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Public Health Implications Associated with the Practice of Utilizing Tires to Singe Meat in Three Major Cities of Ghana: A Concurrent Mixed Methods Study

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PUBLIC HEALTH IMPLICATIONS ASSOCIATED WITH THE PRACTICE OF UTILIZING
AUTOMOBILE TIRES TO SINGE MEAT IN THREE MAJOR CITIES OF GHANA: A
CONCURRENT MIXED METHODS STUDY

by

TEMPEST HILL

(Under the Direction of Evans Afriyie-Gyawu)

ABSTRACT

Utilization of automobile tires to singe meat (e.g., cows) intended for human consumption presents public health risks due to hazardous chemicals released into the environment and meat. This has become a common practice in some African countries such as Ghana. The objective of this study was to investigate the awareness and perception of the residents in three major cities of Ghana (Cape Coast, Kumasi and Accra) using the Health Belief Model and Social Ecological Model. Survey participants (n=196) and focus group discussion members (n=37) completed the study. Data collected from study participants included meat consumption, awareness of the use of automobile tires to singe meat, perceived health threats, perceived barriers and subjective norms regarding the practice of singeing meat with tires. Descriptive statistics, one sample t-test, and one-way ANOVA were used to analyze the quantitative data. The qualitative data were transcribed and coded for common themes. About 74% of the survey participants agreed that meat consumption in the area was high and frequent. A significant number of the study participants (76%) was aware of the use of tires to singe meat in the abattoirs and slaughterhouses ($p < 0.05$). Factors that significantly influenced awareness of the use of tires for meat singeing included gender ($p = 0.014$) and age ($p = 0.012$). Also, over 70% of the survey participants agreed that they were at risk of having some type of negative health effect from

consuming meat singed with tires and 60% of them were concerned about the severity regarding those effects ($p < 0.05$). The focus group discussion participants were in agreement with these survey outcomes. Results suggest that most of the participants are aware of the tire-based meat singeing practice and potential health threats; however, overcoming the perceived barriers to adequately address this issue remains a persistent challenge.

INDEX WORDS: Tire burning, Meat singeing, Abattoirs/slaughterhouses, Ghana, Public health, Toxicological implications, Health Belief Model, Social Ecological Model, Social Norms, Awareness, Perception, Perceived health threats, Perceived barriers

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A Dissertation Submitted to the Graduate Faculty of Georgia Southern University in

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DOCTOR OF PUBLIC HEALTH

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Electronic Version Approved:
December 2015

DEDICATION

“Go confidently in the direction of your dreams. Live the life you have imagined”- *David Thoreau.*

This research is dedicated to those who dare to dream beyond their current situations, those who fight against complacency and work consistently toward improvement and positive change. This body of work is also dedicated to the millions of students who are beginning, in the middle, or finishing the dissertation process. I now understand first-hand the will-power and self-motivation it takes to complete the dissertation journey. Everyone will not have the same dissertation experience, time-frame or end result. This is okay; you don't all have to reach the finish line at the same time, as long as you reach it. I also want to dedicate this research to my nieces, nephew, four God-children and God-sister. You all are very young right now and still trying to figure out this thing called life; however, please know that you all have the resources and support needed to lead positive and productive lives. Lastly, I want to encourage everyone who is working towards a dream to take it one a day at a time. The journey may seem long, tedious and sometimes overwhelming; however, know that you can definitely reach that dream by taking one step at a time.

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CHAPTER 1

INTRODUCTION

One's environment has a substantial role in their mental, physical and emotional health. The term environment can be defined as the physical (includes built environment), chemical, and biotic factors which affect an organism (individual) or an ecological community (Fris, 2012). There is also one's social environment which refers to the influences that may originate from the society or culture and ultimately have an effect on an individual or a population (LaVeist & Issac, 2013; Fris, 2012). Social and physical environments include factors such as influences from family members, neighborhood safety/increased crime, unemployment, access to healthy or unhealthy foods, access to health care, harmful chemicals, metallic compounds, and unsanitary conditions (LaVeist & Issac, 2013; Fris, 2012). Many of those social and physical issues are regarded as determinants of health for various populations and exposure to (or encounter with) those factors may have negative effects on an individuals' overall health (LaVeist & Issac, 2013). One's social and/or physical environments also contribute to social norms, which tend to influence individual behaviors, perceptions and beliefs in a given society (LaVeist & Issac, 2013).

An environmental health objective for *Healthy People 2020* is to "Reduce the global burden of disease due to poor water quality, sanitation, and insufficient hygiene" (U.S. Department of Health and Human Services, 2015). This particular health objective is an issue in various areas throughout developing countries and occurs primarily due to multiple environmental health influences from an individuals' social and physical environment. Additionally, characteristic negative environmental influences may disproportionately affect

specific developing countries due to factors such as lack of (or limited) resources; lack of developed infrastructures such as political, economic, waste management and social infrastructures; along with influences of cultural practices. These characteristic issues include food safety, which has been a continuous battle due to lack of enforced regulations and proper resources or education (United States FDA, 2013). An example of food safety issues within developing areas can be witnessed in West African countries such as Ghana and Nigeria. In these areas as well as in other developing countries, one can typically purchase food items from street vendors and open markets (Duedu et al., 2014; Donkor, Kayang, Quaye & Akyeh, 2009). These street vendors often do not have appropriate water sources for proper hand washing or utensil cleaning. They also lack cold or hot storage devices to keep food at the correct temperatures to avoid bacteria growth. Additionally, these street vendors and food markets are often located in open uncovered and unsanitary environments; or the seller doesn't possess the knowledge of basic food safety rules/regulations necessary to prevent contamination (Duedu et al., 2014; Agyei-Baffour, Sekyere, & Addy 2013; Donkor et al., 2009). The foods that are sold in the markets are mostly supplied by local farmers who grow the vegetables and fruits themselves. The meat products sold in these markets are often supplied by the local butchers who often purchase it from the abattoirs/slaughterhouses located within the city (Agyei-Baffour et al., 2013; Frimpong et al., 2012).

Contamination of the food products in this type of environment can and does occur easily because the proper precautions are either not put into place or not enforced. Often times, due to lack of education on these issues or resources certain contaminants are introduced unnecessarily by human preparation or actions. For instance, the abattoirs, slaughterhouses, /or slaughter slabs

are where meat (or animal carcasses) such as cow, goat, and sheep are slaughtered and stripped of its fur, transported to the market and sold for human consumption (Frimpong et al., 2012; Obiri-Danso, Hogarh, & Antwi-Agyei, 2008). While there are several unhygienic and unsanitary issues which need to be addressed at these facilities; one of the most important issues of toxicological and public health concern is the utilization of scrap automobile tires to singe the meat. In the slaughterhouses and slaughter slabs, the operators routinely burn scrap automobile tires as a source of fuel to remove the fur off the animal carcass (Obiri-Danso et al., 2008). The animal is completely charred, the black residue is washed off, and the animal is then prepared for transport to the markets. Some government funded facilities (usually referred to as abattoirs) use liquefied petroleum gas (LPG) to singe the meat; however, many unfunded facilities or operations who that do not have the same resources utilize the scrap tires for the meat singeing process.

According to the U.S Environmental Protection Agency, scrap tires are ubiquitous nationally and internationally; the U.S. alone has approximately 275 million in stockpile (EPA, 2013a). One of the most common disposal methods of the tires is exporting them to foreign countries. In 2009, the amount of scrap tires exported from the U.S. was approximately 102,000 tons or 204 million pounds (RMA, 2013). While this appears to be a gracious gesture, some of those foreign countries are developing countries. These developing countries do not have the same infrastructures or regulations in place to properly handle the influx of the imported commodities (Ezebilo, 2013; Yiougo, Oyedotun, Some, & Da, 2013; Chang, Huang, & Liaw , 2010). Therefore, materials such as scrap tires become a part of an even larger problem within these countries and aid in perpetuating the cycle of certain environmental issues.

Due to the extremely limited solid waste management and disposal options, these tires are readily available in developing countries such as Ghana. Also, these tires can even be found on the side of the streets free of charge or purchased very inexpensively. Additionally, tire-based flames are very efficient and effective as a source of fuel (EPA, 2013a). These characteristics, especially the cost-effectiveness, may obviously make the utilization of scrap tires a more preferred option compared to the alternatives, wood and liquefied petroleum gas (LPG) as fuel sources for meat processing. Thus, these factors along with other socio-cultural attributes ultimately lead to perpetuating the increase in utilization of scrap tires for singeing meat intended for human consumption.

Problem Statement

Eliminating practices that negatively affect human health within communities is a key component of public health. The EPA does not consider the scrap tires themselves to be hazardous, but it is the burning of these tires which emits noxious gases and have major adverse health effects (EPA, 2013a). Automobile tires are mainly comprised of chemicals such as synthetic and natural rubber, aromatic oils, silica, sulfur and sulfur compounds, phenolic resins, petroleum waxes, carbon black, fatty acids, steel wire, and other materials (RMA, 2011). Once these materials are ignited they emit chemicals such as carbon monoxide, sulfur oxides, nitrogen oxides, particulate matter – such as volatile organic compounds (e.g., benzene, toluene, xylene), dioxins/furans, polycyclic aromatic hydrocarbons (PAHs, e.g., benzo-a-pyrene), polychlorinated biphenyls (PCBs), 1,3-butadiene, and heavy/toxic metals/metalloids (e.g., arsenic, mercury, cadmium, chromium, etc.) (Reisman, 1998). When these tires are used for meat singeing, these emitted chemicals can adulterate the meat and hide; rendering the meat hazardous and

unwholesome for human consumption (Obiri-Danso et al., 2008). Not only can human exposure to these chemicals occur through ingestion of contaminated meat, water, or vegetables grown in contaminated soil; it can also occur through inhalation (i.e., indoor and/or outdoor air polluted with the tire-fire smoke). These exposure scenarios can ultimately cause acute (short-term) and chronic (long-term) health risks to the community and pose occupational risks to the meat processing operators. Several reports have shown that these afore-mentioned chemicals have toxicological and public health implications. Examples of those implications include possible increased cancer rates, birth defects, along with various respiratory, cardiovascular, and neurological effects (EPA, 2014b; ATSDR, 2014a; Reisman, 1997).

Purpose of the Study

The objective of this research is to explore the community awareness and perceptions concerning the practice of utilizing scrap tires to singe meat. The community's health belief surrounding the practice will be explored by applying the theoretical frameworks of the Health Belief Model (HBM), Social Normative Factors, and the Social Ecological Model (SEM). The HBM and social normative factors are used primarily in this study to determine the factors which encourage or discourage the community's willingness or readiness to take action against the practice of using tires to singe meat. The SEM aids in viewing the topic from a broader lens and assesses the social influences surrounding the perceptions of the practice. Quantitative and qualitative techniques will be used in order to collect the necessary data. A validated survey instrument will evaluate knowledge and perceptions surrounding the practice. The focus group interviews will provide further explanation on the community's knowledge and perceptions with a focus on issues such as why the practice is still being perpetuated. The focus groups will also

explore methods to terminate this practice and aid in developing effective, economically viable/affordable, culturally acceptable, and sustainable strategies/alternatives to replace this tire-based singed meat method.

Research Questions

The research questions were developed based on the lack of (or extremely limited) information in the literature and the need to assess the Ghanaian community's awareness and perceptions concerning their health from the practice of using tires to singe meat:

1. How frequent do study participants consume singed meat?
2. Are participants aware of the most commonly used fuel source(s) for meat singeing?
3. What are the perceived health threats among participants surrounding the use of automobile tires to singe meat?
4. What do participants, perceive as barriers to minimizing their exposure to meat singed with automobile tires?
5. What are the social norms among participants which influence the continued use of automobile tires to singe meat?

Significance of the Study

The practice of using tires to singe meat has been a daily occurrence for several years and yet there is highly limited scientific research or peer-reviewed articles on this important public health issue. The existing data (or literature) pertinent to this specific issue only addresses heavy metals which are found in meat singed with scrap tires. To our knowledge, there are no published data that assess the community's perception, awareness, and knowledge regarding the specific subject. Thus, further investigations into the public health implications surrounding this practice

are urgently warranted. Therefore, the main objective of this research is to explore the community's awareness and perception concerning the practice of utilizing scrap rubber tires for singeing meat for human consumption. It is anticipated that findings from this study will (a) heighten awareness of the use of scrap automobile tires for singeing meat, (b) contribute to determining why the practice is still in existence, (c) create momentum in assessing potential health risks associated with this practice, and (d) develop/implement intervention strategies to mitigate the health hazards associated with this practice.

Assessing the community's awareness and perceptions of the issue will help determine whether the citizens and their leaders see the practice as a significant threat, which may be indicative of their support on efforts to define interventions and possibly lead to policy reform and/or enforcement. Also, this research is expected to stimulate further scientific investigations into the food and environment-related issues and to offer alternative method(s) for singeing food animal carcasses.

Assumptions

1. The study participants will be a good representative sample for the three cities.
2. The participants who agree to take the surveys and the focus group interviews will answer questions honestly and openly.
3. The participants will be able to communicate in language in which the questions will be asked.

Table 1.1
Definition of Terms

TERM	OPERATIONAL DEFINITION
Singe	To scorch or burn superficially to remove fur
Abattoir	Mechanized slaughterhouse
Slaughter slab	Facility that does not have the same updated equipment as the abattoirs
Consumers	Person who is purchasing the processed meat products from the market
Carcinogenic	Cancer causing substance
Teratogenic	Agent that causes malformation to an embryo
Mutagenic	Agent which changes the genetic material
Toxicology	Study of the adverse effects of chemicals in humans and other living organism

Organization of the study

The remainder of the study includes the literature review in chapter 2 and synthesis of information that has been gathered thus far, concerning the health effects related to the chemicals emitted as a result of rubber tire combustion. The review will also present information regarding the theoretical frameworks which will be used to help guide the survey and focus group interviews. Additionally, the study will also include chapter 3 regarding the methodology portion of the research which provides the study design and procedures. Chapter 4 will present the results from the quantitative and qualitative findings and chapter 5 will include detailed discussions of those results.

CHAPTER 2

LITERATURE REVIEW

The objective of this literature review is to provide substantial background information regarding the utilization of scrap automobile tires for singeing meat and associated health effects. The review begins with defining open burning and scrap tire management. It progresses to the use of these scrap tires to singe meat and the several chemicals emitted through burning of those tires. The toxicological implications of the chemicals emitted are also briefly explained in order to delineate the biological processes which occur upon exposure to these toxicants. Furthermore, the multi-level exposure effects regarding tire burning is discussed in order to further illustrate the public health significance. Additionally, food safety implications and current food safety regulations and guidelines are substantively discussed. Lastly, a detailed discussion of the theoretical frameworks which will ultimately guide the proposed study is also presented.

Defining Open Burning

The term “open burning” is used to describe the combustion of any material where byproducts (smoke, particulate matter, etc.) are formed and released into the ambient air or the environment without passing through structures such as a duct, chimney or a suitable smoke stack (Estrella & Iino, 2010; Lemieux, Lutes, & Santoniani, 2004; EPA, 2014b). These structures are primarily used to reduce the amount of concentrated emissions at (or near) the ground level (Lemieux et al., 2004). It is worth noting that utilization of structures such as smoke stacks also contribute to environmental issues because they act as conduits for the emission to be carried several hundred miles away. This is dependent upon additional external factors once released, such as wind patterns/ speed and height of the structure (United States Government

Accountability Office, 2011; Lemieux et al., 2004). This essentially affects an even greater number of individuals. Open burning may occur, unintentionally, through activities such as fireworks, accidental fires, grilling, bonfires, campfires, and natural forest fires. Open burning may also occur intentionally through activities such as (but not limited to) the burning of household waste, animal carcasses, crops, electronic waste and tire burning (Estrellen & Iino, 2010; Lemieux et al., 2004).

Scrap Tire Management

Open tire burning is a hazardous practice that federal and state agencies work to prevent. According to the Environmental Protection Agency (EPA), scrap tire management is governed by the individual states rather than having uniformed national laws; with the first state laws not being developed until 1985 (EPA, 2013a). There are currently 48 out of the 50 states in the United States that have scrap tire management programs including programs such as the alternative use or reuse options, processing, taxation/fees on the tires, registration or licensing requirements, cleanup of old tire stockpiles, proper storing guidelines and collection. Scrap tire management is an issue which plagues developed countries and underdeveloped countries due to the overwhelming increase in rubber and tire production (Pierre, 2013; Karagiannidis, Kasampalis, Antonopolos, Perkoulidis, & Zabaniotou, 2010; Shakya, Shrestha, Tamrakar, & Bhattarai, 2008; Lemieux et al., 2004; Birkholz, Belton, & Guidotti, 2003). The U.S. produced 3.9 million tons of scrap tires alone in 2010 (Fini, Oldham, & Abu-Lebdeh, 2013). Disposal of scrap tires is a major environmental dilemma. For instance, burying of scrap tires in landfills lead to environmental problems due to reasons such as extremely slow degradation of rubber and toxic leachate from the tires. Additionally, tire casings lock in oxygen and cause the tires to shift

around or even elevate to the surface of landfills or sites where they are buried. This shifting disturbs other materials in the landfill and presents issues during the revitalization of the dump site (Ziadat & Sood, 2014; Poole, 1998).

Additionally, many areas have large junkyards (often times illegally) or landfills with stockpiles of tires. The stockpiles give way to standing water and lead to an increase in mosquito populations and other insects, which in certain countries (particularly developing tropical countries) may contribute to the proliferation of diseases such as malaria. The tire stockpiles also tend to be highly combustible and have the potential to be a major fuel source in accidental fires due to the chemical and physical properties of the tires. As shown in Table 2.1 and Figure 2.1, tires contain large amounts of combustible materials such as petroleum waxes, naphthenic oil, sulfur oil, carbon black, benzene, toluene, rubber and silica (Ziadat & Sood, 2014; Karagiannidis et al., 2010; Wik & Dave, 2009; Pubchem, 2005; Birkholz et al., 2003; Poole, 1998). The chemical makeup, especially the carbon content along with the steel cords found in tires allow for the tires to have a high *specific heat*; which allows them to absorb a large amount of heat before becoming hot . Additionally, tires tend to burn with a much higher heat output per-pound when compared to other sources of fuel such as coal. These factors make extinguishing large tire fires extremely difficult (Ziadat & Sood, 2014; Poole, 1998).

Table 2.1
Basic Physical and Chemical Composition of Automobile Rubber Tires

Material	Components of Material
Fabric	Steel, nylon, aramid fiber, rayon, fiberglass, polyester steel fabric in the belts and beads of most radial passenger tire
Rubber	Natural and synthetic (hundreds of polymer types)
Reinforcement	Chemicals: carbon black(up to 8 kinds), silica, styrene, resins, sulfur, Metal-Steel wires
Anti-Degradants	Antioxidants/ozonants paraffin waxes
Adhesion promoters	Cobalt salts, brass on wire, resins on fabrics
Curatives	cure accelerators, activators, sulfur
Processing aids	Oils (aromatic, naphthenic, paraffinic) tackifiers, peptizers, softeners
Pigments	Zinc oxide, titanium dioxide

Note. RMA. (2003). Assessment of Markets for Fiber and Steel Produced From Recycling Waste Tires. Retrieved from <http://www.rma.org/publications/scrap-tire-publications/processing-publications>

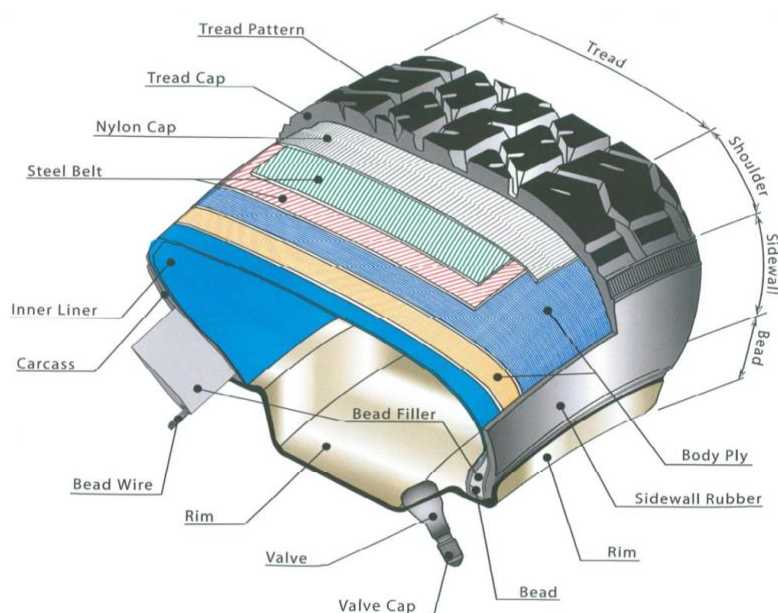


Figure 2.1: Schematic of the Physical Make-up of a Tire.

