisoning by plants, animal and insect bites; but it was less than 2days for those poisoned by foods, alcohol, agrichemicals, and traditional medicines.

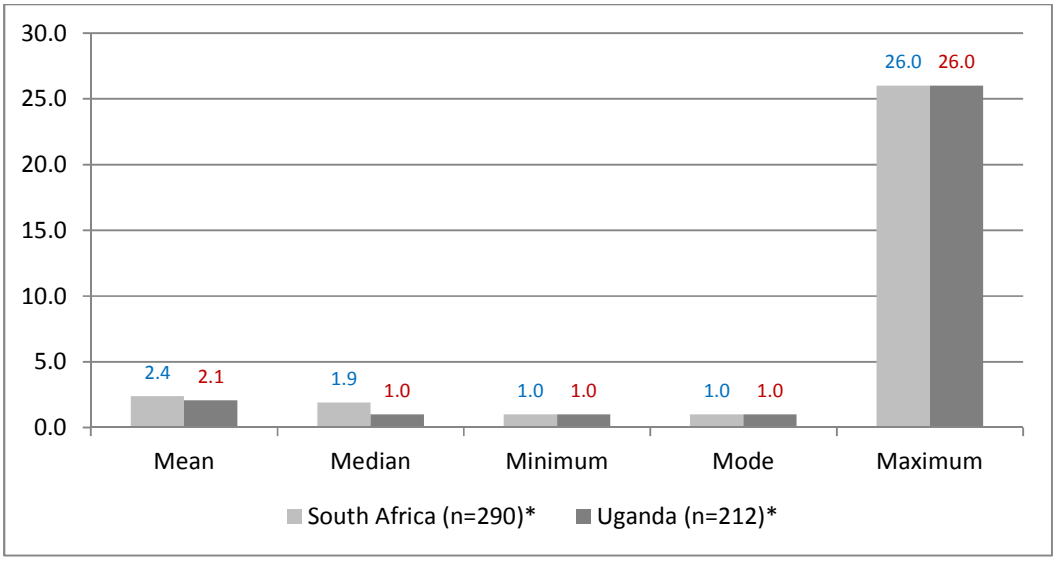


Fig.16: Parameters of the length of stay in hospital

4.4.3. Costs of treatment

Papers V and IV reported some data on costs of treatment of incidents of poisoning; the costs of treatment were based on the length of stay in the hospital. The types of toxic agents influenced the mean cost of treatment; hence, paraffin, the leading household toxic agent, its average cost per patient was ZAR617.24, and its total cost was ZAR89500 for the 145 children whose data were reported in Paper V.

To treat cases of poisoning due to pharmaceutical products was much more expensive than food poisoning. The average cost of treatment per patient poisoned by pharmaceuticals, agrichemicals, plants and foods, was respectively ZAR 656.25, ZAR565.26, ZAR327.16, and ZAR317.31.

4.5 Summary of key results

4.5.1. Similarities in the countries' patterns of acute poisoning

4.5.1.1. Similarities across the three countries

1. Among teenagers, more females (over 60%) than males were victims of acute poisoning
2. Female victims committed more DSP than males among teenagers
3. Male victims committed more DSP than females among young adults
4. The majority of DSP incidents occurred among young adults (20-30years old)
5. Agrichemicals were more involved in deliberate than accidental poisoning
6. Food poisoning affected more females than males
7. The majority of those who died had been poisoned by accident
8. The majority of poisoning incidents involved household products
9. Household products were involved in fatal outcomes in all three countries

4.5.1.2. Similarities Botswana and South Africa

10. The majority of poisoning incidents affected children under 12years old; and were accidental
11. In adults from 20years old, the proportions of those poisoned was similar
12. There was a similar pattern in the way the incidents changed with the age of the victims
13. Female victims constituted the majority of those who were deliberately poisoned
14. There range of toxic agents involved in acute poisoning incidents was similar
15. Pharmaceuticals were more involved in deliberate than accidental poisoning
16. Poisoning by plants and traditional medicines affected more males than female victims
17. The majority of those who died were females (100% in Botswana, 60% in South Africa)

4.5.1.3. Similarities between Botswana and Uganda

18. Household chemicals were more involved in the majority of accidental poisoning

4.5.1.4. Similarities between Uganda and South Africa

19. Small proportions of children under 12years old were victims of deliberate poisoning
20. Similar proportions of people were hospitalized for less than two days; the mean length of stay in hospital was also similar
21. Agrichemicals were involved in the fatal outcomes
22. Similar proportions of people were bitten by snakes; more females than males being affected

4.5.2. Differences in the countries' patterns of acute poisoning

4.5.2.1. Disparities across the three countries

With regard to the demographic profile of the victims of acute poisoning, the main differences were that:

1. In Uganda, the profile of those poisoned was different from the other two countries; Ugandan victims were older than those in Botswana and South Africa were. The mean and median age were 26years and 24years in Uganda as compared to 17.6years and 17years in Botswana; and 18.1years and 17years in South Africa
2. Only in South Africa were Caucasians and Asians reported as victims of acute poisoning
3. Overall, males and females were equally affected in Botswana; but they were more females than males poisoned in South Africa (57.9% versus 42.1%); and more males than females poisoned in Uganda (71% versus 29%)

With regard to the circumstances of acute poisoning, the main differences were that:

4. Overall, in Uganda, there were more deliberate poisoning incidents than in Botswana and South Africa. The proportions of victims who committed suicide was higher in Uganda than in Botswana and South Africa in all age categories
5. In Uganda, males and females were equally affected by deliberate self-poisoning
6. In Botswana, no deliberate self-poisoning was reported among those <12years old
7. Household products predominated in deliberate self-poisoning in South Africa

With regard to the types of toxic agents involved in acute poisoning, the main differences were that:

8. Overall, and in teenagers, the toxic agents most involved in the poisoning incidents were pharmaceuticals in Botswana; household chemicals in South Africa; agrichemicals in Uganda
9. Plants and traditional medicines were involved in fatal outcomes only in Botswana
10. Agrichemicals affected equally males and females in South Africa, more females in Uganda, but more males in Botswana

11. No cases of poisoning by pharmaceuticals, plants and traditional medicines, bees, spiders, or scorpions' stings were reported in Uganda

With regard to the outcomes of acute poisoning, the main differences were that:

12. Household products were involved in three-quarters of fatal outcomes in Uganda, in half of them in South Africa, and in a third of deaths in Botswana
13. Deliberate self-poisoning led to 50% of deaths in Uganda, 30% in South Africa, but no deaths in Botswana
14. Death was reported in younger than 12years only in Botswana; while the majority of those who died were teenagers in South Africa, they were adults over 30years old in Uganda
15. In Botswana, all victims who died were females
16. Plants and traditional medicines were involved in fatal outcomes only in Botswana
17. Agrichemicals were not involved in any fatal outcome in Botswana

4.5.2.2. Disparities between Botswana and South Africa

18. Pharmaceuticals affected more females in Botswana but more male victims in South Africa
19. No cases of plant poisoning were reported in teenagers of Botswana or in those aged 20 to 30years old in South Africa

4.5.2.3. Disparities between Botswana and Uganda

20. Snake envenomation affected more females than males in Uganda, but did not affect any female in Botswana

4.5.2.4. Disparities between Uganda and South Africa

20. In adults over 20years old, 20% of victims who died in South Africa were females who had been accidentally poisoned; but in Uganda, 50% of deaths occurred in females who were victims of deliberate self-poisoning

21. Overall, in Uganda, 75% of deaths occurred in males; while in South Africa it occurred in 60% of females

4.5.3. Patterns of acute poisoning per country

4.5.3.1. Botswana Acute Poisoning Pattern

1. Frequencies of incidents showing a bimodal pattern, higher frequencies among children younger than 12years, particularly younger than 5years old; then peaking again among 20-30years old

