THE KNOWLEDGE AND PRACTICES OF MERCURY COATED BULBS DISPOSAL AMONG HOUSEHOLDS AT GA-MOKGWATHI VILLAGE, LIMPOPO PROVINCE, SOUTH AFRICA

Mokhasi Lucky

[redacted]

MINI-DISSERTATION

Submitted in partial fulfillment of the requirements for Master of Public Health

In the

Faculty of Health Sciences

School of Health Sciences

DEPARTMENT OF MEDICAL SCIENCE, PUBLIC HEALTH AND HEALTH PROMOTION

At the

UNIVERSITY OF LIMPOPO

Supervisor: Mr.Kekana M. P. (MPH, UL)

Co-supervisor: Mr.Matlala S. F. (MPH, UL)

2014

DECLARATION

"I declare that the mini-dissertation hereby submitted to the University of Limpopo, for the degree of Master of Public Health on **The Knowledge and Practices of Mercury Coated Bulbs Disposal among Households at Ga-Mokgwathi Village, Limpopo Province, South Africa** has not previously been submitted by me for a degree at this university or any other university, that it is my work in design and in execution, and that all the material contained herein has been duly acknowledged by means of complete references".

Full Name: Mokhasi Lucky Date: _____

[redacted] Signatures: _____

DEDICATION

To all the people of Ga-Mokgwathi Village, I dedicate this study for their contribution in making it a success. To my supervisor, Mr. M. P. Kekana who continuously supported, encouraged me and showed great patience, ensuring that this research is a success. To my wife, Mpho and my son Rhulani Mokhasi for showing understanding and support all from the start to the end of this research study. To my friend, Kobela Thomas, for assistance in the translation of the questionnaires into Sepedi. To all my co-workers at Letaba Hospital for giving me support and encouragement.

ACKNOWLEDGEMENTS

I want to thank the following persons for their contribution to this dissertation:

- My wife, Mpho Catherine Mokhasi, for her unconditional love, support and encouragement.
- My son, Rhulani Mokhasi, for support and understanding.
- A special thank you to my supervisor, Mr. M. P. Kekana, for his guidance, support, patience and encouragement. He has been my pillar since the beginning of the study to its completion.
- The co-supervisor, Mr. S .F. Matlala, for support and guidance.
- The statistician, Mr. Netshidzibani, for the help in data analysis.
- Letaba Hospital for granting me part time study leave.
- The community of Ga-Mokgwathi Village for taking time off their busy schedule to participate in the study.
- The field workers who assisted in administering the questionnaires to the respondents during data gathering stage.
- The head man of Ga-Mokgwathi village, Mr. N. A. Mohale, for allowing me to conduct the research in his community.
- Medunsa Research Ethics Committee, for giving me the permission to conduct the study.

LIST OF ABBREVIATIONS

- EPHC: Environmental Protection and Heritage Council
- kg: kilogramme
- mg: milligramme
- ml: millilitre
- NEMA: National Environmental Management Act
- SPSS: Statistical Package for the Social Sciences
- UNEPA: United States Environmental Protection Agency
- WMA: Waste Management Act

ABSTRACT

The purpose of this study was to investigate the knowledge and practices among households at Ga-Mokgwathi Village regarding the disposal of mercury coated bulbs. Cross-sectional design with quantitative approach was used in this study. The study objectives were to determine the knowledge about the disposal methods of mercury coated bulbs and also to determine the practices of handling broken mercury coated bulbs among the villagers of Ga-Mokgwathi.

Data collection was done using self-administered questionnaires. Cluster random sampling was used in the study where a total number of 338 households were randomly selected to participate in the study. The results indicated that 36.7 % of the households at Ga-Mokgwathi Village had knowledge of safe disposal methods of mercury coated bulbs, 7.7% were not sure and 55.6% did not have such knowledge. Furthermore, the results indicated that 51.5% of the households had improper practices regarding the handling of broken mercury coated bulbs, 6.2% were not sure and 42.3% had proper practices regarding the handling of broken mercury coated bulb. The results of the study concluded that the majority of people were lacking knowledge of proper disposal methods and the handling of mercury coated bulbs. These results necessitate education of people about the disposal methods and handling of mercury coated bulbs.

Key Words: Knowledge, Practices, Waste Disposal and Mercury coated bulbs.

DEFINITION OF CONCEPTS

- **Mercury** is a heavy silvery-white liquid metallic element used in some thermometer and barometer (The South African Pocket Oxford Dictionary, 2006). It is one of the 12 toxic pollutants identified by the United States Environmental Protection Agency (UNEPA) and can be toxic at low levels in the environment. According to UNEPA, a safe daily intake level of methyl-mercury is 0. 1 milligramme per kilogramme body weight per day. When released in the air, mercury is transported and deposited globally. It ultimately accumulates in water and soil, where it is transformed into a more toxic organic form, methyl-mercury (Khatoon-Abadi, Hoseini & Khalili, 2008).

- **Mercury Coated Bulb** is a light bulb that produces visible light by fluorescence; it is a glass tube whose inner wall is coated with mercury that fluoresces when an electrical current causes vapour within the tube to discharge electrons (The American Heritage Dictionary of the English Language, 4th edition, 2009). In this study it refers to an energy efficient light bulb that contains mercury.

- **Fluorescence** is a light given out by a substance when it is exposed to radiation such as ultra-violet light or X-rays (The South African Pocket Oxford Dictionary, 2006).

- **Knowledge** is the fact or condition of knowing something with familiarity gained through experience or education (Merriam-Webster Dictionary, 2013)**.**

- **Environment** is surroundings, including living things such as humans, animals and plants, and non-living things such as buildings, land, soil, air and water. The environment also includes social and economic surroundings (South Africa, 2008).

- **Integrated Waste Management** is managing waste through a participatory process and holistic approach by multiple techniques to achieve solid waste and resource conservation goals. The technique may include waste reduction,

re-use, recycling, composting, transformation, disposal to landfills and other means (South Africa, 2008).

- **Waste** is an undesirable or superfluous by-product, emission, residue or remainder of any process or activity which is discarded, or is accumulated and stored with the purpose of eventually discarding it, or is stored with the purpose of recycling, reusing or extracting usable product from such mater (South Africa, 2008).

- **Landfill** is a place where rubbish is dumped, flattened, covered with soil and left to decompose or break down and rots away (South Africa, 2008).

- **Recycling** is the sorting, processing, and transportation of solid waste materials, products or containers for the purpose of remanufacture or re-use (Waste Management Planning, 2010).

- **Practice** is a usual way of doing things (Merriam-Webster Dictionary, 2013). In this study it means the usual way of handling and disposing used and broken mercury coated bulb.

- **Pollutants** means direct or indirect alteration of physical, chemical or biological properties of a water resource, air and soil so as to make it-less fit for any beneficial purpose for which it may reasonably be expected to be used, or harmful to the welfare, health or safety of human beings or to any aquatic or non-aquatic organisms, or to the resource quality, or to property (Department of Environmental Management and Tourism, 2009).

- **Household waste** is solid waste generated by single or multi-family residential dwellings, and solid waste of non-hazardous nature, generated by wholesale, retail, theatres, hotels, warehouses, industries operations and manufacturing processes (Kwezi V3 Engineering, 2005).

TABLE OF CONTENTS

	Page
DECLARATION	i
DEDICATION	ii
ACKNOWLEDGEMENTS	iii
LIST OF ABBREVIATIONS	iv
ABSTRACT	v
DEFINITION OF CONCEPTS	vi

CHAPTER 1: INTRODUCTION AND BACKGROUND

1.1 Introduction	1
1.2 Research Problem	2
1.3 Purpose of the Study	3
1.4 Objectives of the Study	3
1.5 Research Question	3
1.6 Conclusion	3
1.7 Chapter Outline	4

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction	5
2.2 Health Effects of Mercury Exposure	5
2.3 Legislative Control and Disposal Methods of Mercury Coated Bulbs	8

2.2 Conclusion 11

CHAPTER 3: RESEARCH METHODOLOGY

3.1 Introduction 12

3.2 Research Design 12

3.3 Study Site 12

3.4 Study Population 13

3.5 Sampling Method 13

3.6 Inclusion and Exclusion Criteria 13

3.7 Data Collection Method 14

3.8 Data Analysis 14

3.9 Reliability and Validity 14

3.10 Ethical Consideration 15

3.11 Conclusion 15

CHAPTER 4: PRESENTATION OF DATA

4.1 Introduction 17

4.1.1 Knowledge based on gender of respondents 17

4.1.2 Practices based on Age of respondents 17

4.1.3 Knowledge based on employment status of respondents 18

4.1.4 Knowledge among households on disposal methods 19

4.1.5 Practices among households 19

4.1.6 Disposal methods among households 20

4.1.7 Cleaning methods among households 20

4.1.8 Wiping methods among households 21
4.1.9 Relationship between knowledge and practice 22

4.2 Conclusion 23

CHAPTER 5: DISCUSSION OF MAJOR FINDINGS

5.1 Introduction 24

5.2 Limitations of the Study 26

5.3 Recommendations 26

6. CONCLUSION 27

REFERENCES 28

7. APPENDIX

7.1 APPENDIX 1: Medunsa Research and Ethics Committee Clearance Certificate 33

7.2 APPENDIX 2: Letter Seeking Permission to Conduct Research from Headman 34

7.3 APPENDIX 3: Headman's Approval Letter 35

7.4 APPENDIX 4: Informed Consent Form 36

7.5 APPENDIX 5: Sepedi Consent Form 38

7.6 APPENDIX 6: English Questionnaire 39

7.7 APPENDIX 7: Sepedi Questionnaire 46

LIST OF FIGURES

FIGURE 1: Disposal Methods among Households 20

FIGURE 2: Wiping Methods among Households 21

FIGURE 3: Relationships between Knowledge and Practice 22

LIST OF TABLES

TABLE 1: Knowledge based on gender of respondents 17

TABLE 2: Practices based on Age of respondents 18

TABLE 3: Knowledge based on employment status of respondents 19

TABLE 4: Knowledge among Households on disposal methods 19

TABLE 5: Practices among Households 20

TABLE 6: Cleaning Methods among Households 21

LIST OF BOXES

Box 1**:** Health Effects from Mercury Poisoning 7

CHAPTER 1: INTRODUCTION AND BACKGROUND

1.1 Introduction

This chapter provides introduction and background of the study, research problem, purpose of the study, objectives of the study and research question. It provides the reader an orientation of what mercury is and its sources. It further outlines the dangers that mercury can pose to the environment and people if it is improperly disposed. It also indicates the reasons which motivated the researcher to conduct the study and what was to be achieved by the study.