The Waste & Resources Action Program. (2006). *The Composition of a Tyre: Typical Components*
Retrieved from www.wrap.org

Utilization of Scrap Tires in Singeing Meat Products

Traditional methods of singeing meat products involved the use of firewood; however, firewood has become scarce in many African countries for several reasons (World Health Organization, 2013; Boucher et al., 2011). Some of the major reasons or driving forces include population growth and urbanization. Along with additional developing countries, Africa is expected to become majority urban within the next two decades (Montgomery, 2008). Although these phenomena can create positive economic results for individuals and communities, they also have unintended consequences - ranging from higher levels of poverty, increased infectious disease occurrence, social/political conflicts, infrastructural issues, food insecurity to ultimately straining the carrying capacity of that area and possibly leading to the depletion of its natural resources (Mojares, 2013).

The depletion of natural resources such as wood is a key component in understanding why rubber tires are heavily used to singe meat. With population growth and urbanization occurring, developing countries must try to meet the demands of the burgeoning populations. One of the primary demands for developing and underdeveloped countries is energy production and consumption (Boucher et al., 2011). While the majority of developed countries have evolved into utilizing resources such as oil, coal, petroleum along with renewable resources such as solar and wind for energy; many developed countries still rely heavily on fossil fuels and wood derived fuel sources such as charcoal to produce energy.

Wood-fuel or wood biomass is used in at least 34 developing countries and supplies over 70% of the country's' energy needs. Wood derived fuel such as charcoal is widely used in urban areas of Africa because the charcoal is easily transported and the charcoal generates less smoke and sulfur fumes than the firewood (Boucher et al., 2011). Charcoal is produced through burning of the trunk or large limbs of trees in an anoxic environment which essentially destroys the entire tree (Day, Gumbo, Moombe, Wijaya, & Sunderland, 2014; Schure, Ingram, Sakho-Jimbira, Levang, & Wiersum, 2013; Boucher et al., 2011). Furthermore, there are approximately 600 million people in Africa that do not have access to electricity; almost all residents living in the rural areas rely heavily on firewood or charcoal as their main source of household energy (Yamusa & Ansari, 2013; Schure et al., 2013; Zulu & Richardson, 2013). Additionally, the harvesting of timber and clearing of land for agriculture purposes and urban expansion contributes to deforestation as well in Africa (Boucher et al., 2011). All of these aforementioned factors have contributed to the large demand for the utilization of wood. They have also caused many parts of Africa to be some of the few areas that are currently experiencing deforestation

(Mariève, Thorsten, Obiri, & Boureima, 2012; Boucher et al., 2011). Therefore, the acquisition of wood for the purposes of singeing meat in urban areas has become laborious and rather costly. Due to this circumstance, residents have shifted from wood-fuel, when singeing meat, to the use of scrap tires which are readily available, easily accessible, inexpensive (sometimes free of charge), and an efficient source of fuel for “semi-commercial” open-air singeing/processing of “Wele” (cowhide) and meat.

Scrap tires have become ubiquitous throughout the developing world primarily because the excess tires in developed countries that are not reused, reprocessed, or buried are shipped to many of these developing countries (Reschner, 2008). However, unlike developed countries many of these developing countries, such as Ghana, do not have the same sophisticated waste management infrastructure in place. Some developing countries have little to no waste management in place or they are operated by private companies (Ezebilo, 2013; Yiougo et al., 2013; Chang, Huang, & Liaw, 2010). Often times, these private companies have minimal competition and therefore do not meet minimal waste management requirements and often deliver subpar services to the consumers; dumping the waste in any open space available without the proper pre-treatment or planning (Ezebilo, 2013; Yiougo et al., 2013; Chang et al., 2010). These waste management infrastructure issues contribute to the tires being easily accessible, very inexpensive to purchase and readily available. The tires can easily be collected by the roadside free of charge and utilized in the meat singeing process.

Chemicals Emitted from Open Burning of Rubber Tires

While the acquisition of these scrap tires is done with marginal cost or risk; there are surmountable environmental and public health cost and risk taken when open burning of scrap

tires occurs, due to the hazardous chemicals that are released. The EPA (2013a) does not consider the scrap tire itself to be hazardous, but the burning of the scrap tires is hazardous due to the array of *carcinogenic*, *teratogenic*, and *mutagenic* chemical compounds emitted from the process. Studies have been conducted with the objective of identifying and quantifying the chemicals released from the open burning of tires. These chemicals include, but are not limited to, sulfur and nitrogen oxides, carbon monoxide, volatile organic compounds (e.g., benzene, toluene, etc.), polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), dioxins, furans, hydrogen chloride, heavy metals including cadmium, chromium, nickel, zinc, mercury and vanadium (See Appendix D) (Gray & Humphrey, 2010; Shakya, et al., 2008; Obiri-Danso et al., 2008; Fullana, 2000; Poole, 1998; Reisman, 1998; Lemieux, 2004).

Toxicological Implications of Chemicals Released via Scrap Tire Burning

The chemicals emitted from tire burning can be classified as toxicants, which are poisonous substances or by-products produced from anthropogenic activities (Casarett & Doull, 2008). Routes of exposure to these toxicants among humans and animals are inhalation, dermal or eye absorption and ingestion through media such as air, soil, water, and food. Upon entry into humans, these chemicals are typically referred to as xenobiotics; which are defined as foreign chemical substances that enter the biological system (Fris, 2012; Casarett & Doull 2008; Baynes & Hodgson, 2004). There are innate biological defense mechanisms and membrane barriers found internally and externally that can block or reduce entry, along with controlling absorption and distribution of these toxicants throughout the body (Baynes & Hodgson, 2004). However, the effectiveness of these barriers depends primarily upon factors such as duration of exposure, route of entry, dosage, interactions with other chemicals (mixtures), molecular weight

of the toxicant, ionization and an individual's physiological characteristics such as susceptibility/sensitivity (Fris, 2012; Casarett & Doull, 2008; Baynes & Hodgson, 2004). These factors dictate the xenobiotic action(s) in an organism and control the rate of absorption and distribution throughout the biological system. Once the xenobiotic enters the body, it begins a systemic process known as toxicokinetics which is the quantitative study of the time course of a toxicant from exposure, through distribution to various parts of the body via bloodstream or the lymphatic system, then biotransformation/metabolism and finally excretion. This process is commonly referred to as ADME, absorption, distribution, metabolism and excretion as shown in Figure 2.2 (Casarett & Doull, 2008; Baynes and Hodges, 2004).

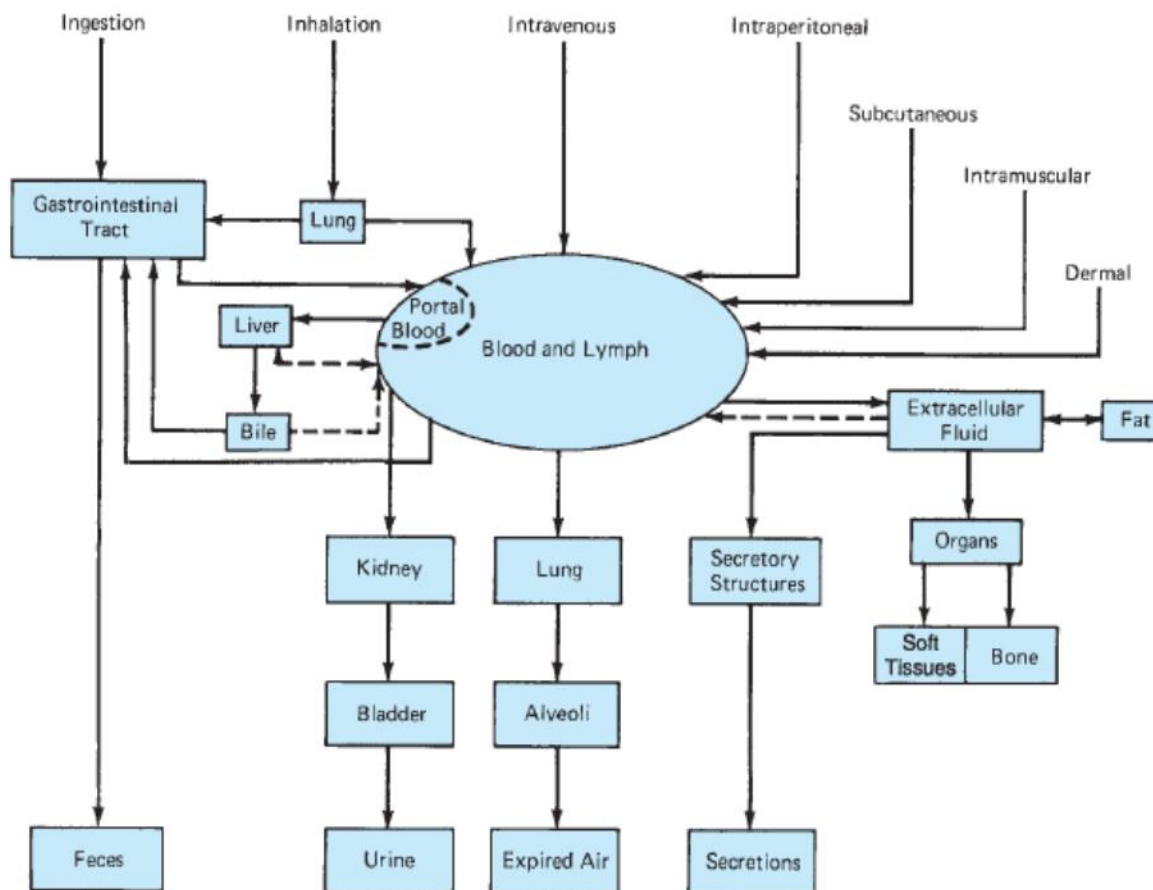


Figure 2.2. Disposition or fate of toxicants via ADME processes. Casarett, L. J., Klaassen, C. D., Amdur, M. O., & Doull, J. (2008). Casarett & Doull's Toxicology: The basic science of poisons. New York: McGraw-Hill

Absorption

The initial step in ADME is absorption, which describes the process of how toxicants cross biological membranes (i.e., peripheral tissue membranes, blood capillaries and cell membranes) and enter the bloodstream (Casarett & Doull, 2008; Yu, 2005). Under normal anatomical and physiological conditions, chemical and physical agents can pass through the membrane by one of the four mechanisms: (1) filtration -whereby toxicants flow through the

spaces and pores of a membrane and is facilitated by water; (2) passive transport (simple diffusion) – a process in which the toxicant moves from a region of higher concentration to one of with a lower concentration without the expending energy - most toxicants cross the cell membrane by simple diffusion; (3) facilitated transport - here, the compound is carried across the membrane by a carrier which is a specialized protein molecule; (4) active transport – which requires expenditure of energy along with a carrier to move the toxicant against a concentration gradient (a low concentration area to a high concentration area). Facilitated transport and active transport occurs primarily when compounds are too large to cross the cell membrane by simple diffusion or lack adequate lipid solubility (Casarett & Doull, 2008; Yu, 2005). Factors such as the physical (lipophilicity, size, and shape) and chemical properties (solubility and degree of ionization) of the toxicant along with the nature of the membrane affect absorption. The primary sites of absorption include the skin, lungs and the gastrointestinal tract (GI) but absorption may also occur in the subcutis, peritoneum and the muscle (Casarett & Doull, 2008; Yu, 2005).

The GI tract is considered one of the most important sites for absorption of toxicants. The GI absorbs most of the environmental toxicants that are found in our food once ingested. For instance, foods that are adulterated with heavy metals (lead, cadmium, arsenic, mercury, etc.) are easily absorbed in human tissues due to the heavy metals solubility in water. This absorption then allows for the heavy metals to have the capability of binding to proteins and nucleic acids, and can ultimately impair their functions (Reyes et al., 2013; Casarett & Doull, 2008; Yu, 2005; Baynes & Hodges, 2004). A historic example of this impairment is the environmental contamination of rice with cadmium in Japan. Once absorbed, cadmium is not readily excreted from the body, it actually begins to accumulate or be stored in the body's tissues such as the

kidneys and liver. Its ionic form is similar to calcium in size and density; thus, it can negatively affect the metabolism of calcium by causing excessive excretion of calcium in the urine and interfering with calcification and bone remodeling. This extreme loss of calcium, along with vitamin D deficiency led to skeletal changes in those exposed to the cadmium contaminated rice. This disease was known as Itai-Itai byo or “ouch-ouch” disease due to the extreme pain of decalcification and skeletal deformation (Yorifuji et al., 2013; Fris, 2012; Masanori, 2012; Eto, Marumoto & Takeya, 2010; Bhattacharyyaa, 2009; Yu, 2005).

Toxicants are also absorbed largely through inhalation and serves as the most rapid route of exposure. Gases such as carbon monoxide, nitrogen or sulfur dioxides, volatile organic compounds (e.g., benzene) along with particulate matter and aerosol enter through the nostrils. The first line of biological defense occurs within the nostrils via the fluid which lines the mucosa and retains gaseous molecules that are water-soluble or those that are highly reactive to the cells surface; these defense mechanisms protect the lungs from potential injuries. However, if a toxicant is inhaled they are diffused from the alveolar and removed rapidly into the blood where they are carried throughout the body to other tissues. This process holds true for most gases except for those that have a unique affinity for specific components (e.g., proteins) in the body. For instance, hemoglobin has over 200X more affinity for carbon monoxide compared to that of oxygen (Casarett & Doull, 2008; Yu, 2005; Baynes & Hodges, 2004).

Dermal exposure serves as the least rapid route of exposure and acts as a substantially sufficient barrier for protecting humans and other organisms from environmental hazards. However, there are toxicants which are absorbed dermally and can ultimately have some type of deleterious effect. The toxicant must first pass through the epidermis which is the external layer

of the skin. Within this layer is the stratum corneum which serves as the primary barrier for blocking the absorption of toxicants (Casarett & Doull, 2008; Yu, 2005; Baynes & Hodges, 2004). Factors such as quantity of the toxicant, thickness of the corneum, the amount of hydration (or lipophilicity), temperature (increased hydration and temperature increase permeability), and size of the molecule affect the toxicants' ability to permeate the skin. If the toxicant penetrates the stratum corneum, it will then travel to the dermis, where it may be absorbed in the sweat, sebaceous glands and the hair follicles and ultimately penetrates the six layers of the skin. Many toxicants move through this process by passive diffusion. Lipophilic compounds (e.g., dioxins) cross these barriers easier than hydrophilic compounds (Casarett & Doull, 2008; Yu, 2005; Baynes & Hodges, 2004).

Distribution

Once a toxicant has been absorbed into the body via the GI tract, the respiratory system or the skin, it is then distributed or transported to various biological tissues. Distribution typically is a rapid process, and the factors which affect the rate of distribution to the organs or tissues include the blood flow and speed of diffusion. Distribution occurs via the bloodstream or the lymphatic system (Casarett & Doull, 2008; Yu, 2005). Once distributed, a toxicant may be stored or metabolized. Storage sites include the liver, kidneys, lungs, adipose tissues, or the bones. The storage of a toxicant at a particular site can be temporary or permanent. The site of storage may or may not be the site where a toxicant bioaccumulates or where toxic actions occurs (e.g., cancer development). It may translocate and accumulate at a different site other than the target area. For instance, the heavy metal lead (Pb) is stored in the bone tissues but concentrates and has an effect in soft tissues such as the brain (Casarett & Doull, 2008; Yu, 2005). A toxicant may

also be distributed to the brain by crossing the blood-brain barrier and the blood-cerebral spinal fluid barrier. These barriers prevent toxicants from entering the brain in large amounts. Factors such as lipid solubility (increases rate) and degree of ionization (decreases rate of entry) affect the rate of penetration into the central nervous system. The blood-brain barrier protects various portions of the brain differently. There are parts of the brain such as the cortex, hypothalamus (hormone production), the lateral nuclei, the posterior lobe of the hypophysis (pituitary gland which regulates metabolic processes), and the pineal body (regulates circadian rhythm) that are more permeable than others (Casarett & Doull, 2008; Yu, 2005). This may be due to the rate of blood flow to these areas or the blood-cerebral spinal fluid barrier easier to penetrate. A toxicant may also cross the placental barrier, which functions to protect the fetus from harmful substances from the mother. Lipid-soluble toxicants cross the placental barrier easily through simple diffusion; however, many toxicants can cross the barrier. Heavy metals such as mercury have the ability to cross the blood brain barrier and the placental barrier leading to neurological conditions as noted with “Minamata disease” and mad hatter’s disease along with neurodevelopmental issues in toddlers (Yorifuji, et al., 2013; Fris, 2012; Eto, Marumoto & Takeya, 2010; Lederman, 2008).

Biotransformation (Metabolism)

Once a toxicant has been distributed to various parts of the body it then undergoes biotransformation or metabolism. Metabolism refers to the chemical reactions that take place within a living cell, in order to achieve homeostasis of the cell. Metabolism involves a metabolic conversion of lipophilic chemicals into hydrophilic chemicals that can be easily eliminated via the urine or bile. Metabolism is also known as biotransformation because once this metabolic

conversion occurs then a structural change takes place (Casarett & Doull, 2008; Yu, 2005). This process can take place in tissues or organs in the body such as the liver, kidneys, lungs and skin. The primary enzyme involved in biotransformation is the mixed-function oxidase usually referred to as cytochrome P-450. The liver plays a vital role in the biotransformation process due to the high number of nonspecific enzymes found or synthesized in this organ with the capability of metabolizing toxicants (Casarett & Doull, 2008; Yu, 2005).

The two phases known to occur during toxicant biotransformation are Phase I and Phase II. Phase I consists of hydrolysis (splitting of ester and amide bonds), reduction (adding hydrogen or gaining electrons) and oxidation (adding oxygen or removing electrons); while Phase II includes conjugation reactions (See Figure 2.3) (Yu, 2005). As a toxicant undergoes the chemical processes in Phase I (hydrolysis, reduction and oxidation), it typically becomes completely altered or broken down, and a primary metabolite is formed from the parent toxicant/compound. The primary metabolite may undergo Phase II reactions where it binds to predominantly polar substances such as glycine, cysteine, glucuronic acid, and sulfates and form a more water-soluble compound. Achieving polarity in Phase II is crucial in order for the toxicant to be excreted from the body. The majority of toxicants tend to be lipophilic and unless their polarity increases, they will remain primarily within the adipose tissues of the body (Casarett & Doull, 2008; Yu, 2005).

