Occupational health and food safety risks associated with traditional slaughter practices of goats in Gauteng, South Africa.

By

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Submitted in partial fulfilment of the requirements for the degree of Master of Veterinary Medicine (Hyg), Faculty of Veterinary Science, University of Pretoria, Promoters: Professor C M E McCrindle and Dr J Oguttu

October 2012

Acknowledgments

Firstly I would like to thank God for the opportunity to be able to do the work in an area I am passionate about and for the strength to able to finish the task given to me.

Secondly, my supervisor, Prof. Cheryl McCrindle, for guiding me throughout, from the design to the implementation of study and for being a great mentor and not giving up on me.

Thirdly my co-supervisor, Dr James Oguttu. Thank you very much for helping me bring my ideas together. You are really a great friend.

To my wife, Cher, thank you for your encouragement and patience throughout the project, you are an inspiration.

Lastly I would like to acknowledge the following people for their support in making this work easier: Mr Ali Makgatho, Dr Didier and my research assistants (students from UNISA) who assisted me with the data collection. I would also like to thank the taxi rank associations for allowing me access to the commuters and commuters who gave an opportunity to speak to them.

The study was supported by the following donors:

- The National Research Foundation
- International Livestock Research Institute
- The University of Pretoria

Dedication

I would like to dedicate this work to my wife **Cher,** who supported and encouraged me throughout the project.

Declaration

I, **Nenene Daniel Qekwana**, declare that this dissertation, which I hereby submit for the degree M Med Vet (Hyg) at the University of Pretoria, is my own work and has not previously been submitted by me for a degree at this or any other tertiary institution.

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SIGNATURE DATE

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Summary

Occupational health and food safety risks associated with traditional slaughter practices of goats in Gauteng, South Africa.

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Ritual slaughter of goats is a common practice in South Africa if the relative proportion of informal slaughter is taken into account. Religious, traditional or customary slaughter is legal in terms of meat safety legislation in South Africa. However, it is suggested that there is lack of understanding of basic food safety and occupational health concepts, and that this exposes the community to a wide spectrum of meat related hazards and food-borne diseases. Many hazards that are associated with traditional or customary slaughter of goats in South Africa have not been identified and characterized.

The aim of the study was to identify, characterize and assess the occupational health and food safety risks of the biological, chemical or physical hazards associated with traditional slaughter of goats, by investigating the cultural practices and informal food chains associated with goats in South Africa.

The study area was the Tshwane Metropole. A descriptive study, a form of qualitative research that describes the nature and the distribution of the outcomes, was conducted with 105 purposively selected adult respondents of both sexes at taxi ranks and places where commuters gather informally. A survey in the form of structured interviews using questionnaires was used. The data was analyzed using a thematic analysis method in conjunction with a statistical analysis. The abattoir or formal goat slaughter process, was considered as a baseline standard for comparison of meat hygiene and occupational health safety during traditional slaughter of goats.

The traditional slaughter pathway, from farm to fork was derived based on structured interviews and compared to legislated norms for slaughter in red meat abattoirs. It was found that there were existing regulations for slaughter of goats at abattoirs, despite the fact that no goat abattoirs exist any longer in South Africa. Physical, chemical and biological hazards associated with ritual slaughter were identified and characterized.

Qualitative data was analysed using Epi-info 7 (Centre of Disease Control, Atlanta, USA) and Microsoft Excel 2010 ® (Microsoft Corporation, USA). The magnitude and likelihood of identified biological hazards was estimated using qualitative risk assessment, modified after the method suggested for BSE in Cattle by FAO (2009).

Methods of ritual slaughter differed between groups, but there was little pre-slaughter examination for disease and stunning was not used. Exsanguination could be improved by hanging the carcass and a more structured approach to decreasing contamination of the carcass by ingesta, soil, leaves and dirt could be prioritized. It was recommended that veterinary services pay more attention to the health of goats in South Africa, as these are not regularly examined at post mortem, as are other

livestock where routine surveillance for disease is carried out at registered abattoirs. Information on how to determine if a goat that is bought for slaughter is healthy, based on veterinary extension and communication, should be communicated to rural communities. A simple pamphlet or poster could be developed and distributed to commuters at taxi stops, or distributed by Animal Health Technicians in rural areas.

Meat hygiene principles, linked to practical hygiene principles such as the WHO “five keys” should also be communicated within rural communities and applied to informal slaughter. The principles of good hygiene and meat safety, are, however, the same. Veterinary services could be involved in actual training of those who regularly slaughter goats to make sure that they cut the throat cleanly and the goat is exsanguinated properly. Welfare of goats during slaughter could be improved by paying more attention to humane transport and restraint as well as the use of sharp knives. Research needs to be done on a practical way of stunning under rural conditions. This however should not infringe upon people’s cultural norms and religious beliefs.

Chapter 1: Introduction

1.1 Background and motivation

Traditional rituals involving the use of sacrificial animals have been performed worldwide for thousands of years. Even in the Bible (Genesis 15:9) it is recorded that Abraham was requested by God to bring three one-year-old goats for sacrifice. According to Thorpe (1993) African traditional religions belong to a category of religious approaches which may be described as primal religions. These religions are grouped together, because they exist independently and have no immediate apparent historical relation to one another, nor to the major religions such as Christianity, Islam, Hinduism or Buddhism. Primal religions in general have no sacred written scripture but are passed from generation to generation orally. In Africa these are commonly referred to as traditional religions and the word is used to distinguish the religious orientation of African people from other religions. These traditional religions play an important role in cultural understanding and awareness within communities (Thorpe, 1993). For many people, traditional rituals and ceremonies are performed to address personal problems, to show respect for the ancestors, for celebrations like weddings or births and also for funerals (Thorpe, 1993; Michel *et al.*, 2004). The animals most often slaughtered in traditional African ritual ceremonies are goats, sheep, cattle and occasionally chickens. However, goats are probably the most common animals for ritual slaughter in Southern Africa. It is estimated that 38 % of goat production in South Africa is for traditional purposes (Braker *et al.*, 2002).

The total population of goats in South Africa is estimated as 2.033 million (DAFF, 2012), however, less than 0.5% of these are slaughtered at registered abattoirs

(DoA, 2006). It can be presumed that a large proportion of the rest are probably used for traditional or informal home slaughter (DoA, 2007a; Sebei *et al*., 2004). Informal marketing of goats is probably a significant source of income for rural communities. Many goat owners are small scale farmers and this is a source of income for their family (Lebbie, 2004; Sebei *et al*., 2004; Simela & Merkels, 2008). In some instances there are people who have independent incomes, and farm with goats as an extra investment. These wealthy people may own houses in the suburbs and pay a member of a low income rural community to be a goatherd, thus also promoting job creation amongst the poorest of the poor. In South Africa, traditional slaughter is legal in terms of the Meat Safety Act (DoA, 2000), provided that there is no unnecessary suffering caused during transport and slaughter, according to the Animal Protection Act (DoA, 1962), and the meat is not sold but consumed locally.

Ritual slaughter usually takes place over weekends and prior to the actual ceremony, there are specific preparations which include the selection of the animal that is going to be used, in consultation with an elder from the tribe or community (Bembridge & Tapson, 1993). There is a high involvement of the entire community in all or most of the ceremony and meat from the sacrificial animal is normally consumed at home or at the same place as where the slaughter of the animal took place. (Michel *et al*., 2004; Thorpe, 1993).

Informal slaughter with consumption of uninspected meat can prejudice the health of the consumer. Diseases such as salmonellosis, staphylococcal food poisoning, anthrax, rabies, Rift Valley fever, and toxoplasmosis, can be transmitted to humans during the slaughter process or consumption of meat or offal (Michel *et al*., 2004).

The World Health Organisation (WHO) defines zoonoses as diseases and infections that are naturally transmitted between vertebrate animals and humans. It is estimated

that 61% of all human pathogens are zoonotic. Many zoonotic diseases are found to be of greater impact in developing countries where the disease burden is high and many affected communities are poor. In these countries life expectancy is lower than developed countries and zoonotic diseases may be an important cause of this (WHO, 2010).

The average life expectancy in South Africa is estimated at 53.3 and 55.2 years for men and women respectively. This life expectancy is influenced by HIV (the median time from infection to death for an HIV positive patient is estimated at 10.5 and 11.5 years for both man female respectively (Bradshaw *et al.,* 2012). Currently it is estimated that 5.24 million people are living with HIV in South Africa (StatsSA, 2010; Mayosi *et al.,* 2012). Many of the infected people are immune-compromised therefore at higher risk of zoonoses.

According to the Centre of Diseases Control, Atlanta, USA (CDC), food borne diseases (FBD) are caused by consuming contaminated foods (CDC, 2010). The diseases may be as a result of disease causing agents such as bacteria, virus, fungi, parasites and poisonous chemicals (Newell *et al.,* 2010). Food borne diseases are not only a problem in developing countries. They are often associated with poor hygiene and handling during the food chain and can pose a risk to the consumer whether in developed or developing countries. S*almonella* spp. and *Escherichia coli* from dirty water have being found contaminating food resulting in food borne diseases. Two other diseases are listeriosis and campylobacteriosis, which are regarded as diseases of developed countries as they are related to long food chains and processed, refrigerated food (CDC, 2010).

Animal welfare is becoming an issue worldwide and animal welfare aspects of ritual slaughter are attracting attention. It is maintained that improved animal welfare during

husbandry and slaughter improves food safety and occupational health (FAO, 2012; OIE, 2012).

1.2 Justification

In rural areas, agriculture forms an important part of job creation. It is estimated that 90% of the world goats are owned by rural households (Lebbie, 2004). Rural communities often depend on their animals as a source of income and food. Furthermore keeping of goats is a low input, low output form of subsistence agriculture. Under these circumstances, animal health can become compromised as there is a close association between animal and human. The animal presented for slaughter could increase the risk of disease to the human as meat inspection is not required for religious slaughter.

1.3 Research problems

Ritual slaughter of goats is probably a significant proportion of goats slaughtered informally. As DAFF (2012) estimates that 99.5% of all goats in South Africa are slaughtered outside the abattoirs, it is likely that informal and ritual slaughter is very common. However, it is suggested that there is a lack of understanding of food safety concepts. This exposes the community to a wide spectrum of occupational health and Food Borne Diseases (FBD) or Food Associated Diseases (FAD) (Michel *et al.,* 2004). Michel, Meyer, McCrindle and Veary (2004) suggested that hazards that are associated with informal slaughter (which includes traditional slaughter), have not been identified and characterized.

Chapter 2:
Literature review

2. 1 Introduction

In Africa there are many ancient religions. The pyramids in Egypt reflect a rich diversity of beliefs and both Christianity and Muslim religions mention that part of their history lies in Egypt.

It has been suggested that 80% of South Africans follow a traditional belief system in addition to being a member of an internationally recognized faith such as the Christian, Muslim, Jewish or Hindu religions (SAI c, 2012). It is difficult to find a good definition of African traditional religions. Ejizu in his online paper on "Emergent key issues in the study of African traditional religions"[1] writes that:

"African traditional religion is generally classified in the group of traditional/indigenous religions or primal world-views of humankind. It is an experience of the sacred by the peoples of sub-Saharan Africa (within the Continent and in diaspora), in their different socio-historical circumstances and backgrounds. African traditional religion is essentially oral and folk religion."

South Africa has nine different provinces and the one with the highest population density (22.39 percent) is Gauteng (SAI d, 2012). There are four main African language groups: Nguni, Sotho-Tswana, Tsonga and Venda. Altogether eleven official languages are recognized, with isiZulu being the most frequently spoken home language. However, the mix of languages, differs from province to province (StatsSA, 2013)

[1] http://www.afrikaworld.net/afrel/ejizu.htm

Health care in South Africa is divided into the public sector, supported by the state and private health care, mainly linked to Medical Aid companies. The state or public sector provides healthcare service to 80% of the South African population (SAI c, 2012).

It is estimated that about 80% of the African population consult a traditional healer alongside the medical practitioner. Therefore the role of tradition healer is important in the control and management of diseases, including food associated diseases (SAI a, 2012).

2.2 Goats and chevon production in South Africa

Goat meat production systems are both formal and informal as discussed by Fisher *et al.*, 2009; Mendiratta & Lakshmanan, 2009; Rodríguez *et al.*, 1993 and Silva *et al.*, 2011. According to the Department of Agriculture the majority of goats are found in the Eastern Cape, Limpopo, KwaZulu-Natal and North West Province. The distribution of goats in South Africa by province is shown below (Figure 2.1). However, there are no registered abattoirs for goats, which means that almost all goat slaughter is informal. It is not known what proportion of goat slaughter is for home consumption and what proportion is for religious or traditional purposes (Kayamandi, 2007).

As most of the goats in South Africa are slaughtered informally there are no accurate statistics. According to the Food and Agriculture Organization of the United Nations (FAO) Statistics website, approximately 2 150 000 goats were slaughtered in South Africa in 2011 (FAO, 2011).

Less than 0.5% of all goats in South Africa were slaughtered in registered abattoirs in 2007, which reflected production by the commercial sector (DoA, 2007a).

Commercial goat farmers are concentrated in the Karoo and Bushveld regions of the country, while the majority of the goats, in the informal sector, are scattered throughout South Africa. In the informal sector, indigenous goats are slaughtered for religious or traditional purposes, but the proportion used for household consumption is not recorded.

The global goat meat production was 5 146 202 tons in 2007, a 22.9% increase from 3 965 874 tons in 2000. The contribution of Africa to global goat meat production in 2007 was 933 983 tons (18.1%), an increase of 16.3% from 781 771 tons in 2000. Fig 2.1 shows the relative proportion of goats per province. It can be seen that the highest relative frequency is Eastern Cape (36%), Limpopo (24%) and KwaZulu-Natal (13%).

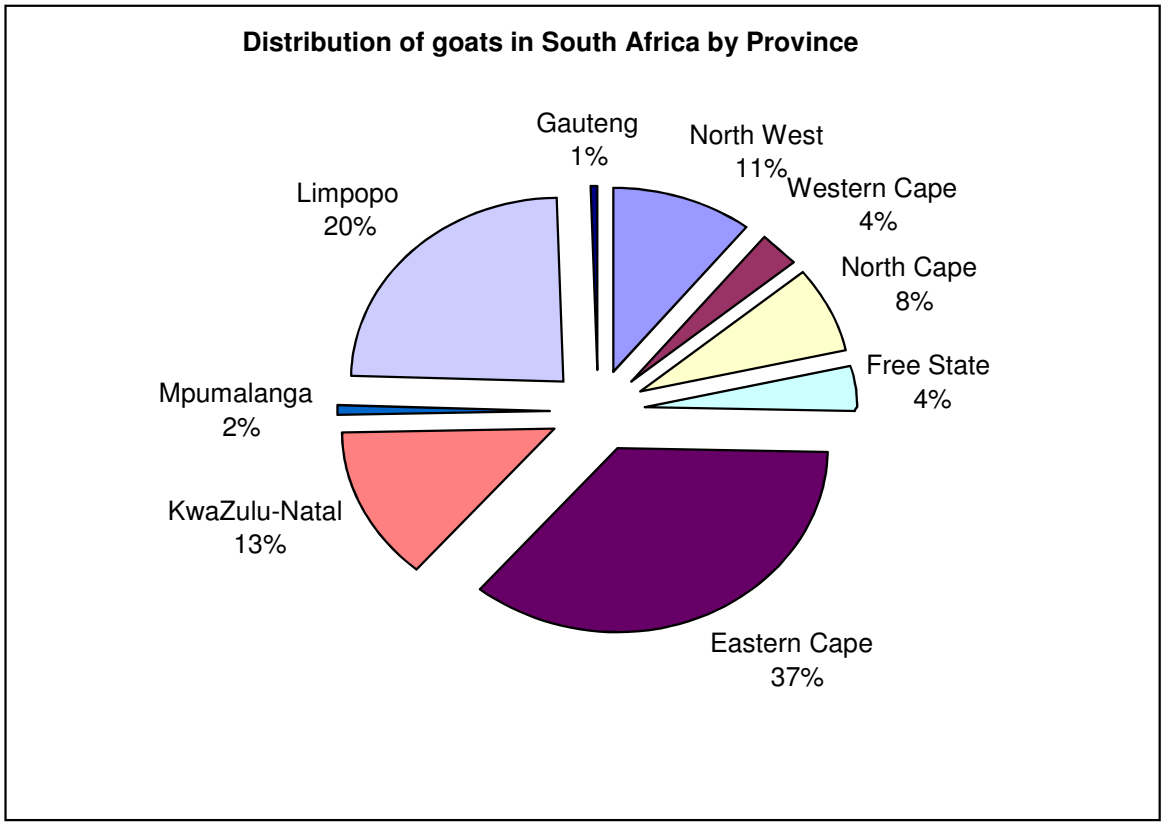

Fig 2.1: Proportion of goats produced in nine Provinces of South Africa (DAFF, 2011)

South Africa contributed 36 500 tons in 2007, which is 0.7 % of the global and 3.9% of the African goat meat production. In 2000 the contribution of South Africa to African goat meat production, was 4.6 %. This percentage has decreased for the past seven years, due to the fact that even although South African goat meat production has remained constant, other African countries have increased their production (FAO, 2011). High demand for goats in South Africa, has seen an import of approximately 250 000 goats into South Africa from Namibia on an annual basis, to make up for the shortage (NAMC, 2005).

2.3 Meat safety legislation

2.3.1 South African Constitution

The South African Constitution, which includes the Bill of Rights, is said to be the cornerstone of South African democracy and preserves the rights of all people in South Africa. In Chapter 2, section 15, it is stated that:

"*Everyone has the right to freedom of conscience, religion, thought, belief and opinion*."

This gives all citizen of South African the freedom to practise their religion but this must be done in accordance with relevant public rules. In section 31 it is also stated that:

"*Persons belonging to a cultural, religious or linguistic community may not be denied the right, with other members of that community, to enjoy their culture, practise their religion and use their language; and to form, join and maintain cultural, religious and linguistic associations and other organs of civil society*", however this must be done within the law (SAGI, 2009).

2.3.2 Meat Safety Act, 2000, (Act No. 40 of 2000)

In South Africa the assessment of food as a risk to consumer health is fragmented between the Departments of Agriculture Forestry and Fisheries (DAFF), Health (DH) and Trade and Industry (DTI). South Africa as a member of the World Health Organization (WHO), is required to follow the guidelines stipulated in the Codex Alimentarius Commission (Codex) document on meat hygiene (CAC, 2005).

The Meat Safety Act was promulgated in November 2000, with an aim of ensuring safe meat and products for animal and human consumption. The Act provides guidelines for the registration of facilities for meat production, as well as the responsibilities of different stakeholders. In the Act provision is made for slaughter of livestock, including goats, at any place other than a registered abattoir, provided that it is for own consumption or for cultural or religious purposes. No meat or animal product obtained from goat slaughtered outside an abattoir may be sold to any person (DoA, 2000).

The Meat Safety Act is also in line with international guidelines on Meat Safety (CAC 2005; DoA; 2000; FAO, 2004; OIE, 2012).

In South African hygiene standards are aligned to an audit approach, where they are monitored and scored for meat hygiene, occupational safety and environmental risk, on an on-going basis. These are sometimes called “Prerequisites” for food safety. All these standards, for each part of the slaughter process, from ante-mortem inspection to final packaging and disposal of waste, are listed in detail in the Meat Safety Act, 2000. In the case of informal slaughter for religious purposes, none of these food safety and hygiene standards are prescribed (DoA, 2000).

2.3.3 Animal Diseases Act 35 1984

To prevent diseases being transmitted to humans or animals, all livestock sent to the slaughter house must adhere to the regulations of the Animal Diseases Act 1984 (DoA, 1984). This legislation is line with the recommendations for control of certain animal diseases as published from time to time in the OIE Terrestrial Animal Code (OIE, 2012) This Act falls under the National Department of Agriculture Forestry and Fisheries. According to Regulation 11, it is the responsibility of the manager or the owner of the abattoir to ensure that necessary steps are taken to prevent the infection of the animals with diseases or parasites and also to ensure diseases are not transmitted to other animals (DoA, 1984). The Act has been replaced by the Animal Health Act 7 of 2002, but the regulations applying to the previous Act are still in force as the new regulations have not as yet been promulgated (DoA, 2002). The Act is applicable for anti-mortem inspection as well as post mortem inspection of condemned carcasses.

2.3.4 Foodstuffs, Cosmetics and Disinfectants Act 54 1972

This Act falls under the National Department of Health and regulates the application of the Hazard Analysis and Critical Control Point (HACCP) system as it is applied to food safety in South Africa (DoH, 1972). Although Hygiene Management Systems (HMS) and Hygiene Assessment Systems (HAS) are applied in all registered abattoirs in South Africa, HACCP is only mandatory for export abattoirs at present, although it is also found in some of the high throughput commercial abattoirs (DoA, 2007b)

2.3.5 The Health Act 63 of 1977

The Act falls under the responsibility of the National Department of Health. It covers the hygienic handling of food and the inspection of food premises, including at abattoirs. It describes primary meat inspection and the duties of meat inspectors and microbiological standards premises as well as food safety (DoH, 1977).

2.3.6 Fertilizers, Farm Feeds, Agricultural Remedies and Stock Remedies, Act 36 of 1947

This Act is administered by the National Department of Agriculture Forestry and Fisheries and regulates the use of farm feeds and stock remedies in food producing animals. If these are not regulated properly they can result in chemical hazards in the form of residues in goat meat (DoA, 1947).

2.4 Overview of ritual slaughter of goats

Ritual slaughter, or animal sacrifice, has been an important part of different communities for many years (Bible: Genesis 4:4). The slaughter of animals for ritual purposes occurs throughout the world, commonly in the Muslim, Jewish and Hindu communities (Clottey, 1985). The sacrifice of animals is a common practice in most African communities but not well documented. Ritual slaughter is part of the identity of communities and is the reflection of their beliefs (Flower, 2010).

2.4.1 Animal sacrifices in the Ancient world

The sacrifice of animals or ritual slaughter is practiced in almost every religion around the world (Nosotro, 2012). It is interesting to compare modern ritual slaughter with that used in Ancient times to see if there are similar hazards and species involved In Ancient Greece, sacrifices was performed for many reasons, including sooth-saying, worship and thanks giving. The use of animals for ritual purposes were not limited to

one species, as the type of animal differed for each ceremony. Affordability was crucial and smaller species (like chickens or goats) were used in preference to cattle, if the sacrificial animal was purchased by a low income family. As seen in Africa today, goats were well recognised as one of the animals used for sacrifice and size of the sacrificial animal involved determined the extent of community involvement in the ritual. The use of chickens in ritual ceremonies required only a single family member, whereas a goat required the involvement of extended families, community members or religious leaders (Carr, 2010; Cline, 2010).

The Ancient Greeks and Romans would perform animal sacrifices as part of a religious ceremony and the inedible parts would be given to the Gods, while the rest would be consumed by worshippers. The external appearance (phenotype) of the animal for slaughter often had to comply with certain criteria. For instance, the animal had to be unblemished and should go willing to sacrifice, not struggling when led to the altar. The use of wild animals in Greek rituals was uncommon, except in the case of the huntress goddess (Minerva or Diana) who preferred game (Cline, 2010).

2.4.2 Ritual slaughter in the modern world

Halal and kosher slaughter are modern forms of ritual slaughter that have a long history. They differ from African traditional slaughter as the steps in the process are well documented as part of religious practices. Thus it is possible to identify hazards along the chain and influence food safety, occupational health and animal welfare concerns. There is, however, very little information available on African ritual slaughter.