2. Overall, poisoning affected equally males and females, there were significantly more female victims during teenage period, but the majority of victims were males among adults over 30years old

3. Deaths affected 44.4% (Paper I) to 66.7% of those younger than 12years old, and 22.2% (Paper I) to 33.3% of young adults; 100% of those who died were female victims accidentally poisoned

4. Though most poisoning incidents were accidental, deliberate poisoning was more common in males aged 20 to 30 years old, and more in females aged over 30years old. Poisoning involved mainly household and pharmaceutical products

5. Household products were more involved in accidental poisoning, that affected male victims, aged less than 12years old, and were involved in 33.3% of deaths

6. Pharmaceuticals were more involved in DSP, among teenagers and female victims, resulted in 33.3% of deaths

7. Alcohol intoxication affected more male young adults

8. Plants and traditional medicines were most involved in accidental poisoning of male adults over 30 years old; and were involved in 33.3% (Paper I) to 66.7% of deaths

9. Food poisoning occurred more in females over 30years old and was implicated in 11.1% (Paper I) of deaths

10. Agrichemicals affected slightly more female than male victims and were involved more in DSP (59.6%) than accidental poisoning

11. Animal and insect bites incidents affected only young adult males; snake envenomation was involved in 11.1% of deaths (Paper I).

4.5.3.2. South Africa Acute Poisoning Pattern

1. Frequencies of incidents showing a bimodal pattern, higher among younger than 12years, particularly younger than 5years old; then peaking again among 20-30years old

2. Overall, poisoning affected more females than males; there were significantly more female victims from teenage period to adults over 20years old; but more male victims among children.

3. Deaths occurred in 60% of female victims, 80% of teenagers, 30% among those who committed DSP; 20% among adults over 20years who were poisoned accidentally

4. Most poisoning incidents were accidental, but deliberate poisoning was more common in males aged 20 to 30years old (45.5%), and more in female teenagers (39%). Poisoning involved mainly household products and pharmaceuticals

5. Household products were more involved in DSP, that affected equally male and female victims, aged less than 12years old, and were involved in 50% of deaths

6. Pharmaceuticals were more involved in DSP, among teenagers and female victims, resulted in 40% of deaths

7. Agrichemicals affected equally male and female but more adult over 30years old, and were involved in 10% of deaths

8. Plants and traditional medicines were more involved in children less than 12years old due to accidental poisoning, affecting male and female equally

9. Food poisoning affected slightly more young adult females

10. Animal and insect bites affected all aged groups, but children young than 12years were less affected than those in other age group categories were; females were slightly more affected than males.

4.5.3.3. Uganda Acute Poisoning Pattern

1. Acute poisoning peaked once from late teenage to young adult periods, then decreased among adults over 30years old

2. Overall, poisoning affected more males than females in all age group categories

3. Deaths occurred in 75% of male victims, 75% among victims over 20years, 50% in those poisoned deliberately, 25% among teenagers

4. Most poisoning being DSP in all age categories, except in children less than 12years old; both males and females being affected equally; poisoning through mainly household products and agrichemicals

5. Household products were more involved in accidental poisoning (60.2%), affected equally male and female victims of all age categories, and were involved in 75% of deaths

6. Agrichemicals were more involved in DSP (59.6%), among teenagers (47.5%), more in female than male victims, and resulted in 25% of deaths

7. Food poisoning affected slightly more adult females over 30years old

8. Animal and insect bites affected all age categories, but more female victims aged less than 12years old.

CHAPTER 5: DISCUSSION OF RESULTS

5.1 Introduction

In this Chapter 5, the findings of the study as presented in the previous Chapter4 are discussed taking into account relevant results reported in the literature. In line with the stated objectives of the study, the discussion is organized around three main themes, namely, the profile of victims and the patterns of acute poisoning, the common toxic agents involved in acute poisoning, and the factors that explain the similarities and the differences in the patterns of acute poisoning observed in the three countries.

5.2 Profile of victims of acute poisoning in the three countries

With regard to the age of victims, their profile is characterized by the predominance of children in Botswana and South Africa, in contrast to adults in Uganda. This is the first disparity noted across the three countries. There was a similarity in the profile of victims of acute poisoning between Botswana and South Africa, since the mean and median ages of victims in both countries were similar and below 20years. In Uganda, these values were much higher; the mean age was 26.6years, while the median was 24years.

The peak incidence was among victims below 5years old in Botswana and South Africa, but below 30 years old in Uganda. The finding from Botswana and South Africa is consistent with reports from other countries such as England and Pakistan (Jepsen and Ryan, 2005; Aqeel et al., 2009), and it corresponds with the period when children are more explorative in their behavior. However, the above distribution is dissimilar to reports from Ethiopia and Iran where the double peaks occurred during the teenage and young adult periods (Desalew et al. 2010; Islambuchilar et al. 2009).

In contrast, in Uganda, and overall, the young adults were the most affected. The above findings are consistent with reports from India, Iran, and other developing countries (Eddleston, 2000; Shadnia et al., 2007; Ramesh et al., 2009; Ahmadi et al., 2010). Nevertheless, these findings differ

with reports from some developed countries where the mean age of victims were above 30years (Tibballs, 1989; Dorado et al., 1996; Viertel et al., 2001; Burill-Putze et al., 2003).

With regard to gender, there was a great disparity across the three countries. Though the majority of the victims were males in Uganda, there were females in South Africa, while in Botswana, females and males were affected equally. Previous studies from single health institutions in South Africa have reported males being more victims of acute poisoning (Joubert, 1990; Meel, 2007) contrary to the findings from this study.

The predominance of males in acute poisoning in Uganda is similar to the reported data from India and Palestine where the male to female ratio was 3:1 and 1.5:1 respectively (Ramesh et al., 2009; Sawalha et al., 2010); but in contrast to some reports from England where females predominated (Hawton and Harriss, 2008).

With regard to whether the victims survived or died, the overwhelming majority of victims survived. However, across the three countries, there was a huge disparity in the distribution of deaths based on demographic characteristics of victims. Since, only studies from South Africa included data on race, the following discussion is limited to the age and gender of victims. In Botswana, all three deaths (100%) occurred among female victims; two very young girls aged one and 2years, and a 28years old woman.

Still in Botswana, data from Paper I showed a similar pattern with four out of nine deaths (44.4%) being reported among children younger than 12years. This is a concern that calls into question how poisoned children are managed in Botswana. Previous studies that assessed the quality of prescribing concluded that prescription was inappropriate in 74% of treatment of children suffering from respiratory diseases in Botswana (Boonstra et al, 2005). There is a need in Botswana for training of clinicians in the management of poisoning incidents as well as on the implementation of the clinical treatment guidelines.

In contrast, in South Africa, of the ten deaths reported, the majority were black Africans (80%), females (60%), and teenagers (80%). Interestingly there was no death reported in children younger than 12years old, even in a large sample of 375 children as reported in Paper VI. Similarly, in Uganda, there was no death among those younger than 12 years old. The majority of deaths (75%) affected males aged at least 20years old; while one death (25%) affected a young adult female. The finding that there were no deaths among children is consistent with many reports from other countries, but contrary to the appalling situation in Botswana as described above (Ahmadi et al., 2010; Meyer et al., 2007; Izuora and Adeoye, 2001). It known that fewer children die from poisoning because they ingest minute quantities of the poisoning agents. However, the circumstances leading to the poisoning may also influence the outcomes as discussed below.