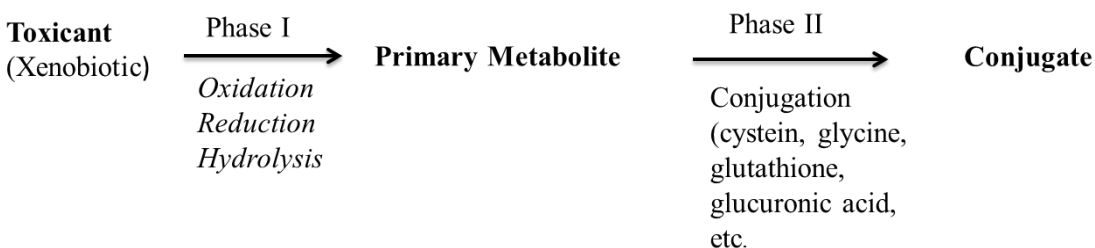


Figure 2.3. Two Phases of Biotransformation. Yu, M.H. (2005). Environmental Toxicology 2nd Edition: Biological and Health Effects of Pollutants. Boca Raton, FL: CRC Press

Although the toxicant biotransformation process primarily increases stability, water-solubility and excretion of the toxicant; this conversion process can also lead to bioactivation of some toxicants with certain chemical properties. This bioactivation by the enzyme cytochrome P450 may lead to the toxicant/metabolite becoming even more toxic than the parent compound. The activated compound has can bind to and mutate the DNA that may ultimately lead to mutations, tumorigenesis and/or carcinogenesis. An example includes the metabolic conversion of benzo[a]pyrene (BaP) into BaP-7,8-dihydrodiol-9,10 epoxide. The epoxide form is more reactive in the body than the parent compound, and is highly mutagenic and carcinogenic. The volatile organic, toluene, metabolizes to hydroxyl and carboxyl metabolites and accumulates in the neuronal membranes (Beckleyand & Woodward, 2011; Batis, Hannigan &Bowen, 2010; Casarett & Klassen, 2008). Additionally, benzene produces the metabolites quinones and semiquinones which can induce hematopoietic (blood cells) toxicity and particularly childhood leukemia (Murugesan et al., 2013; Casarett & Klassen, 2008).

Excretion

If the toxicant reaches the appropriate chemical state (increased polarity and water-solubility) the toxicant is excreted through the lungs (exhalation), kidneys (urine), and/or the gastrointestinal tract (feces) along with body secretions such as sweat, saliva, tears and breast

milk. The primary route of excretion includes the kidneys. Many of the toxicants are removed through urine. Therefore, specific biomarkers to test the levels of certain toxicants such as PAHs, heavy metals and other toxins have been primarily assessed through urine (Pizzino et al., 2014; Wheeler et al., 2014; Genuis, Beesoon, Birkholz and Lobo, 2012). Equally important and a major public health concern is the excretion of these toxins through breast milk. The World Health Organization (WHO, 2015) and the United Nations Children's Fund (UNICEF, 2014) recommends breastfeeding exclusively for the first 6 months of a child's life (Winiarska-Mileczan, 2013; Goudarzi, Parasaei, Nayebpour, Rahimi, 2012). These recommendations are set to ensure that the child receives the essential nutrients, vitamins, and minerals required for healthy growth and development (UNICEF, 2014). Breastfeeding is largely promoted and recommended in developing countries where access to clean water and proper sanitation are issues. Hence, the CDC has listed several diseases/conditions in which breastfeeding is not the optimal choice, with one of them being exposure to environmental toxins (CDC, 2015b). During the first year of life, infants are susceptible to toxicity because vital organs and systems such as the kidneys, liver, and central nervous system are immature and not fully developed. It is during this period of burgeoning that the infants are capable of absorbing high levels of toxins (Goudarzi, Parasaei, Nayebpour, Rahimi, 2012). As mentioned previously, many of these toxins will settle in the fatty tissues located within the breast and begin to increase in concentration and toxicity (Rivezzi et al., 2013). Thus exposure to these high levels of heavy metals through breastfeeding, may impair certain biological functions such as neurobehavioral impairment, decreased IQ and motor skills, learning disabilities, hormonal imbalances and additional health consequences (Goudarzi, Parasaei, Nayebpour, Rahimi, 2012; Su, 2012; Ching-Chun et al.,

2013; Cao, 2009). Although, some excretion processes may cause harm once exposed to certain toxins; without this process many of the xenobiotics would accumulate to lethal levels within the body (Baynes & Hodgson, 2004).

Multi-level Exposure Effects

The process of using tires to singe meat affects the health of populations across several social-ecological levels. The practice largely takes place at abattoirs, slaughterhouses and slaughter slabs (and occasionally by private residents for personal use) (Obiri-Danso et al., 2008). These facilities employ several community members to complete the task of slaughtering and removing the hide from the carcass so the skin may be included as part of the meat. As shown in Figures 2.4, the singeing process involves burning of the tires that produce thick plumes of black smoke that potentially contaminate the meat and pollute the atmosphere. This chronic exposure to the chemicals emitted from the tires and the smoke inhalation pose an occupational hazard to the workers and communities/residents living in close proximity to the meat-singeing operation sites as seen in Figures 2.5a and 2.5b. Not only does this practice affect the workers/community/meat consuming public, and food quality; it also affects the environment where the singeing process is perpetuated - through pollution of water (via runoff), air (smoke, ash, particulate matter, etc.) soil and sediments.



Figure 2.4. Fumes from the practice of utilizing automobile tires to singe meat



Figure 2.5a Occupational implications from the practice of practice of utilizing automobile tires to singe meat



Figure 2.5b Tire based singeing area located near residents

Several studies have noted the health effects associated with the chronic occupational and environmental exposures of many of the chemicals emitted by the combustion of the tires. For example, chronic exposure through inhalation and dermal contact to PAHs at high levels in industrial settings were found to cause elevated risk of lung cancer among the workers (Chen, Tsai, & Wang, 2008; Tsai, Shieh, Leec, & Laic, 2001). Studies have also confirmed that some of the chemicals emitted from the tires have teratogenic effects. For instance, children who were exposed to dioxins and PCBs in utero (followed from birth through 19 yrs.) were found to have lower levels of estrogen along with delayed reproductive development among the females (Su et al., 2012; Leijds et al., 2008). Additionally, children with prenatal exposure to higher levels of PCBs, heavy metals and PAHs were also found to have lower psychomotor skills, delayed mental development, lower cognitive function and visual motor immaturity (Nascimento et al., 2014; Lina et al., 2012; Weiland, Neidell, Rauh, Perra, 2011; Park et al., 2010). Also, prenatal

and early-life exposure to air pollutants such as nitrogen oxides and benzene were also found to cause ear infections, eczema along with respiratory illnesses (Aguilera et al., 2013).

Some of the chemicals emitted may also have a long-term effect on the surrounding environment especially since many of them such as dioxins, PCBs and heavy metals persist or bioaccumulate in the environment (Revich et al., 2001; Bertazzi, 2001). Once emitted, the chemicals can be found in the water, air, soil and sediments throughout a community; thus, exposing that population to certain adverse health effects. Reports have indicated that after 20 years of chronic and acute exposure to dioxins and PCBs in some communities, the adverse health effects included increased rectal and lung cancer incidence among men, increased breast and lung cancers among women and increased mortality due to the cancers (Revich et al., 2001; Bertazzi et al., 2001). Studies also show increased occurrence of diabetes among community members who experienced long-term exposure to PCBs via the environment and contaminated food products (Silverstone et al., 2012; Wang, Tsai, Yang, Guo, 2008). Ultimately, the practice of igniting tires to singe meat is one that has a wide effect which reaches multiple levels of an environment.

Food Safety Implications

It is imperative to analyze the food safety concerns that surround the practice of using tires to singe meat products. Evidence in scientific literature demonstrates that the issue of food safety and proper food handling has not been adequately addressed or enforced in some developing countries including Ghana. In terms of food safety (specifically pertinent to meat products), the slaughtering process within Ghana has been (and continues to be) analyzed. Researchers have identified cases of inhuman treatment of cattle, improper food handling

techniques, inadequate vehicles to transport meat to the markets, along with unhygienic slaughtering facilities. (Frimpong et al., 2012). All of the aforementioned issues surrounding food processing and preparation are factors that contribute to many of the food-borne illnesses (CDC, 2013c). Therefore, the additional introduction of contaminants can be minimized at various points along the food processing chain especially in the slaughterhouse and the markets where the introduction of additional chemical and physical food adulterants occur.

Similarly, the food markets are often unhygienic as well with low minimal availability to water, improper storing equipment for cold or hot foods, with little to no education on proper food safety techniques (Duedu et al., 2014; Agyei-Baffour et al., 2013; Donkor et al., 2009). Studies have also found that most Ghanaians use criteria such as aesthetic appearance of the food, appearance of the seller, interpersonal trust of the seller, price and accessibility when purchasing food from the markets and food vendors. Issues such as food safety, hygiene and cleanliness of the facility were not the major factors (Donkor et al., 2009; Rheinlander T. et al., 2008). The top criteria utilized by Ghanaian consumers indicate that their perception of food safety and what it entails should be altered (Rheinlander et al., 2008). This alteration could be delivered through education of food safety and its importance.

Food Safety Laws

Notably, Ghana has certain bills such as the “*Animals (Control of Importation) Ordinance (Chapter 247)*” and the “*Diseases of Animal Act, 1961 (Act 83)*” put in place to address food safety issues for meat products (Food and Agriculture Organization of the United Nations, 2014; Berry, 1995). The *Disease of Animal Act* specifies that meat products are inspected by a veterinarian. Their job is to ensure the spread of animal disease is avoided and to

ultimately protect consumers. There are consequences such as imprisonment for up to six months and/or a fine of up to 100 GHC. There is an additional proposed law that has only been drafted entitled the *Meat Inspection Law*, which was drafted in 1999 and revised in 2004 (Food and Agriculture Organization of the United Nations, 2014). The law has four parts: (1) controlling authority, qualifications of the inspecting veterinarian, and the appointment, (2) enforcement of the law, labeling and inspection, (3) importation and exportation of meat products and any offences, (4) regulations and interpretation of the law (Food and Agriculture Organization of the United Nations, 2014).

The Meat Inspection Law gives authority to the Veterinary Service Directorate, which is responsible for all hygiene of the meat, inspection and any decision that relates to human and animal health once the meat has entered the slaughterhouse or abattoir (Food and Agriculture Organization of the United Nations, 2014). This law would also provide the legal framework from the Ministry of Food and Agriculture to the veterinarians and the staff that they used to aid in inspection. Currently, due to the lack of guidelines defining the meat inspection process, any offenses identified by the veterinarian can be disputed by the butcher. The law also includes provisions which acknowledge the insufficient staffing of the veterinarians and recommend that the task be shared by public health officers and the Food and Drugs Board (Food and Agriculture Organization of the United Nations, 2014).

Theoretical Frameworks

According to the National Cancer Institute (2005), a theory is a systematic approach to understanding certain events or situations. Theories include various concepts, definitions, and propositions which are used to try to help describe those events and show the relationship

between specific variables. *Theories* can be utilized in various research areas; they can be applied to the individual, family, organizational, community and policy levels. *Constructs* (the key concepts of a theory) from the *Health Belief Model*, *Social Norms and aspects of the Social Ecological Model (SEM)* were used to help develop the survey instrument used for this study and evaluate why the problem of using scrap tires to singe meat even exists within the community. The Health Belief Model was established during the 1950s and is one of the widely used theoretical frameworks in health behavior research. It is used to help explain the change and maintenance of a certain health oriented behavior (Glanz, Rimer, & Viswanath, 2008). It is also widely used to develop and evaluate health interventions in order to change health behavior (Glanz et al., 2008). The Health Belief model includes six constructs which are perceived susceptibility, perceived severity, perceived benefits perceived barriers, cues to action and self-efficacy as shown in Table 2. 2. The six constructs aid in determining the things that motivate or discourage an individual from being ready to act regarding a certain disease or exposure. Researchers hypothesized that an individual's belief regarding personal susceptibility and the severity of a disease or exposure along with their perceptions of the benefit in avoiding that disease or exposure are determined largely by the individual's readiness to act in changing their health outcomes (Glanz et al., 2008).

Table 2.2
Health Belief Model

Construct	Construct Definition
Perceived susceptibility	Perceived likelihood of experiencing negative health effects from consuming tire-singed meat
Perceived severity	Perceived seriousness of those negative health effects associated with consuming tire-singed meat
Perceived benefits	Participants perceived effectiveness of minimizing their exposure to tire-singed meat.
Perceived barriers	Participants perceived cost and inconveniences of eating meat that is not singed with tires
Cues to Action	Factors that activate participants' readiness to change from tire-singed meat consumption
Self-efficacy	Participants confidence in their ability to take action against consuming tire singed meat

Note. Glanz, K., Rimer, B.K., & Viswanath, K. (2008). *Health Behavior and Health Education: Theory, Research, and Practice* (4th ed.). San Francisco: Jossey-Bass. McLeroy. National Cancer Institute (2005). *Theory at a Glance: A Guide for Health Promotion Practice* (2nd ed.). <http://www.cancer.gov/cancertopics/cancerlibrary/theory.pdf>.

Additionally, questions from the survey also assessed social norms. Social norms can be described as what a group of people believe to be normal, or a typical/appropriate action within that group. These social norms are maintained by the individual's desire to meet the groups expectations, these groups are often called reference networks (Mackie, Moneti, Denny, & Shakya, 2008; Fishbein & Ajzen, 2010). These social norms can be classified as descriptive or injunctive norms. Descriptive norm is defined as doing what others do; while injunctive norm is described as doing what others think one should do (Mackie et al., 2012) Social norms have been adapted by the Theory of Planned Behavior which assumes that the behavioral intention is the best predictor of a behavior and that behavioral intention is influenced by the attitude toward the

behavior and the social normative factors concerning that behavior (Mackie et al., 2012; Glanz et al., 2008). The constructs of the Theory of Planned Behavior includes behavioral intention, attitude, subjective norm and perceived behavioral control. Subjective norms explores the magnitude that an individual's peers may have in their decision to perform a certain behavior. If individuals believe that certain peers think he/she should perform a behavior and they are motivated to meet those expectations of those peers; then this is considered as the peers holding a positive subjective norm. If the person believes that their peers don't think they should be performing a certain behavior, then the behavior has a negative subjective norm. This construct allows the researcher to explore if the perceptions of one's peers have a role in the continuation of a behavior (Glanz et al., 2008).

The social ecological model (SEM) was also utilized. The SEM focuses on the importance of one's interactions with their physical and social cultural environment and how they affect their health problems on across various levels. The levels of the SEM include intrapersonal, interpersonal, organizational, community, physical environmental and public policy as shown in Table 2.3. The survey and the focus group interview included components from all of the levels.

Table 2. 3
Social Ecological Model

Level	Definition
Intrapersonal	Individual characteristics that influence behavior.
Interpersonal	An individual's primary groups such as their family, friends and peers which provide social identity and support
Organizational/Institutional	Regulations, rules and policies which may hinder or aid in a certain behavior
Community/Physical Environment	Social standards norms or networks that exist among individuals groups or and organizations
Public Policy	Laws (local, state or federal) which regulate/support healthy actions and practices for diseases prevention, control and management

Note. Glanz, K., Rimer, B.K., & Viswanath, K. (2008). *Health Behavior and Health Education: Theory, Research, and Practice* (4th ed.). San Francisco: Jossey-Bass. McLeroy,

SEM is widely utilized when developing complete interventions which addresses mechanisms of change at all levels that influence the health problem. SEM has four core principles of health behavior (1) "there are multiple influences on specific health behaviors, including factors at the intrapersonal, interpersonal, organizational, community, and public policy levels" (2) "influences on behaviors interact across these different levels," (3) "ecological models should be behavior-specific, identifying the most relevant potential influences at each level", (4) "multi-level interventions should be most effective in changing behavior" (Glanz et al., 2008). One of the major factors of the SEM is that it supports the fact theory that behaviors are mostly changed when environments and policies support healthy lifestyles and choices. The SEM also reverberates that social norms and social support in healthy lifestyles and choices along with

motivation and education have an influential effect on positive behavior change (Glanz et al., 2008).

Summary

The literature provides background information on why using scrap rubber tires to singe meat is a major community health and public health concern. The effects of this practice include environmental contaminants (air, water, soil, sediment); occupational hazards (no PPE); food safety implications (adulteration to the foods, unhygienic conditions) and community health concerns (ingestion of the adulterated meat products and exposure to contaminants through environmental media. Extensive research has confirmed that exposure to some of the same chemicals which are emitted from the tires lead to adverse health outcomes such as increased breast, lung and rectal cancers; diabetes; respiratory effects; impaired reproductive growth (i.e., teratogenesis); and negative effects on motor skills and mental abilities among children. Many of the health outcomes found in cohort studies correspond with the information provided by the International Agency for Research on Cancer (IARC) concerning known and probable human carcinogens.

Furthermore, we know as public health practitioners that a person's environment (social or physical) can play a major role in the status of their health. Therefore, to properly approach the issue multiple levels had to be considered. Utilization of various theoretical frameworks which assess individual, interpersonal, and community level aspects aids in identifying underlying issues which may act as a barriers to ceasing this act or facilitators to perpetuating the practice.

Overall the literature review has provided the necessary background to establishing why the practice of using scrap tires to singe meat needs to be addressed. As part of the review, key chemicals and concepts were identified along with the various associated health effects from exposures to those food and environmental contaminants. The literature review also provided information which aided in describing the toxicological implications behind the chemicals and aid in understanding how crucial it should be to mitigate the problems associated with the release of these chemicals from scrap tire burning. The review also explored cohort studies where individuals were exposed to similar chemicals occupationally or within their communities. These studies aid in establishing or determining some of the possible health outcomes that could occur to the slaughterhouse operators, community members, and the meat-consuming public in Ghana. While research on the practice of burning tires for singeing meat is extremely limited in the scientific literature, there are significant data on the effects of some of the known chemicals emitted through scrap tire-burning. However, there is an urgent need to increase research surrounding the direct health effects of utilizing scrap tires for meat-singeing, individual behaviors, and social along with environmental factors which perpetuate this practice.

CHAPTER 3

METHODS

Introduction

The overall purpose of this research is to explore the community's awareness and perceptions of the practice of singeing meat products using scrap rubber tires. The research questions are as follows: (1) How frequent do study participants consume singed meat? (2) Are participants aware of the most commonly used fuel source(s) for meat singeing? (3) What are the perceived health threats, among participants surrounding the use of automobile tires? (4) What do participants, perceive as barriers to minimizing their exposure to meat singed with automobile tires? (5) What are the social norms among participants which influence the continued use of car tires to singe meat? These questions are exploratory in nature. Exploratory research is primarily used to explore any type of phenomenon which may be present within a certain population (Creswell, 2009). It is also utilized when there is a lack of information regarding an issue and aids in determining if the study is worthwhile or feasible (Sarantakos, 2005). From the literature review concerning this specific issue in Ghana and other African countries, there is limited data that focuses primarily on the adulterations specifically pertinent to the meat. Additionally, to our knowledge, there has been no previous research that focused on the citizens in urban populations and their perceptions or knowledge regarding this specific issue. For those reasons, this study was designed as an *exploratory mixed methods* study. This chapter covers the research design, population and study participants, sampling procedures, instrumentation, data collection techniques, and data analyses.

Research Design

In order to address the research questions, the study design utilized a concurrent mixed methods approach. Within this approach, quantitative and qualitative data was collected concurrently. The quantitative and qualitative data was weighted equally and the results were integrated during the results and discussion portion of the research as illustrated in Figure 3.1 (Creswell, 2009). The quantitative data aided in obtaining a cross-sectional view of the overall awareness, perceptions, and beliefs regarding the practice of using tires to singe meat products. While the qualitative data provided a contextual rationale of the information collected from the quantitative data and integrated additional topics relevant to the study. The quantitative and qualitative data collected in this study essentially complements each other. This design aided in balancing any intrinsic limitation which may have been present in one method and was strengthened by the characteristics of the other method (Roberts, 2010; Creswell, 2009). Ultimately, this approach provided for a robust study and covered areas which may have been disregarded or unknown by either one of the methods.