2.4.3 Overview of Halal and Kosher slaughter

2.4.3.1 Halal slaughter

The word Halal is an Arabic word meaning lawful or permitted (Bonne & Verbeke, 2008; Eliasi & Dwyer, 2002; IFANCA, 2010). Halal slaughter, referred to as the Dhakata, in the Shariah, is a common practice in the Islamic religion (Lever & Miele, 2012). Meat produced for Islamic consumers has to comply with Halal criteria (van der Spiegel *et al*., 2012). The Shariah gives instruction on how Muslims should perform ritual slaughter or animal sacrifice (Ghamidi, 2010). The most popular ritual slaughter practices occur during the celebration of Hajj and Umrah and on the 'Eid of Al-Adha (McDonald, 2005). According to Ghamidi (2010), this ritual originated to commemorate the incident where Ishmael was about to be a sacrifice, as described in the Quran (37:97-107). Eid–al-adha is celebrated during the last months of the Islamic calendar and the sacrifice is called "Udhiya" in Arabic or "Qurbani" in Urdu and Persian (Wright, 2010). The objective of the halal slaughter according to Ghamidi (2010) is to express gratitude to the Almighty. The animal chosen for slaughter must be alive and healthy. The slaughter-man must have a complete awareness of his action and understanding how to slaughter animals for this purpose (Bonne & Verbeke 2008). The instrument used is the knife and it must be very sharp and clean. During the act of slaughter, a prayer is recited over the animal (Al-islam, 2010). Halal slaughter thus shows that attention can be paid to hygiene and animal welfare during religious slaughter, so this may also be possible for African ritual slaughter.

2.4.3.2 Kosher ritual slaughter

The consumption of food under the Jewish law is dealt with by the body of the Jewish law called the Kashrupt (Fiszon, 2008; Rich, 2010). Kosher is a description of the ritual under Jewish law and the word kosher means "fit" (Campbell *et al*. 2011; Eliasi

& Dwyer 2002; Kamins & Marks, 1991). The Jewish laws relating to kosher slaughter are stated in the Torah. According to the Torah the sacrifice of the animal was to be done in the place that Jehova has chosen for that purpose (Bible: Deut 12:13-14). Animals or birds that may be eaten must be slaughtered according to the Jewish law (Rudy & Rudy, 2010). The animal for slaughter must be without disease or flaws although there is an exemption for fish. The ritual process is called the shechitah, it is performed using a special knife known as a "Chalef", and the slaughter is done by a trained person called a "Shochet" (Campbell *et al.* 2011). Rich (2007), states that in Ancient times the main component of the Jewish ritual was the offering of sacrifices (Qorbanot). The sacrifices were performed only by the priest (Kohanim). According to the Torah, the sacrifice was only to be performed in the temple. The practice of sacrifice stopped in the year 70 AD, when the Romans destroyed the temple in Jerusalem (Bible: Deut. 12:13-14).

In Judaism there are many types of sacrifices and laws associated with each sacrifice. The Olah sacrifice also known as the "burnt offering" is the oldest. The entire animal is burnt, with no part being consumed. In the Zebach Sh'lamim, which is the peace offering, a portion is given to the priest and burnt on the altar. The rest of the carcass is eaten by the supplicant and his family. For the Chatat or (Sin) offering, the size of this offering differed from one sin to another and the offering was eaten by the priest. The Asham or (guilt) offering was also eaten by the priest. This was the sacrifice done when there was a doubt to whether a person had committed a sin. In the case of food and drink offerings, a small portion was burnt at the altar, the rest was eaten or drunk by the priest. The Parah Adumah offering of the red heifer had a purpose to purify the impure. In the Bible: Numbers 19:1-10, states that the whole animal was to be burnt as a sacrifice on the altar. Thus, as in the case of African

religious slaughter, there are differences according to why the animal is being slaughtered.

The Torah prohibits the consumption of blood, to ensure that all the blood is removed from the flesh of the animal the kosher animal is either broiled or soaked and salted. The process of removing of blood must be done within 72 hours after slaughter (Rich, 2010; Rudy & Rudy, 2010).

2.4.3.3 Hindu ritual slaughter

Animals occupy an important place in Hinduism. The animal's role is not limited only to a source of food. In Ancient India the animals were used for future prediction, medical purposes, transportation and animal sacrifice. In Hinduism, human beings and other life forms are recognised as having the same spirituality. Hinduism even recognises microorganisms as having souls of their own. Animals compared to man, are seen on a lower scale in terms of God's manifestation. In Hinduism the Vedic people valued animals and they were a preferred way to obtain wealth (Jaharam, 2010).

In the early Vedic Dynasty, animals were used for sacrificial purposes and this changed with time as cows became sacred animals (McClymond, 2002). The cows were not allowed to be slaughtered for any reason (Brooks, 2004). A growth in the popularity of Jainism, Buddhism, Saivism and Vaishnavism resulted in increased awareness about animal welfare. The increase in awareness has not resulted in complete stoppage of the use of animals for sacrifices and other rituals. Animals were sacrificed by the kings to seek blessing and support from divinities (Globaloneness, 2010; Jaharam 2010). In Hinduism, three methods of slaughter were used, decapitation, piercing of the heart and asphyxiation. These sacrifices were common in Tantric worship (Tantricism). The introduction of the law of piety, by

Asoka, put more emphases on the need for compassion and respect for animal life. This law also banned the use of animals for fighting purposes (Jaharam, 2010). The Shaktism community still offers sacrifice to a deity, this is seen even today among the Hindus of Nepal. (Globaloneness, 2010).

In India there are Hindu temples in Assam as well as in Nepal where animal sacrifices are still performed (Witzel, 1997). The Shakit community worship the female nature of Brahman in the form of kali Ma an Durga. During the months of Aswina (September-October) every year, goats are slaughtered. The value of the sacrifice differs from the rich to the poor. The poor offer a small chicken, while the rich can offer a goat (Bolle, 1983). The largest slaughter of animals occurs during the Gadmimai festival, where an estimated 250 000 animals are slaughtered. (Servinghistory, 2010).

2.4.3.4 African ritual slaughter

Even today in Africa, the sacrifice of animals is performed for many reasons including funerals, ancestral worship and healing and celebration ceremonies among others (Ben-jochannan *et al.,* 2001; Thorpe, 1993,). Animals are sacred in African religions as offers to the gods and ancestors, in healing, initiation, and atonement ceremonies (Braker *et al.,* 2002; Jackson, 1977).

The slaughter of animals for ritual purposes remains dominant throughout Africa. In African doctrine, an offering is not found acceptable if it is not recognised by the ancestors. The use of animals as sacrifice, or the spilling of blood, from the African perspective is related to one life for another (Jackson, 1977). For this reason, adults perform traditional slaughter of goats in almost all cases. In African religions animals are respected as they represent the ancestors. The slaughter of an animal is still common as part of weddings, funerals and the celebration of the first born child

(Gchabashe, 2010). In addition, sacrifices are seen as a connection to the spiritual world when necessary. These sacrifices are followed by singing and dances. During the sacrifice the positioning of the animal differs from one sacrifice to another (Nosotro, 2010). From the above it can be seen that like other ritual slaughters, both ancient and modern, the method used in African traditional slaughter varies depending on the type of ritual. It is interesting that there are commonalities from Europe (Greeze) to Middle Eastern (Jewish and Muslim) to far Eastern religions and peoples.

2.5 Food safety risk analysis

Risk analysis has begun to play an important role in management of food related hazards globally (Hoffmann, 2010). It is a key disciple in reducing food-borne illness as well as strengthening food safety systems. In food safety risk management, hazards that could lead to food borne diseases have to be identified and the magnitude of their impact on human health has to determined (Lammerding & Fazil 2000). It focuses on biological, chemical and physical hazards that may arise from food. In developing countries, far more than developed countries, food borne illness are a big problem. It is estimated that 2.2 million people die every year from food borne diseases (Jakab, 2013). Therefore there is a need to understand hazards associated with these diseases. Risk analysis provides science based knowledge of the hazards. It is important to note that not every exposure to pathogens can result in infection or illness, therefore the risk has to be taken into consideration. The magnitude of the risk is linked to the likelihood and the consequences of exposure (Ross & McMeekin, 2003).

The control of food safety hazards does not lie only with the processor but it is the responsibility of each stake holder in the food value chain, including the consumer (Williams *et al.,* 2011). There is a need to evaluate hazards associated with food production not only at the level of processing but at all stages of production. Risk analysis can be used to develop an estimate of the risk to human health and safety. It can also be used to identify and implement appropriate measures to control the risks. Risk analysis is divided into three components risk assessment, risk management and risk communication (Hammerling *et al.,* 2009; Hoffmann, 2010; Lammerding & Fazil 2000; Thompson, 2002). Risk is the probability or likelihood of a particular event occurring. Risk assessment includes hazard identification and characterisation a well as exposure assessment. Risk management is a way to prevent this event, or reduce its magnitude, often by reducing exposure to a particular hazard. Risk communication is communicating ways of managing or mitigating risks, to a particular stakeholder group or target audience (Figure 2.3).

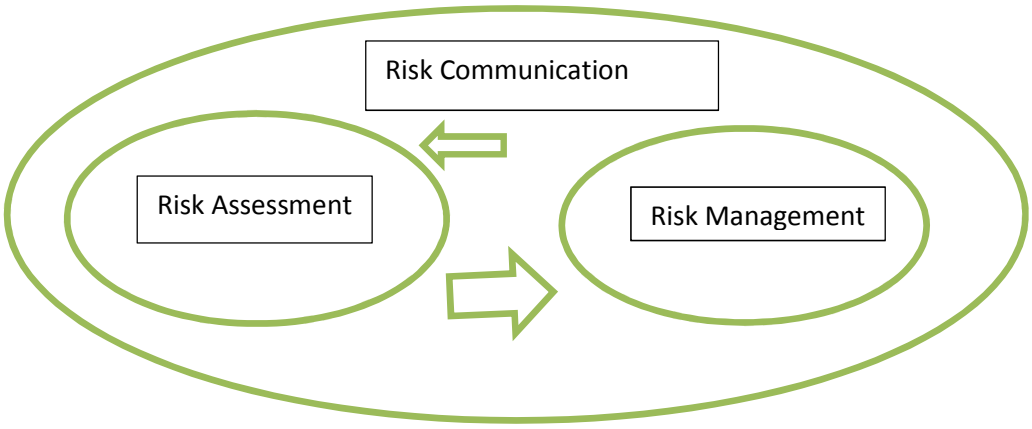

Figure 2.2 Diagram of ongoing feedback between and among risk managers, risk assessors and all stake holders involved in food safety (Modified from FAO, WHO, 2006).

The risk analysis process is highly interactive. It requires ongoing feedback between and among risk assessors, risk managers and all stake holders involved in food safety. The risk analysis process must:

- have a structured approach consisting of risk analysis, risk assessment, risk management and risk communication;
- be based on available scientific evidence and be applied consistently;
- carried in an open, transparent and well documented process;
- be clear in its treatment of uncertainty and variables; and
- be evaluated and reviewed as appropriate on the basis of new information.

2.5.1 Food safety risk assessment

According to Codex, food safety risk assessment is “A scientifically based process consisting of the following four steps: hazard identification, hazard characterization, exposure assessment, and risk characterization” (FAO, WHO, 2006). As mentioned in the definition above, Codex divides risk assessment into the following four steps, which are described in more detail below:

- **Hazard identification**

In hazard identification a specific hazard of concern is identified. A hazard is defined as a substance or an event that has the potential to cause harm (FAO, WHO, 2006). The process starts with listing of potential hazards that are known to be harmful to human. Literature and expert knowledge is used to populate the list with hazards that are relevant in the food chain process (Todd, 1992). The use of both literature and expect opion provide a list that is not too broad and impractical. In meat production the most common hazard are of biological hazards. Therefore the hazard identification will focus mainly on microbiological hazards as the main causes of food

borne diseases (Van Gerwena *et al.*, 1997). In the literature the link between pathogen and adverse health effects is usually well established. However information collected is used to provide insight and a frame of reference to the identified hazards (Lammerding & Fazil, 2000).

- **Hazard characterization**

During hazard characterization, the nature and extent of the adverse health effects known to be associated with a particular hazard is described. The likelihood of adverse health effects and the level of exposure required at the point of consumption is also established where possible. The process can be both qualitative and quantitative, looking at the exposure level and its association to frequency of illness (Roche *et al.*, 2001). For instance assessors could evaluate the infection, morbidity, hospitalization and death rates associated with hazard. Using a microbiological *Listeria monocytogenes* as an example: the characteristics are that it is widely distributed in nature and has been isolated from soil. It causes intra-uterine infection, meningitis and septicaemia especially in adults and juveniles (McLauchlin *et al.,* 2004). Mortality rate in systemic listeriosis has been estimated as being between 20% and 40% and this agent has the ability to cause lesion in the brain (Farber & Peterkin, 1991).

- **Exposure assessment**

In exposure assessment the amount of hazard that is consumed by various members of the exposed population is characterized. It looks at the levels of hazard in raw materials throughout the food production chain, in order to track changes at different stages. In this step the exposure pathways are also described. Microbiological exposure assessment is found to be more complex and dynamic as the organism has the potential to multiply. In some instance the organism dies (ICMSF, 1998).

This data, together with the food consumption patterns of the target consumer population, is used to assess exposure to the hazard and the hazard characteristics over a particular period of time, which may be short or long term (FAO,WHO, 2006; García-Cela *et al.,* 2012). Socio-economic and cultural backgrounds, ethnicity, seasonality, regional differences, and consumer preferences and behaviour can influence consumption patterns therefore need to be included. The characteristics of the target population may also be included (Gerba *et al*., 1996).

- **Risk characterization**

Risk characterization combines the outputs of hazard identification, hazard characterization and exposure assessment to generate an estimate of risk. Where estimates are generated, uncertainty and variability are described. The clear description of uncertainty and variability gives the risk manager an understanding of the impact of limitations of available data, on the results of the risk assessment.

Risk assessment is a crucial component of risk analysis as it provides scientific evidence for estimation of risk (Post, 2006; Williams, *et al.,* 2011), and is becoming an important tool in food safety risk management (Cerf, 2008). It must be designed to fit the purpose for which it is intended. Both quantitative and qualitative risk assessment can be used. Where it is feasible, quantitative risk assessment should be performed, as it has an advantage over qualitative risk assessment for modeling different risk mitigations. To help the risk managers combine risk assessment, epidemiology and economics, it is likely to be most useful to integrate both risk and benefits (Albert *et al*., 2008; Dosman, *et al*., 2001; Hoffmann, 2010).

Risk assessment as defined by OIE, is one of the important tools for harmonization between countries who are members of the World Trade Organization (WTO) in the formulation of coherent Sanitary and Phytosanitary Systems (SPS) for food safety

standards and agreements (Post, 2006). Risk assessment methods are not limited, but differ according to country, class of hazard, the food safety scenario and the time and resources available.

2.5.2 Risk management strategies in food safety

Food safety risk assessment is done based on a specifically described scenario. The scenario will drive the technical and scientific information required to perform the risk analysis. Therefore the risk assessments will differ between different food safety hazards, taking into consideration the available data (FAO & WHO, 2006).Risk management considers the risk assessment and other factors for the protection of health (Post, 2006). Risk assessment is an important component as it provides a scientific component or base in the presence of uncertainty. It is closely linked to risk management as it provides information on potential adverse effects to life and health resulting from exposure to hazards over a specified time period (Cerf, 2008; Hoffmann, 2010).

Risk managers, in deciding whether a risk assessment is possible and necessary, have to consider the psychological and sociological risk perspectives as well. If the decision for performing risk assessment is affirmative, risk managers must follow the appropriate steps required to perform the task.

Risk management has to follow the risk management framework (RFM) developed by the Codex Committee on Food Hygiene (CAC, 2003). The framework has to consider both short term and long term situations. Therefore risk assessment has to be based on best available information or scientific data at the time of assessment. The generic framework for risk management is shown in Figure 2.3 below.

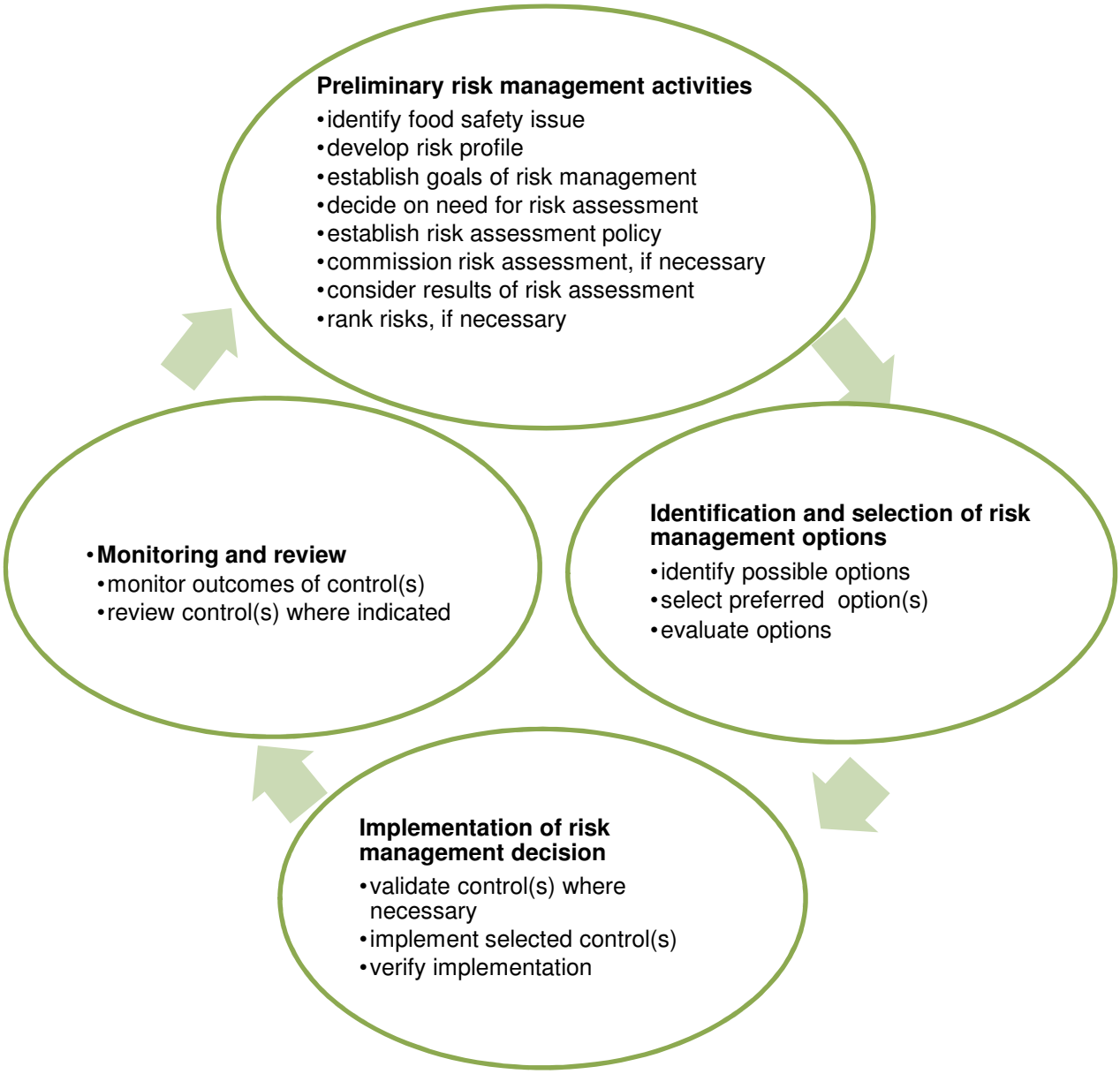

Figure 2.3. Generic Framework for food safety risk management strategies (FAO, WHO, 2006)

In the risk analysis framework, the first stage is the “preliminary risk management activities” as shown in Figure 2.3. In this stage, scientific information is collected and used to develop a risk profile that will guide further risk management actions. The scientific information will be based on the identified hazard, or food safety problem. If more information is required, the risk manager can then seek such information.

Different ranking methods which require the ranking of risk are used in setting risk based standards and these are used in combination.

During this "preliminary" phase, there is lot of information and data to be collected, therefore good risk communication is important between interested parties both internal and external, in other to identify the food safety issue and provide scientific information necessary for risk profiling. The second stage in RMF is identification and evaluation of the variety of possible options for managing the risk. In this stage results of the risk assessment process as well as any economic, legal, ethical, environmental, social and political factors associated with the risk-mitigating measures are weighted as they have an impact on risk management *(*Van Kleef *et al.,* 2007).

In the third stage preferred risk management options are selected and implemented by the relevant stakeholders. It is the responsibility of each partner or stakeholder in the food chain to implement this control measure where necessary. All four stages include monitoring and review in order to determine whether the measures in place are archiving risk management goals or whether there is a need for management strategies to be reviewed.

2.5.3 Food safety risk communication

Risk communication is defined in the food safety risk analysis guide as:

"*an interactive exchange of information and opinions throughout the risk analysis process concerning risk, risk-related factors and risk perceptions among risk assessors, risk managers, consumers, industry, the academic community and other interested parties, including the explanation of risk assessment findings and the basis of risk management decision*" (Van Kleef, *et al.* 2007).

As was shown in Figure 2.3, risk communication is an important element of risk analysis. With regards to food safety, effective communication between different stakeholders including the general public, is critical in understanding the risks and providing a scientific base for informed decisions. This multi-stakeholder communication throughout the process of risk analysis promotes better understanding of risks. It also ensures that greater consensus on risk management approaches is reached.

Risk communication involves sharing information, whether between risk managers and risk assessors, or between members of the risk analysis team and external stakeholders through the process of two way risk communication. The external input makes a major contribution to the decision making by the risk managers therefore cannot be ignored or neglected. In the risk analysis process, at some point, everyone involved is a risk communicator. Therefore risk communication is not left only to the risk managers.

2.6 Biological hazards linked to informal slaughter

Michel *et al.*, (2004) suggested that many areas in South Africa do not have equal access to safe, inspected and hygienically produced meat and that there is lack of control over informal slaughter. There is no meat inspection done during informal slaughter, thus the possibility of transmission of biological hazards such as FBD and zoonoses to the person slaughtering the animal and the general public, is likely to be very high. Diseases of particular interest in South Africa include anthrax, brucellosis, Rift Valley fever, salmonellosis, and *Eschericia coli* and *Staphylococcus aureus* infections (Dubey & Stewart, 2004; Michel *et al.,* 2004; Neser *et al.,* 2004; Swanepoel & Coetzer, 2004;).

Two sorts of diseases can be transmitted from animals to humans during an informal slaughter, these are FAD and zoonoses. In many cases they overlap.

2.6.1 Zoonoses and FAD transmitted during informal slaughter of goats

Zoonotic diseases are diseases that can be acquired from directly from animals. However they may also be acquired through ingestion of contaminated food resulting in FAD (Nørrung & Buncic 2008). These diseases may be severe in vulnerable sub-populations like children and those who are immunocompromised. The extent of the problem goes beyond health implications to negative economic consequences (Parry *et al.,* 2004).