Mercury is an element that is found in rocks in the earth's crust. Through mining and industrial processes, mercury is brought to the earth's surface and used in manufacturing, electricity generation and consumer products such as thermometers, batteries, light bulbs and blood pressure instruments. Eventually, mercury is emitted in the air or discharged to water as a by-product of combustion or improper waste disposal. Once in air and water, mercury presents a risk to ecological and human health (Evers & Clair, 2005).

Mercury in the atmosphere comes from both human and natural sources such as volcanic activity, with anthropogenic emissions far exceeding those from natural sources. In the United States, coal-fired power plants are the largest unregulated source of mercury emissions and are responsible for approximately 40 percent of the country's industrial emissions. Mercury emissions attributable to coal-burning power plants are increasing. Moreover, mercury emissions from coal-fired power plants are expected to increase based on projections of energy production and coal use (Northeast States for coordinated Air use management, 2003).

Mercury coated bulbs are made of phosphor coated glass tubes that contain some mercury vapour. When electric current is switched on, the mercury vapour is

energised, causing it to emit out ultraviolet energy. The phosphor coating absorbs the ultraviolet energy which causes the phosphor to fluoresce and emit out visible light. The mercury coated bulb contains between 4 milligrammes and 30 milligrammes of mercury each (United States Environmental Protection Agency, 2008).

Mercury exposure can occur by breathing in mercury vapour, by direct skin contact, with eating contaminated food or drinking contaminated water. Exposure to mercury is associated with health problems such as brain damage, mental retardation, blindness, seizures, kidney damage, tremors, memory loss, speech impairment, mood swings and damage to developing fetus (Groundwork, 2009). Disposal of household waste was a problem at Ga-Mokgwathi Village as it was observed that people used water streams to dispose household waste which include mercury coated bulbs. Some of the bulbs were also disposed around the yard where children can play with them. This posed a danger to the health of people, animals and also polluting the environment.

The purpose of the study was to investigate the knowledge and the type of practices among households at Ga-Mokgwathi Village regarding the disposal of mercury coated bulbs. Findings from this study assisted in making appropriate recommendations to proper waste management and also in preventing health problems and environmental pollution.

1.2 Research Problem

Since 2006 Eskom, the national electricity supplier, had been supplying mercury coated bulbs to households at Ga-Mokgwathi Village to reduce electricity usage, seemingly without informing the public of the dangers of disposing bulbs in regular household waste. As mentioned above, disposal of household waste was a problem at Ga-Mokgwathi Village as people used water streams to dispose household waste

which include mercury coated bulbs. These improper disposals may result in mercury vapour from broken mercury coated bulbs being swept from the streams into dams and rivers during rainy seasons contaminating the water that people and animals drink. When it is windy, mercury vapour from broken bulbs can be blown into the air and contaminate the air that people breath (Eco-South Travel, 2009). The study was then conducted to investigate whether the villagers of Ga-Mokgwathi have knowledge on proper disposal of mercury coated bulbs and also to determine their practices regarding the handling of broken mercury coated bulbs.

1.3 Purpose of the Study

The aim of the study was to investigate knowledge and practices among households at Ga-Mokgwathi Village regarding the disposal of mercury coated bulbs.

1.4 Objectives of the Study

The objectives of the study were:

- To determine the relationship of demographic data with knowledge and practice.
- To determine knowledge about the disposal methods of mercury coated bulbs among households at Ga-Mokgwathi Village.
- To determine the practices regarding the handling of broken mercury coated bulbs by Ga-Mokgwathi residents.

1.5 Research Question

What is the knowledge and practices among households at Ga-Mokgwathi Village regarding the disposal of mercury coated bulbs?

1.6 Conclusion

Chapter 1 clearly gives the reader an understanding of what motivated the researcher to conduct the study. The researcher indicated the research problem, the aim of the study and clearly defined the objectives of the study which gave complete shape and guide for the whole research project.

1.7 Chapter Outline

- Chapter 1 provides the reader with introduction and background of the study, research problem, and purpose of the study, objective of the study and research question.
- Chapter 2 reviews literature from difference sources, international as well as national.
- Chapter 3 discusses the research methodology of the study which includes the study design, study site, study population, sampling method, inclusion and exclusion criteria, data collection method, data analysis, validity and reliability, and ethical considerations.
- Chapter 4 presents the results of the study in tables and figures.
- Chapter 5 discusses the major findings of the study, limitation of the study and recommendations.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

The literature in this study contains information with regard to the adverse health effects of mercury exposure to people, animals and the environment. Different contexts, international and national, were explored, looking into their legislative control, knowledge and practices, and disposal options of mercury coated bulbs. The findings of each study were then compared with what was observed at Ga-Mokgwathi Village.

2.2 Health Effects of Mercury Exposure

Poisoning due to mercury exposure is either through ingestion, inhalation or absorption and leads to some adverse health effects. The United States Environmental Protection Agency (UNEPA) identified mercury as one of the 12 toxic pollutants globally. Mercury becomes too toxic if a person is exposed to more than 0.1mg/kg per day. Once released in the atmosphere, mercury accumulates either in soil, air or water and is then transformed into a more toxic organic form (Khatoon-Abadi, Hoseini & Khalili, 2008). This includes mercury-coated bulbs that, if improperly disposed, could affect people.

Random mercury disposal is toxic to soil and affects the microbial biomass and enzymes activities (Casucci, Okeke & Frankenberger, 2002). Results from soil samples indicated an increase in the levels of mercury, from 0.5µmol/g to 10µmol/g of dried soil. In the French Guyana tropical soil microcosm were spiked with mercury and incubated at 28°C for a month and the results demonstrated that in tropical soil, mercury affects soil microbial communities (Harris-Hellal, Vallaeys, Garnier-Zarli, 2008). The effects of soil contamination due to exposure to mercury indicated a reduced size of bacteria and protozoa due to long-term exposure in Copenhagen, Denmark (Muller, Westergaard, Christensen & Sorensen, 2001). Similar conditions

of mercury toxicity could be affecting the environment in Ga-Mokgwathi Village due to mercury toxicity, a result of improper disposal of the substance.

Once water is contaminated with mercury, marine life is endangered. Overall antioxidant depletion was verified in fish brain collected at the mercury contaminated stations at the Ria-de Aveiro, Portugal (Mieiro, Ahmad, Pereira, Duarte & Pacheco, 2010). An abandoned mercury mine proved to have an effect on fish, rice, ambient air and drinking water in a study done to assess human exposure levels and environmental mercury contamination at Honda Bay (Maramba, Reyes, Francisco-Rivera, Panganiban, Dioquino, Dando, Timbang, Akagi, Eguchi & Fuchigami, 2006). The results of the study showed that total mercury contamination of surface water also exceeded total mercury permissible exposure standards (Maramba et al., 2006). Poor handling of mercury coated objects could endanger animal life and human beings in Ga-Mokgwathi Village as suggested by studies in Portugal (Mieiro et al., 2010) and Honda Bay (Maramba et al., 2006).

Wang, Shi & Wei (2002) investigated the accumulation and transformation of mercury in soil after it had been deposited in the soil. The results of the study indicated a positive correlation between atmospheric mercury concentration and the content of mercury in soil, thereby proving the toxicity of mercury if proper methods of disposal are not practiced.

Mercury toxicity was discovered in exposed wild birds, mammals and fish in a study conducted in Northern Canada. The purpose of the study was to investigate the effects of environmental methyl-mercury, and the results revealed that exposure to methyl-mercury by mammals, wild birds and fish led to behavioural, neurochemical, hormonal and reproductive changes (Schuehammer, Meyer, Sandheinrich & Murray, 2007). In the state of Michigan, USA, two interns were exposed to mercury after spilling a bottle containing mercury on the floor. That led to clinical intoxication, with

one intern complaining of insomnia, mild agitation and tremulousness (Richard & Stephanie, 2004).

.

It is evident that exposure to mercury, either in water, air or soil could lead to some health effects to human beings and marine life. (EPHC, 2009).The health effects emanating from exposure to mercury are summarised in Box 1 below.

Box 1: Health effects from Mercury poisoning

Central Nervous System damage
Behavioural change
Seizures
Tremors
Memory loss
Kidney damage
Brain damage
Mental retardation
Blindness
Speech impairment
Mood swings
Damage to developing foetus
Death.

Source: Arendt & Katers (2013) and Groundwork (2009).

There seems to be similarities in South Africa and the rest of the world regarding poor handling of mercury. In KwaZulu Natal, mercury contamination in the vicinity of a mercury-processing plant was evident. Mercury was discharged into the Mngceweni River which supplies water to the Inanda dam. A study conducted at the

Inanda area revealed that 50% of fish samples and 17% of hair samples taken from villagers had a mercury concentration levels that exceeded guidelines levels of the World Health Organization (Papu-Zamxaka, Mathee, Harpham, Barnes, Röllin, Lyons, Jordaan & Cloete, 2010). The same problem of exposure to contaminated water was reported amongst people consuming fish from the Umgeni River near Cato Ridge (Papu-Zamxaka et al., 2010).

Coal mining in South Africa contributes towards increased levels of mercury toxicity. The country is the second highest mercury emitter in the world. Most of the emissions arise from coal-fired power stations during electricity generation (Dabrowski, Ashton, Murray, Leaner & Mason 2008). Utility power generator, ESKOM, has thirteen coal-fired power stations that emit large quantities of mercury in the atmosphere, thereby making the exposed environment toxic (Dabrowski & Mason, 2010). Most coal users who took part in a study by Oosthuizen, John & Somerset (2010) indicated increased levels of mercury in their bodies after urine samples were taken and analyzed. Most of them were exposed to mercury either through the inhalation of mercury dust or after consuming contaminated fish or drinking water from polluted water. The source of mercury was a gold mine that was situated next to their residential area that emitted some mercury particles during production (Oosthuizen, John & Somerset, 2010).