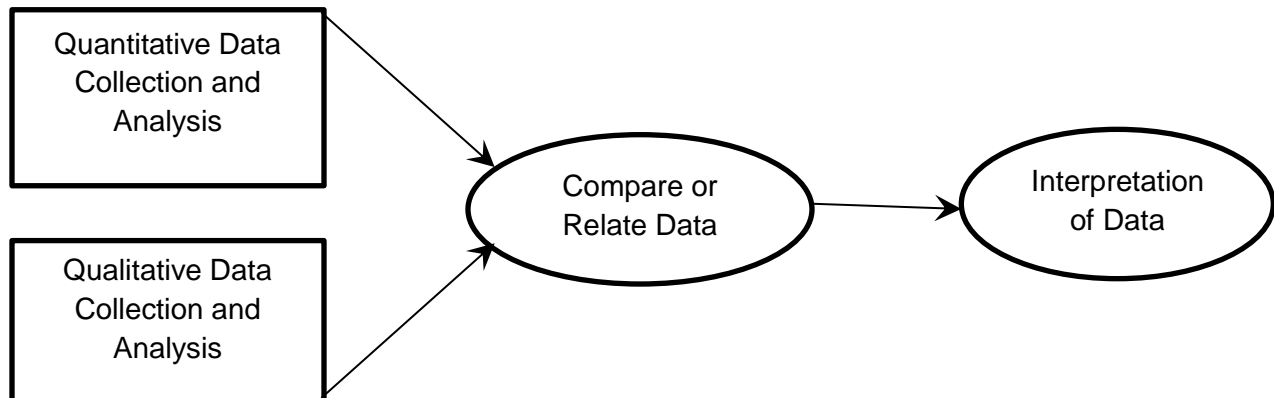


Figure 3.1. Concurrent Triangulation Design. The collection and convergence of quantitative and qualitative data.

Study Population

The target populations for this study were the citizens living in Kumasi, population size approximately 2,035,064; Cape Coast, population approximately 169,084; and Accra (the capital city) with a population of approximately 2.9 million (Ghana Statistical Service, 2013). These areas were targeted because they have large active slaughterhouses and the practice of using rubber tires to singe meat was confirmed during the time period of the research (2012-2014) by the researcher and research team. These 3 cities are also 3 of the most heavily populated cities in the country of Ghana. The official language of these areas is English which is used in their schools. There are also over 100 local languages and dialects spoken throughout the country (Berry, 1995). The literacy rate for the country is 71.5% with males having the highest literacy rate at 78.3% and females at 65.3% (Ghana Statistical Service, 2013). The study participants for the focus groups consisted of individuals from those 3 cities who were 18 years or older. Study participants for the surveys consisted of participants 18 years and older from Cape Coast and Kumasi, due to time restraints.

Sampling Procedure

A nonprobability sampling technique, *convenience sampling*, was utilized in the study. Convenience sampling is used in exploratory research and when the researcher wants to collect basic data and trends to aid in determining what is transpiring in a particular location (Bernard, 2013). This was also one of the most appropriate methods for this particular research environment, due to the following reasons: (1) acquisition of reliable maps within an appropriate time frame; (2) slum like housing without adequate addresses; (3) time restraints and feasibility of research.

To ensure representativeness of the sample the surveys were administered to a broad cross-section of the population. For example, surveys were administered to males and females, diverse age groups, and at various times of the day. The unit of analysis was the citizens; therefore, the surveys were administered in areas where large portions of the citizens frequented (Gravetter, 2010). This included locations such as the marketplace (where much of the produce and meats are purchased), local businesses, secondary schools, taxi stations, busy streets and additional public locations. While capturing diverse groups of participants from varying demographic backgrounds is an important aspect of the study, a potential limitation would be the introduction of bias with respect to having more or less representation of study participants in terms of gender, age, education and other demographic characteristics. Further research utilizing a probability sampling methodology will address these sampling issues.

The qualitative portion of the research consisted of focus group interviews. The focus group interviews included the general population and personnel from the Cape Coast abattoir. There were 2 focus group interviews completed in Cape Coast and Kumasi, there was one focus group interview completed in Accra due to time restraints and other logistical reasons.

Recruitment of Survey and Focus Group Participants

Recruitment of survey participants took place in Cape Coast and Kumasi in the most populated areas of the cities as aforementioned. Participants who were 18 years or older were asked to voluntarily complete the survey, no incentives were given to take the survey. The purpose of the study and the informed consent were explained to the potential participants. If the person could not understand the English language then an interpreter was onsite to further explain in their local language. After the person indicated that they understood the purpose of the

study and their willingness to participate, then he/she was asked to sign the informed consent and begin the survey.

Focus group interviews took place in Cape Coast, Kumasi and Accra. The inclusion criteria were as follows: at least 18 years or older, residents of the respective city, and those who were willing to have an open discussion concerning the issue. Participants were recruited from church services, market areas, and recommendations given by local residents, similar to a snowball sampling method. Specifically, in Cape Coast due to the established working relationship from the previous year, the researcher was able to secure key representatives from the abattoir to participate in the focus group discussions. Many of the focus group discussions took place on Sundays as recommended by Ghanaian citizens to avoid interference with anyone's work schedule. The focus group interview locations were held in areas that would comfortably accommodate all participants. Culturally appropriate refreshments were provided at each interview session. The interviews lasted between one to two hours, depending upon the length of time it took some participants to express their feelings about the subject and whether there was a need to interpret the conversation from English to the local language.

Study Instruments

A cross-sectional survey was developed in order to obtain a numeric description of attitudes, health beliefs and trends which may be present throughout the surveyed population concerning a specific health behavior (IARC, 2013a; Creswell, 2009). This cross-sectional survey also allowed the researcher to compare several variables concurrently (IARC, 2013a; Creswell, 2009). The survey for this study was, a 39 item self-administered instrument. The survey consisted of general demographic questions assessing gender, age; education, marital

status; income and occupation. Table 3.1 illustrates the questions which measured the frequency of singed meat consumption, awareness/concern regarding the practice, and constructs of the HBM (perceived susceptibility, perceived severity, perceived benefits, perceived barriers, cues to action and self-efficacy), and social norms were also measured along with relevant concepts from the social ecological model. The questions which test certain constructs were formatted in Likert Scales with rating options such as: *5=strongly, 4=agree, 3=undecided, 2=disagree and 1=strongly disagree*. Questions that measured the constructs within the HBM were loosely adapted from instruments developed by Champion (1997); the social norms scale was loosely adapted from Fishbein and Ajzen (2010).

Table 3.1
Survey Items Measuring Prevalence, Awareness, HBM and Social Normative Factors

Survey Items
Frequency
1. In the past three months, which of the following best describes the number of times that you have eaten meat/hide that was singed?
Awareness
2. What is/are the most commonly used fuel sources for fur removal (or singeing) by most slaughterhouses after animals are slaughtered?
3. Do you know if slaughterhouses and/or abattoirs use rubber tires (used) for singeing the meat sold in the markets and/or your community?
4. Do you know of any laws/policies that address the issue of burning used rubber tires to singe meat?
Perceived Susceptibility
5. There is a good chance that I will have negative health effects in the next 5 – 10 years from the practice of singeing meat with used rubber tires
6. It is very likely that I will fall sick from eating meat singed with used rubber tires
7. I may get cancer if I continue to eat meat singed with used rubber tires.
Perceived Severity
8. My whole life would change, if I fall sick from eating meat singed with used rubber tires
9. I would experience serious health problems from eating meat singed with used rubber tires
10. I am fearful about the health impacts of eating meat singed with used rubber tires
Perceived Benefits
11. If I exclude meat singed with used rubber tires from my diet, it will prevent future health problems
12. It tastes better to eat meat singed with fuel sources other than used rubber tires
13. The practice of singeing meat with fuel sources other than used rubber tires will help reduce air pollution

Survey Items (cont.)

Perceived Barriers

14. It cost me too much to buy meat that has been singed with gas or firewood
15. I cannot determine if the meat I eat has been singed with rubber tires, firewood or gas
16. I do not know where to purchase meat that has not been singed with rubber tires
17. I do not have the means to get to an abattoir or slaughterhouse that uses only gas to singe meat
18. I live too far to get to an abattoir or slaughterhouse that uses only gas to singe meat
19. My friends and family will tease me if I asked for meat that is not singed with rubber tires

Cues to Action

20. I look for information about used rubber tire burning and the possible health impacts
21. I feel it is important to know the policies on the practice of burning rubber tires in Ghana
22. I feel that it is important to eat meat that has been processed without using rubber tires

Self-Efficacy

23. I am confident that I know how to identify meat singed with used rubber tires
24. I will start asking how meat is singed before buying it
25. I stay away from areas where burning of used rubber tires take place, to avoid negative health effects from the practice

Social Norms

26. Most people who are important to me think that I should not care about how my meat is singed
 27. It is typical of me to buy raw meat without asking how it was singed
 28. My community normally does not see the difference between meat singed with rubber tires vs. other fuel sources
 29. My family typically buys meat that has been singed
-

A focus group was also implemented instead of in-depth interviews. Focus groups create a synergy between participants and enables them to draw from each other's ideas/opinions often times providing a richer conversation. Focus groups also enable a more natural style of conversation to develop thus revealing vital normative influences which are key in understanding a particular issue/health behavior (Ritchie, Lewis, Nicholls, Ormston, 2014). The focus groups questions were guided and developed from the survey used in the study. The questions allowed the participants to expand and share their thoughts concerning the issue. During the focus group interviews, the researcher passed around photos, which were taken the previous year from various abattoirs (See Appendix C) The photos depicted the process of using automobile tires for singeing meat at the slaughterhouses, the environment surrounding the process, and the condition of the workers. The photos were used as probes to elicit conversation regarding environmental issues along with the possible health issues associated with the exposure.

Pilot Test

Survey Instrument:

The survey instrument was piloted in Ghana with 35 participants. The pilot test was conducted to aid in confirming the utility of the survey and to aid in determining if the participants would encounter issues with readability, comprehension, and survey length (Bernard, 2013). Participants were informed about the purpose of the study and were asked to voluntarily answer the survey and note any concerns, misunderstandings, or misrepresentations that found in the survey. Participants were specifically asked if the survey was easy to read, comprehensible, appropriate in length and if there was anything that should be modified in the

survey. Their comments were used to aid in revising the questions on the instruments; only minor modifications were made.

Focus Group Interview

The questions for the focus group interview were piloted with 6-10 individuals in Ghana. The participants were asked to review the questions and critique the interviewing process to ensure that questions were clear and comprehensible. The most important aspect of this was to ensure that the researcher was being culturally competent and sensitive during the interviewing process. It was important to create a welcoming and comfortable environment for the participants during each interview process. All comments and suggestions enhancing cultural competence were included into the interviewing process.

Reliability and Validity

Survey Instrument

Reliability was assessed for each construct on the survey instrument by using Cronbach alpha's calculation which tests the correlation of the items found in each scale. Any alpha coefficient of 0.70 or above was considered acceptable for this research (Soleymanian et al., 2014; Tavakol & Dennick, 2011; Ng, Kankanhalli, & Xu, 2009). The Cronbach's alpha was calculated for each subscale to aid in determining internal consistency of the scale items on the survey instrument. As shown in Table 3.2, there were a total of 21 items within the health belief scale and 4 items which assessed social norms. All constructs from the HBM were employed in the survey. However, not all the constructs were used in the research questions for the study. The Cronbach's alpha for perceived susceptibility the alpha was 0.73, for perceived severity the alpha was 0.71 and for perceived barriers the alpha was 0.62. Perceived benefits (0.057), cues to action

(0.055) and self-efficacy (0.54) were not used to address research questions. The Cronbach alpha for social norms was 0.70.

Table 3.2
Survey Instrument Reliability

Item	Cronbach's Alpha
Perceived Susceptibility (three items)	0.73
Perceived Severity (three items)	0.71
Perceived Benefits (three items)	0.57
Perceived Barriers (six items)	0.62
Cues to Action (three items)	0.55
Self-Efficacy (three items)	0.54
Social Norms (four items)	0.70

Note: The acceptable Cronbach's Alpha for this study was .70 (Soleymanian et al., 2014; Tavakol & Dennick, 2011; Ng, Kankanhalli, & Xu, 2009)

To assess validity of the surveys, face validity and content validity were evaluated. Face and content validity were reviewed by the researcher along with various faculty members at Georgia Southern University's Jiann-Ping Hsu College of Public Health. Those faculty members included Dr. Evans Afriyie-Gyawu who is originally from Ghana and is very familiar with the practice and the culture. Dr. Evans is also a trained Toxicologist and Environmental Health Scientist who does extensive research on national and international environmental and food safety issues. Dr. Andrew Hansen is a Community Health Behavior and Education professor who

teaches and utilizes theory based research to address nutritional health issues. Dr. Gulzar Shah is the Associate Dean of Research and has worked extensively with survey development at various agencies such as the National Association of County and City Health Departments (NACCHO). Face and content validity was once again assessed in Ghana during the pilot testing of the survey instrument.

Trustworthiness of Qualitative Research

Focus Groups

Trustworthiness or merit of qualitative research is used to ensure the information is accurate and to aid in enhancing the rigor of a study. It is achieved when information or a human is experience is presented in a fashion in which the participants who provided the information or experience can immediately identify the description (Thomas & Magilvy, 2011). Guba (1981) provided a model with four criterion to aid in assessing trustworthiness or merit in qualitative material. The four criteria are credibility, transferability, consistency and confirmability or neutrality. (1) Credibility was achieved through reflexivity throughout the data collection process and by framing of the interviewing process. Reflexivity was achieved by the researcher through the use of a journal during the collection period. The researcher detailed daily logistics of the study and the researcher's thoughts and feelings when interacting with the participants (Darawsheh, 2014; Thomas & Magilvy, 2011). The journal also contained frustrations and problems which arose during the research process. This information was used to aid in identifying any biases or preconceived assumption and was used to prevent those influences on the research particular during data collection and data analysis. Additionally during the interview process credibility was enhanced by constant repetition of the interview questions, reframing the

questions if required or expanding the questions and providing additional context to ensure clarity (Thomas & Magilvy, 2011; Creswell, 2009; Guba, 1981). The researcher also repeated the participant's responses to ensure clarity and comprehension. (2) Transferability was achieved by providing adequate descriptive data on location, participants and methodology of the study. (3) Consistency was achieved through inter-coder agreement, checking transcripts for accuracy and triangulation of data (Thomas and Magilvy, 2011; Creswell, 2009; Guba, 1981). A second coder was introduced to determine if they agreed upon the codes developed by the researcher. The second coder separately reviewed and re-coded all transcripts using the codebook and developed additional codes. The researcher then reviewed the second coder's feedback; the agreement was 100% (Creswell, 2009). The transcripts were also checked several times against the audio recordings for accuracy by the researcher. Additionally, triangulation was used by integrating quantitative data from the survey during analysis (Creswell, 2009). (4) Confirmability was achieved through reflexivity and triangulation as well (Thomas and Magilvy, 2011; Guba, 1981).

Data Collection Procedures

The 39-item survey were administered in various places. Before taking the surveys each participant had a chance to read the attached consent form and ask questions. Upon agreeing to take the survey the participant then signed the consent form and began the survey. There were a few participants who wanted to take the survey but needed an interpreter, for those participants an interpreter was on-site to assist. Once the participant was done, the researcher collected the survey, answered any additional questions and graciously thanked the participant for their contribution there were a total of 196 surveys collected.

Prior to conducting the interviews the researcher had experience in moderating and facilitating focus group discussions with local organizations. Before each discussion, the researcher explained the purpose of the study and how the information would be used. The researcher also informed the participants that the interview would be recorded to aid in accuracy and credibility of the study. It was also explained that all participation was voluntary and at any point the participant could withdraw from the discussion. Before beginning each session the researcher asked each participant to verbally consent to participating in the research, this was completed while the audio recorder was on. The researcher also established ground rules before beginning the discussion such as asking the participants to speak one at a time, and to speak loudly for the audio recorder and all participants were asked to silence their cellular phones during the discussion. There were also culturally appropriate foods and drinks provided during the discussions.

There were a total of 5 focus group discussions ranging from an hour to two hours in length. Each interview took place at locations which were deemed appropriate for the participants as for as comfort and space. One was conducted on the campus of Cape Coast University, 3 were conducted at various lodging houses where the food and drinks could be provided easily and the final one was conducted in an office at the Kamfo Anokye Teaching Hospital in Kumasi. At the end of each focus group discussion the researcher thanked the participants for their contributions answered any questions concerning the study and thoroughly explained again how the information would be utilized. Four of the focus group discussions were transcribed by the researcher. One of the discussions which contained heavy accents was

transcribed by an international Ghanaian graduate student who knew the language well. However, this was also checked by the researcher for accuracy and completeness.

Data Analysis

Survey Instrument

For the survey, a code book containing the numerical value assigned to each question and answer was developed. Statistical Package for Social Sciences (SPSS) was utilized to analyze the data. Descriptive statistics such as frequencies, means, modes, standard deviations and percentages were calculated for each item on the survey instrument. Each theoretical construct (HBM and social norms) was transformed into a Likert summation scale to be analyzed. One-Way analysis of variance (ANOVA) was used to determine if demographic variables such as age, gender, education and income had a statistically significant influence on the research questions (See Table 3.3). Tukey's was used during post hoc analysis for the majority of the one-way ANOVA data.

Table 3.3
Research Questions and Data Analysis

Research Questions	Data Analysis
1. How frequent do study individuals consume singed meat?	Descriptive Statistics Focus Group Data
2. Are participants aware of the most commonly used fuel source(s) for meat singeing?	Descriptive Statistics One-Way ANOVA One-Sample t-test Focus Group Data
3. What are the perceived health threats among participants surrounding the use of automobile tires to singe meat?	Descriptive Statistics One-Way ANOVA One-Sample t-test Focus Group Data
4. What do participants, perceive as barriers to minimizing their exposure to meat singed with automobile tires?	Descriptive Statistics One-Way ANOVA One-Sample t-test Focus Group Data
5. What are the social norms among participants which influence the continued use of automobile tires to singe meat??	Descriptive Statistics One-Way ANOVA Focus Group Data

Focus Groups

The qualitative material was analyzed by following the steps illustrated in Figure 3.2 (Creswell, 2009). The raw data from the audio recordings was transcribed, organized and prepared for analysis by the researcher. After typing the transcripts the researcher replayed each interview and read along with the transcription to ensure accuracy and to reiterate the material

for the researcher. The guided process taken by the researcher for coding the data was as follows:

1. Transcripts were read carefully to develop a sense of the entire interview; and notes were made
2. Researcher selected one interview and determined what the interview was about; and identified the underlying meaning of the interview
3. The researcher developed a list of all of the topics, grouping similar topics as major topics
4. Those major topics were marked next to the appropriate section of text
5. The categories were then reduced based on similarity again at that point
6. All coded data was grouped under its corresponding code for analysis purposes

Once the data were properly coded for themes, those themes were interpreted to understand the meaning of the qualitative data. The themes were determined inductively. A code book was developed based on the emerging themes.