The following zoonoses of goats are likely to be hazardous to consumers and those participating in slaughter of goats. All are well described in the textbook on Infectious Diseases of Livestock in Southern Africa (Coetzer & Tustin, 2004) and in the OIE Terrestrial Code (OIE, 2012):

- **Viruses:** Rift Valley Fever, Orf.
- **Bacteria:** Brucellosis, tuberculosis, anthrax, salmonellosis, *Staphylococcus aureus.*
- **Rickettsiae:** Q fever, tick bite fever.
- **Protozoa:** Toxoplasmosis.
- **Fungi:** Ringworm.

These zoonoses will be discussed in further detail in Chapter 5, in the context of the risks posed by observed methods used for ritual or traditional slaughter.

Ensuring food safety to protect public health and promote economic development is a significant challenge in both developing and developed countries. Unacceptable rates of FAD remain. New biological, chemical or physical hazards continue to enter the food supply. There has been progress in strengthening food safety systems in many

countries, making it possible to reduce and prevent FAD. A food-borne hazard is defined by Codex as "*a biological, chemical, or physical agent in or condition of food, with the potential to cause adverse health effects*" (FAO, WHO, 2006).

It is estimated that almost one third of the population of developed countries is affected by FAD annually and the proportion is likely to be even higher developing countries. FAO and WHO have estimated that 2.2 million people each year die in developing countries due to FAD and water-borne diseases, most of them children (FAO, WHO, 2006).

The four most important food pathogens likely to be associated with informal goat slaughters are:

- ***Escherichia coli* 0157**

E.coli 0157 is a commensal of the intestinal tract of ruminants. It has been associated with food borne diseases globally. This includes food related and environmental related transmission (Abongo & Momba, 2009; Morris, 2009). Because of the possible contamination of the carcass during dressing this becomes one of the most important food borne diseases in ritual slaughter of goats. It is also important, as cross contamination of faeces to carcass, or environment to carcass, during slaughter, may occur (Borch & Arinder, 2002;Hedberg & Hirschhorn, 1996). Many of the goats are slaughtered on the ground without protection from environmental or faecal contamination therefore increasing the chance of contamination.

- ***Salmonella* ser. *Typhimurium***

In the year 2005, 176,395 cases of human salmonellosis were reported in the EU. In many cases salmonellosis is self-limiting and the infected people recover within days (Morris, 2009; Parry *et al.,* 2004). Often patients fail to report the cases or even seek

medical attention, because they feel better after few days. In immunocompromised people, this disease can be severe resulting in dehydration and death.

- ***Campylobacter jejuni***

In the EU *Campylobacter jejuni* is one of the two most reported food associated pathogens (Nauta *et al.,* 2008). Human cases of campylobacteriosis, are associated with the thermophilic species, *jejuni*. Infected people present with abdominal pain, bloody diarrhoea, fever and headaches among others (Albert *et al*., 2008; Nørrung & Buncic, 2008). The status of this disease in South Africa is not known because of lack of data and reporting. The practice of ritual slaughter, without trained people to do dressing and evisceration, can result in cross contamination with this organism.

- ***Listeria monocytogenes***

Listeriosis has been described in sheep and goats that eat contaminated silage and, although rare in unprocessed foods, it could result in FAD in consumers. Listeriosis is associated with immunocompromised people, children, pregnant women and the elderly (Pouillot *at el*., 2009). Symptoms may include flu-like symptoms, septicaemia, meningitis, abortion and life threatening diarrhoea (Conan, 2003). The extent of the disease is not known in South Africa. This is important because non-invasive listeriosis is not included in screening of patients with gastro intestinal illness (Miettinen *et al.,* 1999). The incidence of listeriosis is estimated at 0.3 per 100000 population in the EU (Nørrung & Buncic, 2008).

2.7 Summation

The literature review highlights the need for exploration of traditional cultural slaughter of goats. It appears that a significant proportion of the goat population in South Africa is slaughtered informally or for ritual purposes. Globally it is recognised

that during slaughter of any animal for human consumption, there is a potential for food safety and occupational health risks. Risk analysis is used to identify hazards and minimise risk through communicating the best ways of mitigating food safety and occupational risks to workers and consumers. Although potential hazards have been described and characterised for Halaal and Kosher slaughter, as well as for formal slaughter in abattoirs, there is no literature on this aspect for traditional slaughter of goats.

2.8 Hypothesis

That it will be possible to identify, characterize and assess the risk of biological, chemical or physical hazards liable to affect food safety and occupational health, associated with traditional slaughter of goats, by investigating the cultural practices and informal food chains associated with goats in South Africa.

2.9 Benefits arising from the project

The benefits arising from this project will include:

- A better understanding of ritual slaughter of goats in South Africa.
- Identification of areas of food safety and occupational health risk that should be addressed in ritual slaughter.
- Mitigation strategies for hazards associated with informal slaughter will be designed.
- Justification for the State veterinary services to apply disease control interventions will be provided.
- Improved health and welfare of goats during ritual slaughter.
- Improved health for rural communities doing traditional goat slaughter.

2.10 Objectives

- To record and describe the ritual slaughter process for goats and assess the hygiene practices of slaughter and consumption using an integrated food chain approach.
- To identify and characterize biological, physical and chemical hazards at particular points in the food chain flow diagram and estimate which practices which have the highest risk for transfer of zoonoses or Food Borne Diseases (FBD).
- To list possible welfare issues specific to goat management, transport and slaughter associated with ritual practices.
- To develop recommendations for hygienic principles during ritual and informal slaughter of goats in SA for mitigation and communication of risks to veterinary public health officials, environmental health officers, sangoma's and consumers:

Chapter 3: Methods

3.1 Introduction

The objectives of the study were to evaluate ritual slaughter of goats and look at hygiene practices during both slaughter and processing. This study seeks to identify risk factors within the slaughter practices, which have the potential to introduce hazards that may pose risks to both humans and animals.

3.2 Research design

The use of quantitative research as opposed to qualitative research methods, to study human behaviour, has been found to be limited in nature. The use of qualitative research on its own has also been found to be influenced by bias. Therefore a combination of the two methods gives objectivity and subjectivity to data. Abusabha & Woelfel, (2003) argue that using both methods is important in understanding complicated public health dynamics. A descriptive study is a form of qualitative research that describes the nature and the distribution of the outcomes. It also seeks to answer the question “What?” rather than “How much?” (Gramine & Schulz, 2002; Dohoo *et al.,* 2010).

3.3 Population sampling

The number of people that were interviewed were 105. The selection of individuals was based on a non-probability sampling method, purposive sampling. Purposive

sampling is used if the subjects possess one or more attributes of interests (Dohoo *et al*., 2010). In the study participants to be interviewed had to fulfil the following criteria:

- agree to be interviewed; and
- had been involved in the ritual slaughter process as a participator or practitioner.

The study was conducted in Gauteng Province in the Tshwane Metropolitan area, around Pretoria (Fig 3.1). The selected areas were popular areas such as taxi ranks where people gathered in large numbers. The other respondents included were farmers and informal vendors on the side of the road that sold goats for ritual slaughter purposes.

Figure 3. 1 Map of Tshwane municipality (Pretoria) with the name of cities. Map on the right is the Gauteng Province. Source[2]

[2] http://www.sleeping-out.co.za/Tshwane-Map.asp

"Marabastad" is a portion of Pretoria Central and "Wonderboom" is in Pretoria North. Although both are listed as areas visited, they are not shown in Fig 3.1, as the scale is too large to show them. They can be seen in Fig 3.2.

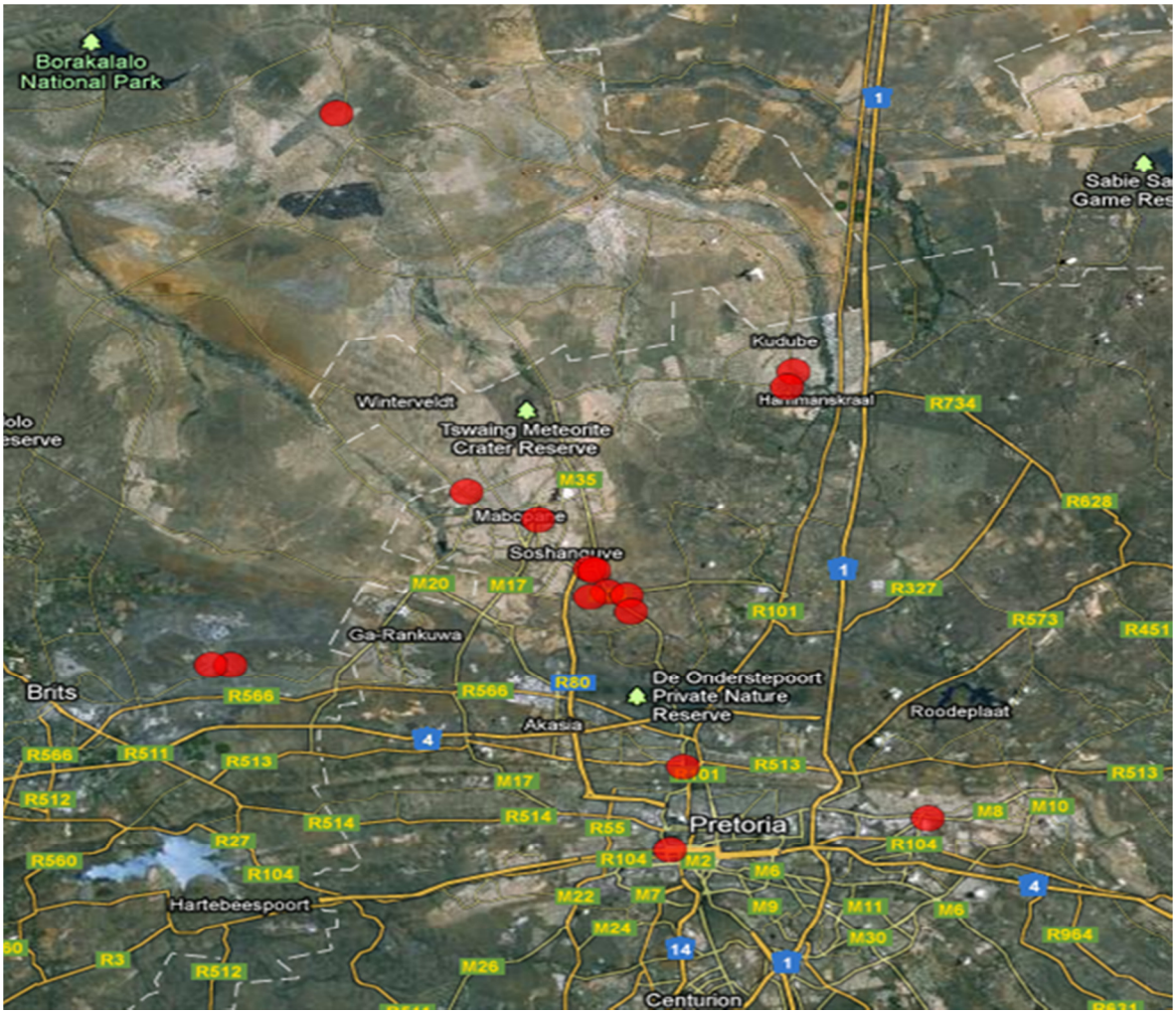

Figure 3.2. Map showing the locations where interviews were conducted in and around Pretoria.

The following taxi ranks were visited see Figure 3.2, Mamelodi, Mabopane, Marabastad, and Wonderboom. The other areas that were visited to interview respondents were in Shoshanguve, Mabopane, Brits (North West Province) and Hammanskraal. In total four taxi ranks and 18 sites around Pretoria were visited.

3.4 Data collection

To collect data, a structured questionnaire interview was used. It consisted of both qualitative and quantitative questions as well as open ended and closed questions. The questionnaires were administered in person to person interviews. Each interviewer was put through a training process prior to interviewing respondents. This method of questionnaire administration had been found to have less missing values (Dohoo, *et al*., 2010)

3.4.1 Questionnaire design

The questionnaire was designed in both Epi-info 7 (CDC, 2012) and Microsoft Excel ® (Excel, 2010). The questionnaires consisted of both open ended and structured questions. The open ended questions allowed the participants to express their views and thoughts on the slaughter process. While the structured questions were used to capture the respondents perceptions on the slaughter process, hygiene, animal welfare and the conditions of the environment where the slaughter occurs.

Closed type questions included checklists, options, multiple answers and rating of opinions according to scale. However in some of the closed questions to address limitation or restriction of the respondent's opinions, a comments space was provided.

The questions within the questionnaires were structured into categories, they cut across borders in terms of food safety, occupational health, environmental hygiene and safety, as well as animal welfare. Below are the categories included in the questionnaire:

1. Pre slaughter activities
    a. Source
    b. Pre-slaughter examination

   c. Transportation

2. Slaughter processing activities
3. Post slaughter activities
   a. Transportation
   b. Storage
   c. Processing
   d. Consumption
   e. Post cooking storage

In each category, the questions became more specific and focused and included the micro - environment. The design of the questions addressed the objectives of the study. It took approximately 30 minutes to interview each participant. The full questionnaire for the structured interviews is shown in Appendix 1.

3.4.2 Pre-testing questionnaires

To pre-test the questionnaires, they were given to employees at the Faculty of Veterinary Science. A small group of ten people from Mabopane was also given the same questionnaires. Feedback from the pre-test was then incorporated into the questionnaires.

3.4.3 Methods of administration

The ritual slaughter questionnaires were administered to respondents using a person to person interview. This method gave the interviewer an opportunity to explain to the respondent concerned, what the questionnaire entailed and how long it would take to administer the questionnaire.

Interviewers were animal health technician students from the University of South Africa (UNISA) and were trained in interview techniques prior to the study. The training process for interviewers was designed firstly, to explain the objectives of the

research. Secondly, it was designed to evaluate both the understanding and ability to explain questions as they appeared in the questionnaire. Thirdly, it was aimed at demonstrating the ability to administer a questionnaire. This is an important step as it prevents interviewer bias and promotes consistency in data collection (Gramine & Schulz, 2002).

3.4.3.1 Selection of participants

The approach to selection of participants depended mainly on the environment and the study area. There was no specific method followed to select the participants. Some came to buy food from vendors and some were approached as they passed through the taxi rank. In some cases the participants were identified when they were going to purchase the goats for any reason. It was therefore purposive rather than randomised selection.

3.4.3.2 Ethical considerations

In South Africa, people's dignity, rights and religion have to be respected in terms of our Constitution, thus each participant was asked in advance if they had any objections to being interviewed about traditional slaughter. Most respondents were willing to be asked their opinions about ritual slaughter and it was not difficult to find volunteers, especially when people were sitting eating or waiting for taxis. Consent was thus obtained (See Appendix 2). Each participant was not forced to answer any question they felt uncomfortable with, confidentiality was maintained.

3.5 Data coding and editing

During the design of the questionnaire, a data entry template was developed in Epi-info. The design of the questionnaire in Epi-info gave direction in terms of how the

question should be phrased for statistical analysis. The software automatically codes the data to prevent confusion between missing information and unanswered questioned. The software was also coded to prevent moving to the next record without completing all the sections.

3.6 Tools for data analysis

3.6.1 Epi-info 7

Some questions consisted of five different answers in which the respondents had to choose as many answers as he/she wished from the provided options, The data was analysed and the frequency of the variables were calculated and tabulated using Epi-info. The data analysis was done using both Epi-info and the thematic analysis method as described below.

3.6.2 Thematic analysis method

Open ended questions were analysed using a thematic analysis method as described by Thomas and Harden (2008). The thematic synthesis started with line by line analysis of the text. The pre-set themes were used as a guideline to develop thematic codes from the data. This pre-set method was not exclusive as line by line analysis of text was also done to identify emerging words or themes.

In the analysis, words that related to pre-set themes or ritual slaughter practices were identified, a method which is also known as word based technique (Ryan & Bernard, 2011). From the technique, a list of common words was compiled. Each word was given a code, the codes were used in statistical analysis using Epi-info. Common or new words were used to construct themes. The red meat abattoir flow process as seen in (Fig 3.2) was used as a base for pre-set themes, but new themes were also

constructed from the data. From these findings a process flow diagram was developed.

The red meat abattoir slaughter process flow is shown in Figure 3.3 below. The process is divided into two sections dirty and clean areas. The formal goat slaughter process normally used in an abattoir, was considered as a baseline standard, as it is a widely known and recognised method of slaughter. This method of slaughter takes into consideration animal welfare, occupational health and safety, as well as the risks to the consumer of hazards associated with the slaughter of goats. In the abattoir there are well defined standard operating procedures to mitigate these risks.

During evaluation of the ritual slaughter practices, the same wording was used as it is used in an abattoir or formal meat processing. The prerequisites in the abattoir in terms of food safety, animal welfare and hygiene were used to set the required prerequisites for ritual slaughter (CAC, 2005). The creation of themes based on the abattoir situation was therefore justified. It is noted that in an abattoir, during the process, certain products such as the ingesta, skin, feet and sometimes the head, are moved to an area regarded as a “dirty section”. This should also possibly hold true when these products are removed during informal slaughter.

The flow chart in Fig 3.3 was used for comparison and discussion when qualitatively estimating the risk of hazards (FAO, WHO, 2009) during the informal or ritual slaughter process and the methods proposed to reduce risk without compromising cultural norms.

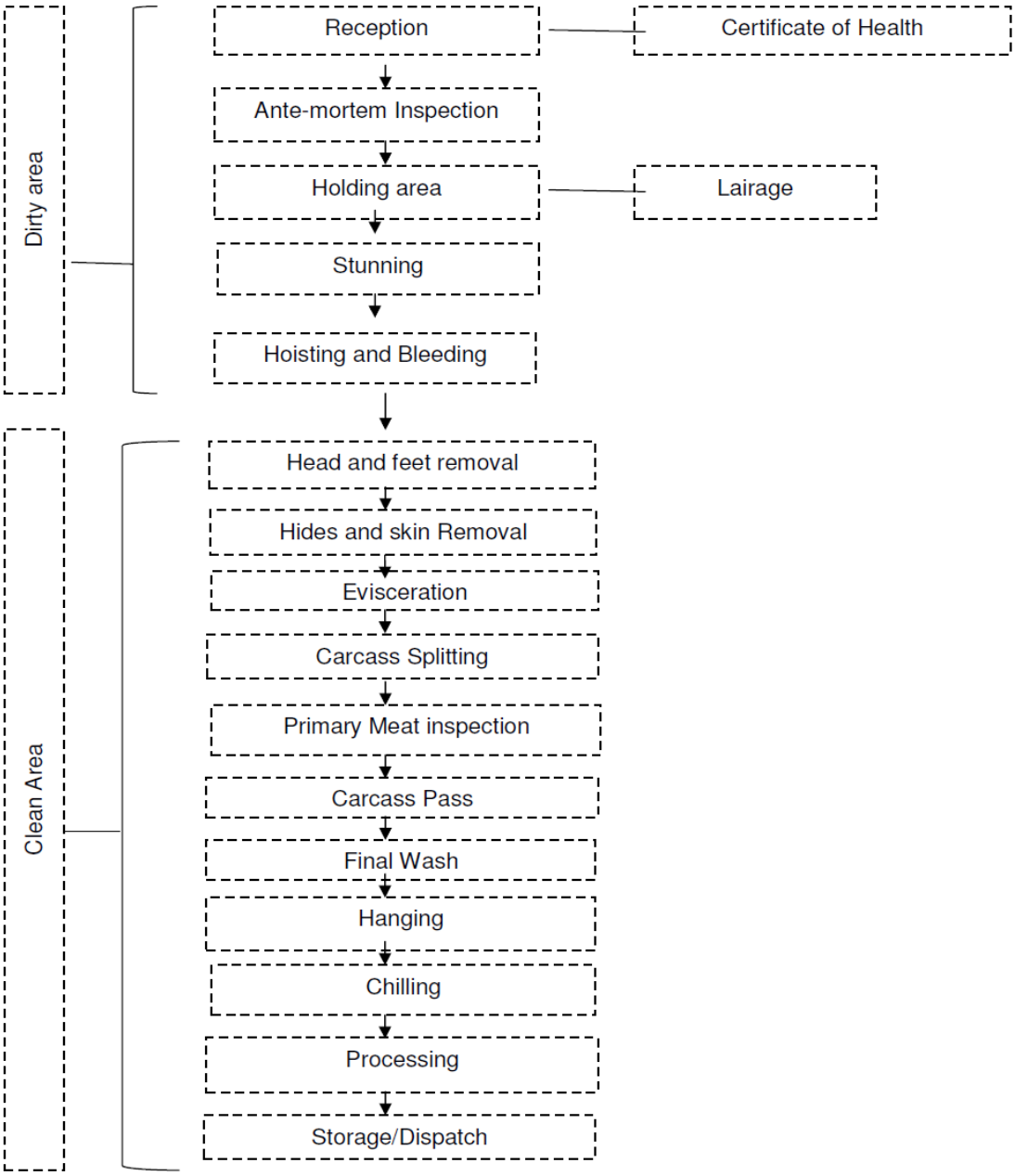

Figure 3.3. A slaughter process flow in the red meat abattoir. Adapted from DoA 2007b

3.6.3 Direct observations

In addition to interviews with respondents, direct observation of the slaughter process was performed and recorded in a similar fashion to how it is done during the application of Hygiene Management and Assessment Systems (HAS) in an abattoir,

or through photographic images if permitted. A similar, simplified checklist will be developed for informal/ ritual slaughter.

3.7 Hazard identification and risk estimation

The hazards that may occur in the slaughter of goat for ritual purposes were listed and divided into three categories: biological physical and chemical. Potential hazards were identified using the literature review, questionnaires data and observations of slaughter (n=4) from the study. Hazards were chosen based on their characteristics, likehood of exposure and consequence of exposure or impact.

Risk was estimated from two types of data. Firstly, from perceptions gained from structured interviews and secondly from checklists during traditional slaughter of goats (n=4). Although it was intended originally that incision or swab samples would be taken from goats during traditional slaughter, this was not possible. Firstly, it was extremely difficult to access traditional slaughter situations because they are religious ceremonies and secondly, no part of the goat sacrificed may be taken away from the area where it is slaughtered.

Participatory methods of estimating risk, as described by Grace et al., (2008) were therefore used in this study. The FAO, WHO guidelines for qualitative microbial risk assessment, were modified so that they were appropriate for informal goat slaughter, without needing microbiological samples (FAO, WHO, 2009). In essence, the problem faced in our study, where we could not sample carcasses for cultural reasons, was similar to that faced by the researchers where they explain there was no way of quantitatively estimating the number of prions in a Bovine Spongiform Encephalomyelopathy (BSE) sample from a bovine at an abattoir. Tables 3.1, 3.2

and 3.3 below, derived from the publication on EFSA BSE/TSE risk assessment of goat milk and milk-derived products, illustrate how to estimate risk qualitatively.

Table 3.1 Qualitative measures of likelihood.

Level	Descriptor	Example description
A	Almost certain	Is expected to occur in most circumstance.s
B	Likely	Will probably occur in most circumstances.
C	Possible	Might occur or should occur at some time.
D	Unlikely	Could occur at some time.
E	Rare	May occur only in exceptional circumstances.

Table 3.2 Qualitative measures of consequence or impact.