2.3 Legislative Control

According to the United States Environmental Protection Agency (2009), mercury coated bulbs contain mercury, and fused bulbs are regarded as hazardous waste under federal and state regulation. However, in some States, hazardous waste bulbs may be managed as universal waste. It is therefore, the responsibility of the generator of mercury coated bulbs to determine whether the bulbs are hazardous waste and to ensure that fused bulbs are in accordance with federal and States regulations.

In Australia, a flourocycle which is a scheme aimed at increasing recycling of mercury coated bulbs was established in 2009 in collaboration with government, industries and the Environment Protection and Heritage Council. Waste disposal and handling is primarily a state and local government responsibility in Australia. Landfill disposal of large amounts of mercury coated bulbs such as those generated by businesses, institutions, or councils is forbidden in the state (Environment Protection and Heritage Council, 2009). In Minnesota, any mercury containing products should not be disposed in landfill, but must be recycled. Their law regulates all mercury containing products including mercury coated bulbs, mercury vapor and metal halide lamps (Minnesota Pollution Agency, 2007).

To ensure that no health or environmental hazards from mercury containing products during their entire life cycle, the European Union has issued a few directives which reduce or ban harmful substances and on the other hand regulate the disposal methods of mercury containing products. The directives regulate the use of certain chemical substances and the disposal of mercury coated bulbs. In Germany, for example, the European directive is implemented by the national law regulating the introduction, collection and environmental friendly disposal of electric and electronic equipment (Osram, 2013).

Florida laws forbid the disposal of mercury coated bulbs at solid waste incineration facilities. Florida has waste-to-energy facilities that incinerate solid waste to produce energy for the State, and people are not allowed to dispose mercury coated bulbs at these facilities. Besides forbidding disposal at incineration facilities, Florida law also forbid people from throwing mercury coated bulbs away at any landfills or municipal solid waste disposal facilities in the State. The law directs landfill operators to assist enforce disposal prohibition. Florida has permitted reclamation facilities where people can take mercury coated bulbs for recycling (Chinn, 2013).

Environment Canada uses regulatory tools under the Canadian Environmental Protection Act (CEPA), 1999 and the Fisheries Act to manage toxic substances such as mercury. Mercury has been deemed a toxic substance under CEPA and is listed on schedule 1 of the Act. There are requirements under CEPA for the management of mercury relating to the chlor-alkali industry, the movement of hazardous waste, environmental emergencies and emissions from various sectors in the National Pollutant Release Inventory. Environment Canada is also involved in the research, development and implementation of a non-regulatory initiative to help reduce and manage releases of mercury due to human activity. The Provinces and territories of Canada have legislation, regulations and guidelines for mercury level in liquid effluent, drinking water and emissions from industrial sources. There are also several non-government organizations in the country dedicated to environmental protection that incorporate mercury management strategies into various initiatives (Canada-Ontario Agreement Respecting the great Lakes Basin Ecosystem, 2005).

According to Venter & Van der Walt (2008), the use of mercury coated bulbs becomes increasingly widespread in South Africa so also increases the concerns relating to their mercury content and the associated hazards. The current legislative framework governs large scale users of mercury coated bulbs, but legislation pertaining to industry regarding industry-specific waste is vague and as yet unresolved. Similarly, the legal requirements of residential consumers relating to any hazardous waste is inferred and practically non-existent. Furthermore, waste separation and recycling are not generally practiced and hence unfamiliar concepts to most South Africans.

2.4 Knowledge and practices

Most people who use mercury coated bulbs are unaware that each bulb contains between 5 and 30mg of mercury (Eco-South Travel, 2009). Mercury coated bulbs were found disposed improperly in the metropolitan area on Minas Gerais, Brazil. A study conducted there found out that most people from the general public to those in

commercial and health sectors did not know how to dispose end-of-life bulbs coated with mercury (Claudio & Hurbert, 2001).

Lack of knowledge regarding the handling of mercury led to about 186 000 kg of mercury being deliberately discharged into the main drainage system of the Maramo Lagoon, Northern Adriatic Sea in Italy. Most of the mercury discharged was from industrial activities. Another secondary discharge experienced at the lagoon was from Idrija in Slovenia (Stefano, Alessandro, Raffaella, Sergio & Cinzia, 2009).

The parks and recreation department warned residents near South Dallas playground to be on the lookout for symptoms of mercury exposure after mercury coated bulbs were illegally disposed at a playground and a vacant lot across the street. Nearly 1000 of smashed remains of mercury coated bulbs were found at the Peary play lot in the 2800 block of Peary Avenue, near Malcolm X Boulevard. Reports indicate that the toxic shards were disposed sometime in the evening and were later discovered by parks and recreation service, local police, storm water management, the environmental quality office and local fire rescue, all of whom were called on the scene to investigate. The park was closed due to this improper practice of disposal of mercury coated bulbs (Davis, 2013).

Mercury coated bulbs are one of the key measures for addressing electric power shortages and climate change mitigation, and mercury coated bulbs are expected to dominate the lighting in China. Although these bulbs are used in large quantities, residents and industries using liquid mercury are practicing improper disposal methods. It is estimated that spent mercury coated bulbs accounts for approximately 20% of mercury input in China (Hu & Cheng, 2012).

According to Sumanapala (2013), Sri Lanka’s public lacks knowledge on proper disposal of mercury containing products such as mercury coated bulbs. Sri Lanka’s

health ministry spokesperson Dharma Wanninayake indicated that the ministry was aware of the health implications of the appliances containing mercury. The ministry was mainly concerned about the disposal of the bulbs as people had no knowledge about it. It was therefore, the ministry's responsibility to ensure that the public receive education or awareness programmes on proper practice of disposal of mercury coated bulbs.

A Vice Mayor in Burlingame was concerned about lack of information with regard to proper disposal of mercury coated bulbs. Even though the State made disposing of mercury coated bulbs in household waste illegal in 2006, community awareness programmes about disposal methods was still a problem. Lack of education to the public about the harmful impact of not recycling the bulbs, contributes to improper practice by the public of disposing mercury coated bulbs in general household waste. The problem was also with the manufacturers of mercury coated bulbs who were providing contradictory information to consumers about proper disposal of mercury coated bulbs (Haughey, 2010).

A study was conducted by Hedge and Hunt (2010) to assess young consumers-college student's knowledge of compact fluorescent lamps regarding the sustainability, energy usage and their willingness to use it in their home. As energy and sustainability issues become critical, the governments around the world have passed regulations to phase out the inefficient incandescent lamps in favor of more efficient light sources such as mercury coated bulbs. The study surveyed 168 college student's knowledge about sustainability and energy efficient regarding mercury coated bulbs. Results indicated that 65% of the students believes that mercury coated bulbs does not contain mercury and 77% dispose them in general household waste.

2.5 Disposal Option

In Australia, landfill disposal is prohibited; an alternative to landfill disposal is taking fused mercury coated bulbs to specialised recyclers who are able to safely recover the mercury, glass, phosphor and alluminium contained in the bulbs. Recovered mercury can be re-used in generating new mercury coated bulbs. Several States in Australia also have household chemical collection programmes or drop off center that accept domestic quantities of mercury coated bulbs for recycling (Environment Protection and Heritage Council, 2009).

The Minnesota Pollution Agency (2007) recommended the following steps to be used when cleaning a broken mercury coated bulb:

- In case of a broken mercury coated bulb, people and animals should be kept out of the room. The windows and exterior doors should be opened for about 15 minutes to vent out mercury vapour from the room. Disposable rubber gloves should be put on before handling the broken mercury coated bulb. A person cleaning should carefully scoop up the glass shards and as much mercury vapour as possible with one or two pieces of stiff paper or cardboard. Hands should not be used, as the shards are sharp and the powder contains mercury.

- Damp paper towel should be used to wipe the area or a disposable wet wipe to pick up any small shards and the powder residue. A sticky tape, such as duct tape, can also be used to pick up small shards and powder. A vacuum machine should not be used until all visible powder of mercury and shards are removed.

- Glass shards, mercury powder and all materials used in the cleaning up should be placed in a plastic bag that can be sealed. The sealed plastic bag should be placed inside another plastic bag and be sealed. The plastic bag should be placed in a safe outdoor storage location until it is collected for recycling.

- Hands should be washed after cleaning up to avoid cross contamination of mercury.

Mercury containing products should be handled with care to avoid breakage. It should be stored in their original packaging where children cannot be able to access them. The original packaging of the bulb should be kept, and it can be used to protect the bulbs during storage and when they are transported for recycling. When transporting mercury coated bulbs, the trunk of the car should be used to carry them. Precaution should be taken to make sure that there are no heavy items in the trunk that can shift or roll around and crush the bulbs. The bulbs should be placed in a heavy duty plastic bag that can be sealed (The Minnesota Pollution Agency, 2007).

The United States Environmental Protection Agency (2009) recommended the following principles on disposal methods of fused mercury coated bulbs:

- Drop off area within the community should be established where fused mercury coated bulbs should be disposed separately from general household waste.
- Fused mercury coated bulbs should be disposed and packed carefully in order to help prevent breakage and mercury exposure.
- All fused mercury coated bulbs should be recycled.

Mercury containing Lamp Waste Management (2012), recommend that when fused mercury coated bulbs are removed and replaced with new bulbs, the used bulbs should be properly packaged in the cardboard boxes that contained the replacement bulbs. The boxes containing the hazardous mercury coated bulbs waste must be labeled. A safe disposal area should be designated and identified to ensure that the bulbs are not accidentally broken or crushed before they are sent to a disposal facility. The disposal area must be well ventilated, with fire extinguisher and

appropriate emergency response equipment in case of accidental emission. Each box of fused bulbs must be stored in a manner that will prevent breakage or damage to the bulbs.