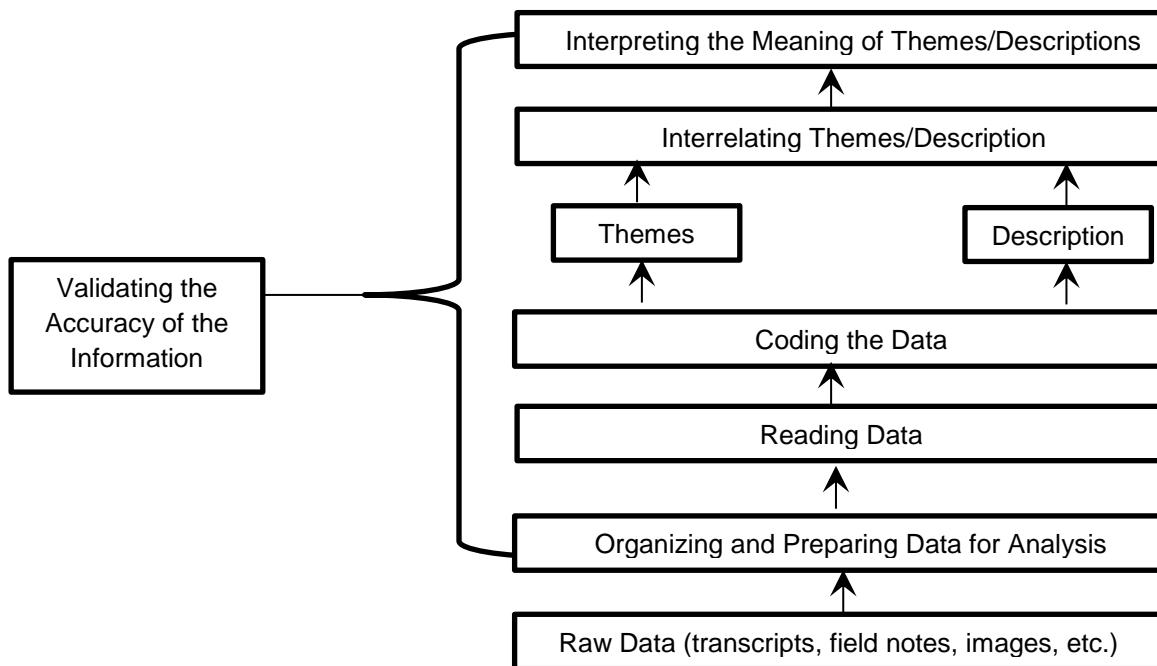


Figure 3.2. Data Analysis Process in Qualitative Research. This figure illustrates the steps in which qualitative will be analyzed (Creswell, 2009).

Ethical Issues

The research was approved by the Georgia Southern Institutional Review Board (IRB). The IRB committee confirms that the researcher has taken the proper preliminary steps to ensure fair and ethical treatment of all study participants. All participants were given informed consents and made aware that their participation was voluntary and they may choose to discontinue the survey process at any time. The researcher explained the study and the contents of the informed consent. The researcher requested that each participant read through the informed consent before signing. Study participants were informed that no personal information from the informed consent such as their names would be shared. Those who chose to participate in the focus group discussion gave oral consent which was recorded on the audio recording device. The researcher explained the study to the group as whole and explained that the interview would be recorded to ensure accuracy but that no identifiable information would be publicly shared. The focus group participants were also made aware that at any time they have the option to withdraw from the study. The researcher's contact information was also provided to those participants who requested for it.

CHAPTER 4

RESULTS

This chapter presents the findings of the survey and the focus group discussions. It begins with descriptive statistics (including age, gender, educational status, income and occupation) of participants of the survey and focus group discussions. The chapter ends by presenting the quantitative and qualitative results for each research question.

Descriptive Statistics

Survey Participants

There are approximately 26 million individuals residing in the country of Ghana. Nationally, about 52% are men and 48% are women (CIA, 2015). As noted in Table 4.1 there were a total of 196 study participants from the cities of Cape Coast and Kumasi with more than half of the respondents being male (55.6 %) and a little under half being female (41.3 %). The ages were organized into 5 categories on the survey 18-24, 25-34, 35-44, 45-54, 55-64, and ≥ 65 . The majority of the survey participants were in the age group of 25-34 (42.9%) with the least represented age groups being those 55-64 (2.6%) and those ≥ 65 (.5%). Approximately 15% reported having completed up to junior high school, about 28% of the respondents reported having at least a high school diploma and 25% reported having a bachelor's degree. Participants were also asked to provide their monthly income approximately 38% of the respondents made less than 500 Ghana Cedis (GHC), which was equivalent to USD 156.76 (the conversion rate was \$1.00 = GHC3.13 in May 2014). This particular question had the most unanswered responses (16%). Interestingly, during the piloting phase of the survey, participants suggested that this question be removed from the questionnaire. They stated that many Ghanaians are not

comfortable discussing their finances. Finally, the most frequently reported occupations among the participants were self-employment (14%), civil servants (12%), and students (10%).

Focus Group Participants

There were a total of 5 focus group discussions completed in the cities of Cape Coast (n=2), Kumasi (n=2), and Accra (n=1). The participants voluntarily agreed to participate in the recorded discussions. Table 4.2 displays the distribution of male and female participants along with their occupations. There were a total of 37 focus group participants 7 (9%) women and 29 (91%) men. During the discussions and recruitment process the participants were asked about their occupations. The occupations represented in the focus groups were students (27%), hospitality staff (19%), butcher (2.7), slaughterhouse operators (5.4%), hospital staff (13.5%) and a local transportation driver (2.7%). The participants were not formally asked to report their income or highest level of education. All the participants were at least 18 years of age.

Table 4.1
Descriptive Statistics of Survey Participants in Kumasi and Cape Coast, Ghana

Variables	Frequency (n)	Percentage (%)
<i>Gender</i>		
Male	109	55.6
Female	81	41.3
Missing	6	3.1
<i>Age (years)</i>		
18-24	34	17.3
25-34	84	42.9
35-44	46	23.5
45-54	23	11.7
55-64	5	2.6
≥65	1	0.5
Decline	3	1.5
<i>Education</i>		
No Schooling completed	7	3.6
Nursery to JHS	30	15.3
Some Secondary, no diploma	26	13.3
Secondary school graduate, diploma or equivalent	54	27.6
Some University cred. No degree	13	6.6
Trade/technical/vocational training	7	3.6
Associate degree	0	0.0
Bachelor's degree	48	24.5
Master's degree	3	1.5
Professional degree	2	1.0
Doctorate degree	0	0.0
<i>Marital Status</i>		
Single	96	49.0
Married	95	48.5
Divorced	3	1.5
Widowed	2	1.0
<i>Monthly Income in Ghana Cedis (American Conversion not given on original survey)</i>		
Less than GHC 500 (Less than \$156.76)	74	37.8
GHC 500 to GHC 999 (\$156.76-\$313.08)	55	28.1
GHC 1,000 to GHC 4,999 (\$313.4-\$1566.69)	26	13.3
GHC 5, 000 to GHC 8,999 (\$1567-\$2820.29)	6	3.1
GHC 9,000 to GHC 14,999 (\$2820.60-\$4700.69)	2	1.0
GHC 15, 000 or more (\$4701+)	2	1.0
No Answer	31	15.8

Table 4.1
Descriptive Statistics of Survey Participants in Kumasi and Cape Coast, Ghana (Cont.)

Variables	Frequency (n)	Percentage (%)
<i>Occupation</i>		
Administrative	4	2.0
Arts	5	2.5
Agriculture	2	1.0
Banking	2	1.0
Barber	1	0.5
Civil Servants	23	11.7
Communications	1	0.5
Construction	2	1.0
Education	15	7.6
Engineer	3	1.5
Environmental Health Field	18	9.1
Hair Stylist	7	3.5
Health Care	2	1.0
Hospitality	1	0.5
Librarian	9	4.5
Marketing and Sales	12	6.1
Non-Employed	3	1.5
Retired	2	1.0
Self-Employed	27	13.7
Social Worker	5	2.5
Student	20	10.2
Transport Services	1	0.5
Technician	3	1.5
Transcriber	1	0.5
Missing	25	12.7
Total	196	100

Table 4.2
Descriptive Statistics for Focus Group Participants in Kumasi, Cape Coast and Accra, Ghana

Variables	Frequency (n)	Percentage (%)
<i>Cape Coast (Focus Group 1)</i>		
Male	10	91
Female	1	9
<i>Cape Coast (Focus Group 2)</i>		
Male	8	80
Female	2	20
<i>Kumasi (Focus Group 3)</i>		
Male	2	40
Female	3	60
<i>Kumasi (Focus Group 4)</i>		
Male	4	80
Female	1	20
<i>Accra (Focus Group 5)</i>		
Male	6	100
Female	0	0
<i>Occupation</i>		
Cape Coast University –Animal Science Staff	6	16.2
Students	10	27
Environmental Health Specialist	1	2.7
Veterinarian	1	2.7
Butcher	1	2.7
Slaughter House Operators	2	5.4
College Professor	1	2.7
Driver	1	2.7
Hotel Staff	7	19
Non-Profit Organization	1	2.7
Unknown	1	2.7
Sanitarian	2	5.4
Information Technologist	2	5.4
Hospital Receptionist	1	2.7
Total	37	

Research Questions and Pertinent Result

Research Question 1: How frequent do study individuals consume singed meat?

Participants were asked to describe the number of times they consumed meat/hide that was singed within the past 3 months. The question did not specify how the meat was singed; it was used just to assess the frequency of singed meat consumption within the area. According to the survey content as seen in Table 4.3, there were 21.9% of the participants who had not consumed singed meat within the past 3 months. Most participants indicated that they consumed singed meat at least 2-6 times in the past 3 months (27%). About 17.3% consumed singed meat at least once in the past 3 months; 9.2% consumed singed meat 7-12 times and 20.4 % consumed singed meat more than 12 times in the past 3 months. Collectively, 73.9% of the participants indicated they did consume singed meat. This large percentage was also confirmed during the focus group discussions. Participants agreed that meat was consumed frequently in Ghana. One of the primary reasons was attributed to the inexpensive cost of meat when compared to other options such as fish. One of the participants stated the following:

“Meat is cheaper, fish is expensive.”

Also participants discussed the concept of increased population sizes and increased demand for meat products. Participants stated that the abattoirs or slaughterhouse have to keep up with the demands from the increasing population.

“Oh yes, we consume a lot of meat. Because there is a very small percent of the population that practices being a vegetarian but other than that we consume a lot.”

“There is largely a population and consumption pattern. The consumption pattern is partly influenced because of the population. In Ghana almost everyone consumes meat one way or the other either beef or pork or what have you so the consumption cuts across. But the issue is the population has an influence on the infrastructure that was set up.”

“So the demand has gone up and because of the demand they are trying to find a way to get the product processed in a short amount of time to the consumer. So they are looking at the faster and cheaper way”

Table 4.3

Frequency of Singed Meat Consumption within the past 3 months among Survey Participants in Kumasi and Cape Coast, Ghana

Variable	Frequency(n)	Percentage
Never	43	21.9
Once	34	17.3
2-6 times	53	27.0
7-12 times	18	9.2
> 12 times	40	20.4
Missing	8	4.1
Total	196	100.0

Research Question 2: Are participants aware of the most commonly used fuel source(s) for meat singeing?

One of the major aims of the study was to determine if citizens were aware of the practice of using tires to singe meat products purchased in the market areas. The survey participants were asked what were the most commonly used methods of fur removal in the area, 40.3% of the participants indicated rubber tires, 28.6% indicated firewood and 7.7% indicated the use of gas; as seen in Table 4.4. A one sample t-test was used to determine statistical significance when compared to the response of 50% of the population ($p < 0.05$). The question was statically significant $t(190) = 23.95$, $p = 0.000$ (see Appendix E). Additionally, to determine if independent variables such as age, gender education and income had an influence on knowing the most

commonly used fuel source, a One-Way Analysis of Variance (ANOVA) was used. There was no significant difference between male and female participants ($p=0.062$). Regarding education, there was a significance ($F(8,175)=2.15$, $p=0.033$). Post hoc analysis utilizing Fisher's Least Significant Difference (LSD) test determined there was a significant difference among several of the education groups (see Appendix F). Descriptive statistics did not show any direct or inverse relationship among educational groups and knowing the most commonly used fuel source for meat singeing (see Appendix F). There was no significance between income ($F(6,183)=0.572$, $p=0.753$) nor age ($F(4,181)=1.99$, $p=0.098$) and knowing the most commonly used fuel source. Further, focus group respondents agreed with the survey participants and stated that the rubber tires were the most frequently used fuel source for reasons such as location of the slaughtering activity or the abattoir/slaughterhouse, the inexpensive cost of the tires and the burning efficiency of the tires as opposed to firewood. The focus group participants stated the following:

“I have never ever seen firewood. Not myself. I've never heard that they use anything else apart from tires.”

Participants views on individual locations of slaughtering activities, location of the abattoir/slaughterhouse facility and cost were as follows:

“But in villages, moles, using tires is not common. The tires are not even readily available, they use the firewood. But it is in the cities that they have access to the lorry tires they use them. Because firewood is quite expensive compared to the lorry tires which come free you walk about.”

“I realize that in the processing of the meat, in the Accra abattoirs we just said they have this furnace that the animals, they want to burn the fur from their skin. They use this furnace to take out the hair. But taking into consideration, the local ones we have here in Cape Coast, they tend to use this cruel rubber embodied mechanism where they use to make fire to take off the hair from their skin”

“What will you replace the tires with? Because the local people they use it because it is cheap, the firewood is expensive. But now that you want to stop the use, what is the alternative?”

One of the participants stated the following concerning the efficiency of the tires compared to the firewood:

“We can sometimes use firewood. But because of scarcity, we tend to use firewood. Also its extremely impossible to use firewood when it's raining.....The firewood is not as fast as the tire....for example, if it will take you about an hour to singe a slaughtered animal with the tire, it could take you about two hours to do the same job when using a firewood...so when using the log its efficiency is not all that they want it when using the tires.”

An additional research questions asked the participants if they knew that tires were used at the abattoirs/slaughterhouse. Many of the respondents (76%) knew that the local slaughterhouses/abattoirs used rubber tires to singe the meat sold in the markets while only 31.4% were not aware (see Table 4.5). When compared to 50% of the population the results were statistically significant ($p < 0.001$). Additionally ANOVA was used to determine if there was a significant difference among knowing if rubber tires are used to singe meat and independent variables such as gender, age, education and income. Regarding gender, there was a significant difference ($F(2,188)=4.40$, $p=0.014$). Descriptive statistics and Tukey's HSD post hoc analysis revealed that a significant percentage of the males were more likely to be aware of the tire usage at the abattoirs compared to their female counterparts ($p=0.012$) between female that knew rubber tires were used at the abattoirs and males (see Table 4.6). There was also a statistical significance among the independent variable, age ($F(4,182)=3.056$, $p=0.018$). Tukey's HSD confirmed a statistical significance among those that were in the age groups 18-24 years old and 25-34 years old (see Table 4.7). The data showed that as the age increased, the frequency of

being aware of the tire usage significantly increased as well ($p=0.015$) (see Table 4.8). There was neither a significant relationship between the education levels ($F(8,176)=1.128$, $p=0.347$) nor income ($F(5,185)=1.46$, $p=0.197$) and knowing whether rubber tires were used at the abattoirs for the meat singeing process. Based on the survey respondents' answers, most of the participants were aware of the practice. The focus group participants echoed the same sentiment that they were aware that the tires were used. Not only were the respondents aware of the tire usage, they were familiar with the processing issues such as improper hygienic condition and the lack of running water. Various participants stated the following:

“Unlike other places, the tools are not well kept and.....during the processing are being left on the floor, are not being washed properly, here we know that they don't use disinfectant to control the place. After just washing it with ordinary water and they just leave it like that. So there are a lot of differences. The other places in terms of the covering, the setup, they're all loose. Sanitation becomes a challenge. Flies become perform the activity of hopping from one place to another and leave their eggs on the carcass. It differs from place to place. High standard areas like Kumasi and Accra.”

“They use tires to burn that and they use dirty water to burn the hair off of the goat or the cow you have to wash it and they don't use clean water to wash it.”

“I wish they had something like garage which where the fire will be and use firewood instead of the tires. Because they use tires most of the guys who do that are not clean. Their dresses, their shirts on because they say that's what we use to work, they hardly wash it. And it's not clean even, they don't use clean water to wash it.”

Table 4.4
Survey Participants Perception of the Most Commonly Used Fuel Source to Singe Meat in Kumasi and Cape Coast, Ghana

Variable	Frequency (n)	Percentage
Used rubber tires	79	40.3
Firewood	56	28.6
LPG (Gas)	15	7.7
Other	2	1.0
Tires & Firewood	19	9.7
Tires & LPG (Gas)	3	1.5
Tires Firewood Gas	10	5.1
Tire Firewood Gas Other	1	0.5
Firewood Gas	2	1.0
Firewood Other	1	0.5
Tire Firewood Other	2	1.0
Missing	6	3.1
Total	196	100

Table 4.5
Overall Awareness of Rubber Tire Usage in Abattoirs among Survey Participants in Kumasi and Cape Coast, Ghana

Variable	Frequency(n)	Percentage
Yes	149	76.0
No	42	21.4
Missing	5	2.6
Total	196	100

Table 4.6
Influence of Gender with Respect to Awareness of Tire Usage among Participants in Kumasi and Cape Coast, Ghana

Gender	Percentage	Significance ¹
Female	68	0.012*
Male	85	

¹Tukey's Post Hoc Analysis; *significance level $p < 0.05$

Table 4.7

Influence of Age with Respect to Awareness of Tire Usage among Participants in Kumasi and Cape Coast, Ghana¹

Age	18-24	25-34	35-44	45-45	55-64
18-24	--	0.015*	0.062	0.325	0.185
25-34	0.015*	--	0.999	0.975	0.909
35-44	0.062	0.999	--	0.995	0.882
45-45	0.325	0.975	0.995	--	0.809
55-64	0.185	0.909	0.882	0.809	--

¹Tukey's Post Hoc Analysis; *significance level $p < 0.05$

Table 4.8

Influence of Age with Respect to Awareness of Tire Usage among Participants in Kumasi and Cape Coast, Ghana

Age	Percentage
18-24	57
25-34	77
35-44	82
45-45	78
55-64	100

Research Question 3: What are the perceived health threats among participants surrounding the use of automobile tires to singe meat?

Many of the participants believed that burning used rubber tires could negatively affect human health (94.9%). Additionally, when asked if they were concerned that the practice of using the rubber tires to singe meat could negatively affect them, their families or their communities 91.8% answered yes, they were concerned. A focus group participant stated the following:

“Yeah, we know we, we care because it’s been on T.V., we’ve even discussed it in class in school so it means people are really concerned but what do you do about it?”

To further investigate the participants’ perception of the exposure; perceived health threats were also assessed. The health threats were measured by utilizing the constructs perceived susceptibility and perceived severity scales. Overall, 60.7% of participants perceived the consumption of tire-singed meat as a health threat ($p < 0.001$) (See Appendix E). The perceived susceptibility was utilized for respondents to indicate their perception of the risk associated with the practice. Among the survey participants, 70.4% agreed or strongly agreed that they were at risk of being exposed to some type of deleterious health effect from the practice of singeing meat with automobile tires. As shown in table 4.9, many of the respondents agreed (29.1%) or strongly agreed (50.0%) that they would experience some type of negative health impact over the next 5-10 years from being exposed to the practice singeing meat with used rubber tires. They also agreed (44.4%) or strongly agreed (39.8%) that they would likely become sick from eating meat singed with used car tires. Additionally, participants agreed (35.2%) or strongly agreed (36.7%) that they may suffer from cancers if they continue to consume meat singed with used rubber tires. A focus group participant added the following:

“...and they will be slaughtered and compromised in one way or the other they will affect the people who consume it and the system they use car tires, in burning the animals can predispose the consumers to some form of cancers. So this is some of the health implications.”