Level	Descriptor	Example description
1	Insignificant	Insignificant impact; little disruption to normal operation; low increase in normal operation costs.
2	Minor	Minor impact for small population; some manageable operation disruption; some increase in operating costs.
3	Moderate	Minor impact for large population; significant modification to normal operation but manageable; operation costs increased; increased monitoring.
4	Major	Major impact for small population; systems significantly compromised and abnormal operation, if at all; high level of monitoring required.
5	Catastrophic	Major impact for large population; complete failure of systems.

Table 3.3 Qualitative risk analysis matrix: level of risk.

Likelihood	Consequences				
	Insignificant	Minor	Moderate	Major	Catastrophic
Almost certain	Moderate	High	Very High	Very High	Very High
Likely	Moderate	High	High	Very High	Very High
Possible	Low	Moderate	High	Very High	Very High
Unlikely	Low	Low	Moderate	High	Very High
Rare	Low	Low	Moderate	High	High

The level of risk was estimated from a literature study of published data on Livestock Diseases of Southern Africa (Coetzer & Tustin, 2004), by specifically selecting diseases of goats prevalent in the study area and pairing the epidemiology and transmission of the disease to critical points as hazards, during informal slaughter of goats.

Chapter 4: Results

4.1 Introduction

This chapter consists of the analysis of data from 105 respondents, gathered in and around Tshwane Metropolitan area in Gauteng. The data was used to describe ritual practices, risk pathways and the food chain of goats slaughtered during ritual slaughter.

The results will be presented under the following sections:

- Geographical position of the interview;
- Demographic profile of respondents;
- Pre-slaughter activities;
- Slaughter activities, and
- Post slaughter activities.

4.2 Demographic profile of respondents

The demographic information collected using structured questionnaires was analysed. Not all respondents answered every question, so relative frequency was

thus calculated for each question. Demographics of age, education, gender and province of origin are reported in different subsections below.

4.2.1 The age distribution of respondents

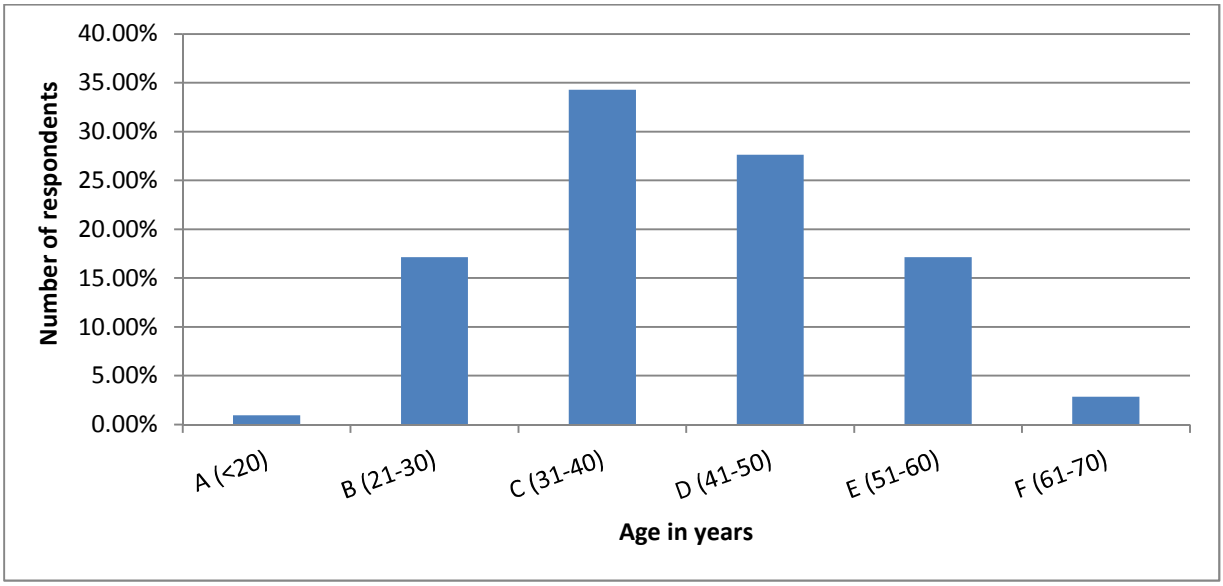

Figure 4.1. Age distribution of the respondents interviewed from different locations in and around Pretoria (N=105).

The highest number of respondents 34.29% (n=36) were between the age of 31-40 followed by those between the age of 41-50 (27.62%, n=29). The least number of respondents 2.86% (n= 3) and 0.95% (n=1) were between the ages of 61-70 and less than 20 years respectively. The age distribution of the respondents observed could be attributed to the fact that those interviewed were people at taxi ranks on the way to work, hence the reason those interviewed generally tended to belong to the employment between the ages of 18 and 65. The median age of respondents was 40 years.

4.2.2 Education level

The education level of respondents is shown below in Fig 4.3

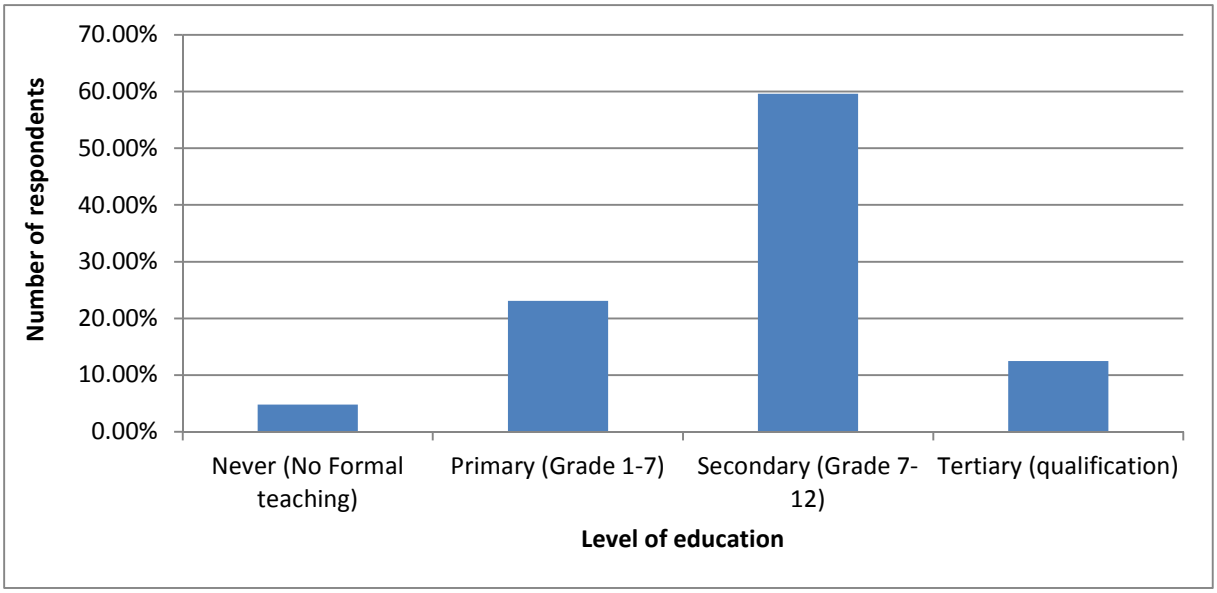

Figure 4.2. The education level of respondents interviewed from different locations in and around Pretoria (N=105).

Almost 60.00% (n=63) of respondents had a secondary education with less than 4.81% (n=5) of respondents having no formal education. Once again this may be linked to the fact that most people interviewed at the taxi rank are catching taxis to work as many of them indicated

4.2.3 Gender of respondents

The gender of respondents is reflected in Fig 4.4. The total number of female respondents was 48 (45.71%) and male respondents were 57 (54.29%).

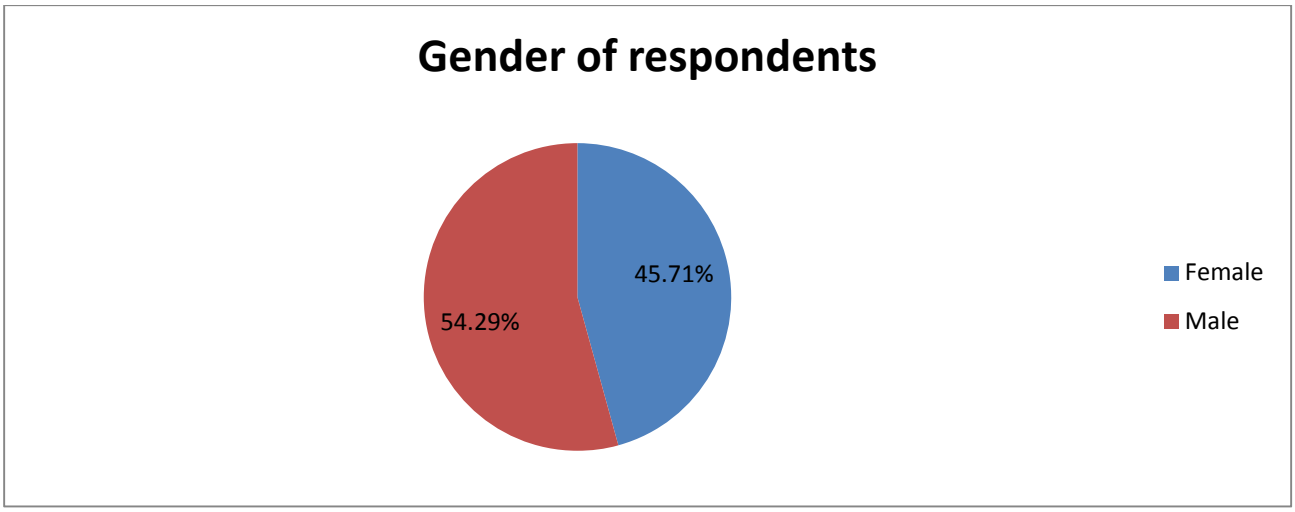

Figure 4.3. Gender of respondents interviewed from all locations where interviews were conducted (N=105).

There is a difference between the genders in age distribution as seen in (Fig. 4.5)

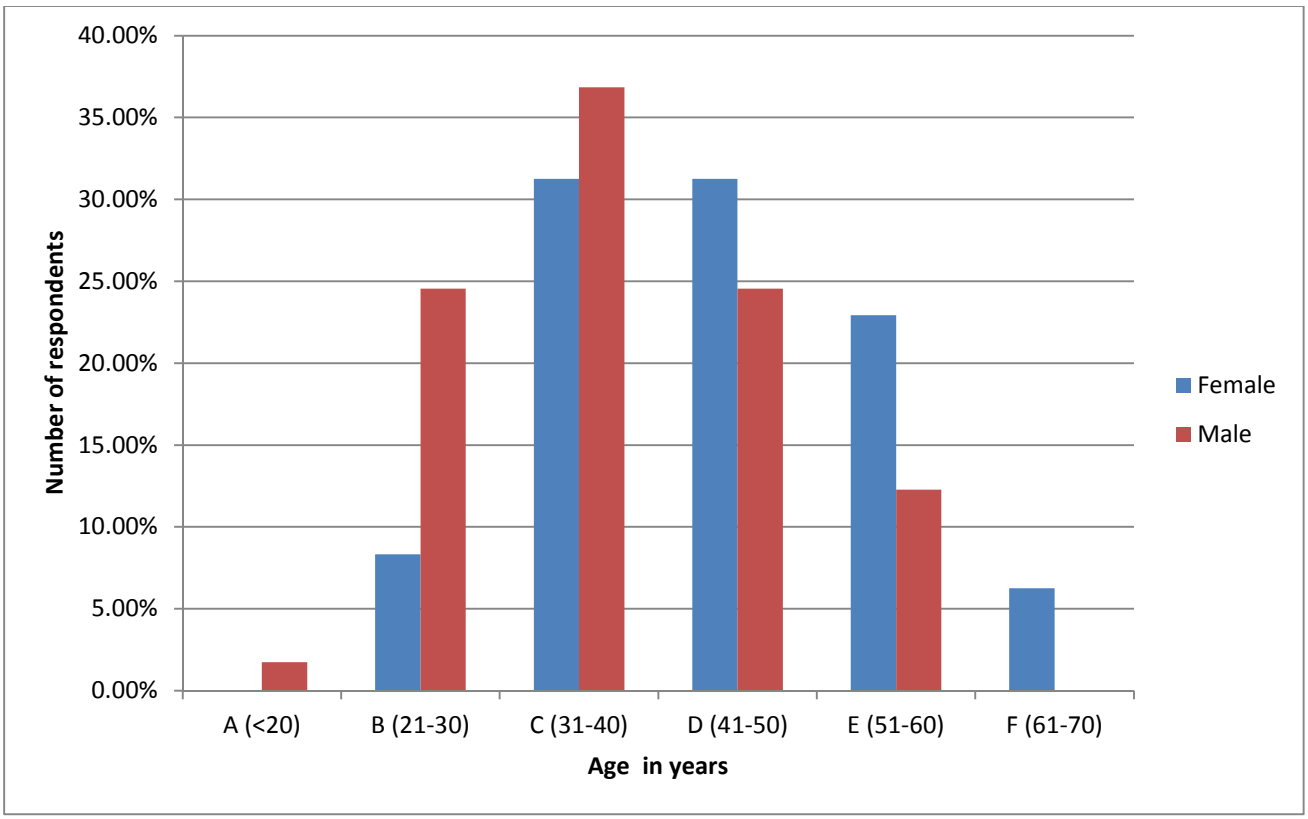

Figure 4.4. Distribution of age groups of respondents interviewed, categorised according by male and female. (N=105)

The age distribution of respondents as seen above was stratified by gender. The median of both genders was calculated as 40.64 and 44.33 years.

Fig 4.5 shows an analysis of educational level by gender

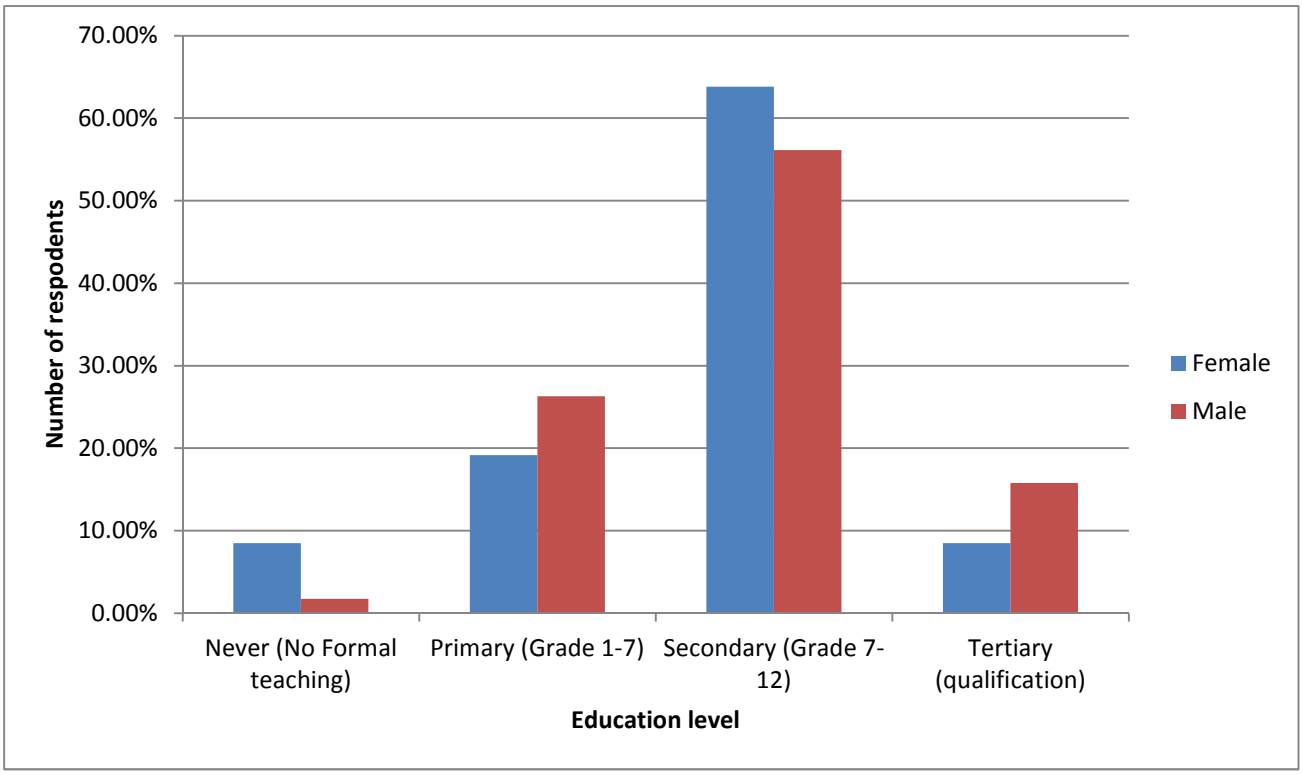

Figure 4.5. The educational level of respondents interviewed categorised according to male and female.

It does not appear to be a significant difference in educational level of the different genders.

4.2.4 Distribution of respondents within provinces

The distribution of respondents by province is shown in Fig 4.7. There are 11 official language groups in South Africa and these are roughly associated with provinces. The cultural practices associated with goat slaughter differ between tribes (language groups/ ethnicity) and thus the origin of respondents was deemed relevant. Tshwane is a major business hub and thus attracts workers from all over South Africa.

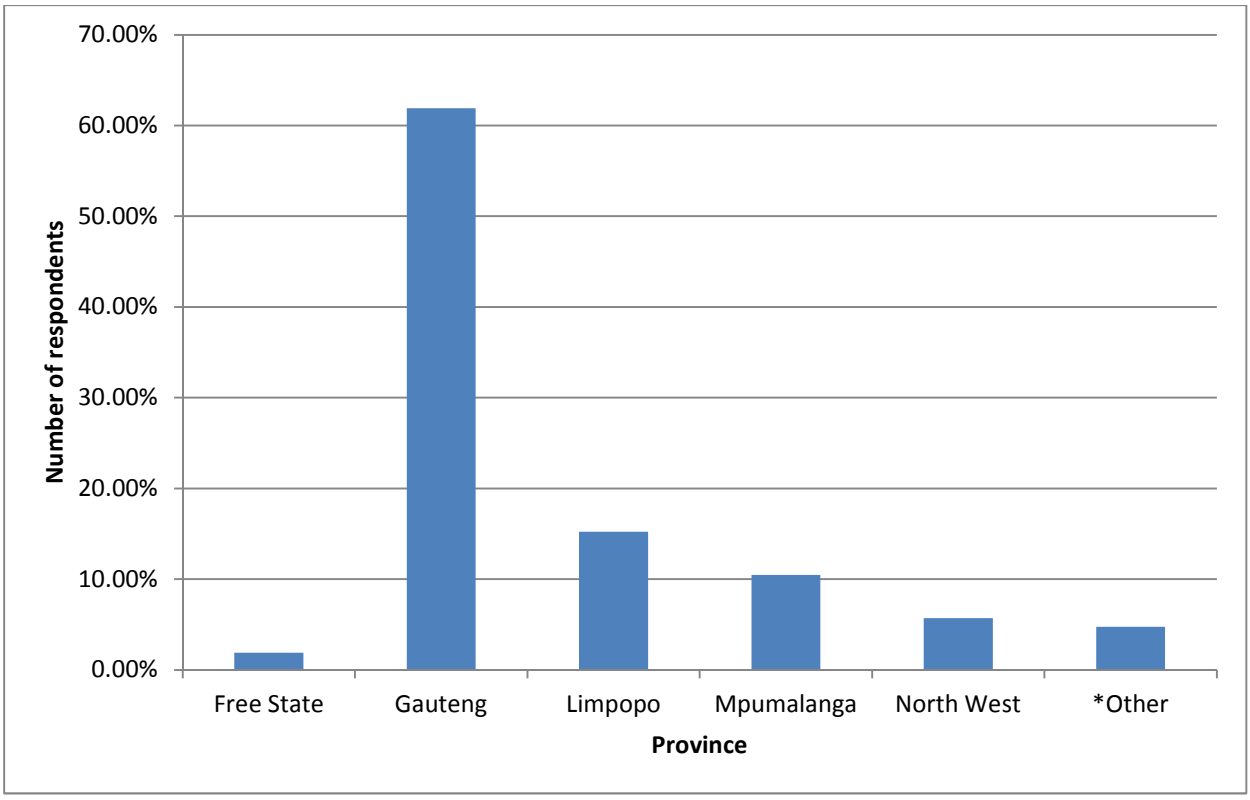

Figure 4.6. The origin or birth place of respondents interviewed according to provinces (N=105)

The majority of respondents 61.90% (n=65) were from Gauteng Province, followed by Limpopo Province that had 15.24% (n=16) respondents. The number of respondents from Mpumalanga was 10.48% (n=11) and this was followed by North West with 5.71% (n=6) respondents. There were respondents from other countries such as Zimbabwe and Mozambique. Free State had the lowest number of respondents, n= 2.

The distribution of respondents based on the suburb or district of the different provinces from which they originate is shown in Figs 4.8 to 4.11.

Only two respondents from the Free State Province were interviewed and both were from the town of Botshabelo in the eastern part of the province.

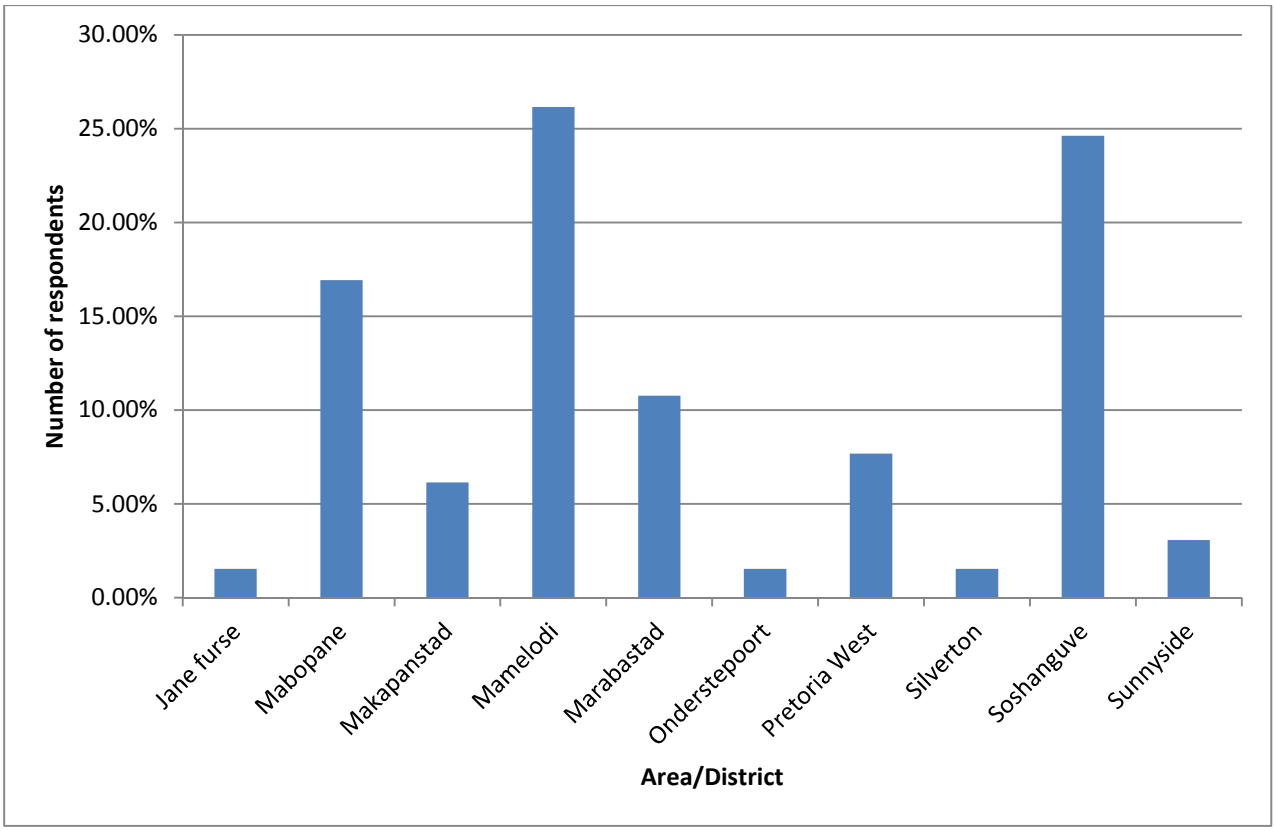

Figure 4.7. The number of respondents interviewed per suburb in the Gauteng Province (N=65).