The United States Environmental Protection Agency (2010) further recommended the following steps for cleaning broken mercury coated bulbs:

Ventilate the room

- Have people and pets leave the room, and don't let anyone walk through the breakage area on their way out.
- Open a window and leave the room for 15 minutes or more.
- Switch off the air conditioning system.

Cleaning steps for hard surfaces

- Carefully scoop up glass pieces and powder using stiff paper or cardboard and place them in a glass jar with metal lid or in a sealed plastic bag.
- Use sticky tape to pick up any remaining small fragments and powder.
- Wipe the area clean with damp paper towels or disposable wet wipes. Place towels in the glass jar or plastic bag.
- Do not use a vacuum or broom to clean the broken bulb on hard surface.

Cleaning steps for carpeting or rug

- Carefully pick up glass fragments and place them in a glass jar with metal lid or sealed plastic bag.
- Use sticky tape to pick up any remaining small glass fragments and powder.
- If vacuum is needed after all visible materials are removed, vacuum the area where the bulb was broken.

- Remove the vacuum bag and put the bag or vacuum debris in a sealed plastic bag.

Cleaning steps for clothing, bedding and other soft materials

- If clothing or bedding materials come in direct contact with mercury powder from broken mercury coated bulb, the clothing or bedding should be thrown away. Do not wash such clothing or bedding because mercury fragments in the clothing may contaminate the machine and pollute sewage.
- You can, however, wash clothing or bedding or other materials that have been exposed to mercury vapour, such as the clothing you are wearing when you clean the broken mercury coated bulb.
- If shoes come into direct contact with broken mercury coated bulb, wipe them off with damp paper towels or disposable wet wipes.
- Place the towels or wipes in a glass jar or plastic bag for disposal.

Disposal of cleaning material

- Immediately place all cleaning materials outdoors in a waste container or protected area for the next normal waste collection.
- Wash hands after disposing the jars or plastic bags containing cleaning materials.
- Check with the local or state government about disposal requirements in your area.

2.6 Conclusion

The above discussion gives an idea about sources of mercury and also risks associated to exposure to mercury. It provides the reader with an understanding of the different approach used internationally and nationally with regard to practices and knowledge about the legislative control and disposal methods of mercury coated bulbs. The information provided helps one to understand which best ways can be employed in preventing people, animals and the environment from mercury exposure.

CHAPTER 3: RESEARCH METHODOLOGY

3.1 Introduction

This chapter contains information concerning the study design, study site, study population, sampling method, inclusion and exclusion criteria, data collection method, data analysis, validity and reliability, as well as ethical considerations. Each aspect is described in detail below.

3.2 Study Design

Cross-sectional design with quantitative approach was used in this research study. It was a quantitative approach as questionnaires were used to collect data. It was a cross-sectional design as the study described the situation or examined that which currently existed in a population (Polit & Beck, 2012).

3.3 Study Site

The study was conducted at Ga-Mokgwathi Village in Mopani District, Limpopo Province, South Africa. The village is located about 75 kilometers on the eastern side of Tzaneen town. Ga-Mokgwathi village was electrified in 1993, one year before the first democratic elections in South Africa. The village did not have a formal landfill then and still does not have one, forcing them to dispose their household waste in the streams. There is also no refuse collection by the municipality in the village. Due to lack of piped water in the village, people use water from Mothathi River for drinking and washing. They also use the river for fishing. There are about three main streams which supply Mothathi River with water.

3.4 Study Population

According to the register book kept by the headman in 2011, Ga-Mokgwathi Village has a population of approximately 3500 people who live in a total number of 650 households. The village is situated in a rural area where most of the people are not employed and depend on their children's social grants and old age grants.

3.5 Sampling Method

Cluster random sampling, which is a form of sampling in which groupings or clusters are selected, typically with successive subsampling of smaller units (Polit & Beck, 2012) was used in the study. Ga-Mokgwathi Village has three sections, Block 10, Block 11A and Block 11B, which is divided into 3 clusters. Block 10 has a total number of 500 households. Each household has its own stand number starting from 1 to stand number 500. From a sampling frame for a population of 500 households in Block 10, 217 households were randomly sampled. The households corresponding to the randomly selected stand numbers were included to the sample. Block 11A had a total number of 95 households with each household having its stand number from 1 to 95, and 76 households were randomly sampled. Block 11B has 55 households and 45 households were randomly sampled. The total sample for the whole village was 338 households. This sample size was determined based on the Krejcie and Morgan criteria for determining the sample size at 95 percent and 99 percent confidence levels (Krejcie & Morgan, 1970).

3.6 Inclusion and Exclusion Criteria

In the study, only respondents aged 15 years and older who can read and write, and living at Ga-Mokgwathi Village were included. People who cannot read and write and were below the age of 15 years living at Ga-Mokgwathi and those who were not the villagers of Ga-Mokgwathi Village were excluded from the study. The reason for their exclusion was because the questionnaire needed to be completed by someone who can read and write.

3.7 Data Collection Method

A questionnaire was used to collect data. The questionnaires were distributed to randomly selected households by field workers. Respondents completed them independently and they were collected back by field workers the same day after about 30 minutes of completion. Questionnaires were translated from English into Sepedi (Appendix 6 and 7). The reason for the translation from English into Sepedi was that some respondents could not understand English, and Sepedi is the language spoken in the area. The questionnaires were constructed through the help of a statistician and the questions were formulated looking at Talty's article (2009). They consisted of 3 sections: section (A) containing demographic information, section (B) knowledge about the disposal methods of mercury coated bulbs among households and section (C) the practices regarding the handling of broken mercury coated bulbs by Ga-Mokgwathi households (See Appendix 6).

3.8 Data Analysis

Data were analyzed using Statistical Package for the Social Sciences (SPSS) version 18. Descriptive Statistics were provided and Spearman correlation was used to compare the relationship between variables. Data Analysis was done through the help of a statistician.

3.9 Validity and Reliability

To ensure validity and reliability, a pilot study was done where the questionnaire to be used was administered by the researcher to 10 respondents from Ga-Mokgwathi Village and those 10 respondents did not form part of the main study. This was done to test if the questionnaire measures the knowledge and practices as intended in the study (Keith, 2005). There were no changes made to the questionnaires after the pilot study was conducted because the questionnaires were valid and reliable.

3.10 Ethical Considerations

Research proposal was submitted to the Medunsa Research Ethics Committee of the University of Limpopo and ethical clearance to conduct the study was granted (Appendix 1). Permission to collect data was sought from the Head-man of Ga-Mokgwathi village (Appendix 2). Once permission was given to collect data (Appendix 3), respondents who were interested in participating in the research were informed of what the research was all about, how it would affect them, the risks and benefits of participation, and the fact that they had the right to decline to participate if they so choose (Bless, Higson-Smith & Kagee, 2006). It was explained to the respondents what the study entailed and what was required of them in terms of participation. Each respondent was asked to sign an informed consent form (Appendix 4 and 5), which was an indication that they indeed understood what had been explained to them. Parents of respondents who were under 21 years of age were asked to give consent on behalf of their children. Data collected from respondents was kept under secure condition. Instead of using names, a number was assigned to a respondent's data to ensure that the data remained anonymous.

3.11 Conclusion

The above information outlined in detail the approach or design of the study. It gave the reader a clear picture of the location and population of the community in which the study was conducted and the method used for selection of respondents of the sample population from the general population. I also outlined the target population for the study. It further gave the reader an understanding of how data were collected and analyzed, and how the instrument was tested before the actual study.

CHAPTER 4: PRESENTATION OF DATA

4.1 Introduction

This chapter contains presentation of data which is organized in tables, pie graphs and bar charts that reflect frequencies and percentage of demographic data, knowledge about disposal methods of mercury coated bulbs, and practices regarding the handling of broken mercury coated bulbs by Ga-Mokgwathi households.

4.1.1 Demographic data

Item 1 (Gender) on Table 1 indicates that 33.4 percent (%) of males and 66.5% of females completed the questionnaires. Item 2 (Age) indicates that 65.6% of respondents were between the age of 15 to 35 years, 28.7% were respondents between the age of 36 to 60 years and 5.6% were 61 years old and above. Item 3 (Employment status) on table 1 indicates that 10.9% of those who completed the questionnaires were employed, 36.3% were unemployed and 52.6% of respondents were students.

Table 1: Demographic Data

Items		Score (%)
1. Gender	male	33.4%
	female	66.5%
2. Age	15-35	65.6%
	36-60	28.7%
	61+	5.6%
3.Employment Status	Employed	10.9%
	Unemployed	36.3%
	student	52.6%

4.1.2 Relationship between gender and practice

Table 2 indicates that gender does not influence the practice regarding the handling of broken mercury coated bulbs in Ga-Mokgwathi Village.

Table 2: Relationship between gender and practice

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	.580[a]	2	.748
Likelihood Ratio	.579	2	.749
Linear-by-Linear Association	.578	1	.447
N of Valid Cases	338		
a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 7.02.			

4.1.3 *Relationship between gender and knowledge*

Table 3 indicates that gender does not have an influence on knowledge about the disposal methods of mercury coated bulbs in Ga-mokgwathi Village.

Table 3: Relationship between gender and knowledge

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	2.532[a]	2	.282
Likelihood Ratio	2.525	2	.283
Linear-by-Linear Association	2.296	1	.130
N of Valid Cases	338		
a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 8.69.			

4.1.4 Relationship between Age and practice

Table 4 indicates that age of a person can have an influence on the practice regarding the handling of broken mercury coated bulbs.

Table 4: Relationship between Age and practice

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	11.912[a]	4	.018
Likelihood Ratio	13.915	4	.008
Linear-by-Linear Association	4.609	1	.032
N of Valid Cases	338		
a. 1 cells (11.1%) have expected count less than 5. The minimum expected count is 1.18.			

4.1.5 Relationship between Age and knowledge

Table 5 indicates that the age of a person can have an influence on the knowledge about the disposal method of mercury coated bulbs.

Table 5: Relationship between Age and knowledge

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	9.902[a]	4	.042
Likelihood Ratio	11.958	4	.018
Linear-by-Linear Association	1.460	1	.227
N of Valid Cases	338		
a. 1 cells (11.1%) have expected count less than 5. The minimum expected count is 1.46.			