5.3 Characteristics of deliberate self-poisoning and fatal outcomes

In addition to the disparity based on age and gender as discussed above, another disparity was due to the circumstances of the poisoning incidents. While the majority of incidents happened by accident in Botswana and South Africa, being respectively 76.7% and 59.1%; in Uganda, 64.5% of acute poisoning cases were deliberate self-poisoning (DSP), where it affected adult male and female victims equally. Nevertheless, across the three countries, female victims committed more deliberate self-poisoning than males among teenagers, particularly in South Africa and Uganda where the difference was statistically significant ($p<0.05$).

On the contrary, young adult male victims committed significantly more DSP than their female counterparts across the three countries. Among adults over 30 years old, there was another difference across the countries in that, contrary to South Africa, in Botswana female victims committed DSP significantly more than males; while in Uganda more males committed DSP than female victims but the difference was not statistically significant. This situation in Uganda is similar to its neighbor, Tanzania, where adult males were three times more victims of suicides than females (Mgaya et al. 2008). Several other authors have reported the predominance of deliberate self-poisoning among adults and women in different countries (Singh et al., 2003; Hawton and Harriss, 2008; Lam et al., 2010; Desalew et al., 2010; Sawalha et al., 2010).

In this study, it is a concern that 5.9% and 7.7% of children younger than 12 years old had committed DSP in South Africa and Uganda respectively. The majority of them were girls. This is in contrast with a report from India where boys less than 13 years were most affected (Krishnakumar et al., 2010). Although this study did not investigate the reasons associated with DSP, data from the literature both from within Africa and elsewhere suggest that the immediate triggers for DSP are numerous. They include quarrels, family conflicts, break-ups of love relationships, failing exams, siblings' fights, and sexual assaults (Sheu et al., 1998; Desalew et al. 2010; Islambuchilar et al. 2009; Dzamalala et al., 2006; Hanssens et al., 2001; Goksu et al., 2002; Mert and Bilgin, 2006; Hawton and Harriss, 2008; Mgaya et al., 2008).

Deliberate self-poisoning incidents led to the deaths of the victims in South Africa and Uganda but not in Botswana, where all fatal cases occurred among those accidentally poisoned. In South Africa, 30% of deaths occurred among those who had committed suicide; the majority of them were female teenagers. While in Uganda, 50% of those who died had committed suicide and they were all over 20 years old, the majority of them being males. These findings concur with many reports that state that deliberate poisoning is associated with high mortality because of the ingestion of large quantities of the toxic agents (Dzamalala et al., 2006; Hanssens et al., 2001; Goksu et al., 2002; Mert and Bilgin, 2006; Desalew et al., 2010; Sawalha et al., 2010).

However, the odds of dying from deliberate versus accidental poisoning showed a difference that was not statistically significant in South Africa and Uganda based on the data used in the calculations. This suggests that some underlying factors are at play in order to explain these differences. Among them, the amounts ingested and the types of toxic agents involved in the incidents as discussed below.

5.4 Involvement of toxic agents and fatal outcomes

5.4.1. Household products

Overall, household products as a group comprising diverse chemicals were the most involved toxic agents in acute poisoning in the three countries, affecting almost half of the victims. They were followed by agrichemicals, pharmaceuticals, animals and insects bites, food poisoning, and finally plant and traditional medicines.

The involvement of household products in acute incidents was not similar in the three countries. One of the disparities includes the finding that, in teenagers, the toxic agents most involved in the poisoning incidents were pharmaceuticals in Botswana; household chemicals in South Africa; agrichemicals in Uganda. Clearly, the above finding highlights the differential access to these chemicals among the different groups of populations. With regard to household products specifically, paraffin was the most common product involved in accidental poisoning because of its wide availability for use as source of energy for cooking and lighting in many rural and low-income homes; as well as because of improper storage practices (Jayashree and Singhi, 2010;Tshiamo, 2009; Lang et al., 2008; Reed, 1997).

In South Africa, paraffin poisoning has been reported in children less than 5 years as far back as in 1950s (Drubin and Cohen, 1955). Other household products involved in incidents were carbon monoxide, alcohol, potassium permanganate, and diverse unspecified chemicals. Across the three countries, only three of these household products were involved in fatal outcomes; these products were paraffin in Botswana, alcohol and carbon monoxide in Uganda, and carbon monoxide as well in South Africa.

The differential involvement of household products in fatal outcomes highlights yet another disparity among the three countries with regard to the management and outcomes of poisoning incidents. While it is unclear whether poor clinical management of paraffin and carbon monoxide poisonings may have led to the fatal outcomes, there is a need for further investigations to determine the reasons for such avoidable deaths. The management of both often requires oxygen administration, which sometimes may be out of stock in health facilities (MoH-Uganda, 2010; MoH-RSA, 2008; Malangu, 2006).

Nevertheless, deaths from paraffin have been reported also in Nigerian and other children (Belonwu and Adeleke, 2008; Benois et al., 2009). However, new treatment modalities are being investigated, and there is hope for improved treatments (Yu et al., 2010; Shen et al., 2010). Data from other settings suggest that mortality from carbon monoxide poisoning is usually low (Cho et al., 2008; Lam et al, 2010). Hence, one death out of four (25%) in Uganda, and four deaths out of 10 (40%) in South Africa, among teenagers and young adults, raise some concerns about the management of these incidents before admission to and within health care facilities. New treatment modalities are being investigated, it is hoped there will be some improvement in the management of patients who are victims of carbon monoxide poisoning (Celikdemir et al. 2010).

Similarly, the current treatment for alcohol intoxication involves the use of metadoxine, a drug that enhances the elimination of alcohol and its metabolites such as acetaldehyde through the kidneys. Its efficacy has been proven in both acute and chronic alcohol intoxication (Fehér et al., 2009; Viagia et al., 2008). Despite many fatal alcohol intoxications in Uganda, it is noteworthy that, even the most recent, 2010 Edition of the Uganda Clinical Guidelines does not mention this drug for the management alcohol intoxication (MoH-Uganda, 2010). There is clearly a need for such a medicine to be included in the guidelines and made available at health facilities given the possibility that alcohol intoxication will continue to occur as explained below.

With regard to the incidence of alcohol intoxication, in contrasting the above findings with reports from other studies, it seems that alcohol abuse is common in teenagers and young adults from developed countries such as Australia and USA, as well as in other developing countries such as Pakistan (Shah et al., 2006; Woolfenden and Williams, 2002; Gilvarry, 2000; Bukstein, 1997).

5.4.2. Agrichemicals

With regard to agrichemicals, their involvement in acute poisoning illustrates another disparity among the countries studied. While agrichemicals affected significantly more male than female victims in Botswana (5.2% versus 3.4%, $p<0.05$); they were involved only marginally in more females than male victims in South Africa (9.4% versus 9.0%), and Uganda (41.3% versus 38.8%). This finding highlights again the differential access to these chemicals among men and women in different settings. Studies elsewhere have reported that agricultural pesticides account for at least one-third of all deaths due to suicides, and at least 250,000 suicide deaths occur each year (Eddleston, 2000). They have been involved in poisoning incidents of female agricultural workers (Mancini et al, 2005).

In this study, more than half of all cases of deliberate self-poisoning and 25% of deaths in Uganda were due to agrichemicals; while in South Africa, agrichemicals contributed to 17.3% cases of DSP and 20% of deaths. These findings concur with reports from the literature that state that deaths attributable to pesticide self-poisoning varies from as low as fewer than 5% of suicide in Europe, to 25% and over 50% of fatalities, respectively in Africa and Asia (Lee et al., 2009; Gunnell et al., 2007; Bertolote et al., 2006).