Inhabitants of Gauteng constituted the largest number of participants (Fig 4.8). Twenty six percent (26%) of Gauteng respondents were from Mamelodi, followed by Shoshanguwe with 25 percent (25%). Mabopane and Marabastad each contributed 17 percent (17%) and eleven percent (11%) of respondents respectively. Pretoria West and Makapanstad had few numbers (8% and 6% respectively), while Jane Furse (Gauteng), Sunnyside and Silverton had the least number of respondents (1% each).

There were 16 respondents from Limpopo Province. Of these, the suburbs with the highest number of respondents were from Groblersdal which had three respondents (19%), while Giyane and Polokwane each had 2 respondents (13%). The rest of the suburbs had one each (6.25%).

Mpumalanga had eleven respodents, three from Hendrina, Mhlanga and Morgenson. Bethal, Nelspruit, Pankop,Vaalbank and Witbank each had one respondent.

In total, six respondents were interviewed from North West province and the majority of respondents (50%) were from one suburb, Makau. One respondent came from each of the suburbs of Hebron, Makapanstad and Muthutlung,

4.3 Assessment of pre slaughter activities

For the purposes of this research, slaughter activities are divided into pre-slaughter, slaughter and post slaughter.

4.3.1 Source of goats

The first important activity in the pre-slaughter phase at an abattoir is trace-back, source or origin (as discussed in Chapter 3). The source of goats used for ritual slaughter is shown in Fig 4.11 below.

In general, goats for ritual purposes can be purchased externally, or bred by the owner or a relative. In the above histogram all categories except “own goat” were purchased animals.

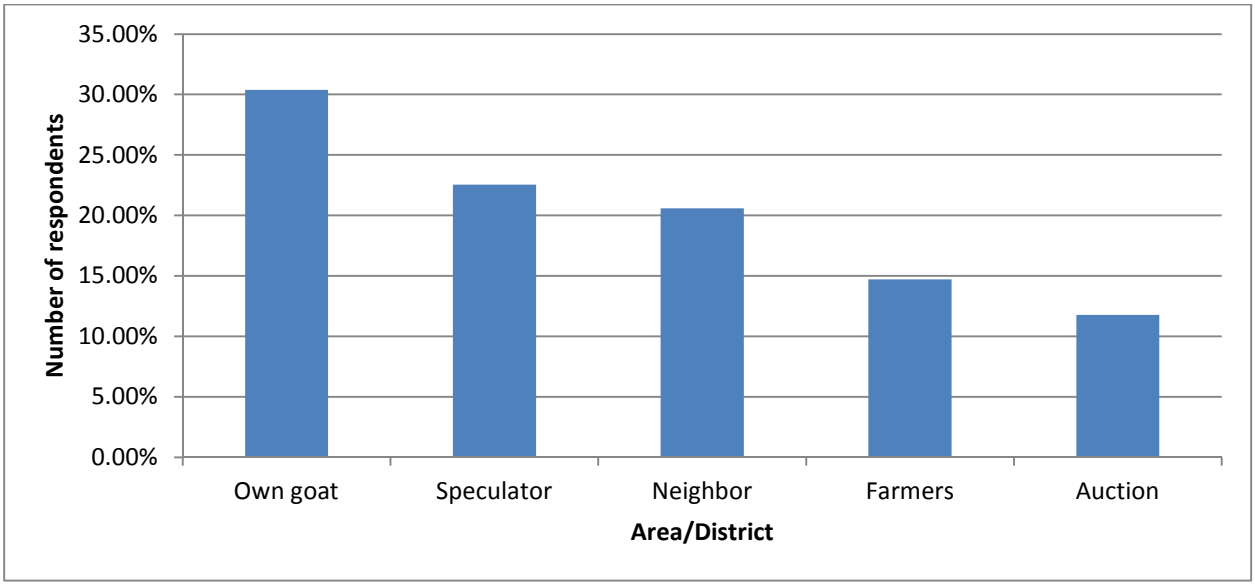

Figure 4.8. Relative frequency of possible sources for goats used in ritual slaughter (N=105).

4.3.2 Pre purchase examination for slaughter goats

None of the respondents asked for a health certificate when purchasing a goat, although this should be asked if the animal was sent to an abattoir (DoA, 2000). The respondents were further asked if they performed any sort of “pre purchase” examination, when purchasing a goat. The respondents further added that was important was the characteristics of the animal must be as required to please the ancestors. Twenty percent (n=21 out of 105), indicated that they did. Based on the response of the respondents the common criteria for pre-purchase inspection included checking the following:

Skeletal abnormalities

- Broken hooves
- Footrot
- Foot problem of unknown cause
- Lameness
- Inability to stand
- Abnormal ribs

Integumentary system

- Skin disease

Special organs

- The colour of the eyes

General

- Any abnormality
- Check for bad smell

- Check for sores
- Craziness (behaviour)
- Wounds around the body

Urogenital system

- Colour of urine
- Not sure looked sick

Gastro Intestinal System

- Diarrhoea

While some performed a “pre-purchase examination” of sorts, none of the respondents mentioned ever performing pre-slaughter examination. Of those who said that they carried out pre-purchase examination, none had attended formal training. It was mentioned by 12 of the respondents, that even though they were not formally trained, they gain experience from training by their older relatives whom were respected because of their experience in ritual slaughter.

4.3.3 Transportation of goats

Fig 4.9 below indicates the distance between origin and ritual slaughter of goats.

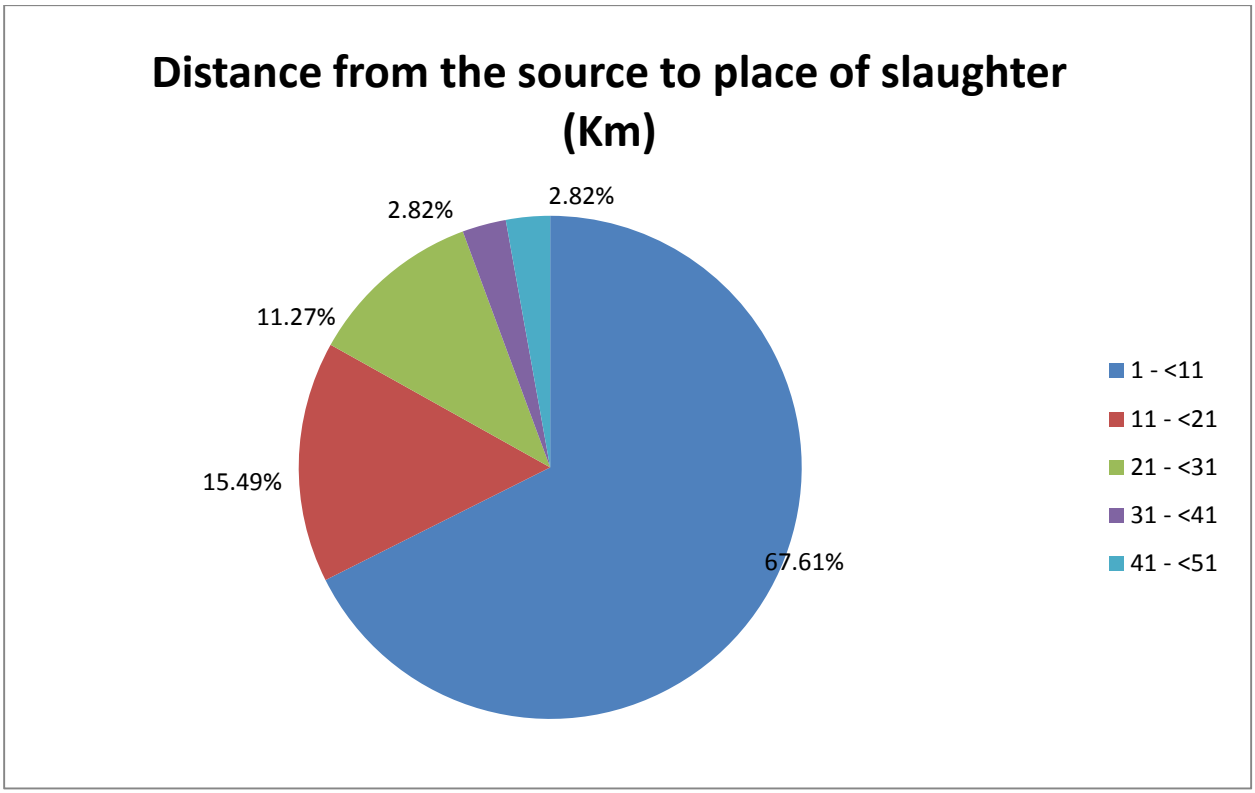

Figure 4.9. The distance the respondents said the animal travel between where the goat was sourced and place it was slaughtered (N=71).

The majority of respondents travelled a distance of between one and eleven kilometres to source a goat for ritual slaughter. This represented 67.61 % (n=48) of the respondents answered the questions (n=71). Fifteen percent (n=11) of respondents indicated that they had to travel a distance between 11 and 20 km to buy the goats, while eleven percent (n=11) of the respondents had to travel a distance between 21 and 30 kilometres. A small percentage of respondents 2.82% (n=2) had to travel distance between 31 to 41 and 41- 51 km respectively. None of the respondents indicated that they had to travel a distance of more than 51 km to buy a goat. Methods of transport are shown in Fig 4.10.

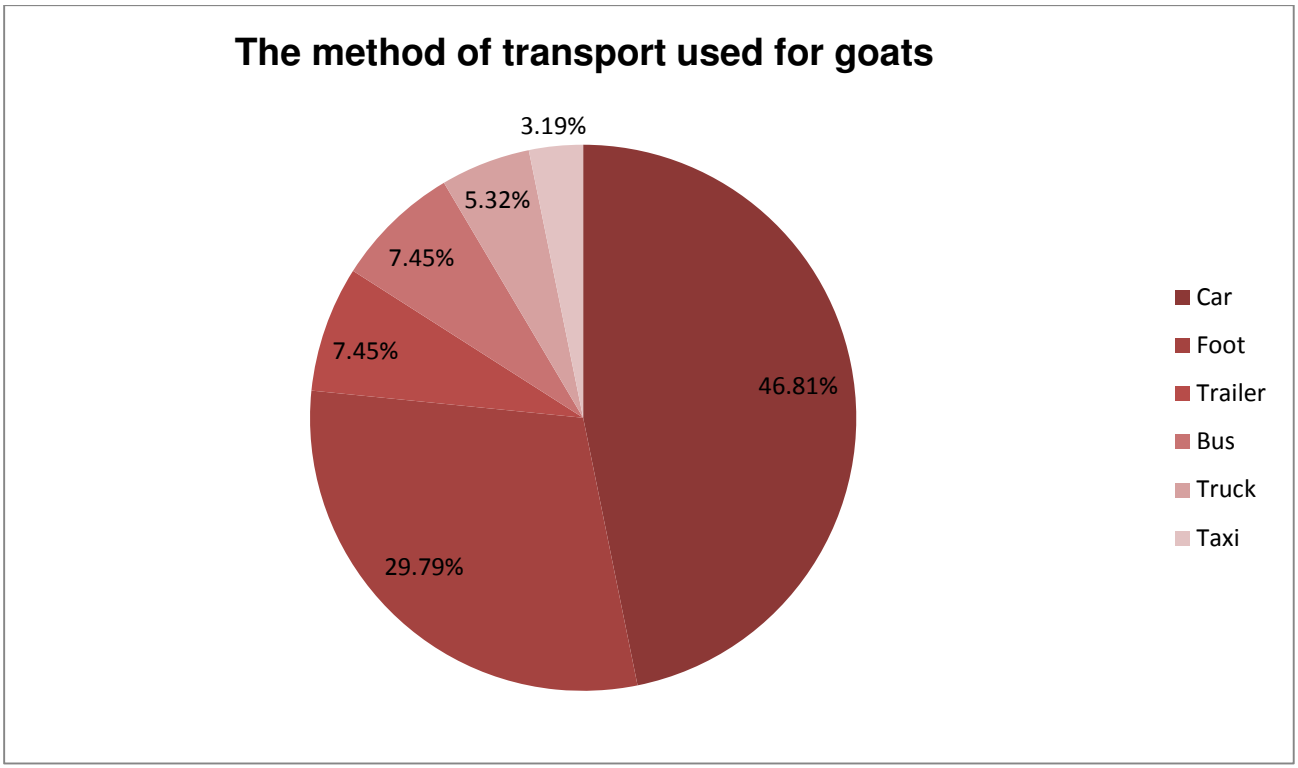

Figure 4.10. Method of transport used to transport the animal to a place of slaughter. (N=105)

From Fig 4.10, the highest proportion 46.67% (n=49) of transport methods was the use of a car to transport the goat from the place of purchase to the place of slaughter. Thirty percent 30.48% (n=32) of respondents herded goats from the source, to their home or a place in which the slaughter is going to occur. A bus with a trailer was used by 7.61 % (n=8) of respondents respectively.

The method of restraint during transportation is shown in Fig 4.11.

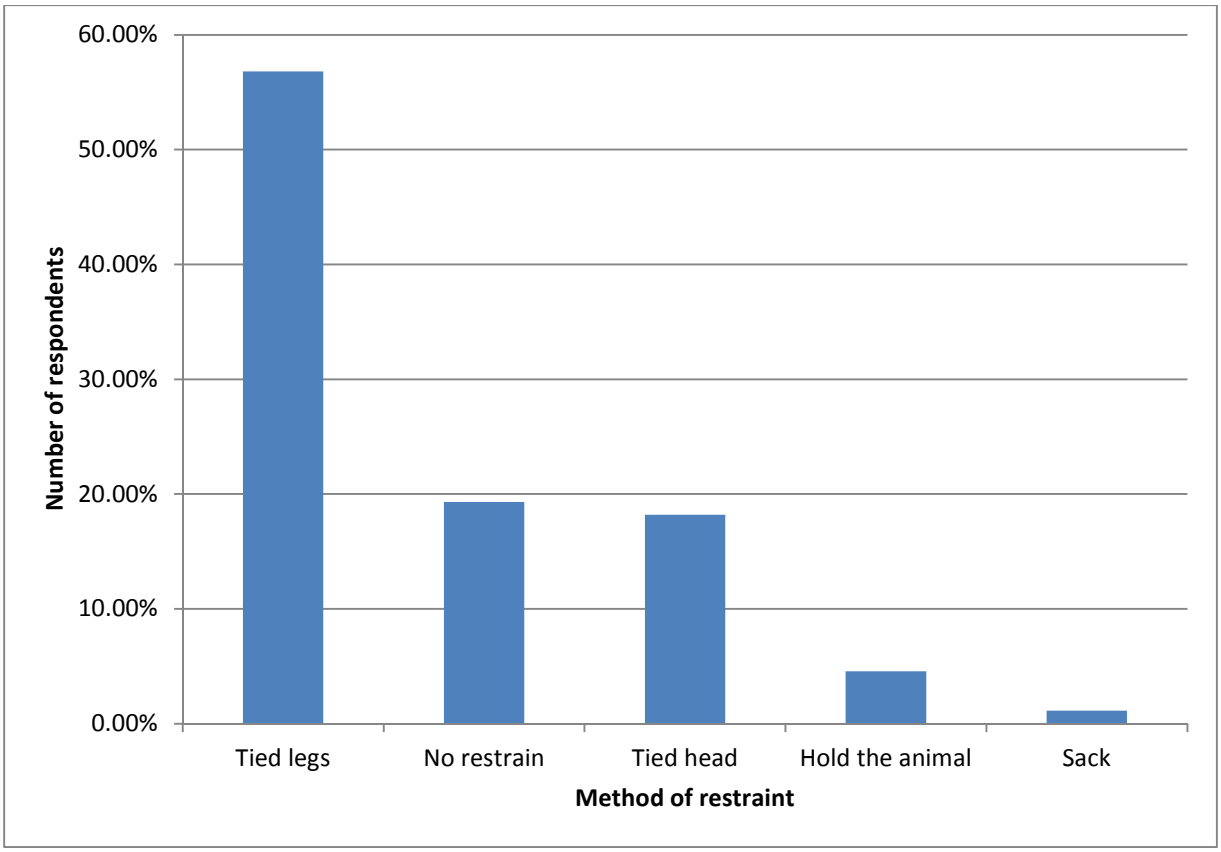

Figure 4.11. Methods of restraint that was used during transport of goat to a place of slaughter (N=49)

Respondents that used cars (n=49) were asked if the transport they used had a protective cover, sixty percent 60% (n=29) of them said they did not use protective covers.

4.3.4 Pre-slaughter Holding Area

The different types of holding areas used for goats prior to slaughter are indicated in Fig 4.12 below

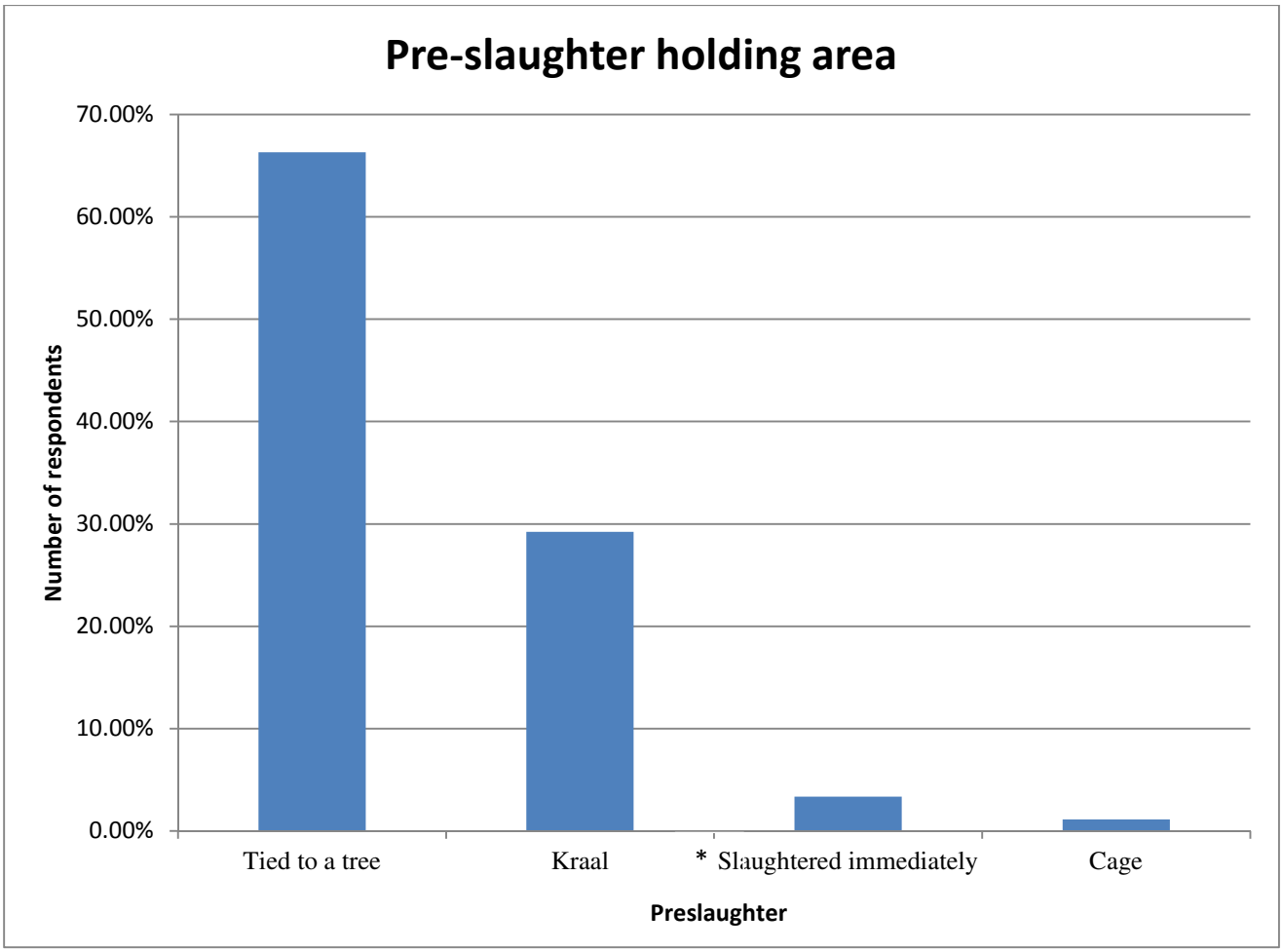

Figure 4.12. The type of facility used to keep the animal after arrival before slaughter (N=89).

*In some cases there was no facility required as they were slaughtered on arrival.

From the above it can be noted that the majority (66.29%, n=59) of respondents kept the goat tied to a tree just before slaughter. This is followed by 29.21% (n=26) of respondents who kept the animal in a kraal. There were a few respondents 3.37% (n=3) that said goats were slaughtered as soon as they arrived. The number of hours the goat is kept prior to slaughter is shown in Fig 4.13 below.