The perceived severity was utilized for respondents to express their perceptions of the seriousness of their exposures to contaminants via meat singeing or any consequences associated with this practice. Collectively, 60.4% agreed or strongly agreed that the associated health effects

would be severe ($p < 0.001$) (See Appendix E). Participants agreed (40.8%) and strongly agreed (27%) that their lives would change if they fell sick from the exposure about 42.9% agreed and 40.8% strongly agreed that they would experience serious health problems (see Table 4.9). Approximately, 42.9% agreed and 36.2% strongly agreed that they were fearful of the health impacts surrounding the consumption of meat singed with the used rubber tires. Additionally, One-Way ANOVA was used to determine if independent variables such as gender, education, age and income had an influence on perceived health threats. There was no significance among any of the independent variables and perceived health threats. The perceived susceptibility and perceived severity scales were also analyzed separately with each independent variable, there was no significance found among the variables.

Additionally, the participants in the focus group discussions were cognizant of potential health threats along with environmental threats from the singeing practice. Participants stated the following:

“I want to touch on the atmospheric conditions, it destroys our ozone layer, its adds another problem to us as humans. So I think it clearly tells us that the car tires create great danger for us.”

While focus group participants were concerned and aware about the potential health threats; they offered in-depth justification as to why that concern would not change the patronage of the practice from the community. The major reasons included issues such as individual attitude and cultural norms, cost effectiveness of using tires and the fact that the meat would be cooked. Participants stated the following:

“People don’t care so much about what they eat so they think “everything goes” attitude is still prevailing. So they go here and they find any meat and then they go in for.”

“If it would have killed me, it would have killed me a long time ago. That’s what they say.”

“And they go behind and they see those conditions I’m sure and they still don't mind because at the end of the day it’s going to be cooked. So we talk about the people who does those things but we also have us, those of us who think that when I take it to this guy I get it paid less than what I am being charged w/o really thinking about the conditions of where you are taking a lot of money The only thing is you know you are going to cook it at home. That is our consolation, if I, at the end of the day you will cook so it will kill a lot of these...”

Table 4.9
Perceived Health Threats among Survey Participants in Kumasi and Cape Coast, Ghana¹

Survey Item	Frequency (n) and (Percentage)					Mean	Missing
	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree		
There is a good chance that I will have negative health impacts in the next 5-10 years from the practice of singeing meat with used tires	98 (50.0)	57 (29.1)	14 (7.1)	13 (6.6)	9 (4.6)	4.1623	5 (2.6)
Very likely that I will fall sick from eating meat singed with used rubber tires	87 (44.4)	78 (39.8)	17 (8.7)	6 (3.1)	4 (2.0)	4.2396	4 (2.0)
I may get cancer if I continue to eat meat singed with rubber tires	72 (36.7)	69 (35.2)	38 (19.4)	6 (3.1)	3 (1.5)	4.0691	8 (4.1)
My whole life would change, if I fall sick from eating meat singed with used rubber tires	53 (27.0)	80 (40.8)	26 (13.3)	14 (7.1)	7 (3.6)	3.8778	16 (8.2)
I would experience serious health problems from eating meat singed with used rubber tires	80 (40.8)	84 (42.9)	18 (9.2)	6 (3.1)	3 (1.5)	4.2147	5 (2.6)
I am fearful about the health impacts of eating meat singed with used rubber tires	71 (36.2)	84 (42.9)	8 (4.1)	4 (2.0)	4 (2.0)	4.2515	25 (12.8)
Total							63

¹ Perceived susceptibility and severity were the constructs used to define perceived health threats

Research Question 4: What do participants perceive as barriers to minimizing their exposure to the consumption of tire-singed meat?

Survey participants indicated that one of the major barriers to minimizing their exposure to tire-singed meat was the difficulty in determining how the meat was singed (32.1% agreed; 37.2% strongly agreed); specifically distinguishing between gas, firewood and tires. Participants were also not aware of an area that sold meat singed exclusively with gas (35.7% agreed; 29.1% strongly agreed). According to the data participants were undecided (23.5%) if the cost of meat singed with gas or firewood was too much for them to afford. Most participants strongly disagreed (35.7%) and disagreed (18.9%) that social taunting from family and friends was a barrier for them when asking the butchers how the meat was singed before purchasing it (Table 4.10). Due to the low Cronbach's alpha for the perceived barriers scale, each question was analyzed separately to determine if there was a statistical significance among specific barriers and gender, education, age and income. One-Way ANOVA determined that there was significance between gender and the cost of meat singed with gas or firewood ($F(2,193)=3.21$, $p=0.042$). Descriptive statistics and Tukey's HSD post hoc analysis revealed that a significant percentage of women found cost of LPG- or firewood-based singed meat to be a barrier compared to men ($p=0.033$) (see Table 4.11). There were no statistical significant differences found between any of the six items in the construct and education, age or income.

The focus group participants introduced additional barriers such as the lack of political influence, the influence of law enforcement, lack of education, the difficulty of acquiring other products such as gas and firewood along with the cost incurred of options such as firewood or gas. Participants stated the following:

“...It has political dimensions to it, if you are the government and you want people to stop using lorry tires which are cheaper or they come at no cost. And now you want them to incur cost by buying gas. You know, they wouldn't like it. They would think that it's going to have a toll on their profit, they pick the tires for free now they are going to buy gas with money I mean it can make the government unpopular if you have such laws, it can but not now.”

“They can only hold us accountable once they have provided us with the gas and we still use the tires...other than that, they cannot hold anyone accountable for using tires to singe the meat. The government has any right to arrest the person using the tire instead of the gas. If the government provides them with the gas, then they will stop using the tires.”

Another participant also addressed proper enforcement of the laws and regulations:

“Government, see this is thing about African culture, if the government appoints me, to go and supervise I can even go there collect some money and put it in my pocket.”

“They literally threaten them (threaten the police). Because you cannot just condemn one animal as unfit for consumption, that is the thing...you are putting that person out of a job. That is what the person does for survival. So there are losses, specific losses. Until the government is ready to enforce the law, that is it.”

Participants offered the following statements addressing the difficulty in using other products such as firewood or gas.

“...So in the absence of the tire, you can use firewood, you can use gas but here you can't get it (gas). You see...and even in Ghana. Frustrations... you are not supposed to cut down trees... so how do get firewood?”

“Well apart from the gas...then its firewood ...ok... but you see, in Cape Coast for example.. you have to travel several miles away before you can get firewood ...you see...and even if you will get, on the way coming, police will ask you...will arrest you...take money and the rest and it's a challenge...so when it happens like that, will you go for it again?...no...”

Table 4.11
Influence of Gender with Respect to Perceived Barriers among Participants in Kumasi and Cape Coast, Ghana

Gender	Percentage	Significance¹
Female	37	0.033
Male	29	

¹Tukey's Post Hoc Analysis; *significance level $p < 0.05$

Research Question 5 What are the social normative factors among participants which influence the continued use of car tires to singe meat.

Social norms play a vital role in individual's behaviors and routine. One of the major social norms among the study participants was not asking the butcher how the meat was singed (89%). Focus group participants also agreed and explained that asking how the meat was processed would be frowned upon or insulting if they did ask the butchers. One participant stated:

“How can you go and ask, the butcher man will go and insult you. You can't even go and ask. So it's insulting to the butchers? They want to remain in business. They want to make money, so they will not tell you the truth.”

Survey participants also indicated that most individuals cannot normally see the difference in how the meat was singed rather with tires or other fuel sources (agreed 30%; strongly agreed 39.8%; 69.8%) (see Table 4.12). This finding was also indicated as a perceived barrier. Additionally, 39% agreed or strongly agreed that most people close to them thought they should not care how the meat was singed (43% disagreed or strongly disagreed) One-way ANOVA results revealed that there was a significance among education and the social norms scale $F(8, 181) = 2.024$, $p = 0.046$. Post Hoc analysis further determined where the significance lied and further mining of the data showed an indication of a possible inverse relationship between

the influence of social norms and education ($p < 0.05$). Specifically, as the education level increased the effect of the social norm began to slightly decrease (see Appendix G). Focus group participants had mixed opinions on this issue; some stated that you can see that the meat is darker due to the tar from the tires and the smell is stronger, while others stated that it is not discernible.

“Yes you can tell...those that they use the tire... you can feel... like you can smell the smoke...they look very black as compared to those that we use the firewood.”

“It depends on who is preparing it and if they were lazy in when dressing the meat. If the person did not wash it well then you will still smell the scent. They will prepare it in a way in which you won't smell anything at all.”

Focus group participants also raised the issue of the general attitude that the practice is what has been socially accepted in the area.

“...this is what they believe in, this is what is going on here. Even when we know things are wrong, that is what we're going to do .That's Africa.”

Participants agreed that educating the community on the practice and the possible health consequences will be important in altering the social norms regarding the practice.

“People don't care so much about what they eat so they think “everything goes” attitude is still prevailing. So they go here and they find any meat and then they go in for. But if they are educated, for them to realize that you know you may go in for a meat but it is a potential hazard that you are taking into your being, people will be aware and start to not patronize.”

“Yes, education will be a major impact, attitude, and they need enforcement. Education will come in, it's like we all know what's right. And if we enforce.

CHAPTER 5

DISCUSSION AND CONCLUSION

The purpose of this study was to explore the awareness and perception of Ghanaian citizens regarding the utilization of scrap tires to singe their meat. The study involved identification of the perceived health threats among study participants surrounding exposure to chemical contaminants associated with this practice. Additionally, recognizing the perceived barriers and social norms within the culture, which facilitate the continued utilization of the practice, was also addressed in the study. The final chapter provides the summary of the study and discussion of the findings. This chapter also includes the public health implications and recommendations, strength and limitations of the study and the conclusion.

The utilization of scrap tires to singe meat in Ghana is a complex issue which has to be addressed and understood from an ecological perspective including influences from the intrapersonal level, interpersonal, community, institutional and public policy levels (National Cancer Institute, 2005). The study design incorporated these factors through the use of quantitative and qualitative methods. The quantitative method consisted of a self-administered survey, which was completed by 196 study participants in Kumasi and Cape Coast. The qualitative portion included focus group interviews involving 37 participants from Kumasi, Cape Coast and Accra. The study included five research questions and utilized the Health Belief Model and social normative perspectives to guide the research and address awareness, perceived health threats, perceived barriers and social norms.

Both survey and focus group participants were in agreement that there was a high frequency of meat consumption in communities, especially beef; confirming that the

investigation into this practice was warranted. Most of the survey respondents (76%) were aware of the use of tires to singe meat at their local abattoirs/slaughterhouses. Results showed that men were more aware of the tire usage compared to women. Also, there was a direct relationship between age and awareness as well as education and awareness of tire usage for singeing meat intended for human consumption. Focus group participants were also aware of the practice and offered further details surrounding the physical conditions of the abattoirs/slaughterhouses. Focus group participants also offered justifications as to why the tires were being used. They suggested issues such as easy access to the tires, cost effectiveness of the tires and the lack of availability to alternative products (firewood or LPG), maximizing profit, increased processing time and efficiency in meat singeing, increased demand for meat, and individual perception.

Overall, participants were concerned about the potential health threats (60%) associated with the consumption of tire-singed meat. About 95% of the participants believed that burning used scrap tires could have some type of negative health impact on humans. While 79% of the respondents agreed or strongly agreed that they would personally experience negative health impacts from being exposed to the practice, approximately 83% agreed or strongly agreed that they would be sick from eating the meat, and about 72% agreed or strongly agreed that they may develop cancers from consuming the singed meat. Most participants (79%) were fearful of potential health impacts surrounding the consumption of meat singed with automobile tires. The focus group participants expressed similar concerns but raised additional topics regarding environmental effects. They also expressed that although the community was concerned, their actions will not change until there is an adjustment of attitude among citizens along with political support.

The barriers to minimizing the consumption of singed meat included issues such as: difficulty finding a location that sold meat singed with safe alternative fuel sources (65%), difficulty in differentiating between tire singed meat versus LPG singed meat, lack of political support, lack of appropriate law enforcement, lack of education and the expensive cost of using alternative sources. Social normative factors within the communities were issues such as purchasing the meat from the market without asking how it was singed and the general acceptance of the practice by many of the citizens.

The quantitative and qualitative results suggest that citizens of Cape Coast, Kumasi and Accra are aware of the practice and are concerned about the possible health impacts. Participants were very vocal about the issues and strongly believe that citizens need to be educated on the health effects. They also believe that the government needs to provide the financial support to enable the abattoirs/slaughterhouses to sustain the use alternative methods such as LPG.

Discussion

Meat Consumption

A significant number of survey participants (74%) and focus group participants confirmed that meat and meat products are heavily consumed throughout Ghana. Focus group participants offered justifications such as the inexpensive cost of purchasing meat and population growth as to why the consumption level of meat is high. These findings suggest influence from multiple factors at the intrapersonal, interpersonal and organizational levels of the social ecological model

Intrapersonal and Interpersonal Levels

Factors such as individual food norm or personal preferences and income/accessibility may play a role at the intrapersonal level in the decision to consume tire-singed meat. The survey respondents indicated their individual food norm as far as their consumption rate within a given time frame and their average monthly income. The majority of survey participants indicated that their average monthly income was less than GHC500 (less than \$156.76 monthly). The Ghana Statistical Service reported that the average annual household income is GHC 1,217 (GHC 101 monthly); with an average household size of 4.4 in 2010; which is a decline from 2000 with a reported size of 5.1 (Ghana Statistical Service, 2013). The survey participants' reported having about similar income to that of national income. Cost plays a major role in why meat products are consumed so heavily. Focus group participants explained, buying meat is cheaper and it can be used to sufficiently feed a larger number of people when compared to fish products. Studies have found that the cost of food products have spiked globally. Specifically in Ghana, the cost of beef in 2013 was GHC6.00 for one kilogram (2.2 pounds); it increased to GHC14 in 2014. Additionally, the family structure and some cultural practices pertinent to foods (such as food apportionment to immediate and/or extended family members) also serve as examples of the interpersonal level of the Social Ecological Model. Typically in the Ghanaian culture the family residing in a home consists of the extended family instead of the nucleated families (mother, father, and children). Therefore being able to provide for the increased amount of individuals may have an influence on the type of meat that is purchased (Annim, Awosabo-Asare, Amo-Adjei, 2014; Ghana Statistical Service, 2013).

Organizational Level

Population growth in certain areas was also identified among focus group participants as a reason for the increased demand for meat products. Ghana has experienced exponential population growth since the 1960's which is shortly after the country gained its independence from Britain (in 1957) (US. Central Intelligence Agency 2015; Ghana Statistical Service, 2013). As the focus group participants stated, the population size has a direct effect on the demand of meat products. Researchers suggest that an increase in population in certain developing countries and improvement of job acquisition and salary has led to the increase in demand for certain food products such as meat along with other foods (Cohen & Garret, 2015). Osei-Asare and Eghan (2014), found that beef is the most commonly purchased and consumed meat product in Ghana, and is followed by mutton/goat; which are both processed by local abattoirs/slaughterhouses. Researchers also found that the urban areas consume more of these meat selections than the rural areas; making the meat industry quite profitable in the urban areas of Ghana (Cohen & Garret, 2015; Osei-Asare & Eghan, 2014). Therefore, the abattoirs/slaughterhouses are trying to satisfy the demands of these urban populations while implementing the most economically feasible and profitable method for processing the meat.

Awareness of Tire Usage

Intrapersonal Level

Survey and focus group participants were largely aware that tires were used as a fuel source to singe meat products at the abattoirs/slaughterhouses. Results from the One-Way ANOVA revealed that variables such education, gender and age influenced awareness of tire usage at the abattoir/slaughterhouse. Although there was significance found among various

education levels among the participants, there was no clear direct or inverse trend regarding the influence of education which indicates that being aware of the use of tires may not be affected by one's education level. This finding suggest that one's education or lack thereof is not a barrier to being aware of this issue. This finding may also indicate that this issue is on a broader social or political scale and may be receiving increased attention from several outlets, therefore increasing the citizens' awareness. Gender also had an influence on awareness. Results showed that males had a higher frequency of being aware of the tires than the women. Although gender was statistically significant, the actual difference between the means of the two groups was small with an effect size of (.03) (Cohen, 1988). This small effect sizes indicates that there is not a large difference between the two groups; indicating that males and females may only be made aware of the tire/usage at slightly different rates. This finding may also be due to the increased number of male participants in the study as compared to the female respondents. Culturally and from the observations of the research team over the past two years, the actual slaughtering facility appeared to have a large male presence, witnessing very few women on-site. However, because the women play a large role in the daily meal preparation and purchasing of food items, they may be made aware of the usage of tires through other social venues such as family and friends or media. Age was also significant regarding awareness. Further analysis showed a direct relationship among age and awareness, as the age increased the percentage of those that were aware increased as well. This may indicate that there is a need for increased awareness among various age groups and may provide insight on what age group should be targeted when trying to implement an intervention. These findings are heavily influenced by factors at the intrapersonal level, for instance personal and biological history such as age, gender and education, as seen in

the results; are factors which may have an influence on one's health behavior at the intrapersonal level and ultimately affect their awareness and knowledge regarding certain health issues (CDC, 2015d).

Organizational Level

Focus group participants were aware of the tire usage and also cognizant of the unhygienic conditions of the abattoirs/slaughterhouses. The lack of clean water used at the abattoirs and slaughterhouses, the lack of a routine disinfection process, the lack of an appropriate employee personal hygiene practice, improper waste management and the presence of excessive flies in the area; were issues raised among the group discussion and further corroborated by scientific research in the area. For instance, Ofosu-Koranteng (2014), performed an evaluation on the hygienic conditions of an abattoir located in the Greater Accra region and highlighted the same issues. The researcher also tested the water which was being used for the routine operations of the abattoir (e.g., washing the singed meat, washing down slaughtering surfaces, etc.) and confirmed fecal coliform bacteria and E.coli. Both bacteria are introduced into water bodies from sources such as animal feedlots, sewer malfunction/overflow, and contaminated storm waters along with other sources (EPA, 2014g). These findings show the effects of organizational influences, because the workers are not provided with the proper equipment, training or slaughtering facility they are ultimately exposing the meat to additional contamination and adulteration.

The focus group participants offered reasons as to why the tires were used. Their reasons included the expensive cost of various fuel sources, efficiency of the tire based flames and limited accessibility to LPG or firewood. Participants stated that the tires are acquired at a very

low cost as compared to LPG and firewood. The abattoirs/slaughterhouses that have LPG in the urban areas are funded by private companies or by minimal government support (Frimpong, et al., 2012). However, sustaining the LPG still presents itself as a problem and once the LPG is depleted, some of the abattoirs/slaughterhouses resort to tire usage to complete their processing. Participants also mentioned that due to deforestation, firewood is not easily accessible and there are strict laws in place which govern those who have access to the firewood. Lastly, the efficiency of the tire based flames were raised; some of the participants stated that the tires can be used even in the rain, burning longer and twice as fast as firewood. These findings were similar to the findings of Amfo-Otu, Agyenim & Adzraku, (2014), where only butchers were interviewed in the study and asked to discuss why the tires were utilized instead of firewood and LPG they offered the same responses of the tires being easily accessible and having a lower cost.

Moreover, all of the explanations provided by the participants contributes to maximization of profit for the butchers, farmers and abattoirs/slaughterhouse operators. As mentioned previously the meat processing industry is a lucrative market in Ghana due to the increased demand for meat (Cohen & Garret, 2015; Osei-Asare & Eghan, 2014). Participants indicated that the tire is acquired at a lower cost compared to LPG or firewood, the tire is easily accessible and the tire burns much more efficiently and rapidly versus other alternatives. An additional issue that was raised by the focus group participants was that if the abattoirs or slaughterhouses were supplied with alternative methods, then this may jeopardize the workers' job and the butchers' profit margin. They also stated that the alternative methods may cause substantial increase in consumer prices of the meat.