With regard to South Africa, previous studies reported that agrichemicals contributed to only 1% of suicide cases (Scribante et al., 2004), but a recent study has reported a mortality of 2% (Balme et al., 2010). Thus, the figure of 20% reported from this study is very high and suggests that perhaps there is an increasing trend in the case fatality rate as more people are resorting to the use of agrichemicals for self-harm. The high mortality from agrichemicals may be due to many reasons including the current evidence that the standard treatment consisting of intravenous atropine, pralidoxime and diazepam, is not always effective (Hussein et al., 2010; Eddleston et al., 2009). It is important that clinicians from the three countries keep abreast of new evidence-based treatment modalities through professional continuing education (Hussein et al., 2010; Eddleston et al., 2009; Perrera et al., 2009).

5.4.3. Pharmaceuticals

There was a disparity across the three countries with regard to the involvement of pharmaceuticals; in Uganda, there was no report of any incident due to pharmaceuticals in the series of cases reviewed, but pharmaceuticals were involved in 63% and 28.3% of DSP in Botswana and South Africa respectively. The two countries differed in that there were more female than male victims who used pharmaceuticals for DSP in Botswana, but in South Africa, both male and female victims were almost affected equally. The above findings concur with reports from other countries where pharmaceuticals are the most used toxic agents for suicide or para-suicide purposes particularly by women (Hawton and Harriss, 2008; Liu et al., 2009; Desalew et al., 2010).

In addition, drugs of abuse, in particular cocaine and marijuana were involved in poisoning incidents only in South Africa. Indeed, illicit drug use is a serious problem in South Africa; recent data show that the cumulative incidence of marijuana or cannabis use is 8.4%, for cocaine and related drugs it is 2%, while it is 19.3% for psychoactive medicines (van Heerden et al., 2009). Moreover, in line with findings from this study, van Heerden et al. (2009) reported also that illicit drug use/abuse in South Africa was more prevalent among Caucasians.

As reported from other settings, paracetamol was the most common medicine involved in the poisoning incidents but did not lead to fatal outcomes among the cases reviewed in this study; other authors have reported fatalities (Zain et al., 2006; Hawton and Harriss, 2008). It was the drug of abuse, cocaine that was involved in 40% of deaths reported in South Africa. This finding concurs with reports from other countries that showed that cocaine was involved in fatal outcomes (Strang et al., 1999; Tardiff et al., 1994; Kaye and Darke, 2004; Darke et al., 2005; Berstein et al., 2007). Reports from Pakistan show a similar trend whereby, narcotics such as heroin and morphine were involved in 18.7% and 15.6% of deaths respectively (Shah et al., 2006).

5.4.4 Food poisoning

Overall, food poisoning affected less than 5% of victims. Across the three countries, Botswana was the most affected followed by South Africa. There was a similarity across the three countries in that females were more significantly affected by food poisoning than men, particularly in Botswana and Uganda. This suggests that women may have eaten more of the offending foods. This finding is contrary to some reports from China and Ethiopia where food poisoning was not reported among cases analyzed; but is consistent with findings from Iran where food poisoning was also reported (Desalew et al., 2010; Lam et al., 2010; Ahmadi et al., 2010).

A recent study from the USA reported that 59% food-borne illnesses were caused by viruses, 39% by bacteria, and 2% by parasites. The same authors reported that 64% of deaths due to foodborne infections were caused by bacteria, 25% by parasites, and 12% by viruses (Scallan et al., 2011). Unfortunately, data on the micro-organisms involved in the poisoning was not available from the records of patients included in this study. This is because the clinical guidelines on the management of food poisoning cases are silent on the need to identify the potential offending agents (MOH-Uganda, 2010; MOH-RSA, 2008). Yet it is important to encourage the identification of the causative micro-organisms so that appropriate antibiotics could be prescribed and for surveillance purposes.

In this study, data from Paper I showed that food poisoning was involved in 11.1% of deaths in Botswana. The above findings concur with reports from Pakistan, where women were the majority of victims of mushroom poisoning that resulted in 13 deaths (Jan et al., 2008).

5.4.5. Snake, spider and scorpion bites

The proportions of those affected by snake envenomation was almost similar between South Africa and Uganda (15.1% South Africa versus 14.1% Uganda); the most affected being females particularly young adults and adults over 30 years old. This suggests that those who were bitten by snakes were the people who would normally be involved in outdoor activities including farming and harvesting. These activities are reported as circumstances that increase the probabilities of meeting snakes (Whitehall et al., 2007; Al et al., 2010; Bentur et al., 2008). These findings are contrary to the situation in South America, where the majority of snakebites occurred among men (Benitez et al., 2007).

From Paper I, of the nine fatalities, one death was due to snake envenomation in Botswana; no death from snakebites was reported in South Africa and Uganda. This suggests that perhaps most of the bites were from less venomous snakes or that the victims were timely and effectively treated though it is unclear on what the reasons could be since the types of snakes involved in the series of patients in this study were not identified.

Moreover, there was a disparity across the three countries with regard to insect bite exposures in that though bee stings, spider and scorpion bites were reported in South Africa, no such cases were reported in Uganda. In contrast, scorpion' stings were reported in Botswana among children under 12 years old. These findings suggest that insects bites and stings may be more common in Southern Africa than in East Africa, since similar findings have been reported in Zimbabwe where 1.5% of hospital admissions were related to insect exposure (Nhachi and Kasilo, 1993). However, more data will be needed to establish whether the difference in ecosystems between Southern and Eastern Africa may be playing a role. In this study, no death due to insect bites was reported; this is in contrast with a report from Tunisia, where Bouaziz et al. (2008) reported on 951 cases of scorpion bites incidents and stated that there were 7.5% of deaths, mainly in children.

5.4.6. Plants and traditional medicines

Plant poisoning reported in this study was mainly about wild berries (V*accinium spp)* and Elephant' ear *(Colocasia spp)* in South Africa and Botswana. Cases from South Africa predominated in male children as reported in Paper VI. This finding is consistent with reports from other settings that show that children are prone to plant poisoning involving seeds, fruits, and leaves because of their curiosity, and explorative behavior (Tagwireyi and Ball, 2001; Becharat et al., 2008) as well as their inability to distinguish between edible berries from the poisonous ones. Hence, one death out nine deaths (11.1%) was recorded in Botswana. This finding concurs with other studies that reported fatal outcomes from plant poisoning (Eddleston et al., 2000; Joskow et al., 2006).

Similarly, traditional medicines were involved in two of the nine deaths (22.2%), and in one of three deaths (33.3%) as reported respectively in Papers I and II. It is a concern that children younger than five years old and a young woman died from traditional medicine poisoning. While, this can be regarded as iatrogenic poisoning, it raises a concern on whether these poisoning incidents were really accidental or were deliberate. It is important that clinicians seeing such patients should probe more to establish clearly the circumstances surrounding the poisoning incident. This includes insisting that the products or remaining amounts of the product be brought to the hospital for laboratory identification if feasible; that the details on the time of the incidents, the witnesses if any, the particular behavior or issues that the victims was going through before the incident, are all explained and recorded on the patient's file. The clinicians should be mindful of the fact that some of the poisoning incidents reported as accidental or iatrogenic may be actually criminal. In Southern Africa, fatal outcomes from traditional medicines have been often reported previously but there was no efforts made to determine whether indeed these deaths were accidental, iatrogenic, or criminal (Joubert, 1990; Kasilo and Nhachi, 1992; Stewart et al., 1998; Tagwireyi and Ball, 2002).