4.1.6 Relationship between employment status and practice

Table 6 indicates that employment status have an influence on the practice regarding the handling of broken mercury coated bulbs.

Table 6: Relationship between employment status and practice

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	37.105[a]	4	.000
Likelihood Ratio	38.395	4	.000
Linear-by-Linear Association	4.619	1	.032
N of Valid Cases	338		
a. 1 cells (11.1%) have expected count less than 5. The minimum expected count is 2.30.			

4.1.7 Relationship between employment status and knowledge

Table 7 indicates that employment status have an influence on the knowledge about the disposal methods of mercury coated bulbs.

Table 7: Relationship between employment status and knowledge

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	31.050[a]	4	.000
Likelihood Ratio	33.543	4	.000
Linear-by-Linear Association	.677	1	.411
N of Valid Cases	338		
a. 1 cells (11.1%) have expected count less than 5. The minimum expected count is 2.85.			

4.1.8 Knowledge among households on disposal methods

Knowledge regarding the disposal methods of mercury coated bulbs among households at Ga-Mokgwathi Village is indicated in Table 8 and was determined by section B in the questionnaire (Appendix 6 & 7). The table indicates that 36.7 % (n=124) of the households who completed the questionnaires had knowledge about disposal methods of mercury coated bulbs, 7.7% (n=26) were not sure, and the majority of the households, 55.6% (n=188), had no knowledge of disposal methods.

Table 8: Knowledge among households on disposal methods

	Frequency	Per cent	Cumulative Per cent
Knowledgeable	124	36.7	36.7
Not sure	26	7.7	44.4
No Knowledge	188	55.6	100.0
Total	338	100.0	

4.1.9 Practices among households

Results of Table 9 below indicates that a higher percentage of 51.5% (n=174) of households who answered the questionnaire had improper practices regarding the handling of broken mercury coated bulbs, 6.2 % (n=21) were not sure and 42.3% (n=143) used proper practices regarding the handling of broken mercury coated bulb. Practices among households were determined by section C on the questionnaire (Appendix 6 & 7).

Table 9: Practices among households

	Frequency	Per cent	Cumulative Per cent
Improper Practice	174	51.5	51.5
Not sure	21	6.2	57.7
Proper practice	143	42.3	100.0
Total	338	100.0	

4.1.10 Disposal methods among households

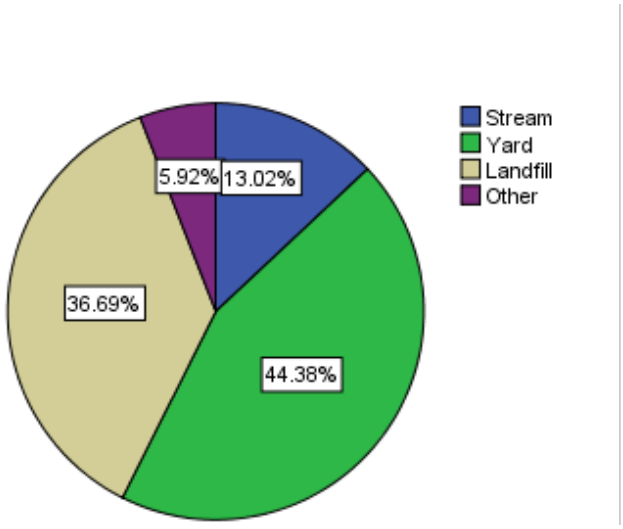

Figure 1: Disposal methods among households

The majority of the respondents (44.4%) indicated that they disposed their fused mercury coated bulbs in the yard. Less than 36.7% of them disposed their bulbs in the landfill, 13% disposed them in the stream and only 6% of the respondents used other methods of disposal other than in yards, landfill and streams.

4.1.11 Cleaning methods among households

Results on Table 10 below indicates that 92.6% (n=313), which is almost every household at Ga-Mokgwathi Village, used a broom to clean mercury coated bulbs, 3.8% (n=13) used a vacuum cleaner, 2.4% (n=8) used stiff paper and 1.2% (n=4) used other methods.

Table 10: Cleaning methods among households

	Frequency	Per cent	Cumulative Per cent
Broom	313	92.6	92.6
Vacuum cleaner	13	3.8	96.4
Stiff paper	8	2.4	98.8
Other	4	1.2	100.0
Total	338	100.0	

4.1.12 Wiping methods among households

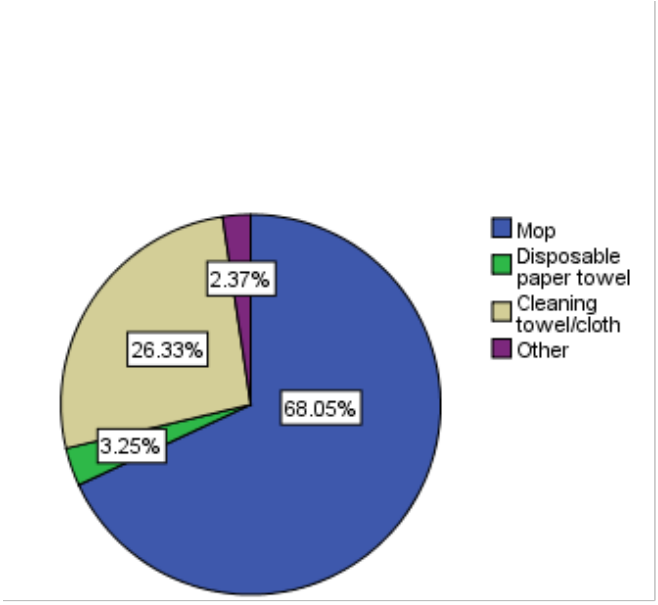

Figure 2: Wiping methods among households

Figure 2 above indicates that the majority of the households which were 68.1% used a mop to wipe mercury coated bulb, 3.3% used disposable paper towel, 26.4% used cleaning towel/cloth and 2.4% used other methods.

4.1.13 Relationship between knowledge and practice

Table 11 below indicates that households who had knowledge about the disposal methods of mercury coated bulbs had 0% of improper practice regarding the handling of broken mercury coated bulbs, 0.3% were not sure and 36.4% had proper practices regarding the handling of broken mercury coated bulbs. From households who were not sure about the knowledge of disposal methods of mercury coated bulbs, 0% had improper practice regarding the handling of broken mercury coated bulbs, 4.7% were not sure and 3.0% had proper practice. From households who had no knowledge about the disposal methods of mercury coated bulbs, 51.5% had improper practice regarding the handling of broken mercury coated bulbs, 1.2% were not sure of what to practice and 3.0% had proper practice.

Table 11: Relationship between knowledge and practice					
		Practice			Total
		Improper Practice	Not sure	Proper practice	
Knowledge	Knowledgeable	0	1	123	124
		0.0%	0.3%	36.4%	36.7%
	Not sure	0	16	10	26
		0.0%	4.7%	3.0%	7.7%
	No Knowledge	174	4	10	188
		51.5%	1.2%	3.0%	55.6%
Total		174	21	143	338
		51.5%	6.2%	42.3%	100.%

4.1.14 Correlation between knowledge and practice

Table 12 shows that P value was 0.000 using the chi-square test. This indicates that there is a relationship between knowledge and practice.

Table 12: Correlation between knowledge and practice using chi-square test

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	433.536[a]	4	.000
Likelihood Ratio	431.096	4	.000
Linear-by-Linear Association	282.715	1	.000
N of Valid Cases	338		
a. 1 cells (11.1%) have expected count less than 5. The minimum expected count is 1.62.			

4.2 Conclusion

The above result concludes that more than half (55.6%) of households at Ga-Mokgwathi Village have no knowledge about the disposal methods of broken mercury coated bulbs, and as a result they did not dispose their bulbs properly.

CHAPTER 5: DISCUSSION OF MAJOR FINDINGS

5.1 Introduction

This chapter discusses in detail the major findings of the study which are supported by the literature; also limitations of the study and recommendations are discussed. Limitations in this study were all the problems that were encountered by the researcher during data collection. The recommendations are the solutions that are to be applied after the problems have been identified from the study findings.

Table 8 indicates that less than 36.7% households at Ga-Mokgwathi Village have knowledge about disposal methods of mercury coated bulbs and 7.7% were not sure. Furthermore, the results indicate that 55.6%, who were the majority of the households at Ga-Mokgwathi Village, did not have knowledge about the disposal methods of mercury coated bulbs. In other words, most people at Ga-Mokgwathi Village lack knowledge about disposal methods of mercury coated bulbs when compared to those who had knowledge. In a study conducted by Shoemaker and Ghaemghami (2003) at Boston, USA, household materials such as bulbs, batteries and thermometers were high risk sources of mercury because many people did not have knowledge about proper disposal methods (Shoemaker & Ghaemghami, 2003).

Results on Table 9 indicate that just above half (51.5%) of households at Ga-Mokgwathi Village practiced improper handling of broken mercury coated bulbs and 6.2% were not sure of their practices. Less than half (42.3%) had proper practices regarding the handling of broken mercury coated bulbs. These results were similar to a study conducted by Mauro, Jarbas, Gilmar & Mamerto (2011) to investigate consumer practice on the disposal of fused mercury coated bulbs in Sao Paulo, Brazil. The results indicate that about 100 million mercury coated bulbs are used a year, and only 6% is recycled. The study concludes that most of the bulbs are disposed improperly (Mauro et al., 2011).

Figure 1 reflects that most of the households (44.4%) at Ga-Mokgwathi Village dispose their mercury coated bulbs around their yards.These results clearly indicate that the majority of the residents at Ga-Mokgwathi Village lack knowledge about proper disposal of mercury coated bulbs. According to Minnesota Protection Control Agency (2007), mercury coated bulbs must be handled and disposed properly to avoid polluting the environment and posing a health threat. The agency further indicate that mercury coated bulbs may not be disposed in a landfill, streams and yards, but must be recycled. Eco-South Travel (2009) indicates that most people who use mercury coated bulbs are unaware that each bulb contains between 5 and 30mg of mercury and exposure to improperly disposed broken bulbs could lead to adverse health effects.