Potential Health Threat

Intrapersonal Level

The potential health threats were measured through one's perceived susceptibility and perceived severity. Perceived health threats are influenced by factors at the intrapersonal level. One's perception of threat is often associated with behavior change, but that is not always the case. Generally, as the perceived risk increases, engagement in that certain health behavior also decreases (Hayden, 2009). Survey results indicated that 70% of the participants agreed or strongly agreed that they were at risk (susceptibility) of having some type of negative health effects from exposure to singed meat products. There were also 60% of the participants who agreed or strongly agreed that the potential associated health effects would be severe. According to Hayden (2009), one's perception of seriousness can be based on the beliefs surrounding any complications that the exposure/disease may create or the effects that the exposure will have on their lives. Additionally, there was no statistical significance difference found between perceived health threat and factors such as education, income, gender and age. These findings may indicate that it is regarded as a perceived health threat among all social classes and factors such as socioeconomic status, gender and age have very little influence over the perceived health threats regarding the negative health impacts of tire-singe meat.

However, focus group participants suggested that some citizens believe that they are not at any risk because cooking the meat takes care of anything hazardous in it. Researchers have found that cooking may increase or decrease the contaminant level (Adam, Okyere, & Teye, 2013; Domingo, 2011; Ganbi, 2010; He, Ke, & Wang, 2010; Perello et al., 2010). Moreover, the increase or decrease is attributed to factors such as the specific toxin, the cooking method (i.e., baking, grilling, steaming, frying, etc.) and the food item being prepared. Researchers have

found that those cooking methods that allow fat to be removed or released from the food item tend to reduce the total concentration of the toxin. However, it does not always reduce the contaminant level below the maximum permissible levels; rendering the food product still unsafe for consumption (Adam et al., 2013; Domingo, 2011; Ganbi, 2010; He et al., 2010; Perello et al., 2010). Focus group participants offered statements which suggest that even though the community has a high perceived threat, they will not alter their behavior until a catastrophic event occurs which scares the citizen away from consuming tire- singed meat. This concept aligns with the suggestion of Witte (as cited in Glanz, 2008, p. 62), who indicated that when the perceived threat is high, the perceived barriers may be the best predictor of behavioral change among the population.

Perceived Barriers

Policy Level

One of the major barriers among survey participants was not being able to determine if the meat had been singed with rubber tires, firewood or LPG (69%). This barrier received mixed responses among focus group participants. Some participants stated that yes one can tell from the color and smell, others suggest that one cannot. A previous abattoir/slaughterhouse employee suggests that it depends solely on how well the meat was washed after singeing. The employee stated that if the meat was washed poorly, then yes, the customer will still see and smell remnants from the tires on the meat. This finding is similar to other studies which found that Ghanaians typically purchase their meat and other foods based on observation of the meat product and the surroundings (Nkegbe, Aikins-Wilson, Assuming-Dediako, & Munkaila, 2013; Rhienlander, 2008). This appears to be a policy level issue regarding the lack of proper food

labelling of meat. Implementation of food labelling for certain foods or ensuring that the meat is acquired from approved sources aids in mitigating possible foodborne illnesses and contaminations (United States Food and Drug Administration, 2014) Survey participants also indicated that finding a location that sells meat singed with LPG was a barrier (65%), followed by having the means to get to a location which uses only LPG or firewood (55%), and living too far from a location that uses only LPG (42%) were all barriers. Studies have found that location does have an impact on one's food options regarding availability and access to certain foods. This lack of accessibility may have an overall effect on one's health and ultimately hinders their ability to choose healthier and safer options (Walker, Christopher, & Jessica, 2010; Coveney & Dwyer, 2008). Survey participants were not as concerned about the cost (29%) of buying meat that had been singed with LPG. This low level of concern regarding cost in this instance may be attributed to the fact that LPG-singed meat is not clearly differentiated from tire singed meat when purchased at the markets. Results from the ANOVA indicated that there was a significant difference among gender and cost of meat singed with alternative fuels sources as a barrier. Female participants perceived cost more as a barrier than the men. However the effect size was small (0.03) indicating that there was only a small difference between the two groups (Cohen, 1988). Similar to perceived health threats factors such as education, age, or income had no significance with any of the individual barriers in the scale.

Focus group participants also identified barriers such as lack of political support, law enforcement, education and the difficulty of sustaining the use of LPG and firewood along with cost of alternative methods. Lack of political support and lack of adequate law enforcement were the most discussed barriers among all focus groups. Participants truly felt that the only way

the abattoir/slaughterhouse operators would stop utilizing tires is when the government gets involved. They explained that the government has the power, through funding and law enforcement, to change the practice. They also expressed that without the government's financial support, sustaining alternative methods such as LPG would be an issue. Participants spoke of corruption within law enforcement, stating that bribery is a regular occurrence which lessens the effectiveness of the law. Influences from the policy level affects one's health behavior greatly, if the proper policies are not implemented or developed then individuals may not have the resources or tools necessary to make adequate health behavior choices.

Social Norms

Results of the study revealed an inverse relationship between education and the social norms scale indicating that as one's education increased the effects of the social pressures also decreased. Survey participants indicated social norms such as purchasing the meat without asking how it was singed (89%). The focus group participants shared that asking a butcher how the meat was singed is insulting to the butcher. They added that the butcher may become offended and run them off or the butcher will not tell the truth about how the meat is singed. Survey participants also disagreed or strongly disagreed (43%) that those close to them thought they should not care how their meat was singed. However, focus group participants felt as though many citizens had accepted that the practice is the norm in their area. This behavior coincides with social behaviorism where social norms are defined by behavioral regularities. Behavioral regularities refer to individuals making decisions based on the common behavior in their social environments (Morris, Hong, Chiu, & Liu, 2015). The participants explained that the citizens have the attitude that eating the meat hasn't caused them harm yet so they will continue

to consume the products. They also want to have scientific evidence which shows that consuming meat singed with scrap tires causes health effects before they change their habits. One's attitude along with other factors such as socioeconomic status, education, religious affiliation, personality and mood greatly influence their beliefs towards an issue (Glanz, 2008).

Strengths and Limitations

There were several strengths within the study. The initial strength is the use of a concurrent mixed methods design. This design allowed the researcher to collect both quantitative and qualitative data. The collection of both types of data provides for a robust study and allows the strengths of one method to overcome any weaknesses found in the other method. The study also analyzed the issues on an ecological perspective including intrapersonal, interpersonal, community and policy levels. Viewing the issues on various levels helped the researcher gain a broader perspective regarding the facilitators and barriers of the issue. The study utilized the Health Belief Model to quantify the perceptions of the citizens regarding singeing meat with rubber tires. Furthermore, the Health Belief Model is designed to aid in determining the individual's perceived threats and understanding the factors which influence the person's willingness to take action against their exposure. An additional strength included the researcher being able to create vital community partnerships and build cultural competence by visiting the same cities the year prior to research activities. The researcher was able to work with these contacts to aid in data collection and gain insight into the best practices within the culture. The researcher identified and conveyed some of the cultural norms and the practices witnessed at the abattoir/slaughterhouse which may have aided in fostering fluid and in-depth conversations in the focus group discussions. This may have also aided in the respondents having some level of

trust with the researcher making them more likely to provide honest responses regarding the issue. Overall, the focus group participants were open to discussion and provided valuable insight into the unspoken internal and external factors surrounding the use of tires to singe meat. This research also contributes to the body of knowledge in the scientific literature. To our knowledge, there are no publications which focus on the citizens' awareness and health perspectives regarding the practice of using rubber tires to singe meat. This particular research provides both the quantitative and qualitative information needed to aid in possible policy reform and or enforcement.

The research also had some limitations. One of the primary limitations was the short time frame in which the data were collected. All data were collected from July 1 - August 1, 2014. Due to the limited time frame and the inability to locate reliable maps for the survey areas, a convenience sampling method was utilized. This may have introduced a slight bias in the survey data. Convenience sampling only allow researchers to survey a certain portion of the population without randomization and may not have been representative of the entire population. Therefore, conclusions of the study may not be generalizable to the entire population and beyond. An additional limitation was the absence of incentives to complete the survey material. Many of the survey participants asked if there was any incentives given for completing the survey, offering incentives may have increased the number of participants exponentially. The researcher was not able to access the rural areas surrounding the cities that were surveyed. As discovered in the focus group interviews, rural residents may have a different perspective and experience with the issue. Lastly, the low Cronbach's alpha scores for some of the survey scales proved to be a

limitation. Future research needs to explore possible alternatives to Cronbach's alpha or modify survey questions.

Public Health Implications and Recommendations

The current research demonstrates that factors such as socioeconomic status, age and gender do not influence most participants' awareness of the use of rubber tires to singe meat or perceived health threat. Most participants are aware and perceive it to be a potential health threat. Furthermore, understanding that one's quality of life relies on different community systems and influences such as individual attitudes and beliefs along with policies or lack thereof; altering the current political systems or enforcing those systems to protect the population would be ideal for this health threat. To our knowledge there are currently no national laws which prohibit the use of tires to singe meat. The information from this study could be used as a basis for a more comprehensive research using probability sampling methodology and also aid in initiating the necessary policy reform.

The findings also suggest that there are immediate occupational health concerns which should be addressed. For instance the lack of appropriate PPE, washrooms and clean water increases the employee's risk of direct exposure to contaminants which may lead to unfavorable acute and/or chronic health conditions. Occupational health should be addressed by starting with simple changes such as access to clean water, and basic PPE such as gloves and mask, which could be implemented to improve worker safety.

Community Mobilization

Among the study participants, there appeared to be a lack of community empowerment along with a gap in community mobilization. Community mobilization refers to communities

identifying and taking action to address a common concern. Methods of mobilization include community organization and community advocacy (McKenzie, Neiger & Thackeray, 2013). Individuals involved in the focus group discussions were aware of the perceived health threat; however overcoming the indicated barriers did not appear to be attainable or an achievable goal for the participants. The participants suggested that the change starts at the top with the policies, and laws. However, in order for the communities concerns to be heard there has to be some ground work done to strengthen the legitimacy of the case. This groundwork can begin through community organization which entails community groups bannng together to isolate common problems, pool resources and develop strategies to address the problem and reach the common goal (McKenzie et al., 2013). This community organization can be aided through community advocacy which refers to the community actions causing or facilitating social, environmental, or organizational change. Citizens should be made aware of their influence and power regarding the issue and begin to partner with the necessary entities to begin changing factors which impact their lives (Laverack, 2008). One of the steps to being successful in community organization and advocacy is to build and foster community participation along with key partnerships. Research has found that individuals stand a greater chance of obtaining their health goal if they have participants/advocates who are also affected by the same or similar issue (Laverack, 2008). Community partnerships are also vital in this situation. Partnering with various entities such as non-profit organizations, hospitals and academic institutions will also provide the community with the confidence needed to address this issue. There are institutions within their areas that have already begun to investigate this specific issue and can aide in providing any necessary scientific information (Amfo-Otu et al., 2014; Adam et al., 2013; Obiri-Danson et al., 2008).

Education

Not all community members are aware or concerned about the health effects surrounding tire usage, therefore the message has to be tailored and delivered broadly. Participants suggested that the education begin in the schools and eventually integrated into the curriculums. This integration could be done on a broader scale, and include food safety issues such as proper hygiene and contamination issues using the practice of singeing meat with tires as a practical example. Studies have found that the most effective food safety program in schools were those that incorporated authentic experiences rather those that were classroom lecture based courses (Faccio et al., 2013; Deale, 2010). Furthermore, the education should also reach those that are not in the school settings. Healthy People 2020 suggest that education and community based programs should be broad and be designed to reach those in nontraditional settings such as worksites, private health care facilities, and throughout communities. Targeting a wide range of settings allows for the information to reach those in multiple social structures and ultimately maximizes the impact of the information. It may also provoke information sharing throughout the community during routine social interactions. Fostering much needed conversations and countering misguided or misinformed information regarding possible health effects of tire-singed meat. Additionally utilizing existing communication outlets such as radio and television programs may also serve as an avenue to reach a vast amount of individuals.

Alternatives to Tire Usage

One of the primary factors in ending the use of tires is finding an acceptable and affordable alternative to the tires. The current alternative is the use of LPG, the facilities which utilize this method are normally larger abattoirs/slaughterhouses that are funded by the

government or private companies (Frimpong et al., 2012). Additional alternative options include burning other materials such as palm tree products (i.e., palm oil, leaves, and shells). Studies have found that palm tree waste such as leaves, sheaths, kernels and petioles can possibly be used as a bioenergy source to produce electricity or as fuel to burn products such as bricks (Mallaki & Fatehi, 2013; Razuan, Finney, Chen, Sharifi & Swithenbank, 2011). Investigating the use as fuel sources is a viable option. Additional alternatives include solar powered energy and industrial machinery, all of which would require substantial funding to be sustainable.

Future Research

- Re-evaluate the psychometrics of the survey instrument to improve the reliability of each scale. The current survey results can be used as an instrument to guide the researcher in the development of the modified scales.
- Expand the research to the rural areas of Ghana and compare their perceived health threats and barriers surrounding the use of tires to singe meat.
- Expand the research into other countries to determine if the utilization of automobile tires to singe meat intended for human consumption is an issue in other locations.
- Investigate cost effective and sustainable alternatives of singeing meat products.
- Explore the occupational setting of the practice, focusing mainly on the employees and the health hazards presented onsite. Expansion of the research should include collection of hair, urine and/or blood samples to determine certain toxicity levels.
- Collect and test tire-based singed meat samples and analyze tire-derived smoke for additional assessment of contaminants.

Conclusion

As mentioned previously, to our knowledge, there are currently no mixed methods studies focusing on the awareness and perception of at the population level regarding the practice of using tires to singe meat. Many of the chemicals released from open tire burning can cause acute and/or chronic adverse health effects such as various cancers, increased incidence of diabetes, respiratory and neurological issues and are endocrine disruptors along with being teratogenic. Understanding the perceptions of the citizens regarding the issue will allow researchers and communities to identify the target areas to which attention should be focused in order to alter the practice. Many of the participants are aware of the practice and find it to be a substantial health threat; however, there is seemingly social and political acceptance of this practice and exposure to chemicals via the tire-singed meat or the effects of burning the tires is seemingly unavoidable. Therefore, a systemic cultural shift or adjustment is necessary to address this persistent problem. Knowing that there are several major factors which play a role into why the practice still exists, the situation must be approached carefully and strategically, to properly resolve the issue. The quantitative and qualitative information from this research offers valuable insight into the citizen's awareness and perception of the practice. Although the results cannot be generalized to the entire population, they provide key concepts and ideas which can be used to further investigate the issue in more robust studies with probability sampling methodology.

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APPENDIX A

Informed Consent forms for:
Survey &
Focus groups

COLLEGE OF Public Health

DEPARTMENT OF (Environmental Health)

**GUIDELINES FOR
MODEL INFORMED CONSENT-Survey Instrument****1. Research Investigators**

Tempest Hill is a second-year public health Doctoral candidate at Georgia Southern University's Jiann-Ping Hsu College of Public Health. She is doing research in Ghana as part of the Ghana Study Abroad Program, under the supervision of Evans Afriyie-Gyaww, PhD, MPH Assistant Professor in the College of Public Health,

2. Purpose of Study:

The purpose of this research is to explore the community's perception concerning the practice of using automobile tires to singe meat for human consumption, also to further determine if they perceive the act as a potential health threat and to discover the social factors that facilitate the practice of using automobile tires to singe meat.

The purpose of these focus groups is to obtain information from selected participants from the community. The information collected will provide further insight into why the practice of using automobile tires to singe meat product is utilized in the area. It will provide a contextual view of the issue, which may be missed when using quantitative methods alone.

3. Procedures:

The focus groups will be conducted in Kumasi and Cape Coast and will be tailored to consumers, health officials and the general population. It will explore the social normative factors that facilitate the usage of the tires or those factors that act as barriers for stopping the use of the tires. Pictures showing how the tires are set up and the area around the site where the tires are burned will be shown to elicit conversation and act as probes. No faces will be identified in any of the pictures. A focus group is a group discussion led by a trained facilitator and includes 8 to 10 of your peers. The focus group will last from one hour to two hours and will be audio-recorded.

4. Discomforts and Risks:

This is considered a minimal psychological risk study with minimal psychological risks as the focus is on the perception of the community. Some participants may experience minor discomfort discussing their views on the issue. The risk of disclosure by other participants in the focus group cannot be prevented.

5. **Benefits:**

Focus group participants will gain the ability to express their thoughts on an issue that is relevant in their community and contribute to the overall purpose of the study which is exploring and understanding perceptions concerning the singeing of meat with tires. This research will also help facilitate educational activities to consumers about the potential public and environmental health impacts associated with the process of singeing meat with used car tires and other exposure scenarios – including consumption of meat smoked with used car tires.

6. **Duration/Time required from the participant:**

Focus group: 60 min to 120 min

7. Community participants will be chosen to join in a focus group discussion. Focus groups will last no more than 60 minutes to 120 minutes depending on the participant group.

The total time required from the participant could be anywhere between 60 to 120 minutes.

8. **Statement of Confidentiality:**

Your responses will be kept confidential. Only the research team will have access to the information related to the study. Transcripts from focus groups will be stored on the PI's password protected computer. The focus group discussions will be recorded, and the audio recordings will be destroyed after transcripts are created. The focus group transcripts will be kept on a password protected computer for a period of 7 years. After which all files will be destroyed. Confidentiality can only be promised by the investigators and not for the other participants in the focus groups.

9. **Right to Ask Questions:**

You have the right to ask questions and have those questions answered. If you have questions about this study, please contact Dr. Evans Afriyie-Gyawu whose contact information is located at the end of the informed consent. For questions concerning your rights as a research participant, contact Georgia Southern University Office of Research Services and Sponsored Programs at 912-478-0843.

10. **Compensation:**

Participants will not receive incentives for participation in the surveys; participation will be completely voluntary.

11. **Voluntary Participation:**

. It is your right to choose to participate or not, and after you decide to participate, you may choose to discontinue or withdraw your participation at any time should you become uncomfortable during the study. Also, you can decline to answer specific questions in the survey if you so choose. The principal investigator of this research reserves the right to terminate your participation if your participation will disrupt the progress of the study. If you have any questions or concerns, please contact Dr. Evans Afriyie-Gyawu.

12. **Penalty:**

There is no penalty for deciding not to participate in the study; you may decide at any time you

do not want to participate further. There is no penalty or retribution for withdrawing from this study.

13. Disclaimer:

You must be 18 years of age or older to consent to participate in this research study. If you consent to participate in this research study and to the terms above, please sign your name and indicate the date below

You will be given a copy of this consent form to keep for your records. This project has been reviewed and approved by the GSU Institutional Review Board under tracking number H_____.

Title of Project: Use of scrap tires for smoking meat in developing countries: Public health concerns

Principal Investigator: Evans Afriyie-Gyawu
P.O. Box 8015
Georgia Southern University
Statesboro GA. 30460

Other Investigator(s): Tempest Hill, Dr.PH student JPHCOPH
Faculty Advisor: Evans Afriyie-Gyawu
P.O. Box 8015
Georgia Southern University
Statesboro GA. 30460

Participant Signature

Date

I, the undersigned, verify that the above informed consent procedure has been followed.

Investigator Signature

Date

COLLEGE OF Public Health

DEPARTMENT OF (Environmental Health)

**GUIDELINES FOR
MODEL INFORMED CONSENT-Focus Group****14. Research Investigators**

Tempest Hill is a second-year public health Doctoral candidate at Georgia Southern University's Jiann-Ping Hsu College of Public Health. She is doing research in Ghana as part of the Ghana Study Abroad Program, under the supervision of Evans Afriyie-Gyauw, PhD, MPH Assistant Professor in the College of Public Health,

15. Purpose of Study:

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The purpose of these focus groups is to obtain information from selected participants from the community. The information collected will provide further insight into why the practice of using automobile tires to singe meat product is utilized in the area. It will provide a contextual view of the issue, which may be missed when using quantitative methods alone.