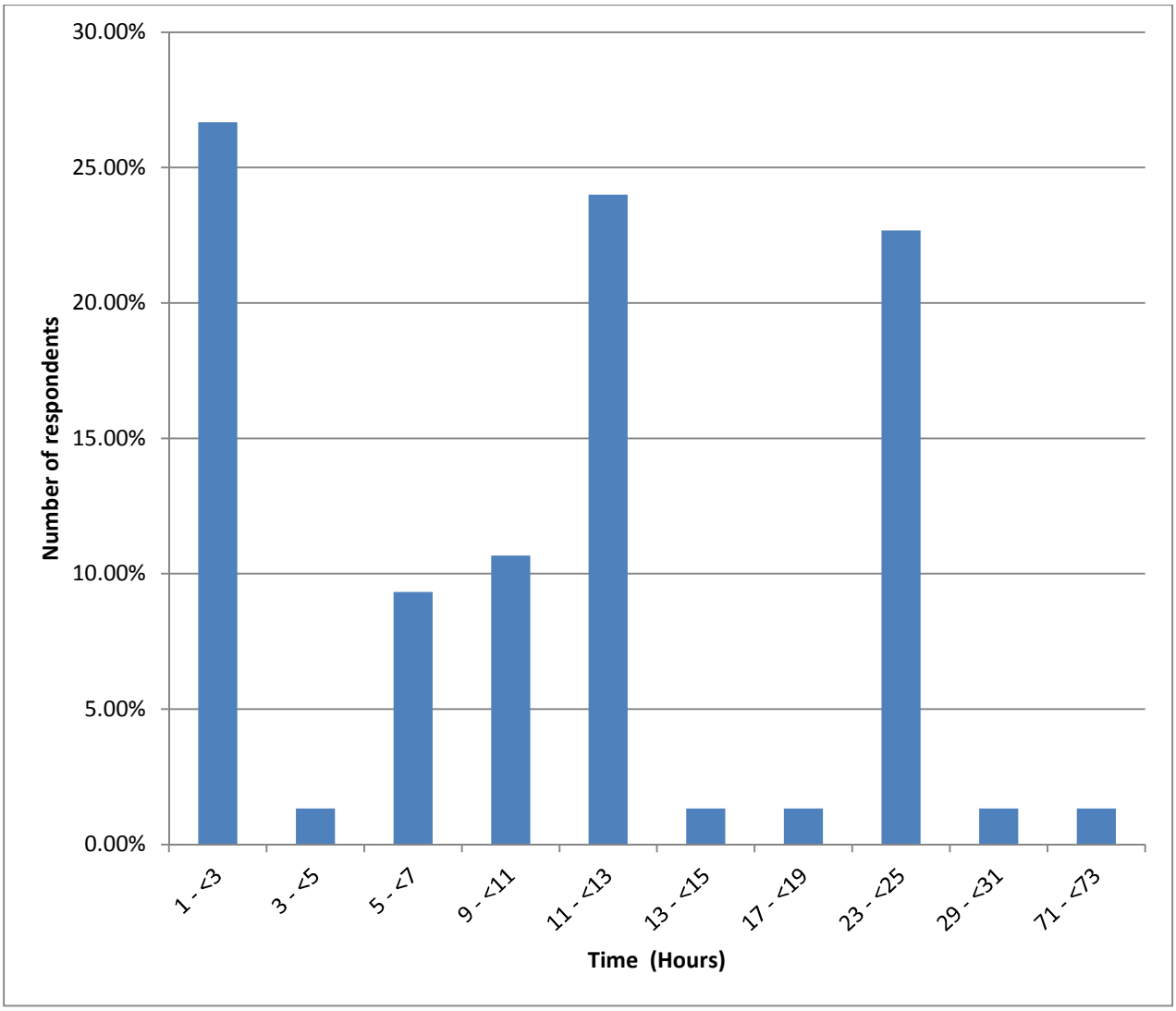

Figure 4.13. Number of hours a goat was kept before slaughter, from time it was bought to when it was slaughtered. (N=105)

It appears from the histogram that most respondents either slaughtered immediately, slaughtered the next morning (11-13 hours or slaughtered the following day (23-25 hours). It may be important to look if animals kept longer than 8 hours were in a kraal rather than tied to a tree, for welfare reasons.

The different types of restraint methods used in the holding area just before slaughter are show in Fig 4.14 below.

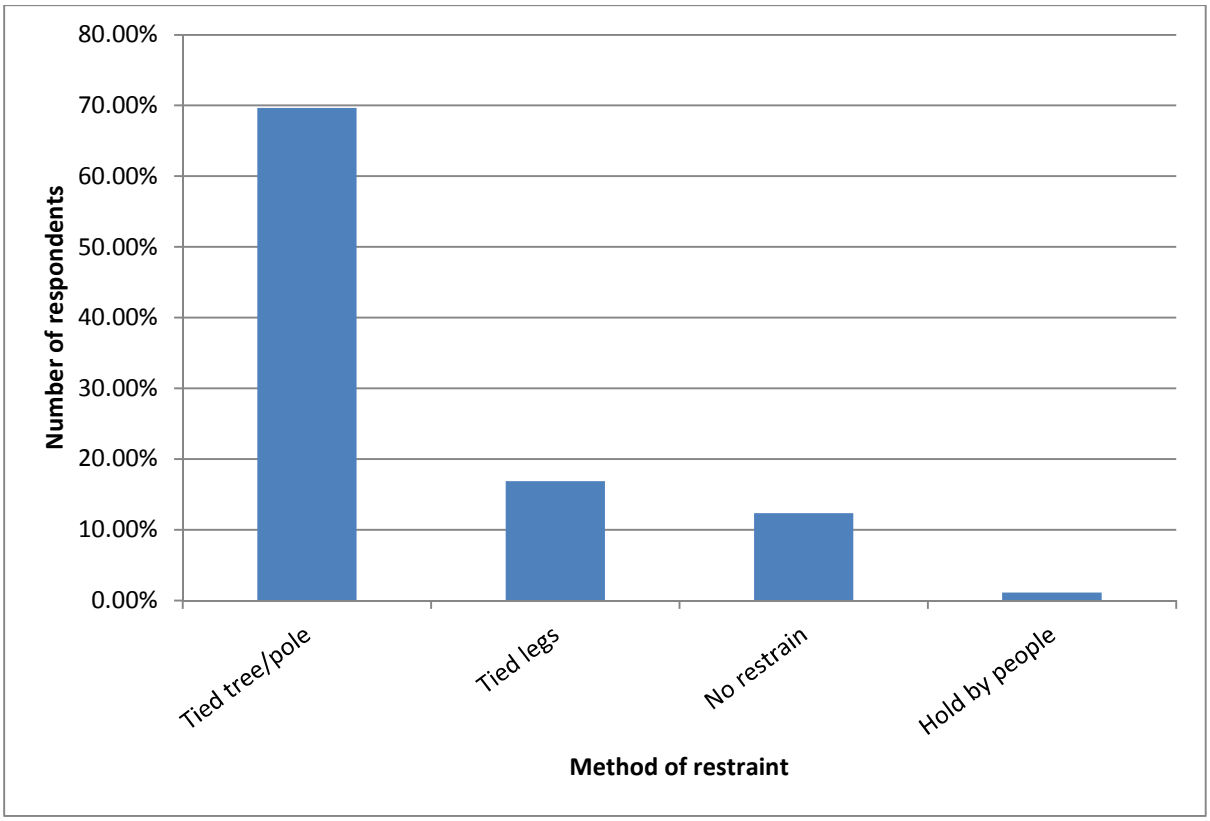

Figure: 4.14. The method used in the holding area to restrain a goat before slaughter (N=89).

From Fig 4.14 above, the most common method of restraint, as indicated by 70 % (n=62) of respondents, was to tie the goat to a tree or a pole using a loose rope around its neck. This was followed by 16.85% (n=15) of respondents. Who said say they just tied the goat legs. A small number of people (n=1), said they would hold on to the animal just before slaughter.

The respondents were asked if food and water were provided to the goats before slaughter. Out of a total of 89 respondents, 65.17 % (n=58) indicated that they provided food and water, while 34.83 % (n=31) of respondents said that they did not provide food and water. The longer the animal is kept before slaughter, the more important it is that food and water are provided.

4.4 Assessment of slaughter activities

Fig 4.15 below shows the preferred time for slaughter.

Figure: 4.15. The time of the day in which slaughter took place (N=105).

The majority of respondents 58.89% (n=53) indicated that the slaughter of goat occurs in the early hours of the morning. This is followed by 38.89% (n=35) of respondents performing slaughter in the evening. From the Fig 4.15, it can be seen that few (2.22 % n=2) people slaughter during the afternoon.

The number of people involved in the slaughter of goats in shown in Fig 4.16 below.

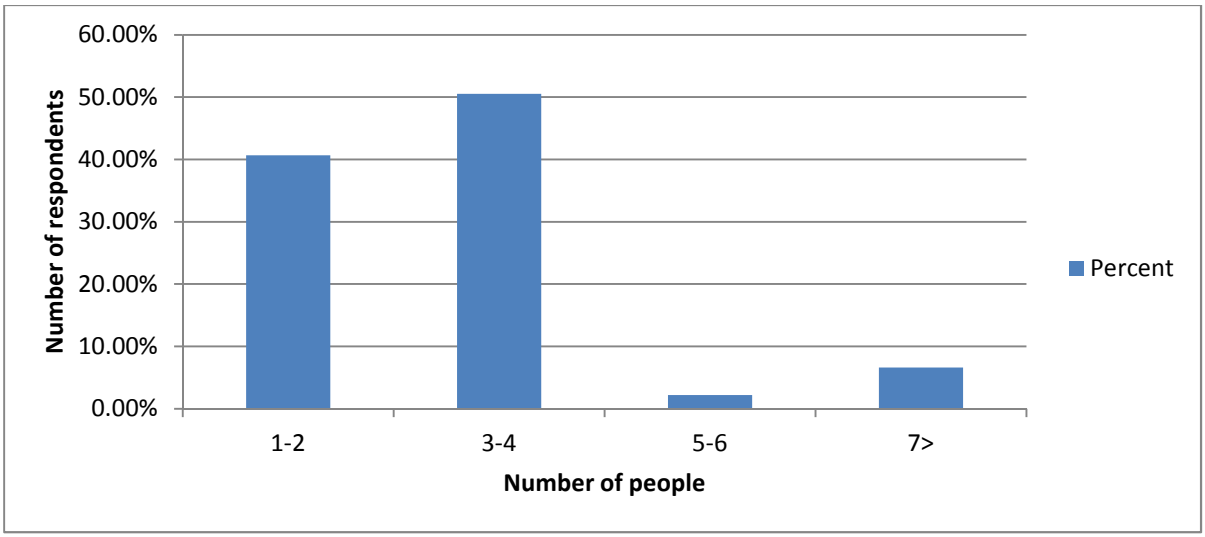

Figure: 4.16. The number of people involved in exsanguination of goats during ritual slaughter (N=91).

From the histogram above (Fig 4.16), the number of people involved in the slaughter of goats at the stage of throat slitting and exsanguination is between one and four. This was the confirmed by 91.21% (n=83) of the respondents interviewed. A small percentage 8.79% (n=8) of respondents indicated five or more people. Fig 4.17 below shows the most common surface on which the exsanguination of goats occurs.

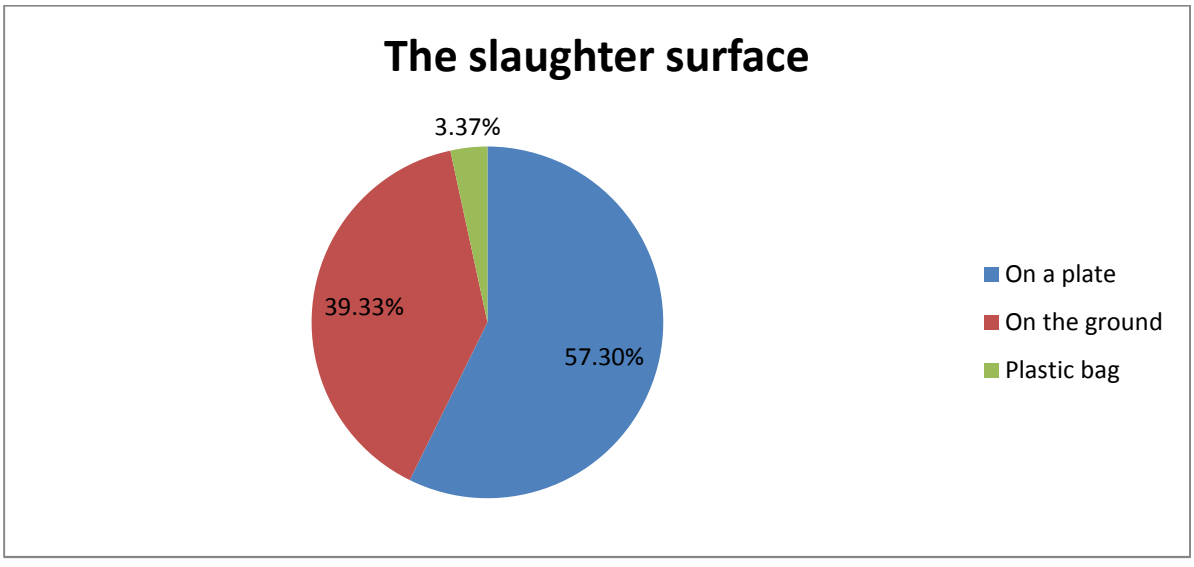

Figure: 4.17.The surface on which exsanguination took place (N=89)

According to the majority (57.30%, n=51) of respondents, slaughter of goats was normally performed on a corrugated iron roof sheet (zinc plate). While 39.33% (n=35)

of respondents indicated that they slaughtered the goat on the ground. Very few (3, 3.37%) respondents indicated that they used a plastic bag or sheet as a surface for slaughter.

4.4.1 The profile of people performing the slaughter.

From the survey, mainly men did the slaughter; according to 99% (n=1) of 105 respondents. Only one respondent indicated that females were involved in the actual killing. The most common qualification of the males who perform slaughter, based on respondent response (n=90. An experienced person (62.22% n=56); a person designated by the family who bought the goat (35.56% n=32) a Sangoma (2% n=2), were answers.

4.4.2 Stunning

During the ritual slaughter practice, the goat is not stunned in any way, as indicated by 100% (n=105) of respondents, although two respondent described “drowning in water in a bucket”, before the throat was cut.

4.4.3 Throat cutting

Thematic analysis showed that the first action when killing a goat was to cut its throat, while according to respondents, the position of the goat being restrained for slaughter, differed. The most common method was holding the goat on its side (33% n=35), followed by 12 (11.42%) respondents who said that the throat was cut while the goat was held so that it lay on its back. Three (2.86%) of the respondents indicated that the goat was hoisted by its hind legs from a tree or pole before cutting the throat. The other respondents in the group did not answer this question about the position of the goat. However, they may have confused it with the next question about how the goat was restrained, as 55 (52.38%) of respondents said that the

goat's legs were held before cutting its throat, while 33 (31.43%) said the legs were tied. Eleven (10.48%) of the respondents said that they tied the head to a tree and held the legs before cutting the throat and one put the head in a bucket of water while holding the feet, before the throat was cut.

Respondents reported that the slaughter of animals starts with the extension of the neck dorsally and slitting the throat with a knife. It was also observed from the respondent's responses (as many "mimed" the cutting action), that the mechanism of cutting differed. The most common one being a back and forth movement of cutting the throat. Some respondents indicated that they use a swift single cut method. The back and forth motion gave the impression that sharp knives were not used.

The respondents were asked to describe the criteria they used to determine that the goat was dead after throat slitting. The thematic analysis indicated that the following criteria were used to confirm death.

- after cutting the throat the goat is considered dead;
- after cutting the throat and removing the head, it is dead;
- by just looking at it;
- when it is no longer breathing;
- when the eyes are no longer moving;
- when it is no longer kicking;
- when it is no longer moving and there is no blood flow;
- when it is no longer making a noise;
- it urinates when it is dead;
- just know;
- no movement and tongue hangs out; and
- blood stops pumping out.

The time it takes for the goat to die, according to the respondents, was between one and 45 minutes. The majority of respondents (n=71) indicated that the animal died within 10 minutes of cutting the throat. This indicates that in all probability one or more of the main vessels (both carotid arteries and both jugular veins are supposed to be severed during slaughter) were not severed.

After the animal is slaughtered 83.3% (n=69) of respondents indicated that it was suspended from a tree or pole, for it to bleed out. However, 16.87% (n=14) indicated that the animal is not hung, but skinned and then left on top of its own skin to bleed out. They were further asked about how long the carcass is left to hang (See Fig 4.18 below).

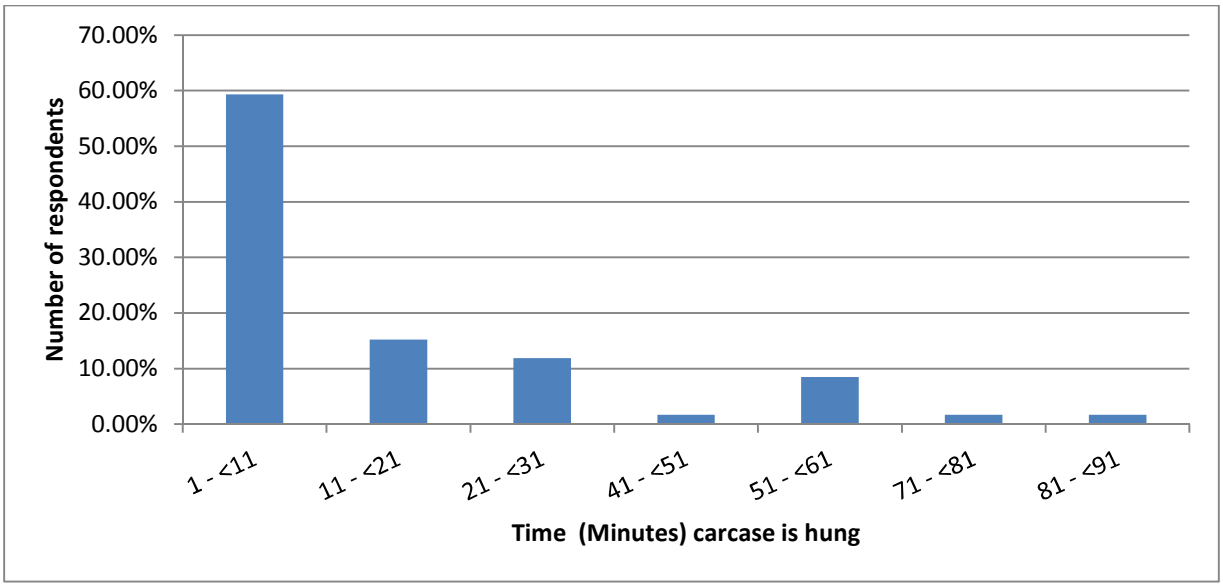

Figure: 4.18. The number of minutes the carcase was hung, after the throat was cut (n=69)

The majority of respondents n=35 (59.32%) hung the carcass for a maximum of 10 minutes, this would probably be sufficient to allow for good bleeding out. Nine hung the carcase for between 10 and 20 minutes and seven for 20-30 minutes. Only two reported that the carcass was hung for longer than an hour.

4.4.4 Flaying and dressing

When the time between slitting the throat and removing of the skin was assessed, the majority of respondents (n=59 out of 71) indicated that the skin is removed immediately after slaughter or bleeding, while 11.27% (n=8) of respondents said that they prefer to remove the skin after 2-5 minutes. There were four respondents who indicated that the skin is removed five minutes after the goat has died.

The respondents were asked to describe the process of removing the skin, head and feet and the descriptions are summarised below:

- **Process 1 (n=65/71, 91.55%)**

After the animal's throat has been cut, it is put on its back with the legs facing up. The animal is then held by 4-5 people, each holding a leg. A sharp knife is used to make an incision starting from the medial surface of each leg from the knee towards the abdomen. Then the cut edges of the skin are loosened using a knife, this is followed by "fisting" of the skin. The carcass is then left on the goat's skin apparently to avoid contamination, in two of the observation in the carcass is put on a corrugated iron roofing. At this point the feet and the head are not removed because they are used to hold the carcass. After the skin is removed completely, then the feet and the head are cut off and removed from the rest of the carcass.

- **Process 2 (n=6/71, 8.45%)**

After the goat has been slaughtered it is hung with its front leg facing downwards. A sharp knife is used to make an incision starting from the medial surface of each hind leg from the knee towards the abdomen. Then the cut edges of the skin are loosened using a knife, this is followed by "fisting" and or pulling of the skins. After the skin is removed the feet and the head are also removed. The carcass is left hanging on a

pole or a tree. This method is used when two or less people are involved in the slaughter of the goat.

4.4.5 Evisceration

The two methods used for evisceration, are described below. During the observed slaughters the abdominal organs were removed first, and then the pluck, after opening the diaphragm.

- **Process 1 (n=65/71, 91.55%)**

With the animal lying on its back, a small incision of the abdominal muscle is made allowing fingers to be inserted into the abdomen. The insertion of the skin into the abdomen works as a safety measure to prevent piercing of the abdominal content. The knife is used to cut though the abdominal wall and the goat is eviscerated.

- **Process 2 (n=6, 8.45%)**

While the carcass is still hanging, a small incision is made in the abdominal wall and two fingers inserted. A sharp knife is used to cut the abdominal muscle into the abdominal area. The abdominal organs are then removed (evisceration).

There was conformity between process 1 and process 2, that is, respondents who described the method of flaying and dressing as process 1, also used process 1 for evisceration. In all cases, it seems that skinning or “flaying” took place before evisceration, in contrast to the method usually used by hunters, where antelope are eviscerated before skinning, to prevent excessive soiling of the outside of the carcass with ingesta, if the rumen is punctured evisceration (FAO, 2000).

4.4.6 Carcass Splitting

It was noted that that there was no carcass splitting. This is not unexpected, as carcass splitting requires a strong or mechanical saw and a “good eye” so that it

goes straight. Immediately after the carcass has dried or immediately after the evisceration the carcass is then chopped into smaller pieces.

4.4.7 Primary Meat Inspection

After the abdominal organs are removed, according to all respondents interviewed (100%), no primary meat inspection is performed.

4.4.8 Carcass Pass

Since no meat inspection is performed, the respondents were asked what happens if the carcass is found to have abnormalities:

- the abnormal area is cut off and thrown away, or burnt, or buried (96.70% n=88)
- nothing(1);
- take back to where it was bought (1); or
- the whole carcass is buried (1).

4.4.9 Final Wash

The respondents explained that after evisceration, the inside of the carcass and not the whole carcass is washed with water and allowed to dry.

4.5 Post slaughter activities

4.5.1 Transport of carcass and products

- **Red and rough offal**

Of the 105 respondents, 87.50% (n=92), said that after the abdominal organs are removed, red and rough offal are put in separate containers, whereas the remainder

indicated that they put the all offal in the same container. Of those that mix the offal in the same container, six indicated that they do not eat offal and they are thrown away.

- **Handling of the Carcass**

The transport of the carcass to the processing area or "kitchen" is done by men. The legs are held by two men or one man carries it over his shoulder.

4.5.2 Storage

Of 87 respondents who answered the question about storage only 48.28% (n=42), said that the carcass was stored before it was chopped or cut up in preparation for cooking, while the rest indicated that the meat was cut into pieces immediately after slaughter, therefore the meat is not stored.

The respondents who had said that they stored the carcass were further asked how it was stored. The answers were as follows (ranked according to the number of respondents who gave the answer):

- hung from a roof frame, garage or a tree (85.71%, n=36); or
- left on a table, covered (14.29% n=6).

The time interval from storage to utilization of the carcass, ranged from 10 minutes to 24 hours. This depended on the type of ritual. In some instances the meat was processed the following day.

The cutting of the carcass was done mainly by men (93.90%, n= 82). Only five respondents indicated that women were also involved in the cutting of the carcass.

4.5.3 Carcass cutting (preparation)

The preparation of the carcass took place inside a room, or outside, on top of a table. It was cut into small pieces, usually seperated at the joints and these were put into containers for cooking. Large bones had the meat cut off and they were thrown into

the fire. During this time, any part of the carcass important for a specific ritual, was removed and kept separate, or separated from the rest of the meat. Then the pieces for the ritual, were usually washed just before cooking.

4.5.4 Preparation of offal

- **Red offal**

The respondents (n=105) were asked how they prepared red offal and they indicated that it was put into one dish containing water to be washed and cut into small pieces, then placed into a pot or container ready for boiling.

Two processes were described for the preparation of rough offal (that is, fore-stomachs and intestines):

- **Process 1 (n=13/71, 18.31%)**

The rough offal was transported in a dish to the cleaning area. If there was a hosepipe, it was used to remove intestinal contents by inserting the end into the intestines or fore-stomachs and flushing the ingesta out with water. After that it was cut into small pieces, for cooking.