Table 10 indicates that 92.6% of the people, which is almost every household at Ga-Mokgwathi Village, use a broom to clean broken mercury coated bulbs. It further indicates that few households (2.4%) use stiff paper to clean up pieces of broken mercury coated bulbs. According to the United States Environmental Protection Agency (2013), a broom must not be used to clean broken mercury as it breaks the mercury into smaller droplets and spreads the mercury all over. Also a vacuum cleaner must not be used because it will emit mercury into the air and increase exposure. Instead of using a broom or a vacuum, a stiff paper or cardboard can be used to gather mercury beads.

According to the guidelines of cleaning a broken mercury coated bulb by Minnesota Protection Control Agency (2007), a disposable paper towel should be used to wipe down powder residue of broken mercury. A mop should not be used, as it is not disposed after cleaning, and will spread further mercury beads to uncontaminated areas. However, figure 2 indicates that the majority of the households (68.1%) at Ga-Mokgwathi Village use a mop to wipe down mercury coated bulbs and only a small number of the household (3.3%) used disposable paper towels. The reason for them to use the mop could be that a mop can be used for many months without buying a

new one. Disposable towels may be expensive for them as they may not last for many days and many people have no steady income.

Table 11 indicates that people who were knowledgeable about disposal methods of mercury coated bulbs were practising proper handling of broken mercury coated bulbs. On the other hand, people who were not knowledgeable about the disposal methods of mercury coated bulbs, had improper practice regarding the handling of broken mercury coated bulb. The result concludes that lack of knowledge about proper disposal methods of mercury coated bulbs leads to improper handling of broken mercury coated bulbs.

5.2 Limitations of the study

The study excluded people who cannot read and write and therefore does not represent the entire village.

5.3 Recommendations

- People should be educated about disposal methods and handling of mercury coated bulbs. This should be done through community awareness campaigns.
- Educating people about the risks of mercury poisoning and indicating what domestic products they can use that contain mercury so that when these are to be discarded proper disposal procedures are used.
- The issue of the need for proper waste management should be brought to the attention of the leaders in the community.
- The municipality should be engaged to establish controlled disposal systems for mercury containing waste. For example, drop off centres for fused mercury coated bulbs should be selected around the village where people can access them with ease.
- Establishment of national or regional safe containment facilities for mercury contaminated waste.

6. CONCLUSION

The study investigated knowledge and practices among households at Ga-Mokgwathi Village regarding the disposal of broken mercury coated bulbs. The results of the study indicated that people were not knowledgeable about the disposal methods and the handling of mercury coated bulbs. Furthermore, findings from this study assisted the researcher in making appropriate recommendations regarding waste management and also in preventing health problems and environmental pollution.

REFERENCES

Arendt, J.D. & Katers, J.F. 2013. Compact fluorescent lighting in Wisconsin: elevated atmospheric emission and landfill deposition post-EISA implementation. From: http://www.ncbi.nlm.nih.gov/pubmed/23635464.htm (accessed 30 April 2013).

Bless, C., Higson-Smith, G. & Kagee, A. 2006. *Fundamentals of social research methods an African perspective*. 4th edition.Cape Town: Juta.

Canada- Ontario agreement respecting the great lakes basin ecosystem, 2005. Municipal actions to reduce mercury. From: http://www.ec.gc.ca/4670AC23-8CA3-4684-A5EE-4A99DOC992DB/FinalDownload/DownloadId-8726815E664226931A539FD5B186AD1D/4670AC23-8CA3-4684-A5EE-4A99DOC992DB/mercure-mercury/CB7978FC-627E-415C-50DDF22DBA70/municipal-Actions_E.pdf

Casucci, C., Okeke, B.C. & Frankenberger, W.T. 2002. Effects of mercury on microbial biomass and enzyme activities in soil. *Biological Trace Element Research,* 94 (2): 179- 191.

Claudio, R. & Hurbert, M.R. 2001. Contamination of the environment by the current disposal methods of mercury-containing lamps in the state of Minas Gerais, Brazil. *Waste Management Journal,* 21 (7): 661-670.

Chinn, L. 2013. Florida fluorescent disposal laws. From: http://www.eho.com/list_6908934_florida-fluorescent-disposal-laws.html.

Dabrowski, J.M., Ashton, P.J., Murray, K., Leaner, J.J. & Mason R.P. 2008. Anthropogenic mercury emissions in South Africa: Coal combustion in power plants. *Atmospheric Environment,* 42 (27): 6620-6626.

Dabrowski, J.M. & Mason, R.P. 2010. Emissions of mercury associated with coal-fired power stations in South Africa. From: http://soer.deat.gov.za/dm-documents/emission. (accessed 9 february 2010)

Davis, J, 2013. Residents warned of mercury exposure after bulbs dumped at Dallas playground. From: http://www.wfaa.com/news/local/dallas/Residents-warned-of-mercury-exposure-after-bulbs-dumped-at-Dallas-parks-226547081.html

Department of Environmental Management and Tourism. 2009. *Integrated pollution and waste management in South Africa*. Pretoria: Government Printer.

Eco-South Travel. 2009. Safely dispose of your energy saving light bulb. From: http://www.ecosouth.icslovestheweb.com. (accessed 07 April 2009).

Environmental Protection and Heritage Council. 2009. Safe disposal of mercury containing lamps. From: http//www.ephc.gov.au (accessed 13 August 2010).

Environmental Protection and Heritage Council. 2009. Safe disposal of mercury containing lamps. From:http://www.environment.gov.Au/topics/environment-protection/national-waste-policy/mercury-containing-lamps.pdf.

Evers, D.C. & Clair, T.A. 2005. The extent and effects of mercury pollution in Northeastern North America.*Ecotoxicology*, 14 (1&2): 5.

Groundwork. 2009. Mercury. Environmental justice action in South Africa. From: http://www.groundwork.org.za/pamphlets/mercury.htm (accessed 5 August 2009).

Harris-Hellal, J., Vallaeys, T., Garnier-Zarli, E. & Bousserrhine, N. 2008. Effects of mercury on soil microbial communities in tropical soil of French Guyana. *Applied Soil Ecology,* 41 (1): 59-68.

Haughey, S. 2010. Burlingame vice mayor prompts bulb recycling. From: http://www.Sfexaminer.co/local/Burlingame-vice-mayor-prompts-bulb-recycling-99499659.html. (assessed 30 July 2010).

Hedge, A.L. & Hunt, E. 2010. Young consumer's knowledge of compact fluorescent lamp: Energy, sustainability and willingness of use. *The international journal of environmental, cultural, economic & social sustainability, 7 (1): 49-58).*

Hu, Y. & Cheng, N. 2012. Mercury risk from fluorescent lamps in China: Current status and future perspective. *Environment international journal,* 44 (1): 141-150.

Keith, F.P. 2005. *Introduction to social research: Quantitative and qualitative approach*. 2nd edition. India: Sage.

Khatoon-Abadi, A.I., Hoseini, A.R.S. & Khalili, B. 2008. Effect of mercury on the human health and environment. *International Journal of Food Safety, Nutrition and Public Health*, 1 (1): 33-40.

Krejcie, R.V. & Morgan, D.W. 1970. Determining sample size for research activities. *Educational and Psychological Measurement,* 30 (3): 607-610.

Kwezi V3 Engineering. 2005. *Integrated waste management*.

From: http://www.uace.org.ug/pdf/liebenbergcj.pdf (accessed 10 January 2010)

Maramba, N.P.C., Reyes, J.P., Francisco-Rivera, A.T., Panganiban, L.C.R., Dioquino, C., Dando, N., Timbang, R., Akagi, H., Eguchi, T. & Fuchigami, Y. 2006. Environmental and human exposure assessment monitoring of communities near abandoned mercury mine in Phillipines. *Journal of Environmental Management,* 81 (1):135-145.

Mauro, M.L., Jarbas, V.N., Gilmar, J.D. & Mamerto, G.G. 2011. A study of consumer behavior on recycling of fluorescent lamp in Sao Paulo, Brazil. *International Journal of Business Administration*, 2 (3):101.

Mercury containing lamp waste management. 2012. Lamp waste management procedural guidelines.

From: http://www.2.doe.gov.ph/pelmatp/Lwm%20procedural%20Guideline_final.pdf.

Merriam-Webster Dictionary. 2013. Definition of knowledge. From: http://www.merriam-webster.com/dictionary/knowledge (accessed 5 May 2013)

Mieiro, C.L., Ahmad, I., Pereira, E., Duarte, M. & Pacheco, M. 2010. Antioxidant system breakdown in brain of feral golden grey mullet (lizaaurita) as effect of mercuryexposure. From: http://www.ncbi.nlm.nih.gov/pubmed/20309630 (accessed 23 March 2010).

Minnesota Protection Control Agency. 2007. Managing and cleaning up broken fluorescent and high-intensity discharge lamps. From: http://www.mnpoison.org/cs/groups/public/documents/webcontents/poison_scraped_144.pdf.

Müller, A.K., Westergaard, K., Christensen, S. & Sorensen, S.J. 2001. The effect of long- term mercury pollution on the soil microbial community. *Microbiology Ecology,* 36 (1):11-19.

Northeast States for coordinated Air use management. 2003. Mercury emissions from coal-fired power plants.
From: http://www.nescaum.org/documents/rpt031104mercury.html (accessed 19 October 2010).

Oosthuizen, M.A., John, J. & Somerset, V. 2010. Mercury exposure in a low-come community in South Africa,*' South African Medical Journal,* 100(6):366-371.

Oosthuizen, M.A. & Enrlich, J. 2001. The impact of pollution from mercury processing plant in Kwazulu Natal, on the health of fish eating communities in the area: an environmental health risk assessment. *International Journal for Environmental Health Research,* 11(1): 41-50.

Osram, G.A. 2013. Recycling: Osram guide for proper lamp disposal. From: http://www.osram.com/media/resource/HIRES/339247/783060/0sram-guide-for-proper-lamp-disposal.pdf.