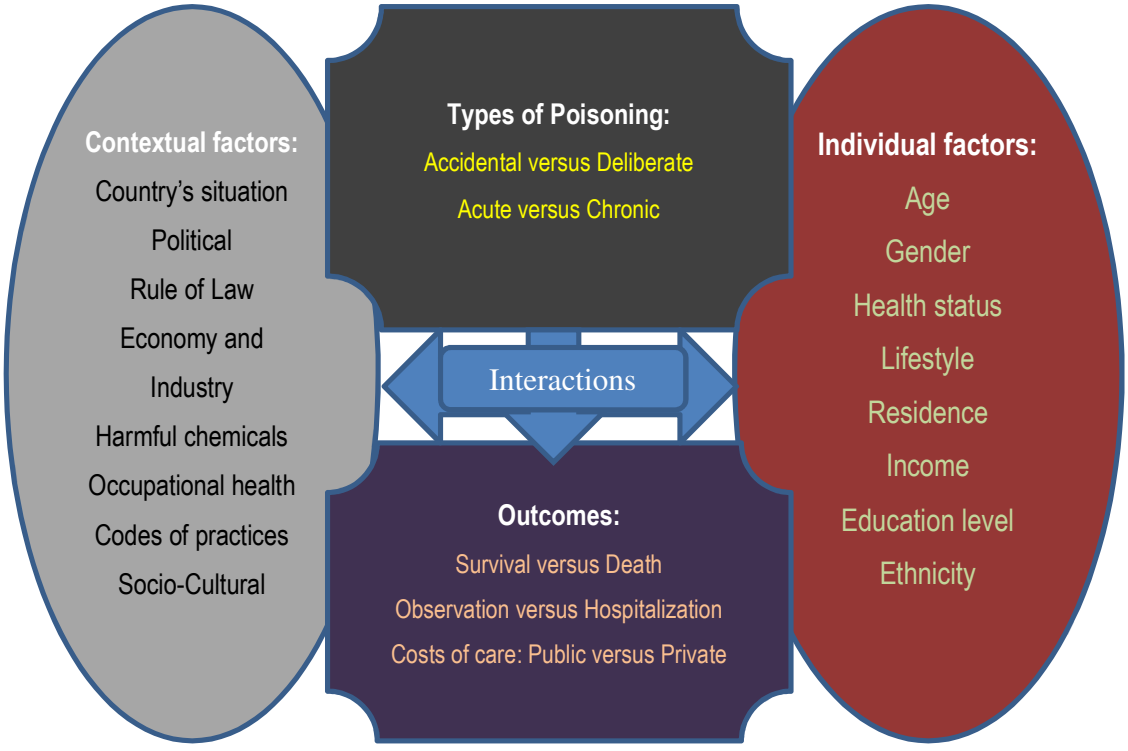
A major observation from this study is that there is a huge disparity across the three countries because, although poisoning by traditional medicines was also reported in South Africa, there were no fatalities reported.

Interestingly, there was no case of plant or traditional medicine poisoning reported from Uganda in the series of cases reviewed; however, other investigators had reported poisoning from traditional medicines and plants from Uganda (Bwilo, 1969; Cardozo and Mugerwa, 1978). In Botswana, traditional medicines were involved in two-thirds of the deaths reported. Hence, there are several factors that could explain this and other disparities as reported below.

5.5 Factors explaining the prevalence and outcomes of acute poisoning

5.5.1. Country-level contextual factors

As shown in the figure below, it seems that the country's context and the characteristics of an individual interact to produce the type of poisoning as well as the outcomes of the incident.



Box 1: Interacting factors in a poisoning incident

As explained below, the political stability and the rule of law, the opportunities offered by the size of the country's economy, the cultural view on deliberate poisoning and other factors influence the occurrence of poisoning incidents (Nattrass and Seekings, 2001; Emsley, 2005).

With regard to the political situation, historically, Whorton (2010) reported that in 19th century, arsenic was the poison of choice in Europe; it was implicated in a third of all cases involving the administering of a toxic substance for political gains. In Africa, in Cameroun as well as Nigeria's instability periods, it is widely believed that poisoning was used to eliminate some of their leaders (Pyenson et al., 1998; Reza et al., 2001; Holt, 2005; Brittain, 2006; Eze et al., 2010).

With regard to the economic situation, Botswana and South Africa have heavy mining industries as reported in Chapter 2. The existence of these industries is associated with the presence of a wide range of chemicals used in these industries as well as the level of development and the lifestyles of their populations. This explains the diversity of household and industrial chemicals involved in acute poisoning incidents in the two countries.

With regard to cultural and other considerations, in many other countries, intentional poisoning is commonly practiced but because autopsies are often not carried out, their perpetrators get away with their criminal acts (Eze et al., 2010; Pyenson et al., 1998). In countries where the culture of 'honor (or forced) suicide' is practiced such as in Turkey and China, poisonous substances are valued and traded in the black market. In Turkey, it is reported that criminal poisoning or forced suicides can be committed, and then be disguised as accidental events (Bilefsky, 2006). In China, the Chinese government outlawed a rodenticide, tetramethylenedisulfonetetramine, whose human lethal dose is only 7–10 mg, following numerous reports of murders due to this substance. The law prohibited its manufacture, distribution, possession and sale. Nevertheless, in 2003, the Chinese police seized 92,282 kg of this product; an amount equivalent to at least 9.2 billion potential lethal doses (Trestrail, 2007). Because there was a demand, criminals ensured that there was supply. China accounts for 26% of suicides committed worldwide as it is commonly regarded as an act of honour and bravery (Weiyuan, 2009).

The above discussion illustrates the contextual factors, namely, socio-political, socio-economic, cultural, and judiciary features that affect the availability of harmful chemicals, shape the individual views and practices on intentional and criminal poisonings.

Other well established factors include the level of violence and the political stability in the country (Schlebusch and Bosch 2002), in one hand; and in the other hand, at individual level, acculturation, unemployment, mental health status, and other factors (Schlebusch et al. 2003) as discussed below.

5.5.2. Influence of contextual and individual factors in acute poisoning

Injuries, in general, are a common cause of hospitalization and one of the leading causes of death and disability worldwide. In Uganda, intentional injuries represent 7.3% of injury burden (Zwi, 1993; Bakama and Bakama, 2006; Mutto et al., 2010). With regard to acute poisoning, whether accidental or deliberate, it is a multi-faceted phenomenon, which is unevenly distributed across various socio-economic status (SES) groupings. Based on the five components of the socioeconomic status, namely income, education, residence, occupation and ethnicity; data from many settings clearly show that people of lower SES suffer a higher morbidity and mortality rate related to injuries particularly poisonings (Matthews et al., 2009; Mbembati et al, 2002; Budlender, 2000; May et al., 2000; Cubbin et al., 2000).

Yet, an individual socioeconomic status depends largely on the country's context, that is, the political, socioeconomic, and cultural factors that ultimately affect the abilities of individuals to seize opportunities that impact on their socioeconomic status (Nattrass and Seekings, 2001). This interaction between the country's context and the individual characteristics has important implications on the occurrence of acute poisoning incidents. Often the link between the political stability and the economic opportunities as well as the distribution of wealth plays a major role as explained below.

Studies elsewhere have reported links between the economic and unemployment situations in a country and the rates of suicide. A 'chain of adversity' has been described from job loss for instance

to depression that leads to suicide ideation and finally suicide attempts (Corcoran and Arensman, 2009).

Moreover, although the mental health status of victims is well a well-known factor in the onset of suicides (Nordentoft, 2007), it was not assessed in the series of patients in this study. Nonetheless, in South Africa, it is well established that the lifetime prevalence of major depression is about 10%, and that mood disorders are associated with the female gender (Tomlimson et al, 2009).

Previous studies by Schlebusch et al. (2003) reported that mood disorder was the most common diagnosis, being present in 64% of non-fatal suicidal in African patients. Additionally, the risk for attempted suicide has been reported to be influenced by the age, gender and ethnicity of the victims. A study by Joe et al. (2008) reported that, though 7 .5% of attempts are unplanned; 50% of planned first attempts of suicide occur within one year of the onset of ideation. The risk of suicide is highest among young adults, people of mixed race ethnicity, female and those with lower level of education. The findings from this study concur with the above reports with regard to the influence of age and gender of the victims.