- **Process 2 (n=58/71, 81.69%)**

If there was no hosepipe, or running water available, the rough offal was put into a container such as a metal or plastic washbasin or bucket. Then the intestines were "milked" or squeezed, to eject the ingesta. The fore-stomachs were opened, most of the ingesta was scraped out and they are washed and cut into pieces. Some people preferred cooking them before they were washed clean. Process 2 was more common (n=58/71, 81.69%), probably because the goats were slaughtered in rural areas where there may not had been ready access to piped or running water.

4.5.5 Consumption

The interval between cooking and consumption is displayed in Fig 4.19 below.

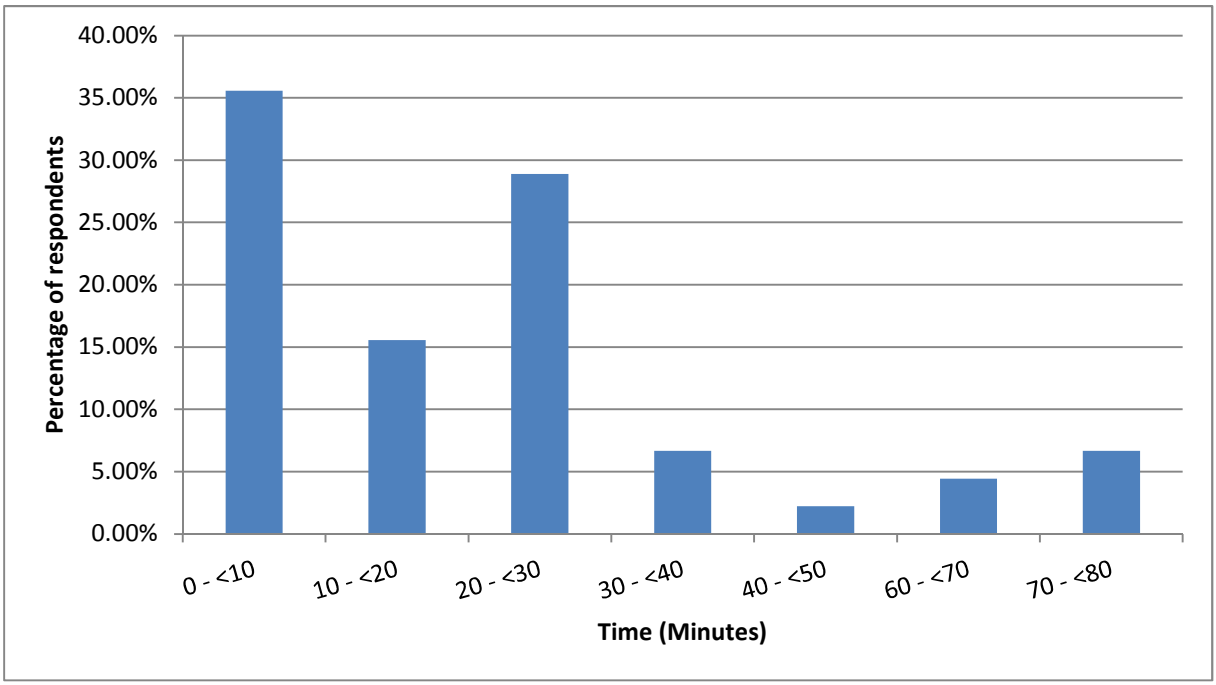

Figure: 4.19. The time it minutes between cooking and consumption of prepared meat (N=45).

From the histogram above it can be seen that 80.01% (n=36/45) of those who answered the question consumed the meat within 30 minutes of cooking. Of these, n=16 consuming it within 10 minutes of cooking. Five respondents consumed the meat an hour after cooking.

4.5.6 Post cooking Storage

The majority of the 96 who answered this question (n=58 55.24%) reported that there were usually no left - overs as all the meat was eaten at one go. However, n=34 (32.38%) stored left - overs in the fridge, while only four respondents indicated that

they used left overs to make biltong. Fig 4.20 below shows the number of hours the meat was stored after cooking.

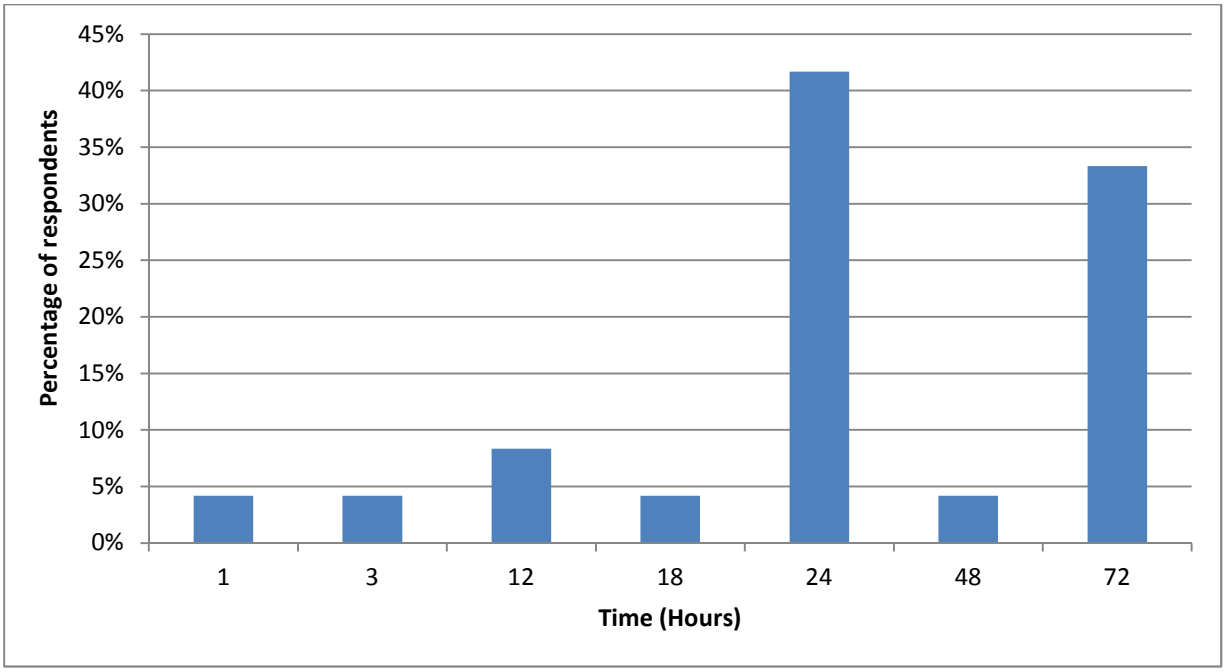

Figure: 4.20. The number of hours the meat is stored after cooking (N=34).

From Fig 4.20 it can be seen that the majority (79.41%, n=27) stored the cooked meat for more than 24 hours. Few respondents (n=6, 17.64%) stored meat for less than 24 hours.

4.6 Observation during ritual slaughter

Due to the secretive, religious nature of traditional or customary slaughter, permission was only obtained to document four cases. From the observations during these, as well as the information obtained from structured interviews with respondents, a flow diagram has been developed for the ritual slaughter process in goats (see Fig 4.21). From the observations it was also possible to correlate findings with the data obtained from structured interviews. Several critical points for hygiene and welfare interventions were identified and are discussed further in Chapter 5 as well as being illustrated in Table 4.1.

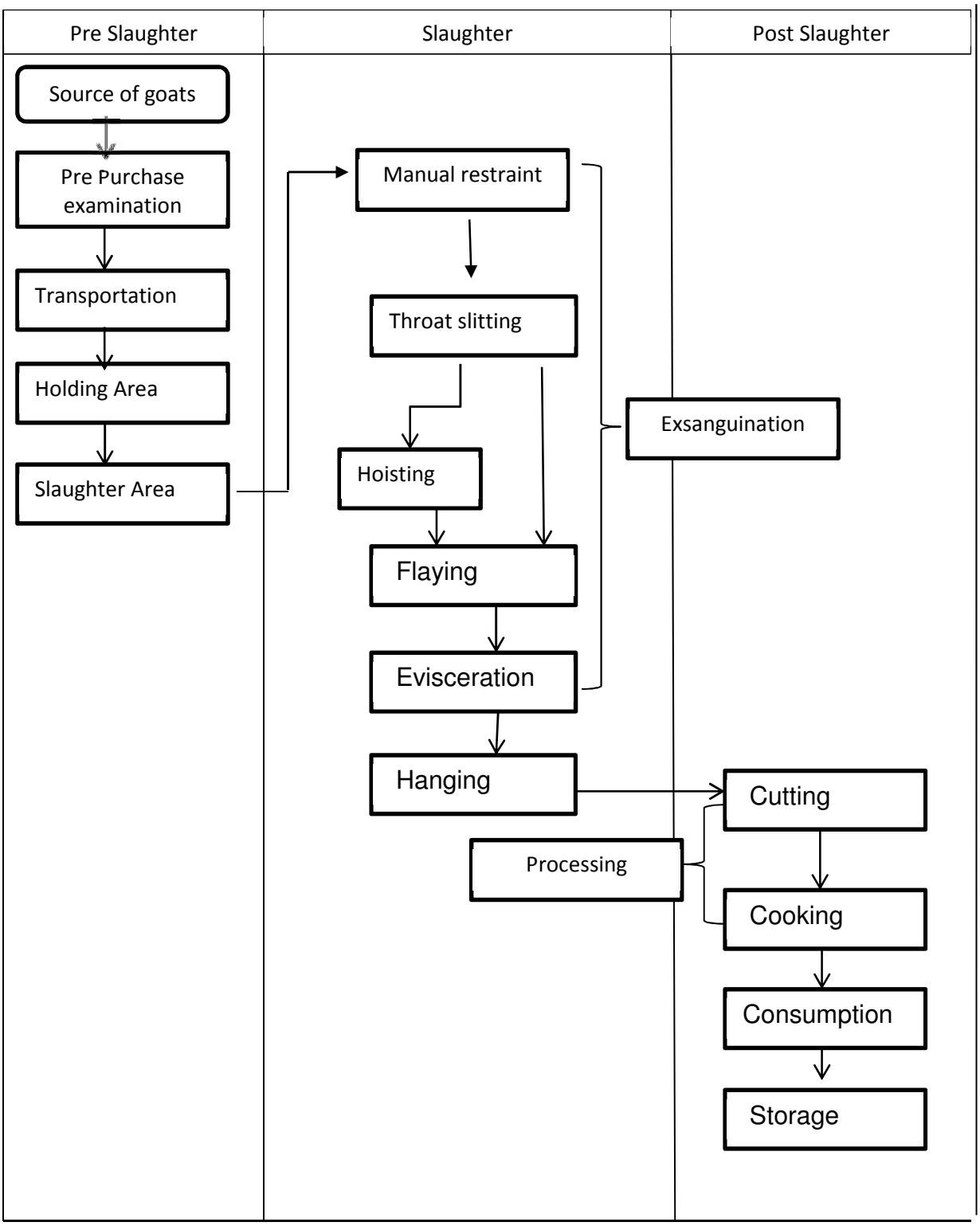

Figure 4.21 Flow diagram showing ritual slaughter process based from this study data.

4.7 Hazard identification and risk estimation

Previously, the, main constraint to estimating the risks of food safety and occupational health hazards during African traditional slaughter, was that the process flow chart had not been described. Using the observations of four ritual slaughters of goats as well as the data obtained from structured interviews, it is postulated that the process flow in Figure 4.21, is a good approximation that can be used to do risk analysis.

The qualitative risk analysis methods described in Chapter 3 were used to develop the hazard identification shown in Table 4.1. It can be seen from the table that each step in the process flow has associated hazards. These are divided into biological, physical and chemical hazards. Biological hazards are probably the most important risk to human health. As mentioned in chapter 3, the epidemiology and risk of transmission of zoonotic agents and FBD associated with goats (the host species), were allocated to critical points in the process flows (Table 4.1). The magnitude and likelihood of specific risks related to FAD and occupational health were estimated based on published literature, mainly the two volume textbook on Infectious Diseases of Livestock in South Africa, Coetzer and Tustin (2004).

In Chapter 5, qualitative risk assessment of ritual slaughter will be discussed based on the findings shown in Fig 4.21 and Table 4.1.

Table 4.1 Microbiological food safety and occupational health hazards associated with ritual slaughter of goats.

Process Flow	Biological Hazards	Physical Hazards	Chemical Hazards
Source	*Bacillus anthracis, Brucella melitensis* Rift Valley fever, *Salmonella typhimurium* E.coli 0157, *Toxoplasma gondii* Contagious Ecthyma (Orf), *Bacillus cereus* *Clostridium botulinum, Campylobacter jejuni* *Listeria monocytogenes*	Mud, Grass Physical Injury	Residues
⇩			
Throat slitting and exsanguination	*Bacillus anthracis,* Rift Valley fever *Toxoplasma gondii,* Contagious Ecthyma (Orf)	Physical Injury	
⇩			
Flaying	*Bacillus anthracis,* Rift Valley fever *Salmonella typhimurium, E.coli 0157* *Toxoplasma gondii,* Contagious Ecthyma (Orf) *Bacillus cereus, Campylobacter jejuni* *Listeria monocytogenes, Staphylococcus aureus*	Dirt, Soil	
⇩			
Evisceration	*Bacillus anthracis, Brucella melitensis* Rift Valley fever, *Salmonella typhimurium* *E.coli 0157, Toxoplasma gondii* *Bacillus cereus, Campylobacter jejuni* *Listeria monocytogenes, Staphylococcus aureus*	Dirt, Soil	
⇩			
Processing (cutting and cooking)	*Bacillus anthracis,* Rift Valley fever *Salmonella typhimurium, E.coli 0157* *Toxoplasma gondii, Bacillus cereus* *Clostridium botulinum, Campylobacter jejuni* *Listeria monocytogenes, Staphylococcus aureus*	Dirt, Soil	
⇩			
Storage	*Bacillus anthracis,* Rift Valley fever *Salmonella typhimurium, E.coli 0157* *Toxoplasma gondii, Bacillus cereus* *Clostridium botulinum, Campylobacter jejuni* *Listeria monocytogenes, Staphylococcus aureus*	Dirt, Soil, Insects, Scavengers, Rodents, Leaves, Plant residues	
⇩			
Cooking	*Bacillus cereus, Clostridium botulinum* *Staphylococcus aureus*	Dirty water, Dust, Insects,	
⇩			

Consumption	*Bacillus anthracis, Salmonella typhimurium E.coli 0157, Toxoplasma gondii Bacillus cereus, Clostridium botulinum Campylobacter jejuni, Listeria monocytogenes, Staphylococcus aureus*	Dirty Knives, Dust, insects, dirty hands	

Chapter 5: Discussion

5.1 Introduction

The results of the study will be discussed by linking them to the original objectives which were achieved on not achieved. The objectives can be found in Chapter 1 and have been summarised in each of the subsections below. Comparison with existing literature is difficult as there is almost no literature available on African ritual slaughter of goats.

5.2 Geographical position of interviews

Tshwane metropolis is the second largest municipality in Gauteng Province, among six biggest metropolitan municipalities in South Africa. Pretoria is the biggest the city within the metro (City of Tshawane, 2010). The city consists of both well-developed and developing areas. The research included people from both areas within and around Pretoria as seen in Figure 3.2. The selection of areas for data collection considered the movement of people in the city and the most likely place to find people performing ritual slaughter.

The practice of ritual slaughter is very secretive and very hard for people to speak about this was also seen in the study where the majority of woman and man whom where either involved or know about ritual slaughter where uncomfortable to speaks about. However as stated they were more than willing to share even though it was

uncomfortable. This finding are consistent with the report by CRL in 2009. Which indicated that ritual slaughters were still done, but in secret. For the study it was therefore important that the respondents were not forced but willing to share information and this was achieved.

The taxi ranks and informal traders were chosen as the study population and structured interviews administered to those respondents who agreed to participate. This choice was substantiated by the results, as a cross-section of people from rural areas, both male and female, who had been involved in some way with traditional slaughter of goats, were interviewed. Taxi ranks were found to be places where people are concentrated in large numbers with many of them going to workplaces accessible to the taxi rank. In 2005 the Department of Transport estimated that 2.5 million of commuters used taxis as a mode of transport, which was 63% of the total number of commuters that use public transport (Arrivealive, 2013). Furthermore, most taxi ranks have a mall or a shopping centre close by, which is thus easily accessed for household shopping. In almost all taxi ranks there were taxis from different areas outside of the central city, indicating that the taxi rank is essentially a hub for exchange of knowledge and culture.

As commuters originate from a diversity of rural, urban and peri-urban areas, as well as cultures, taxi ranks were found to be ideal for gathering opinions on ritual slaughter across the board. Thus, although the sample was not randomised, for reasons presented in Chapter 3, it was found that the respondents were representative of a cross-section of views and backgrounds and also included a balanced proportion of men and women.

5.2.1 Demographic profile of respondents

In 2011, Census South Africa, showed that there was diversity in languages across provinces. The diversity in languages was also linked to racial segregation as noted by Christopher (2004). Racial segregation during apartheid resulted in clusters of culture and language, as shown in figure 5.1 below. Therefore the cultural norms were linked to both language and province. Figure 5.1 bellows shows languages prominent in each province

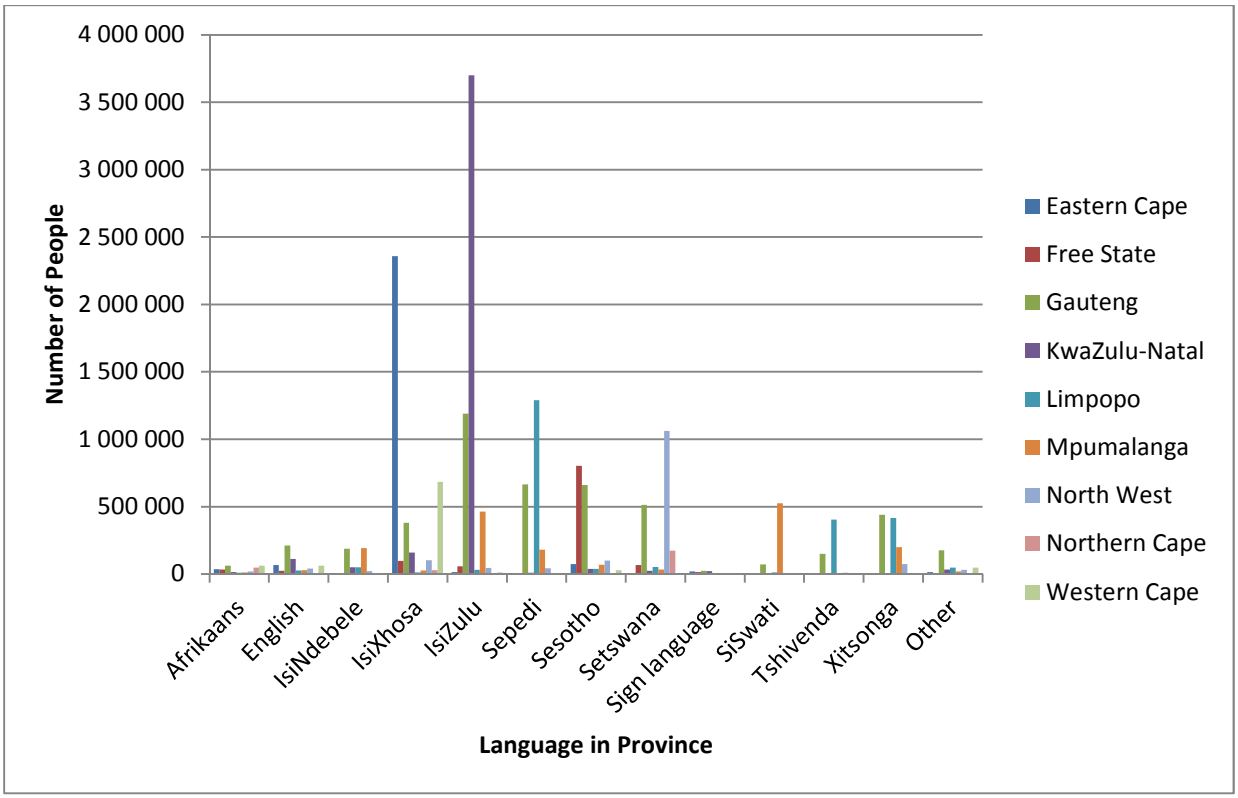

Figure 5.1 Language and culture of the South African population (StatsSA, 2011)

The presence of people from different provinces at the taxi ranks was probably as a result of migration to the cities to look for a better life after 1994, as many jobs are found in and around urban areas such as Pretoria (Rogerson, 1996). In the process people have brought with them cultural practices and beliefs (Christopher, 2004). The link between place of origin language and culture has created an opportunity to capture information on different cultural activities during the study. However there

were insufficient respondents in each group, based on languages, to make definite findings.

It is suggested that the practice of cultural activities in cities is an attempt for many traditional slaughter practitioners to continue with their religion, in spite of being far from their original home or place of birth. As a result many people with different languages and culture exchange and share ritual slaughter practices.

Thus, from the above discussion, it can be suggested that when looking at occupational health and food safety issues related to traditional slaughter of goats, different cultural practices may result in different hazards or in a greater or lesser magnitude of risk to the consumer. Risk communication strategies should not only be available in different languages, but consideration should be given to cultural norms associated with those language groups as this might differ from province to province.

There are also legal aspects related to traditional or ritual slaughter. The Constitution of the Republic of South Africa, Act 108 of 1996, Section 15(1) [3] states that "*Everyone has the right to freedom of conscience, religion, thought, belief and opinion*". In section 31(1) it is further stated that "*Persons belonging to a religious community may not be denied the right to practice their religion*". The impact of this right to religious freedom is confirmed by the Meat Safety Act (2000) which allows for religious, customary or traditional slaughter of livestock, including goats throughout South Africa but this has to comply with city by-laws. In the Tshwane metropolitan area there are no specific bylaws, therefore, regulations of the Meat Safety Act 40 of 2000 are used as guidelines, and residents must apply for permission from the municipality if they want to slaughter goats within residential areas. This limitation is not applied to farms or rural areas, as under the same Act, a farmer is allowed to

[3] Chapter 2 Bill of Rights, section 15

slaughter for home consumption (DoA, 2000). The law is therefore applied differently in different areas: urban and rural.

5.2.2 Gender, Age and Education

From interviews with respondents, it was shown that both men and women are involved in traditional or ritual slaughter. However, the extent of the involvement of woman in the ritual slaughter is not known. When a women miscarry, a goat is slaughtered for her cleansing, this will be a ritual that is specific for women (Bongiwe, 2013). Therefore the slaughter of goats is linked not only to marriages, funerals and other celebrations, but also coming of age and atonement. It was found that women were equally well informed about the process and methods of ritual slaughter as men. From the study nearly the same number of woman as man were interviewed, those who have being involved in ritual slaughter. However woman were excluded from the actual killing, during certain rituals as stated in section 4.5.1.

The area where the study was done could have influenced the age group, as respondents were commuters, who were employed. These are people likely to be living in rural or peri-urban areas and work in urban areas in or around Pretoria. Were shown to belong to the employable sector as they were aged between 18 and 65 years (Figure 4.1). Interviewing people in the rural areas might have given a slightly different result as a large proportion of community members are on pension and still involved in farming, thus from an older age-group.