Papu-Zamxaka, V., Mathee, A., Harpham, T., Barnes, B., Röllin, H., Lyons, M., Jordaan, W. & Cloete, M. 2010. Elevated mercury exposure in communities living alongside the Inanda dam.*Journal of Environmental Monitoring,* 12 (2): 472-477.

Polit, D.F. & Beck, C.T. 2012. *Nursing research: Generating and assessing evidence for nursing practice*. China: Lippincott Company.

Richard, R. & Stephanie, B. 2004. Mercury exposure aboard an ore boat. *Environmental Health Perspectives,* 112 (8): 910-913.

Scheuhammer, A.M., Meyer, M.W., Sandheinrich, M.B. & Murray, M.C. 2007. Effects of environmental methyl-mercury on the health of wild birds, mammals and fish. *A Journal of the Human Environment,* 36 (1): 12-19.

Shoemaker, P.A, & Ghaemghami, J. 2003. Protecting the public from mercury exposure: Success though micro exchange events. *American Journal of Public Health,* 93 (12).1997-1999

South Africa. 1998. National Environmental Management Act, no. 107, 1998. Pretoria: Government printer.

South Africa. 2008. Waste Management Act, no. 59, 2008. Pretoria: Government printer.

Stefano, C., Alessandro, A., Raffaella, P., Sergio, P. & Cinzia, D.V. 2009. Recent contamination of mercury in an estuarine environment. *Estuarine, Coastal and Shelf*, 82 (2): 273-284.

Sumanapala, C. 2013. Consumers unaware of mercury hazards in compact fluorescent light bulbs. From: http://www.colomboherald.com/news/consumers-unaware-of-mercury-hazards-in-cfl-bulbs. (assessed 22 September 2013).

Talty, C. 2009. Disposing energy-saving fluorescent light bulbs. From: http://www.health –family.org (accessed 06 April 2010).

The American Heritage Dictionary of the English Language. 2009. 4th edition. Houghton Miffin Company.

The South African Pocket Oxford Dictionary. 2006. 3rd edition. Cape Town: Oxford University Press.

United States Environmental Protection Agency. 2009. Fluorescent lamp recycling. From: http://www.epa.gov/solidwaste/hazard/wastetypes/universal/Lamp/lamp-recycling2-09-pdf. (accessed February 2009)

United States Environmental Protection Agency. 2008. Mercury containing light bulbs.
From:http://epa.gov/epawaste/hazard/wastetypes/universal/lamps/faqs/htm#1.2008 (accessed 04 April 2010).

United State Environmental Protection Agency. 2013. Mercury releases and spills. From: http://www.epa.gov/hg/spills/pdf (accessed 27 April 2013)

Venter, L & Van der Walt, M. 2008. Recovery of compact fluorescent lamps from the general household waste stream.

From:
http://www.ngopulse.org/sites/default/files/Recovery%20of%20compact%20fluorescent%20lamps%20from%20the.pdf.

Wang, D., Shi, X. & Wei, S. 2002. Accumulation and transformation of atmospheric mercury in soil. *The Science of the Total Environment,* 304 (3):209-214.

Waste Management Planning. 2010. Integrated feasibility study for municipal waste. From: www.ba-phalaborwa.go.za/docs/idp/bpm-sdbip-2-010-2011pdf (accessed 01 October 2010).

7. APPENDIX

7.1 APPENDIX 1: Medunsa Research and Ethics Committee Clearance Certificate

UNIVERSITY OF LIMPOPO
Medunsa Campus

MEDUNSA RESEARCH & ETHICS COMMITTEE

CLEARANCE CERTIFICATE

MEETING:	**07/2012**
PROJECT NUMBER:	**MREC/HS/201/2012: PG**
PROJECT :	
Title:	The knowledge practices of mercury coated bulbs disposal among house-holds at Ga-Mokgwathi village, Limpopo Province
Researcher:	Mr. L Mokhasi
Supervisor:	Mr. MP Kekana
Co-supervisor:	Mr. SF Matlala
Department:	Public Health
School:	Health Sciences
Degree:	MPH

DECISION OF THE COMMITTEE:

MREC approved the project.

DATE: 12 September 2012

PROF GA OGUNBANJO
CHAIRPERSON MREC

The Medunsa Research Ethics Committee (MREC) for Health Research is registered with the US Department of Health and Human Services as an International Organisation **(IORG0004319)**, as an Institutional Review Board **(IRB00005122)**, and functions under a Federal Wide Assurance **(FWA00009419)**
Expiry date: **11 October 2016**

Note:
i) **Should any departure be contemplated from the research procedure as approved, the researcher(s) must re-submit the protocol to the committee.**
ii) **The budget for the research will be considered separately from the protocol.**
PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES.

Finding Solutions for Africa

7.2 APPENDIX 2: Letter Seeking Permission to Conduct Research from the Headman.

Mokhasi L

Po Box 5181

Mokgwathi

0861

To: Ga-Mokgwathi Headman

Re: APPLICATION FOR PERMISSION TO CONDUCT A RESEARCH STUDY

I am currently studying for a Master's degree in Public Health at the University of Limpopo, and I am expected to conduct a research study as a partial fulfilment of the course. The title of the study is: *The Knowledge and Practices of Mercury Coated Bulbs Disposal among Households at Ga-Mokgwathi Village, Limpopo Province, South Africa.* The objectives of the study are to determine knowledge about the disposal methods of mercury coated bulbs among households at Ga-Mokgwathi Village and to determine the practices regarding the handling of broken mercury coated bulbs by these residents.

I therefore humbly request your permission to conduct this study in your village.

Yours Sincerely

Mokhasi Lucky

0764054693

7.3 APPENDIX 3: Headman's Approval Letter

Headman's Approval Letter

From: Mr Mohale N.A (Headman)

To: Mokhasi L

Date: 18 February 2013

Subject: APPROVAL LETTER TO CONDUCT A RESEARCH

- This letter is to ascertain that Mr Mokhasi Lucky (Researcher) has been granted a permission to conduct a study at Ga-Mokgwathi Village.
- I Mohale Albert, I am aware of all the activities that the researcher will be doing in the village as a partial fulfillment of his course.
- I have also been told about the objectives of the study which I found that they can be beneficial to the community
- Thank you

Yours Faithfully

Mr Mohale N.A

.....

MOKGWATHI TRIBAL AUTHORITY
BOLOBEDU - LIMPOPO PROVINCE
2013 -02- 18
THE HEADMAN: MOHALE A.N.
5142 MOKGWATHI 0861
SIGNATURE: A.N. MOHALE

7.4 APPENDIX 4: **Informed Consent Form**

Research title: *The Knowledge and Practices of Mercury Coated Bulbs Disposal among Households at Ga-Mokgwathi Village, Limpopo Province, South Africa.*

The Aim of the study is to investigate knowledge and practices among households at Ga-Mokgwathi Village regarding the disposal of mercury coated bulbs.

The objectives of the study are to determine knowledge about the disposal methods of mercury coated bulbs among households at Ga-Mokgwathi Village and to determine the practices regarding the handling of broken mercury coated bulbs by residents in this village.

Study site: Ga-Mokgwathi Village

Upon approval by the Medunsa Research Ethics Committee, data will be collected from the respondents.

You are kindly invited to participate in a research study, and participation is voluntary. You have the right to refuse to participate and you will also be free to withdraw from the research at any time without facing any penalty. It should take not more than 20 minutes of your time to complete a questionnaire which consists of 3 sections. Information provided by the respondent will be protected and made unavailable to anyone other than the researcher. A single visit will be made at each household at Ga-Mokgwathi Village and it will take the researcher only three days to cover those households. There will be no risks, pain or discomfort to the individuals participating in the study, including risks to the health or well-being of a respondent.

Be informed that there will be no money or any other form of material goods provided in return for your participation. However, the research may benefit the community at large as it may help to make people aware of proper ways of handling and disposing off mercury coated bulbs. It may also help to prevent the community from unnecessary mercury exposure, which can cause adverse health effects. After completion of the study, respondents will be informed of the findings of the research study in general through report giving.

I …….. has been informed that my participation in the study is not compulsory but voluntary, and that I have the right to withdraw at any time without facing any penalty. I was also informed that any information that I provide shall remain anonymous and I therefore give consent.

Respondent's, parent's or legal guardian's signature…….

Date signed…….

Researcher's signature…….... Date signed…….

7.5 APPENDIX 5: Sepedi Consent Form

Tumelelano ya gotšea karolo ya resetšhe

Hlogo ya resetšhe: Tsebo le madirelo ka go lahla ga mabone a mohlagase a goba le mekhuri ka badudi ba Ga-Mokgwathi, profensing ya Limpopo ka Africa borwa.

Maikemišetšo a resetšhe ke go nyakolla tsebo le madirelo ka go lahla ga mabone a mohlagase a goba le mekhuri. Se setla diriwa ka go lebelela gore naa badudi ba Ga-Mokgwathi ba nale tsebo efhe mabapi le go lahla ga mabone a mohlagase a goba le mekhuri le golebelela gore ao a thubegilego a swariwa bjang kamalapa a Ga-Mokgwathi.

Lefhelo la resetšhe ke Ga-Mokgwathi

Ka go fhiwa tumelloka komiti ya resetšhe ya yunibesithi ya Medunsa:

O gopelwa gotšea karolo ya resetšhe. O tsebe gore gotšea karolo ya resetšhe a se kgapeletšo, o nale thokelo ya go lesa nako yengwe le yengwe kantle le go otlhwa. O gopelwa go tlatša dipotšišo tšeo di aroganego ka dikarolo tše tharo. Go tlatšea metsotso e masome pedi go araba dipotšišo kamoka. Tseba gore botlhatse bjo o tla fanang kabjona e tlaba sephiri. O kasebe le ditefo tšeo o tladi fhiwago katsela ya tšhelete goba seripa sa resetšhe eupša puelo ya resetšhe e tlaba le mogola setšhabeng kamoka.

Nna…… ke ya dumela goba karolo ya resetšhe kantle le go kgapeletšwa, eupša ke thatho yaka. E bile keboditšwe gore ke nale thokelo ya golesa goba karolo ya yona nako yengwe le yengwe kantle le go otlhwa.