Across the three countries many disparities were noted with regard to the distribution of acute poisoning incidents based on the demographic variables, the types and extent of involvement of toxic agents, and the patterns of fatal outcomes. Unfortunately, the data on the socioeconomic status of the subjects in this study were not recorded. But it is understandable that, as reported in other settings, the socioeconomic status of the victims played a role in their differential access to toxic agents, in the expediency with which they were taken to medical care, and ultimately in the outcomes of the treatment (Feachem, 2000; Mutto et al, 2010).

With regard to South Africa and Botswana, the similarities and disparities could be explained by the contextual factors such as the countries socioeconomic and cultural aspects. Indeed Botswana and South Africa are geographically and culturally similar, with economies that are interlinked (Bogetić and Fedderke, 2006); with South Africa having more Tswana population than Botswana

itself. This explains in part the similarities in the range of toxic agents involved in the poisoning incidents.

Despite the commonality in the levels of poverty in both countries, the socioeconomic position of South African women is reportedly better than of women in Botswana mainly because of the opportunities that have opened up for women in South Africa due to enhancing policies of Affirmative Action and Black Economic Empowerment (Grant, 2004; Cornwell and Inder, 2007). These opportunities have raised the socio-economic status of several women in South Africa through high profile employment and other social measures such as social grants. This may explain why, contrary to South Africa, in Botswana, female victims committed deliberate self-poisoning significantly more than males. Furthermore, it is well established that there is more illicit drug use in South Africa than in Botswana (INCB, 2006; UNODC, 2010); this may explain why more cases of poisoning from cocaine and cannabis as well as the related fatal outcomes were reported in South Africa where current use seems to be increasing (Peltzer et al., 2009).

With regard to South Africa and Uganda, both countries share a socioeconomic profile that is characterized by significant disparities between rich and poor, with violence and injuries being important contributors to premature death (Nattrass and Seekings, 2001; Matzopoulos, 2002; Donson and Niekerk, 2002; Sukhai and Matzopoulos, 2002). Lower level of social cohesion, and dysfunctional family relationships that are known to be associated with the development and occurrence of a broad range of violence and injuries including deliberate self-poisonings, are prevalent; as a legacy of Apartheid in South Africa; and due to ongoing civil war and ethnic divisions in Uganda (WHO, 2002; Mutto et al., 2010). In fact, violence and injuries are the second leading cause of death and lost disability-adjusted life years in South Africa (Seedat et al., 2009).

Additionally, gender-based violence seems to be prevalent in the two countries (Mbembati et al., 2002; Mutto et al, 2010; Lett et al., 2006). These factors could explain why female victims committed more deliberate self-poisoning than males among teenagers, both in South Africa and Uganda. Moreover, the compositions of the populations of South Africa and Uganda differ in some respects, namely, that in Uganda 50% of population is less than 15 years, while about 48% is aged between 15 and 65 years old; the corresponding figures for South Africa are 29% and 65% respectively (CIA, 2010).

Furthermore, in Uganda, 82% of the labor force work in the main economic sector, which is agriculture; while in South Africa, 65% of the labor force work in the service sector (CIA, 2010). The above data explain at least partially the differential access to agrichemicals and why in Uganda, agrichemicals were involved in about 60% of deliberate self-poisoning in comparison to 17% in South Africa. People in Uganda may have more easy access to agrichemicals from their workplaces than people in South Africa.

5.5.3. Availability and accessibility to alcohol and other products

Of the six groups of toxic agents discussed above, alcohol, agrichemicals, and pharmaceuticals are the ones more amenable to legislative changes and indeed are subject to several regulations with regard to their availability and accessibility. Easy availability may be particularly important in unplanned, impulsive attempts of acute poisoning; of the 82 patients investigated in a recent study, all of whom had attempted suicide, almost 50% reported an interval of no more than 10 minutes between their first thought of suicide and their actual attempt (Deisenhammer et al., 2009). However, as explained below, the widespread availability and accessibility to alcohol and other substances lead to their misuse, abuse, and involvement in acute poisoning.

With regard to alcohol, its abuse and misuse is a major social problem across in the three countries. In South Africa, recent data show that the prevalence of risky, harmful, or heavy drinking, defined as drinking five or more standard drinks per day for men and three or more drinks per day for women, is between 21% to 39% in men; and 30.1 to 35% in women. The corresponding figures are 40.1 % for men and 20.3% for women in Uganda; while in Botswana, 31% of men and 17% of women met the criteria for heavy alcohol consumption (Tumwesigye and Kasirye, 2005; Melles, 2005; Phorano et al, 2005; Peltzer and Ramlagan, 2009; Suliman et al., 2010).

Many consequences are associated with risky drinking such as alcohol-related deaths in road traffic accidents, suicides, and homicides, unprotected sexual intercourses, rapes, as well as fetal alcohol syndrome in babies born from intoxicated mothers (Mathews et al., 2009; Weiser et al., 2006; Wolff et al, 2006; Wasserman, 2001).

One of the main underlying factors associated with risky drinking seems to be the culture that promotes alcohol drinking. For instance, in Uganda, alcohol is reported to be present at most traditional and socio-cultural gatherings (Wolff et al., 2006; Tumwesigye et al., 2009; Kullgren et al., 2009). Other factors include poverty and unemployment that have been implicated as contributing to high alcohol consumption, though others investigators suggest that it is alcoholism that leads to poverty and unemployment (Neufeld et al., 2005; Claussen, 1999). However, the undisputed facilitating factor seems to be the availability of all types of alcohol at prices that are affordable even to the poor (Rabinovich et al., 2009; Anderson and Baumberg, 2006; Parry et al., 2002).

In the three countries, the legal age for alcohol drinking is 18years, but a survey conducted among Ugandan youths aged 13-15years showed that 12.8% of the respondents had at least one alcoholic drink on one or more days during the past 30days prior to the survey. Among them, 21% reported having experienced a number of undesirable effects such as a hangover, felt sick, missed school, or got into fights because they were drunk (Tumwesigye and Kasirye, 2005). In South Africa, a study reported that 36% of males and 19% of females younger than 16years reported heavy drinking during the two weeks prior to the survey (Parry et al., 2005).

In the three countries there are legislations in place that restrict opening hours of bars, and license alcohol selling outlets, but the enforcement of these laws is again not optimally exercised. For instance, in South Africa, taverns are licensed selling outlets, but most sheebens are not; however, several of them continue to operate albeit illegally (Rondganger and Maugham, 2011). The above data suggest clearly that the laws and regulations restricting access to and availability of alcoholic drinks to minors are neither complied with, nor enforced.

Similarly, there are regulations about the sale, storage, and disposal of agrichemicals in the three countries (Odong, 2009). However, dangerous agrichemicals such as Aldicarb®, Temik®, and others can be bought from the streets of all major towns of the three countries (Rother, 2010). This situation points out to the need for a national pesticide policy that balances agricultural and economic needs against the public health impacts of acute and chronic human toxicity stemming from the availability of agrichemicals. Reports from other settings suggest that the powerful

multinational companies are negatively influencing decision-makers on the issues of regulation and relevant policy (Rosenthal, 2005; Burch et al., 2010; Collishaw, 2010; Chapman, 2011).

Furthermore, despite the above disappointing findings, none of the three countries has a national policy on alcohol, or a national strategy to address alcohol abuse and alcohol-related problems. Yet, this is not only necessary, but urgently needed since there is some emerging evidence that suggests that excessive alcohol intake is a major cause of premature death as demonstrated by reports from Russia. It is reported from studies from Russia that a substantial proportion of deaths due to diseases of the circulatory system, and deaths from external causes, may be linked to the effects of excessive alcohol consumption (Zaridze et al., 2009).