The majority of respondents had secondary education, some even had tertiary education and possessed a degree (Figure. This means that if trained, they would be able to understand the need for food safety precautions and be able to take back information to their communities that would be relevant for mitigation of food safety risks (Dosman et al., 2001). One can also deduct from the findings that those who

participated in traditional slaughter are not limited to the segment of the population in the rural areas that are uneducated.

5.3 The ritual slaughter process

"*Objective 1: To record and describe the ritual slaughter process and assess the hygiene practices of slaughter and consumption using an integrated food chain approach*".

It was found that the health status of the animal was not considered to be very important to purchasers unless the goat was visibly sick. The end result of ritual slaughter practice is not only spiritual, but there is a "by-product" which is goat's meat. In terms of the ritual, the goat may be an ideal sacrifice, but in terms of human health, the meat may cause disease unless the goat is healthy at the time of slaughter. This aspect of ritual slaughter is well covered in the choice of animal during Halaal and Kosher slaughter of goats, where animals showing signs of disease are rejected. It is obvious that it was considered important not to make people sick, even in ancient times. The question then, can this aspect of religious control to promote basic hygiene, be introduced today as part of the customary slaughter practices in African culture?

5.3.1 Assessment of pre slaughter activities

In section 4.3.1 the source of goats for ritual African slaughter were summarised. These are discussed further below as well as the pre-purchase examination.

5.3.1.1 Source of goats

In meat production the primary source of hazards can be introduced during primary production at farm level. The way goats are managed on the farm, is crucial in

ensuring that the likelihood of introduction of hazards is reduced or eliminated. The application of good hygiene practice and good agricultural practices at the primary level is an important factor in reducing the risk of zoonotic or food associated diseases (FAO, WHO, 2009)

One of the areas that could be important is identification of hazard entry at the source where the goat is bought. Traceability is recognised internationally as essential in ensuring that diseases can be traced back to source and linked to preventive measures on farm (OIE, 2009). This ensures that the farm or the source of the animal maintains good agricultural practices to reduce the risk of biological hazards. This is not always the case for animals used in ritual slaughter in the African context, as animals are frequently sourced from dealers in peri-urban areas or farmers unknown to the purchaser. It was interesting to note that more than 65% of those who purchased goats bought their goat from sources other than their own flocks. Thus they have no control over the circumstances in which the goat was reared, or its exposure to hazardous diseases or residues of substances such as dips and stock remedies. Some effort should be made to obtain the history of the animal or insist on a health certificate. However this will be almost impossible in the ritual slaughter process, so it therefore suggested that the Animal Health Technician in particular community be requested to assist with anti-mortem inspection or regular visits to the dealers in the area, in line with disease control norms.

5.3.1.2 Pre purchase examination for slaughter goats

In South Africa currently the Meat Safety Act 40 of 2000, requires that a health certificate stating clearly the origin of the animal for traceability purposes, be issued to a designated person at an abattoir before the animal can proceed to slaughter (DoA, 2000). However, this is not a requirement for home slaughter (including

slaughter for cultural purposes). Nonetheless mitigations for occupational health and food safety could be put in place with the assistance of veterinary services in rural areas.

In the formal sector, pre-slaughter certification and examination are a major contributing factor in the production of meat that is safe for human consumption. The health certificate is an assurance that the animal presented for slaughter poses no or minimum risk to human in terms of diseases. It is probably equally important in traditional slaughter, however this study showed that relatively few people did a pre-purchase inspection to try to check if the goat was healthy or not (section 4.4.2).

In the formal slaughter sector, a formally qualified veterinarian or meat inspector is responsible for evaluating the health status of an animal to determine fitness for slaughter, using internationally agreed, science-based criteria (OIE, 2009). In contrast, the person who selects a goat for traditional slaughter has only word of mouth information that is passed from generation to generation. The criteria they used (see section 4.4.2) were found to be mainly based on aesthetic evaluation, as what they indicated as criteria overlapped and were very broad and nonspecific. Although some respondents linked pre-purchase examination to food safety, there was the lack of knowledge about animal diseases. This was clear when they examined a goat they were going to purchase, they were unsure of what they should be looking for.

Pre-purchase examination of goats for ritual slaughter purposes can be equated to pre-slaughter examination of a goat in the abattoir and is an important area for hazard identification and characterisation. After the goat is bought it cannot be sent back to the speculator or source, so they must use the animal and its meat, irrespective of finding symptoms of disease at or after slaughter.

Therefore it is important that the conditions of the goat presented for sale is equivalent to the standard expected in formal markets and abattoirs. For traditional slaughter the health of the animal is probably even more critical, for the following reasons:

- Lack of veterinary services in rural areas.
- Lack of awareness about animal health diseases and their prevention in rural areas.
- Presence of serious zoonotic and food associated diseases like brucellosis, bovine tuberculosis, anthrax, rabies, toxoplasmosis, salmonellosis and Rift Valley fever in goats in Southern Africa.
- Lack of primary and secondary meat inspection during ritual slaughter.
- Lack of recognition of abnormalities and signs of disease in the carcase.
- Unhygienic slaughter conditions which result in faecal contamination, thus making the transmission of salmonellosis and other faecal pathogens more likely.
- The health status of consumers, particularly vulnerable groups such as children, the elderly and those who are not immuno-competent (HIV positive persons).

5.3.1.3 Transportation of goats

The distance between the sources of the goat to the place where the ritual slaughter will be carried out, could influence the method of transport and restraint during transport (Figure 4.9). The FAO recommends that “goat trekking” should not exceed

24 km in one day and goats should be given water and food after 24 hours of the journey, however the total travelled time must not exceed 36 hours of travelling (FAO 2001, DoA 2007b). In this study, the majority of people travelled between one and 11 km. This is within the FAO recommendation.

5.3.1.4 Pre slaughter holding area

According to 66% (n=69) of respondents the most common form of restraint was to tie the goat to a tree by a rope around its neck (Figure 4.10).The FAO (2001), maintains that the slaughter of animal immediately after arrival, if it is stressed by transport, increases the chance of bacterial growth on the meat if contaminated. If the meat is contaminated by bacteria during slaughter particularly pathogenic bacteria, this can result in food poisoning. The lack of glycogen in the muscle as a result of stress and a lack of rest before slaughter, prevents maximum levels of lactic acid production being archived resulting in the meat not being able to reach its pH of 5.4-5.6 (McIntyre, 2006). The pH itself is important in regulating or retarding the growth of bacteria. Resting is thus recommended. Immediate slaughter was identified as part of the knowledge gap on the part of the respondents, but this was only 3.37 % of the responses (Fig 4.12). At abattoirs a minimum lairage time of one hour is the prescribed for goats in the red meat regulations. However If the veterinarian or meat inspector is happy with the condition of the animal they can be slaughtered the animal immediately (DoA, 2007). It was found in the study that all respondents (n=105) reported that the minimum number of hours the goat was kept was more than one hour therefore they comply with the recommended rest period.

5.3.2 Slaughter activities

The environmental temperature during slaughter affects meat safety. Cold weather inhibits bacterial growth, while when the environmental temperature is high it can

result in high bacterial growth and a decrease in shelf life of the meat (CAC, 2005). A positive aspect of traditional goat slaughter is that it was found that a majority of people (59%, n=62) slaughter during the cool morning hours, while only 35% (n=37) slaughter during the day. The temperature in Pretoria can reach a high of 30 and a low of 18^{o}C during summer and during winter a high of 21 and a low of 5^{o}C (World weather online, 2013). Therefore doing ritual slaughter in the early morning would be a better option and could be communicated to the target populations as a form of risk mitigation. The study showed that meat produced from the ritual slaughter practice was consumed immediately, in most cases, although certain rituals demand that it should stand overnight. This was in agreement with the opinion of Gchabashe (2010). A small number of people kept the meat in a refrigerator overnight and five made “biltong” but this was done in the same place as the slaughter, but respondents mainly reported that it was not allowed for meat to be taken home. This therefore means that, in general, there is no need to be concerned with shelf life of raw meat in ritual slaughter practices.

If cooking follows slaughter almost immediately and is coupled with long periods of cooking, the risk of FBD are minimized according to FDA, (2013). During the four ritual slaughters observed meat was cooked in a stew for a long time. However it was observed that cooked food was eaten with the fingers and the same damp cloth was used to wipe off hands, thus transmitting any organisms between consumers. As hand washing facilities were not present, pathogens from the goat could contaminate hands during slaughter and removal of ingesta. This would also increase the risk of zoonoses and FAD being transmitted during slaughter and handling of the meat. Deaths as a result of food poisoning or a zoonotic disease could occur after informal slaughter (Newell *et al.,* 2010; OIE, 2012). However, it is unlikely that deaths and

diseases associated with eating of meat from ritual slaughter would be directly correlated, unless they occurred within a few hours (Staphylococcal food poisoning) (Miwa *et al.,* 2001) or gave clear cut symptoms (anthrax) (Babamahmoodia *et al*., 2006). In such cases, the medical practitioners consulted should contact state veterinary services and trace-back is likely.

5.3.2.1 Stunning, Hoisting and Bleeding

The stunning of goats prior to slaughter is advocated on the OIE website in the Terrestrial Animal Code (OIE, 2012). It is also encapsulated in the Meat Safety Act of 2000. However, Meat Safety Act provisions do not apply to traditional or cultural slaughter. Results of the structured interview (n=105) showed that ritual slaughter practitioners do not stun goats before slaughter. Lack of stunning may result in the animal been stressed and suffering during slaughter. This can result in poor meat quality (Ferguson & Warner, 2008). However, failure to provide for stunning is not unique to African ritual slaughter, in South Africa. Halaal and Kosher slaughter does not require stunning either (DoA, 2000).

Proper restraint is important to prevent injury to the person slaughtering the goat. Lack of facilities means that more people are needed to be able to restrain the goat. In the study four to seven people were needed. Furthermore, the person bleeding the goat might be at risk of cutting himself with a sharp knife. In view of this, accidents are a possibility for the assistants if the animal struggles.

The maintenance and proper use of equipment for goat slaughter has an influence on animal welfare as well as food safety. The use of a clean sharp knife ensures that throat slitting is rapid and followed by rapid exsanguination if all vessels are severed (as recommended by the OIE Terrestrial Animal Code) except that goats were not stunned. Respondents (n=71) in this study described a forward and backward

movement during the cutting of the throat, indicating knives were not sharp. This is not only a cruel procedure but also decreases the possibility that both jugular veins and both carotid arteries are severed. Insufficient exsanguination increases the risk of food safety being impaired (DoA, 2007b).

One respondent described that in some instances, the use of water was used to drown or suffocate the goat. This method has serious welfare and food safety implications and should be strongly discouraged. Adetunji and Odetokun (2011), state that the slaughter of animals in Nigeria, occurs in an unhygienic way, with the process occurring on the floor. The statement was found in agreement with the lack of hygiene observed in the four ritual slaughter practices during the study, as well as the methods described by respondents. Slaughter on the ground was also contrary to the recommendations of the Red Meat Manual, that a bleeding rail be high enough (2.4 metres) for the goat carcase to hang above the floor level to effective exsanguination (DoA, 2007b).

After the goat is slaughtered it should be hung to allow proper drainage of blood (OIE, 2012). This is very important for good quality of the meat. Proper bleeding also decreases FBD since blood acts as a medium for multiplication of bacteria after slaughter (CAC, 2005).

5.3.2.2 Flaying and evisceration

During the four ritual slaughters observed, the recumbent animal was dressed on its own skin, after flaying. Respondents (n=65) described the use of a piece of corrugated iron roofing. Flaying and evisceration allow contamination of the surface of the carcass when the rumen and intestines are removed if the carcass is not hoisted.

The process of flaying or '"skinning" was described by respondents to occur on the floor during ritual slaughter, depending on the number of people assisting with slaughter. If two or less were involved they tended to hang the carcase (n=6) so as to facilitate removal of the rumen and ingesta without piercing them. Piercing the rumen can result in contamination of the carcass with faecal coliforms, *E. coli* type 1 and pathogenic organisms such as *Clostridia, Campylobacter, Salmonella* and *Shigella* spp (Adetunji & Odetokun, 2011).

5.3.2.3 Meat inspection

The lack of meat inspection during ritual slaughter poses a serious challenge to human health. This is very important as it was observed that during the four ritual slaughters many members of the community were involved. The concept of a link between poor hygiene during slaughter and resultant FAD, appeared to be lacking both from observations and interviews. Although if those involved in slaughter recognised abnormalities, they do merely cut them off but did not discard the carcase.

5.3.3 Post slaughter Activities

During the four ritual slaughters observed, both the rough offal (intestines and rumen, reticulum, omasum, abomasum) and red offal (heart, lungs, liver) were placed in separate containers and moved away. This is similar to the separation effected at abattoirs to prevent cross contamination with faecal organisms. It was interesting to note that not only the ingesta, but also the offal itself was thrown away or burned after slaughter, according to some respondents (n=6). The general practice of carrying the carcase by the legs from where it is slaughtered to where it will be cooked, does not hold an inherent risk for food safety. If it is however, carried over a shoulder or against the body, the people's clothes and skin could be contaminated

with blood and ingesta that could carry zoonotic pathogens. Also, the person carrying the meat could breathe pathogens onto the meat or transmit them from dirty clothing. By holding only the lower legs and hooves of the carcase, these risks are reduced.

Although the meat was eaten immediately after slaughter as earlier described, this was not always the case. In some rituals the goat was hung overnight and only processed 24 hours later (Figure 4.20). Under these circumstances, the environment in which the carcass was stored was very important as it influenced whether the meat will be contaminated or not. Sources of possible contamination could be dust, plant material, dogs, rodents, flies and unsanitary environmental conditions.

Meat from ritual slaughter is cooked for long periods of time. This has the potential to reduce the risk of FBD if the pathogen is heat labile. However some pathogens produce spores (e.g. *Cl. botulinum*,) and others heat stable toxins (e.g. *Staphylococcus aureus*) (Hanson *et al.*, 2011). When such meat is eaten it is possible for the consumer to go down with food intoxication.

5.4 Hazards and risk estimation.

"Objective 2: To identify and characterize biological, physical and chemical hazards at particular points in the food chain flow diagram and estimate which practices which have the highest risk for transfer of zoonoses or FBD"

An integrated food chain approach (see Objective 2 above), includes "farm to fork" methods such as GAP, FSMS, HACCP, HMS and HAS (see Chapter 2).

These reduce the magnitude of identified risks during slaughter at abattoirs. Some sort of such quality assurance systems should be developed for ritual slaughter to address food safety issues along the food chain.

5.4.1 Hazard identification and characterisation

In accordance with Objective 3, above, hazards described or observed during ritual slaughter were divided into physical, chemical and biological as (Table 5.1). The biological hazards were both food borne and zoonotic.

In Table 5.1, the hazards associated with ritual slaughter are summarised. In addition to the pathogenic microorganisms associated with FAD, there are several zoonoses that pose potential occupational health risks. Physical hazards are mainly a risk of injury and physical particles such as dust and insects that contaminate the meat after slaughter. Chemical hazards would not be easily recognised except by taking a history of farm treatments, which is unlikely.

5.4.2 Risk Estimation

The estimation of risk has been linked to critical points in the food chain (See Table 5.1. In Table 5.1, the level of risk, which is colour coded, incorporates both probability (likelihood of exposure) and magnitude of risk (consequences of exposure). For instance, although the overall likelihood of anthrax in a carcase may be low, if the goat has anthrax, the likelihood of the person being infected at slaughter is high and the consequences of anthrax infection may be fatal. The risks estimated in the table 5.1 are based on literature references (evidence based approach). These literature references are summarised in table 5.2. This is to my knowledge, the first time that quantitative risk assessment, proposed by FAO, WHO (2009) has been applied to real research problem, in the field. It was previously used in BSE certification. However Table 5.1 indicates strongly that it would be a suitable tool for participatory risk analysis in informal food chain.

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Table 5.1 Estimation of risk of food borne diseases and zoonotic disease

	Pathway for the ritual slaughter of goats							
Hazards	Source	Bleeding	Flaying and dressing	Evisceration	Processing	Storage	Cooking	Consumption
Bacillus anthracis	Very High	Very High	Very High	Very High	Very High	Very High	Very High	low
Brucella melitensis	Low	High	High	High	Very High	low	low	low
Coxiella burnetii	Low	low	Low	low	High	Low	Low	Low
Rift Valley fever	High	Very High	High	High	High	high	Moderate	low
Salmonella typhimurium	Low	low	Moderate	High	Very high	High	Moderate	low
E.coli 0157	low	low	Moderate	High	Very high	high	moderate	low
Toxoplasma gondii	Low	low	Moderate	Low	Moderate	Moderate	Low	low
Contagious Ecthyma (Orf)	Moderate	Moderate	Moderate	Moderate	low	Low	Low	low
Bacillus cereus	Low	Low	Moderate	Moderate	High	High	Moderate	Moderate
Staphylococcus aureus	Low	low	Moderate	Moderate	High	high	low	High
Clostridium botulinum	Low	Low	Moderate	Low	high	High	Moderate	Moderate
Campylobacter jejuni	Low	Low	Moderate	Moderate	High	High	Moderate	Moderate
Listeria monocytogenes	Low	Low	Low	Low	Low	Low	Moderate	Moderate
Chemical Residue	High	Low	Low	Low	Low	Low	Low	low
Physical Injury	High	High	Low	Low	low	Low	Low	low

Table 5.2 Literature references for each identified hazard

Disease	Literature references that refer to the disease
Bacillus anthracis	Kamal *et al,* 2011
Brucella melitensis	Kabagambe *et al.,*2001
Coxiella burnetii	Alsaleh *et al.,* 2011
Rift Valley fever	Balkhy & Memish 2003
Salmonella Typhimurium	Duffy *et al*., 2009; Parry *et al*., 2004; Gormley *et al*., 2010
E.coli 0157	Akanb*i et al*., 2011
Toxoplasma gondii	Györke *et al*., 2011
Contagious Ecthyma (Orf)	Guo *et al*., 2003
Bacillus cereus	Bhandare *et al*., 2010
Staphylococcus aureus	Hanson *et al*., 2011
Clostridium botulinum	Bhandare *et al*., 2010
Campylobacter jejuni	Nauta *et al*., 2008; Albert *et al.,* 2008; Williams *et al* 2011
Listeria monocytogenes	Conan, 2003; Pouillot *et al*., 2009
Chemical Residue	Nadeem et al., 2003
Physical injury	Gregory, 2008

5.5 Welfare issues

"Objective 4: To list possible welfare issues specific to goat management transport and slaughter."

During the discussions above, the welfare of the goats has been mentioned. However, welfare is becoming of importance internationally and therefore it is emphasised that goat welfare would be compromised mainly during transport, restraint and the slaughter itself. Criteria for improving welfare would be to improve management practices on farm, to adhere to FAO norms during transport (FAO, 2001) and to use the OIE guidelines (OIE, 2012) during slaughter. These facets should be incorporated in risk communication strategies, as poor animal welfare often results in poor meat quality.

5.6 Recommendations for traditional slaughter of goats

"*Objective 5: To develop recommendations for hygienic principles during ritual and informal slaughter of goats in SA for mitigation and communication of risks to veterinary public health officials, environmental health officers, sangoma's and consumers*"

The recommendations for informal and traditional slaughter of goats will be made under "Conclusions and Recommendations" in Chapter 6.

Chapter 6:
Conclusions and Recommendations

6.1 Overview

Traditions and rituals are part of life of many African communities, including South Africa. They are the centre for cultural understanding and identity of these communities. During the cultural ceremonies many people are involved, that could be at risk if exposed to hazards associated with the practices. Therefore potential hazards need to be identified and characterized. The aim of the study was to describe the ritual slaughter pathway and within the pathway identify the hazards that may pose a risk to food safety and occupational health. In the course of the research it was discovered that the last goat abattoir in South Africa had been closed down. At this point 100% of goats produced in South Africa are slaughtered informally. This is a change from less than 5% as stated previously by the Department of Agriculture Forestry and Fisheries (DAFF, 2011). In this study it was found that there were existing regulations for goat slaughter at abattoirs, even although licenced goat abattoirs no longer exist.

6.2 Conclusions

Many people from different provinces come to cities in search of better standard of living, bringing with them their cultures and customs. The taxi rank was found to be a place where commuters from different origin and areas congregate, on their way to urban or rural destinations. It would therefore be possible to use taxi ranks for dissemination of knowledge about the risks to food safety and occupational health posed by ritual slaughter of goats.

Woman demonstrated knowledge of rituals even although it was found that they were not directly involved in ritual slaughter of goats. It was also shown that the participation in traditional slaughter was not limited to a segment of the population in the rural areas that was uneducated. The integrated food chain approach can now be used for informal as well as ritual slaughter and it will be possible to design specific mitigation for specific diseases, linked to identified critical steps or points in the slaughter process.

The magnitude and likelihood of biological hazards can be estimated using qualitative risk assessment. There was little pre-slaughter inspection and stunning was not used. Exsanguination could be improved by hoisting the cause and it was concluded that this could be communicated to those participating in ritual slaughters as it would improve meat safety. Also a structure approach to meat hygiene, based on FAO and WHO published guidelines could be prioritised and taught to communities by AHT.

The current practice of carrying the carcass over the shoulders without protection is discouraged. Although the meat was consumed immediately after slaughter, it is important that is cooked properly and that the GAP and HAS principles are used from farm to fork to reduce the risk through the value chain.

Traditional slaughter ceremonies performed in the rural areas put at risk impoverished and vulnerable people who depend on these ceremonies not only as a source of meat but also spiritual comfort. These include the unemployed, the malnourished, children, the elderly and those suffering from chronic disease such as tuberculosis and HIV who are immunocompromised. In such communities, food borne diseases and zoonoses that result from slaughtering and consuming diseased

animals can have life-threatening consequences. The hypothesis for this qualitative study stated:

"That it will be possible to identify, characterize and assess the risk of biological, chemical or physical hazards, associated with traditional slaughter of goats, by investigating the cultural practices and informal food chains associated with goats in South Africa."

It is concluded that all the criteria in the above hypothesis have been met.

6.3 Recommendations

From the findings in this study, it was found that it would be possible to develop training strategies, through veterinary services, to improve meat hygiene and safety. The salient points are:

- It is recommended that veterinary services pay more attention to the health of goats in South Africa, as these are not regularly examined at post mortem, as are other livestock where routine surveillance for disease is carried out at registered abattoirs
- Veterinary services could be involved in actual training of those who regularly slaughter goats to make sure that they cut the throat cleanly and the goat is exsanguinated properly.
- It is suggested that information on how to see if a goat that is bought for slaughter, is healthy, based on veterinary extension and communication, be instituted. A simple pamphlet or poster could be developed and distributed to commuters at taxi stops, or distributed by Animal Health Technicians in rural areas.

- Meat hygiene principles, linked to practical hygiene principles such as the WHO “five keys” should also be communicated within rural communities and applied to informal slaughter, as “Customary” or “ritual slaughter” may make people feel uncomfortable. The principles of good hygiene and meat safety, are, however, the same.
- Slaughter goat welfare would be improved by more attention to humane transport and restraint as well as the use of sharp knives. Research could be done on a practical way of stunning under rural conditions. This should not infringe upon people’s cultural norms and religious beliefs.
- Discussions should be held with traditional healers towards designing a checklist to improve hygiene during slaughter similar to the religions rules of Halal and Kosher slaughter.

Chapter 7: References

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ADDENDUM

1. QUESTIONNAIRE
2. CONSENT FORM