Signature ya motswadi kappa yo a tšeyang karolo ya resetšhe…….. Letšatši……

Signature ya motsamaisi wa resetšhe……letšatši……..

7.6 APPENDIX 6: English Questionnaire

Mokhasi L

Po Box 5181

Mokgwathi

0861

Dear Sir/Madam,

The researcher (a Master of Public Health student at the University of Limpopo, Turfloop campus) is undertaking a research project to investigate knowledge and practices among households at Ga-Mokgwathi village regarding the disposal of mercury coated bulbs. You are kindly requested to complete the questionnaire which consists of 3 sections (A-C). It should take not more than 20 minutes of your time to complete the questionnaire and your response is of the utmost importance to the researcher.

Please do not enter your name or contact details on the questionnaire. It remains anonymous.

The completed questionnaires should be kindly returned to the researcher on the same day of completion.

Yours sincerely

Mokhasi Lucky

0764054693

Researcher.....

PLEASE ANSWER THE QUESTIONS IN ALL SECTIONS BY CROSSING (X) IN THE RELEVANT BLOCK OR WRITING DOWN YOUR ANSWER IN THE SPACE PROVIDED.

EXAMPLE of how to complete this questionnaire

Your gender

Male	**1**
Female	**2** X

SECTION A

Demographic Information

This section of the questionnaire refers to demographic information. Although the researcher is aware of the sensitivity of the questions in this section, the information will assist to compare groups of respondents. Once again, be assured that your response will remain anonymous. Your co-operation is appreciated.

A1. Gender

Male	1
Female	2

A2. Age

15-35	1
36-60	2
61+	3

A3. Employment Status

Employed	1
Unemployed	2
Student	3

SECTION B

This section of the questionnaire determines the knowledge about the disposal methods of mercury coated bulbs among households at Ga-Mokgwathi village.

B1. Where do you dispose your fused mercury coated bulbs?

Stream	1
Yard	2
Landfill	3
Other (specify)	4

B2. Do you have places that replace fused mercury coated bulbs in your area?

Don't know	0
Yes	1
No	2

B3. Do you separate fused mercury coated bulbs from household waste?

Don't know	0
Yes	1
No	2

B4. Do you burn your fused mercury coated bulbs with your household waste?

Don't know	0
Yes	1
No	2

B5. Do you break or crush your fused mercury coated bulbs before disposal?

Don't know	0
Yes	1
No	2

B6. Do you get information about proper disposal of mercury coated bulbs?

Don't know	0
Yes	1
No	2

SECTION C

This section of the questionnaire determines the practices regarding the handling of broken mercury coated bulbs by Ga-Mokgwathi households.

C1. How often do you ventilate your room before you start clean-up of broken mercury coated bulbs?

Never	1
Seldom	2
Sometimes	3
Often	4
Always	5

C2. How often do you use rubber or latex gloves to remove broken glass of mercury coated bulbs?

Never	1
Seldom	2
Sometimes	3
Often	4
Always	5

C3. How often do you remove people and pets from the room where mercury coated bulb has broken?

Never	1
Seldom	2
Sometimes	3
Often	4
Always	5

C4. What do you use to clean up broken mercury coated bulbs?

Broom	1
Vacuum cleaner	2
Stiff paper	3
Other (specify)	4

C5. What do you use to wipe down an area where broken mercury coated bulb has occurred?

Mop	1
Disposable paper towel	2
Cleaning towel/cloth	3
Other (specify)	4

C6. How often do you use a sticky tape to pick up pieces of broken glass and mercury powder on the floor?

Never	1
Seldom	2
Sometimes	3
Often	4
Always	5

C7. How often do you keep the heater or fan turned off when mercury coated bulb has broken?

Never	1
Seldom	2
Sometimes	3
Often	4
Always	5

C8. How often do you dispose the debris in the sealable plastic bag after cleaning broken mercury coated bulb?

Never	1
Seldom	2
Sometimes	3
Often	4
Always	5

C9. How often do you wash hands, face and change clothes after cleaning broken mercury coated bulbs?

Never	1
Seldom	2
Sometimes	3
Often	4
Always	5

C10. How often do you place linen on the floor when changing a fused mercury coated bulb to avoid breakage in case it falls down?

Never	1
Seldom	2
Sometimes	3
Often	4
Always	5

Thank you for your co-operation in completing this questionnaire. Kindly return the questionnaire to the researcher immediately after completing.

7.7 Appendix 7: Sepedi Questionnaire

Mokhasi L

Po Box 5181

Mokgwathi

0861

Thobela

Motsamaisi wa resetšhe o nyaka go dira resetšhe yeo e nyakollang tsebo le madirelo ka go lahla ga mabone a mohlagase a goba le mekhuri. O gopelwa go tlatša dipotšišo tšeo di aroganego ka dikarolo tše tharo. Go tlatšea metsotso e masome pedi go araba dipotšišo kamoka.

O seke wa tlatša leina la gago. E tla dula e le sephiri

O tla bosetša Dipotšišo tšeo o di tladitšego go motsamaisi wa resetšhe

Wa gago

Mokhasi Lucky

0764054693

Motsamisi wa resetšhe

.....

O GOPELWA GO ARABA DIPOTŠIŠO TŠA DIKAROLO KA MOKA KA GO SWAYA LEPOKISI LEO LE NYAKEGAGO KA LESWAGO LASEFAPANO GOBA O NGWALE FASE KARABO MO O FILWEGO SEKGOBA.

MOHLALA wa go bontša gore go tlatšwa bjang dipotšišo

Bong

Monna	**1**
Mosadi	**2**

KAROLO A

Tsebo ya Demographic

Karolo ye ya dipotšišo e amana le tsebo yafarologanyo ya Batho. Le ge motsamaisi wa resetšhe a tseba kagadipotšišo tšeo dikgwathago karolong e, tsebo e tla thuša go lekalekantša dihlopha tša bafethudi. Gape o ya gonthišišelwa gore dikarabo tša gago di tla dula dile sephiri. Tšhumisano ya gago ea amogelwa

A1. Bong

Monna	1
mosadi	2

A2. Mengwaga

15-35	1
36-60	2
61+	3

A3. mošomo

Šoma	1
Sašome	2
moithuti	3

KAROLO B

Karolo ye ya dipotšišo e nyakolla gore e kaba malapa a Ga- Mokgwathi a diriša mohuta mang wa go lahla mabone a mekhuri.

B1. O lahlela kae mabone ao a sweleng a mekhuri?

moeding	1
jarateng	2
bolahlelatlakala	3
gongwe laetŠa	4

B2. Na le na le mafelo ao a amogelang mabone ao a sweleng a mekhuri?

Ga ke tsibe	
Ee	1
Aowa	2

B3. Na oa aroganya mabone ao a sweleng a mekhuri le matlakala a lelapeng?

Ga ke tsibe	0
Ee	1
Aowa	2

B4. Na oa fiša mabone a gago ao a sweleng a mekhuri gatee le matlakala a gago a lapa?

Ga ke tsibe	0
Ee	1
Aowa	2

B5. Na oa thuba goba go pšatla mabone a gago ao a sweleng a mekhuri pele oa lahla?

Ga ke tsibe	0
Ee	1
Aowa	2

B6. Na oa gwetša tsebo ka tahlo ya mabone a mekhuri?

Ga ke tsibe	0
Ee	1
Aowa	2

KAROLO C

Karolo ye ya dipotšišo e nyakolla gore mabone ao a thubegileng a swariwa bjang ka malapa a Ga-Mokgwathi?

C1. Ke ga kae o bulela moya phapošing ya gago pele oka thoma go hlwekiša mabone ao a thubegilego a mekhuri?

Le gatee	1
Go sego kae	2
Gatee nakong	3
KgafetŠa	4
Ka mehla	5

C2. Ke gakae o diriša raba ya gotšhiretša matsogo go tloša digalase tšeo dithubegilego tša mabone a mekhuri?

Le gatee	1
Go sego kae	2
Gatee nakong	3
kgafetša	4
Ka mehla	5

C3. ke gakae otloša batho le diruiwadiratwa ka phapošing eo lebone la mekhuri le thubegilego go yona?

Le gatee	1
Go sego kae	2
Gatee nakong	3
Kgafetša	4
Ka mehla	5

C4. O diriša eng gohlwekiša mabone ao a thubegilego a mekhuri?

Lefielo	1
Motšhene wa go gogalerole	2
Pampiri ya gogwahla	3
Tše dingwe (laetša)	4

C5. O diriša eng go phumola fase lefelong leo lebone la mekhuri le thubegilego gona?

Mopo	1
Toulo ya pampiri ya goberekišwa gatee fela	2
Toulo ya gohlwekiša Sekoropo	3
Tše dingwe, (laetša)	4

C6. Ke gakae o diriša pampiri gomaretša ge ontšha digalase tšeo dithubegilego le bopi bja mekhuri lebatong?

Le gatee	1
Go sego kae	2
Gatee nakong	3
Kgafetša	4
Ka Mehla	5

C7. ke gakae o tima seruthufatši, Sefokišamoya le selaolamoya le phišo ge lebone la mehkuri lethubegile?

Le gatee	1
Go sego kae	2
Gatee nakong	3
Kgafetša	4
Ka mehla	5

C8. Ke gakae o lahlela ditšhila ka gare ga polasetiki ye e tswalelegago ge oseno fetša go hlwekiša lebone leo lethubegilego la mekhuri?

Le gatee	1
Go sego kae	2
Gatee nakong	3
Kgafetša	4
Ka mehla	5

C9. Ke gakae o hlapa diatla, sefahlego le go fetola diaparo morago ga e o seno go hlwekiša mabone ao a thubegilego a mekhuri?

Le gatee	1
Gose go kae	2
Gatee nakong	3
Kgafetša	4
Ka mahla	5

C10. Ke gakae o beya tukwana lebatong ge o tšentšha lebone leo lesweleng la mekhuri go thibela gore leseke la wela fase la thubega?

Le gatee	1
Gose go kae	2
Gatee nakong	3
Kgafetša	4
Ka mehla	5