In contrast, this study found that there was no poisoning due to pharmaceuticals reported among the cases analysed from Uganda. This suggests that access to and availability of medicines within households is limited. Indeed, a major survey conducted by Kibira et al. (2008) reported that only about 1% of Ugandans have medical insurance, and that 64% of respondents stated that medicines were not affordable. This is consistent with the widespread poverty in Uganda (Kiguli et al., 2009; Odega, 2004). This explains at least partly why households could not afford to keep medicines in their homes that could possibly be implicated in a poisoning incident, whether accidentally or deliberately.

Nonetheless, just like agrichemicals, pharmaceutical products and drugs of abuse are easily available from the black market and can be bought on the streets in the three countries despite the existence of laws and regulations restricting the sale of pharmaceuticals to licensed pharmacies; and prohibiting the possession and sale of drugs of abuse. In one survey, patrons of retail pharmacies in South Africa reported that they bought steroid creams from flea markets and cosmetic shops although these products should be obtained only through prescriptions (Malangu and Ogunbanjo, 2006).

The above discussion (subsections 5.4.2 and 5.4.3) serves to highlight the fact that the country's overall profile with regard to its political, socioeconomic, cultural, legal and judiciary systems determines how easily the individuals will have access to products or chemicals that are not only potentially toxic but are actually capable of intoxicating them when misused, abused, or otherwise used inappropriately. It further highlights the individual characteristics that are associated with both accidental and intentional self-poisoning as well as the influence of the lack of relevant policies and the non-enforcement of existing laws. Once an incident of acute poisoning occurs, oftentimes, the victim is taken for medical attention; however, its clinical management is also influenced by many factors as discussed below.

5.5.4. Clinical management and outcomes of acute poisoning

Acute poisoning is one of the most common heath conditions that most medical doctors encounter regularly in their practices. However, as explained above the clinical guidelines that ought to assist them in the management of acute poisoning are incomplete, not up to date, sometimes they do not own a copy of the guidelines at all , or even have access to them at their workplaces (Zungu et al., 2009). For instance, it is known that pre-hospital management, first aid assistance, or treatment offered by ambulance personnel, can save patients' lives. Yet, clinical guidelines do not provide any guidance on the pre-hospital measures that should be instituted (MOH-RSA, 2008; Manoguerra et al., 2008).

Moreover, these guidelines do not provide clear instructions on which specialists should be contacted if the attending doctor realizes that the case before them is difficult to handle. In the specific case of any serious poisoning, a clinical toxicologist, or clinical pharmacist, or a toxicologist, can give the necessary help to the clinicians faced with unusual or difficult case of acute poisoning. Such skills are rare in the three countries. Unfortunately, except in South Africa, there is no drug or poison information centres in Botswana or Uganda where at least a toxicologist might be available for consultation. In Uganda, there is an Injury Control Centre that is focusing its work on road accidents, keeping an injury registry, conducting research, and training activities; but with less emphasis on poisoning issues.

Similarly, there is a South African National Injury Mortality Surveillance System that is involved in studying suicidal behavior, but it does provide assistance to clinicians (Schlebusch, 2005).

Moreover, in taking the patient history, it seems that when the patients or those accompanying him/her state that they do not know the toxic agent involved, or claim that this was an accidental incident, their word is taken without any doubt by clinicians. It is clear from the review of clinical guidelines on poisoning management from the three countries, that there are no directions given to assist the attending doctor to probe those accompanying the patient /victim in order get more information that could be used to assess whether the case might be a deliberate, and possibly a criminal poisoning. Yet, it seems pragmatic to be suspicious when accidental poisoning is claimed if the victim is at least over 7 years old, moderately or severely affected, or comatose. As stated earlier, it seems that some cases of poisonings that are reported as accidental may be actually deliberate and/or criminal (Trestrail, 2007).

Finally, in the specific case of deliberate self-poisoning, the guidelines should have instructed that the case be referred to a psychiatrist or clinical psychologist, but this is not the case from the guidelines reviewed (MoH-Uganda, 2010; MoH-RSA, 2008). Based on data from the literature reviewed, this should have been included so that the psychologist or psychiatrist could manage the patient with the view of avoiding or at least decreasing the risk of repetition (Nordentoft, 2007). There is a need for more research that could assist in providing guidance on how such collaborative approaches should be set up and evaluate their performances. Therefore, the lack of detailed guidelines, specialist skills, as well as appropriate training, and other factors influence how poisoned patients are managed. The above factors ultimately affect the outcomes of the treatment as discussed above.

5.6 Implications of the findings

5.6.1. Public health and policy implications

The data presented above both from the six papers, and the literature reviewed demonstrates the alarmingly prevalence and magnitude of acute poisoning and deaths from it. However, the lack of national policy coupled with weak and poorly enforced laws provide the impetus for increased availability, and accessibility to harmful chemicals and their potential use in poisoning incidents, particularly, in para-, and suicides. Moreover, the absence of a comprehensive and reliable data on the extent of the problem of deliberate self-poisoning makes it difficult to convince the decision-makers and the general public on the scale and magnitude of the problem. Thus, epidemiological surveillance is necessary to assess the magnitude of the problem and its major risk factors, so that preventive measures can be taken and evidence-based interventions could be designed and implemented (Buckley and Gunnell, 2007).

Hence, there is a need, firstly, for the establishment of acute poisoning surveillance system, or toxicovigilance. It is better to have a national system in place; however, due to the acute scarcity of relevant skills, it may be easier to attract relevant people to a regional poison information/research centre, such as Southern Africa, Eastern Africa, and so on. The centre should be mandated with the responsibility to collect, aggregate, analyse, and report on acute poisoning with specific focus on deliberate poisoning. It should operate as an independent research and educational institution serving both clinicians and policy-makers. This regional centre should keep a database of toxic agents and related information such the doses that led to poisoning or fatal outcome, the number of deaths per specific toxic agent, the circumstances of exposure and the socioeconomic status of the victims.

Secondly, because alcohol intoxication and abuse are common in the three countries, and that enforcement of the existing laws seems either difficult or not practiced, each country should put more efforts into the development of a national policy and a strategy to address alcohol consumption and problems related to it. Similarly, national strategic policies about drugs of abuse, agrichemicals, and other toxic products, should be designed, and implemented.

Each strategy must take into consideration the cultural aspects, and the differences relating to the demographic and other factors associated with acute poisoning. It is important that the civil society is mobilized in to order to assist the laws-enforcement agencies to perform their duties so that the relevant legislation is complied with.

With regard to drugs of abuse, South Africa is the only country with a drug use surveillance system based on treatment demand (Pluddermann et al., 2009); the two other countries could learn from South Africa and establish a similar system.

Since the easy availability and accessibility to agrichemicals facilitate their use in acute poisoning incidents, it is necessary to restrict access to more toxic pesticides based the guidelines issued by the Food and Agriculture Organization (FAO) with reference to class I and II pesticides (FAO, 2010). The aim should be to phase them out and ensure their active surveillance (Konradsen, et al., 2003). In addition, a relevant curriculum must be designed for educating farmers and agricultural workers in the safe use of pesticides. Moreover, there is an urgent need to enforce regulatory restrictions on the sale and distribution of the most toxic class II pesticides (Mancini et al., 2009).

Data from the literature show that deliberate self-poisoning is prevalent, and suicidal behaviour seems to result from complications or undiagnosed psychiatric conditions, most commonly mood disorders, substance use disorders (particularly with alcohol), personality and anxiety disorders. Hence, as a matter of policy, interventions to address DSP must be included in the country's mental health strategy (Ohaeri and Odejide, 1993; Mann, 2003; Nordentoft, 200; Igwe and Ojinnaka, 2010). There are some good examples of interventions that have been implemented such as the South African Police Services suicide prevention program, the Mental Health Information Centre of South Africa, the LifeLine Southern Africa telephone counselling service, and the South African Depression and Axienty Group (SADAG), an advocacy and support network for those suffering from depression, bipolar mood disorders, other psychiatric conditions (Schlebusch, 2005).

Public education programs are necessary to increase the population's awareness of the risks of poisoning at home (Barnett and Calvert, 2005). This includes designing messages dealing with appropriate storage of products in the home, and explaining what to do in case of a poisoning incident. This is particularly necessary with regard to snakebites. This study reported that more females than males were affected in South Africa and Uganda, a public campaign targeting women is required so that evidence-based information about how to avoid snake envenomation and what to do in case of snake envenomation is conveyed in a constant manner.

5.6.2. Implications for clinical practice

There is a need for a revision of clinical guidelines so that clear instructions are laid therein to assist clinicians in the management of acute poisoning as well as to update them with relevant information on evidence-based practices about new medicines and new treatment modalities.

Because psychiatric and psychological states are underlying factors in deliberate poisoning, the guidelines should specifically state that the management of poisoning incidents should include an assessment by a clinical psychologist or psychiatrist. Where these specialists are not available, there are several assessment tools such as Beck's Depression Inventory, Hopelessness Scale, Rosenberg Self-Esteem Scale and CAGE-score that could be used to assess the victims "psychological or psychiatric' status and the results discussed with the relevant specialists (De Leo and Kienhorst, 1995; Nordentoft, 2007).

Given the need to treat patients effectively, better antivenoms' provision particularly in rural district health facilities, as well as the availability of other antidotes, must be assured through effective management of the supply chain and establishment of earmarked budget lines.

5.6.3. Implications for further research

Studies are required to better define the patterns of acute poisoning incidents and deaths based on the socioeconomic status of the victims; this will assist to identify effective interventions to reduce the harm caused.

Prospective population-based studies are suitable and need to be conducted in order to collect data necessary to determine factors that are associated with higher mortality; this information will allow clinicians to triage and manage patients more effectively.

More studies are required to establish the reasons for the apparent non-enforcement of existing laws and the influence of various stakeholders on the non-enforcement culture.

5.7 Limitations of the study

There were several limitations about this study including, its ecological nature which has inherent methodological problems that severely limit causal inference. For instance, data from primary studies were from institutions, mainly hospitals; these data were not population-based, hence they do not reflect the situation of acute poisoning of each country. Additionally, this study relied on retrospective data as presented from the six papers; hence, the design made it impossible to assess independently the accuracy of the history of the incidents as recorded. Moreover, other pertinent details such as the time of the incidents, some important aspects of the socioeconomic status of victims were not reported in the Papers.

A further potential limitation is that data on deaths and poisonings were recorded from hospitals records. This implied that deaths that occurred at home and poisoning cases that were managed at home, that were not brought to the hospitals were not registered on hospitals' records. The details of such incidents could not be included in the analysis of the datasets used in the Papers.

CHAPTER 6: CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

This study sought to compare the patterns of acute poisoning in Botswana, South Africa, and Uganda, by examining the similarities and disparities based on the sociodemographic characteristics of the victims, the toxic agents involved, and the circumstances surrounding the incidents.

In total, the six Papers reported data on 1780 patients; 54.8% were male. The median age was 24 years in Uganda, but as low as 17 years in Botswana and South Africa. In Botswana and South Africa, acute poisoning incidents occurred mostly in children younger than 12 years old, then decreased among teenagers , and increased again among young adults, before decreasing among patients over 30 years old. In contrast, the situation in Uganda was that less than 5% of children younger than 12 years were victims of poisoning. Then, there was an increase among teenagers and young adults before a decrease occurred among adults over 30 years old. The overall case fatality rate was 2.1%, ranging from 1.4% in Uganda; 2.4% in South Africa; to 2.6% in Botswana.

The similarities found across the three countries include the following:

- Among teenagers, more females (over 60%) than males were victims of acute poisoning;
- Female victims committed more DSP than males among teenagers;
- Male victims committed more DSP than females among young adults;
- The majority of DSP incidents occurred among young adults (20-30 years old);
- Agrichemicals were more involved in deliberate than accidental poisoning;
- Food poisoning affected more females than males;
- Household products were involved in fatal outcomes in all three countries.

The disparities noted across the three countries included:

- With regard to the age of victims, their profile was characterized by the predominance of children in Botswana and South Africa, in contrast to adults in Uganda;

- With regard to gender, there was a great disparity across the three countries. Though the majority of the victims were males in Uganda, there were females in South Africa, while in Botswana, females and males were affected equally;
- While the majority of incidents happened by accident in Botswana and South Africa, being respectively 76.7% and 59.1%; in Uganda, 64.5% of acute poisoning cases were deliberate self-poisoning;
- Deliberate self-poisoning led to 50% of deaths in Uganda, 30% in South Africa, but no death in Botswana;
- Among teenagers, the toxic agents most involved in the poisoning incidents were pharmaceuticals in Botswana; household chemicals in South Africa; agrichemicals in Uganda;
- With regard to the involvement of pharmaceuticals, in Uganda, there was no report of any incident due to pharmaceuticals in the series of cases reviewed, but pharmaceuticals were involved in 63% and 28.3% of DSP in Botswana and South Africa respectively.

6.2 Recommendations

The findings from the study provide some basis for refining further public health, regulatory, and clinical practices' responses to the problem of acute poisoning. Therefore, this study recommends:

- that policies addressing the overall strategies aimed at addressing the issues of alcohol and illicit drug abuse as well as pharmaceutical and pesticide misuse should be designed and implemented in order to address acute poisoning and related mortality;
- that practical measures should be implemented in order to improve toxicovigilance through the establishment of national or regional poison centres; and that interventions should take into account the specific factors shaping the patterns of acute poisoning observed in each country;
- that restrictive legislation and regulations on toxic agents particularly agrichemicals class II should be enacted and enforced through a concerted effort between the legislative and judiciary arms of government with the active participation of civil society;
- that the clinical guidelines should be updated and in-service training provided regularly to clinicians in order to facilitate their adoption of evidence-based management of acute poisoning cases;
- that public education with appropriate messages on the prevention and home management of acute poisoning be tailored to various populations groups through diverse media channels;
- that prospective cohort studies, both facility-based and population-based, should be conducted so that data on a comprehensive range of variables can be collected, and used in building predictive models of acute poisoning patterns and guide the design of interventions.

6.3 Concluding statements

In conclusion, the contextual factors of each country led to a pattern of acute poisoning that showed some similarities with regard to the distribution of deliberate self-poisoning among females, teenagers, and young adult victims. However, there were disparities relating to the differential access to toxic agents, based on the age, and gender of the victims. Moreover, though the case fatality rate was similar across the three countries, the distribution of deaths based on age, gender, circumstances of poisoning and types of toxic agents involved differed among the three countries. These findings suggest that multifaceted interventions should be implemented including policy development, enforcement of the existing legislation, and the establishment of a surveillance mechanism, training and revision of treatment guidelines. These interventions should be tailored to meet the specific realities of each country.

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APPENDIX 1: REPRINTS OF ORIGINAL PAPERS

Paper I. Kasule M, Malangu N. Profile of acute poisoning in three health districts of Botswana. *Afr J Primary Health Care and Family Medicine 2009**; 1**(1), Art. #10. DOI: 10.4102/phcfm.v1i1.10.*

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Paper IV. Malangu N, Ogunbanjo GA. A profile of acute poisoning at selected hospitals in South Africa. *SA J Epid 2009;**24**(2): 14-16.*

Paper V. Malangu N, du Plooy, Ogunbanjo GA. Paraffin poisoning in children: What can we do differently? *SA Fam Pract 2005;**47**(2):54-56.*

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