16. Procedures:

The focus groups will be conducted in Kumasi and Cape Coast and will be tailored to consumers, health officials and the general population. It will explore the social normative factors that facilitate the usage of the tires or those factors that act as barriers for stopping the use of the tires. Pictures showing how the tires are set up and the area around the site where the tires are burned will be shown to elicit conversation and act as probes. No faces will be identified in any of the pictures. A focus group is a group discussion led by a trained facilitator and includes 8 to 10 of your peers. The focus group will last from one hour to two hours and will be audio-recorded.

17. Discomforts and Risks:

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18. Benefits:

Focus group participants will gain the ability to express their thoughts on an issue that is relevant

in their community and contribute to the overall purpose of the study which is exploring and understanding perceptions concerning the singing of meat with tires. This research will also help facilitate educational activities to consumers about the potential public and environmental health impacts associated with the process of singeing meat with used car tires and other exposure scenarios – including consumption of meat smoked with used car tires.

19. Duration/Time required from the participant:

Focus group: 60 min to 120 min

20. Community participants will be chosen to join in a focus group discussion. Focus groups will last no more than 60 minutes to 120 minutes depending on the participant group.

The total time required from the participant could be anywhere between 60 to 120 minutes.

21. Statement of Confidentiality:

Your responses will be kept confidential. Only the research team will have access to the information related to the study. Transcripts from focus groups will be stored on the PI's password protected computer. The focus group discussions will be recorded, and the audio recordings will be destroyed after transcripts are created. The focus group transcripts will be kept on a password protected computer for a period of 7 years. After which all files will be destroyed. Confidentiality can only be promised by the investigators and not for the other participants in the focus groups.

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24. Voluntary Participation:

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25. Penalty:

There is no penalty for deciding not to participate in the study; you may decide at any time you do not want to participate further. There is no penalty or retribution for withdrawing from this study.

26. Disclaimer:

You must be 18 years of age or older to consent to participate in this research study. If you consent to participate in this research study and to the terms above, please sign your name and indicate the date below

You will be given a copy of this consent form to keep for your records. This project has been reviewed and approved by the GSU Institutional Review Board under tracking number H_____.

Title of Project: Use of scrap tires for smoking meat in developing countries: Public health concerns

Principal Investigator: Evans Afriyie-Gyawu
P.O. Box 8015
Georgia Southern University
Statesboro GA. 30460

Other Investigator(s): Tempest Hill, Dr.PH student JPHCOPH
Faculty Advisor: Evans Afriyie-Gyawu
P.O. Box 8015
Georgia Southern University
Statesboro GA. 30460

Participant Signature

Date

I, the undersigned, verify that the above informed consent procedure has been followed.

Investigator Signature

Date

APPENDIX B

Survey Questions used in the Study

USE OF SCRAP TIRES FOR SINGEING MEAT IN DEVELOPING COUNTRIES: PUBLIC HEALTH IMPLICATIONS

You are invited to participate in a study conducted by Dr. Evans Afriyie-Gyawu, Assistant Professor at Georgia Southern University (GSU), Georgia, USA; in collaboration with Dr. Ahmed Adu-Oppong, Chair - Dept. of Comm. Med. Univ. of Cape Coast, Cape Coast, Ghana. The purpose of this survey is to determine participants' knowledge and perceptions on: 1) meat processing operations using scrap rubber tires for singeing meat, 2) why this method is used, and 3) potential health consequences associated with this procedure. Please note that your participation is voluntary and you may stop at any time; data that we gather from you will not be linked to your name or other personal information. Your information will not be shared with any other person. The Institutional Review Board at GSU has reviewed and approved this research. Should you have any questions, please ask the person administering this survey or contact Dr. Afriyie-Gyawu [Ph: Email: evansafriyiegyawu@georgiasouthern.edu]. We appreciate your participation. Thank you!!!

Questions 1-6: Demographics

1. What is your gender?
 - Female
 - Male

2. To which of the following age groups do you belong?
 - 18 – 24 yr.
 - 25 – 34 yr.
 - 35 – 44 yr.
 - 45 – 54 yr
 - 55-64 y
 - ≥65 yr
 - Decline

3. What is the highest degree or educational level you have completed? *If currently enrolled, indicate highest degree.*
 - No schooling completed
 - Nursery school to JHS
 - Some secondary school, no diploma
 - Secondary school graduate, diploma or the equivalent
 - Some University credit, no degree
 - Trade/technical/vocational training
 - Associate degree
 - Bachelor's degree
 - Master's degree
 - Professional degree
 - Doctorate degree

4. What is your current marital status?
 - Single
 - Married
 - Divorced
 - Separated
 - Widowed

5. What is your total monthly household income?

- Less than GHC 500 GHC 500 to GHC 999 GHC 1,000 to GHC 4,999
 GHC 5,000 to GHC 8,999 GHC 9,000 to GHC 14,999 GHC 15,000 or more

6. What is your occupation?

Questions 7-13: Addressing knowledge and concern about the practice

7. What is/are the most commonly used fuel sources for fur removal (or singeing) by most slaughterhouses after animals are slaughtered? (**Check all that apply**)
- Used rubber tires firewood LPG (Gas) Other
 (**Specify**) _____
8. Do you know if slaughterhouses and/or abattoirs use rubber tires (used) for singeing the meat sold in the markets and/or your community? –Categorical Variable
- Yes No
9. Are you concerned that the practice of singeing meat with used rubber tires can negatively affect you, your family and community now or in the future?
- Yes No
10. Do you believe that burning used rubber tires could negatively affect **human health**?
- Yes No Not sure
11. Are you concerned about potential negative impact(s) of used rubber tire burning on **human health**?
- Yes No Not sure
12. In the past three months, which of the following best describes the number of times that you have eaten meat/hide that was singed?
- Never Once 2-6 times 7-12 times
 >12 times
13. Do you know of any laws/policies that address the issue of burning used rubber tires to singe meat? - Categorical
- Yes No Not sure
14. Compared to other individuals in your age group, how often do you fall sick?
- Much less often Less often As often More often Much more often

Questions 14-39: Measuring the Health Belief Model and Social Norms

Directions: For each question, please check the box that applies to you	Strongly Agree (5)	Agree (4)	Undecided (3)	Disagree (2)	Strongly Disagree (1)
15. There is a good chance that I will have negative health effects in the next 5 – 10 years from the practice of singeing meat with used rubber tires					
16. It is very likely that I will fall sick from eating meat singed with used rubber tires					
17. I may get cancer if I continue to eat meat singed with used rubber tires					

Directions: For each question, please check the box that applies to you	Strongly Agree (5)	Agree (4)	Undecided (3)	Disagree (2)	Strongly Disagree (1)
18. My whole life would change, if I fall sick from eating meat singed with used rubber tires					
19. I would experience serious health problems from eating meat singed with used rubber tires					
20. I am fearful about the health impacts of eating meat singed with used rubber tires					

Directions: For each question, please check the box that applies to you	Strongly Agree (5)	Agree (4)	Undecided (3)	Disagree (2)	Strongly Disagree (1)
21. If I exclude meat singed with used rubber tires from my diet, it will prevent future health problems					
22. It tastes better to eat meat singed with fuel sources other than used rubber tires					
23. The practice of singeing meat with fuel sources other than used rubber tires will help reduce air pollution					

Directions: For each question, please check the box that applies to you	Strongly Agree (5)	Agree (4)	Undecided (3)	Disagree (2)	Strongly Disagree (1)
24. It cost me too much to buy meat that has been singed with gas or firewood					
25. I cannot determine if the meat I eat has been singed with rubber tires, firewood or gas					
26. I do not know where to purchase meat that has not been singed with rubber tires					
27. I do not have the means to get to an abattoir or slaughterhouse that uses only gas to singe meat					
28. I live too far to get to an abattoir or slaughterhouse that uses only gas to singe meat					
29. My friends and family will tease me if I asked for meat that is not singed with rubber tires					

Directions: For each question, please check the box that applies to you	Strongly Agree (5)	Agree (4)	Undecided (3)	Disagree (2)	Strongly Disagree (1)
30. I look for information about used rubber tire burning and the possible health impacts					
31. I feel it is important to know the policies on the practice of burning rubber tires in Ghana					
32. I feel that it is important to eat meat that has been processed without using rubber tires					

Directions: For each question, please check the box that applies to you	Strongly Agree (5)	Agree (4)	Undecided (3)	Disagree (2)	Strongly Disagree (1)
33. I am confident that I know how to identify meat singed with used rubber tires					
34. I will start asking how meat is singed before buying it					
35. I stay away from areas where burning of used rubber tires take place, to avoid negative health effects from the practice					

Directions: For each question, please check the box that applies to you	Strongly Agree (5)	Agree (4)	Undecided (3)	Disagree (2)	Strongly Disagree (1)
36. Most people who are important to me think that I should not care about how my meat is singed					
37. It is typical of me to buy raw meat without asking how it was singed					
38. My community normally does not see the difference between meat singed with rubber tires vs. other fuel sources					
39. My family typically buys meat that has been singed					

APPENDIX C

Focus Group Script used in the Study

Welcome and Introduction:

- Good Afternoon, my name is Tempest Hill. I am a Georgia Southern University student and I would like to welcome you our meeting today, thank you all for coming.
- Our meeting today is concerning the practice of using scrap tires to singe meat products.
- My partner, Dr. Evans will help with the group today he is a Georgia Southern University Professor
- The purpose of today's meeting is to obtain information from you all concerning your feelings about using scrap tires to singe meat, why it happens and why it has not been stopped.
- I am here to listen. Everyone's opinion is very import to us. There is no right or wrong answer. I am interested in negative comments as well as positive comments.
- Your participation is completely voluntary. You have the right to stop participating at any time. Just let Dr. Evans know and he will assist you.
- I plan to audio record the discussion today so that I can capture everything that has been said. Because I am using the recorder I ask that everyone please speak up and for only one person to speak at a time.
- Everything said in this focus group today will be kept strictly confidential; your names will not be attached to any of the comments or transcripts.
- The meeting will last about an hour to an hour and a half. Thank you and let's get started.

I'd like to go around the room and get to know you better. Please tell the group your first name, what area you are from, and what you enjoy about living that area.

The first part of today's session will address your overall thoughts about the slaughterhouses in your area?

1. When I say slaughterhouse or abattoir what's the first thing that comes to your mind?
2. Based on your experience, what are the conditions at the slaughterhouse/ abattoir?
 - a. Were there any improvements that should be made from what you witnessed or know of the facilities or conditions?

- b. What factors would make it hard for the facility to make those improvements?

Now in this section we will talk about the process used at the slaughterhouse/abattoir

3. At the local slaughterhouse/abattoir what are the methods that are used to help remove fur from the animals? Is it by using gas, tires, or firewood?

Follow-up: Let's address each method, which works the best and why?

4. When I show you this picture (Figure 1), what is the first thing that comes to your mind?

Probes: What is this from?

Probes: What are your thoughts about being near this and your health?

Probes: What are your thoughts on what this does to the environment?

Probes: How often have you seen something like this?

5. Let's look at the next two pictures (Figure 2-3), what are your thoughts on why tires are being used to singe meat?

Follow-up: Explain what would make it easier for people not to use tires to singe meat?

What are some things that make it harder for people to stop using tires to singe meat?

In the third section we will address how the group feels about the process?

6. How do you all feel about the practice of using tires to smoke meat? How do you think the community or your family feels about the practice?

Follow-up: Do you think you are well-informed about the potential health effects concerning the use of scrap tires to singe your meat?

7. What are your ideas/ recommendations on how to improve the method?

Probe: Do you think the method should be changed? Why or Why not?

Probe: What can be done? Is there anything that can be done?

Follow-up: How long do you think it will take for the practice to be changed? Or do you think it will ever change?

8. What can be done to overcome any barriers or constraints to improving or changing this method?

Wrap-up of Discussion:

This concludes our formal line of questions. Is there anything you think I should have asked you

but did not? Is there anything else anyone would like to say or add that has not already been mentioned today?

Closing:

I would like to thank you all for coming today and sharing your thoughts with us. You have really given us some interesting information that will be very useful to understanding why the process is used and the community's perception of the practice of using scrap tires to singe meat. We will be compiling all your comments and sharing what we found with members of the community. Again, thank you for your time.

**All photos belong to the researcher and were taken in the field 2013.*



Figure 1:



Figure 2:



Figure 3:

APPENDIX D
Chemicals Emitted from
Open Tire Burning
and Associated Health Effects

Chemicals Emitted from the Open Tire Burning and Associated Health Effects

Chemical	Health Effects	Reference
<i>Criteria Air Pollutants/Gases</i>		
Nitrogen Oxides (NOx)	Lung, eye, throat and nose irritant may cause shortness of breath, fatigue & nausea. Low levels of Exposure: Fluid build-up High levels exposure: Burning or swelling of throat tissues, decreased oxygen in body tissues, fluid build-up in lungs and even death; Dermal effects such as skin burning	ATSDR, 2002b
Sulfur Dioxide	SO ₂ is a nose and throat irritant; Obscure breathing; May affect lung function	ATSDR, 2011c
Carbon Monoxide (CO)	Death: reduction of oxygen in the blood. Low levels may cause heart and brain damage High levels of exposure: CO binds with hemoglobin and forms carboxyhemoglobin (COHb). COHb reduces oxygens carrying capacity of blood leading to hypoxia. CO may also cause cellular injury or dysfunction	Giles and Koehle, 2014
<i>Volatile Organic Compounds (VOCs)</i>		
Benzene	CARCINOGENIC TO HUMANS Inhalation of high levels of benzene: dizziness, drowsiness, headaches, confusion, unconsciousness, death Ingestion: vomiting, sleepiness, convulsions, death Long-term effects: affects bone marrow leading to decrease in red blood cells (anemia) Affects the immune system Irregular menstrual periods decreasing the size of ovaries; Linked to Leukemia	CDC, 2013a
Toluene	Fatigue, headache, decreased manual dexterity, subtle changes in neurological functions including cognitive and neuromuscular performance, respiratory, cardiovascular, hematological, musculoskeletal, hepatic, renal, endocrine, gastrointestinal, dermal and ocular effects	ATSDR, 2014d
Xylene	Acute Effect: Eye, skin, nose, throat and mucous membrane irritant, impaired respiratory function nausea, vomiting, impaired short-term memory & reaction time Chronic Effect: Central nervous system effects such as headaches, tremors, mental confusion, narcosis dizziness. Neurological effects such as anxiety, forgetfulness, inability to concentrate, sensation of intoxication; Possible effects on the kidneys Increased risk of spontaneous abortions; Developmental effects	ATSDR, 2014e; EPA, 2013c
1,3-Butadiene	CARCINOGENIC TO HUMANS Acute Effects: Eye, throat, lung and nasal passage irritant Neurological effects such as fatigue, blurred vision, headache and vertigo Chronic Effect: Increase in cardiovascular diseases Effects on the respiratory and cardiovascular systems also affects the blood and liver Linked to Leukemia	EPA, 2013d

Chemicals Emitted from the Open Tire Burning and Associated Health Effects (Cont.)

Chemical	Health Effects	Reference
<i>Poly aromatic Hydrocarbons (PAHs)</i>		
PAHs Can Exist in over a 100 combinations	Benzo [a] pyrene: CARCINOGENIC TO HUMANS Dibenz[a,j]acridine: Probably Carcinogenic Dibenz[a,h]anthracene: Probably Carcinogenic Dibenzo[a,l]pyrene: Probably Carcinogenic	IARC, 2014b; EPA, 2007e
PAHs	Slightly mutagenic, effects on the pulmonary, gastrointestinal, renal & dematologic systems Inhalation Effects: breathing problems, chest and throat irritation, coughing, chest pains, bloody vomit bronchiovascular markings and pleural effusions Have been linked to increase incidence of breast, lung, skin, bladder and colon cancers in humans BaP exposure in children forms BaP-DNA adducts which can lead to errors in DNA replication along with increased cancer risk Effects on the development and function of the immune system, decreased birth weight and may case reduced fertility	IARC, 2014b; EPA, 2007e
<i>Polychlorinated Biphenyls(form of dioxins)</i>		
PCBs	A total of 209 PCB congeners approximately 14 are Carcinogenic to Humans PCBs Leads to skin conditions such as acne and rashes. Alters blood and urine those alterations may indicate liver damage Causes infants to have low birth weight; affects motor skills, short-term memory and affects the immune system Linked to cancer of the liver and biliary tracts	IARC, 2014b ATSDR, 2014f
<i>Heavy Metals</i>		
Arsenic	CARCINOGENIC TO HUMANS Acute Effects: bloody diarrhea, nausea and vomiting, shock, hypotension, vasodilation, delayed cardomyopathy, encephalopathy Chronic Effects: patchy skin hyperpigmentation, skin lesions, hyperkeratosis (appears as small corn-like elevations, focal keratoses, cirrhotic portal ; hypertension; renal effects, muscular weakness, cramps, tenderness, numbness; effects respiratory and hematopoietic systems; anemia and leukopenia, hepatic lesions, localized edema, fatty degeneration of the heart, hemorrhagic gastroenteritis, hepatitis Arsenic is also teratogen which readily crosses the placental barrier Linked to lung, skin, prostate, kidney , liver and bladder cancer	American Cancer Society, 2014 ATSDR, 2010g
Cadmium	CARCINOGENIC TO HUMANS Acute Effects: vomiting, diarrhea; found to be a stomach,bronchial and pulmonary irritant, even death, Chronic Effects: Inhalation of cadmium at low levels for long periods of time may lead to kidney disease, causes the bones to become fragile and can easily break; also causes bronchiolitis and emphysema Reduces birth weight, possibly a reduction in sperm numbers	ATSDR, 2014h EPA, 2013f

Chemicals Emitted from the Open Tire Burning and Associated Health Effects (Cont.)

Chemical	Health Effects	Reference
<i>Heavy Metals</i>		
Mercury	<p>Acute Exposure: nausea, vomiting, diarrhea, increased blood pressure and heart rates; lung damage, skin rashes, and eye irritation</p> <p>High level exposure may lead to effects on brain function such as tremors, memory problems, alterations in vision, and hearing; permanent damage to the brain, kidney and developing fetus</p> <p>Effects on children: mercury passes to the fetus and may cause mental retardation, incoordination, blindness, seizures, inability to speak, brain and kidney damage. Also developmental problems in the nervous and digestive systems</p>	ATSDR, 2013i
Chromium VI	<p>CARCINOGENIC TO HUMANS</p> <p>Respiratory effects include irritation of the lining of the nose, runny nose, asthma, coughing, shortness of breath, wheezing, development of allergies such as skin rashes</p> <p>Gastrointestinal effects such as stomach and small intestine irritation and ulcers, anemia</p> <p>Damage to sperm and the male reproductive system</p> <p>Linked to lung cancer</p>	ATSDR, 2014j
Lead (Pb)	<p>The early stages of lead poisonings consist of persistent fatigue irritability loss of appetite stomach discomfort and/or constipation, reduced attention span, insomnia</p> <p>Lead poisoning if not treated may lead to poor muscle coordination nerve damage to the sense organs and nerves controlling the body increased blood pressure hearing and vision impairment</p> <p>It may also lead to decreased sperm count, and impaired fetal development</p> <p>Children may also experience damage to the brain, liver, kidney and nervous system, anemia, hearing loss, behavioral problems, hyperactivity, developmental delays and even death</p>	EPA, 2013g
Particulate Matter	<p>PM exposure is associated with respiratory and cardiovascular conditions such as myocardial infarction, stroke, atherosclerosis, bronchitis, and asthma, nonfatal heart attack, irregular heartbeats, decreased lung function, coughing</p>	Giles and Koehle, 2014; EPA, 2014h

APPENDIX E

One Sample T-test

Research Question 2 and 3

One-Sample t test for Research Questions 2 and 3

Variable	df	t	Sig. (2-tailed)	Confidence Interval (lower-upper)
Aware of Tire Usage in the abattoirs	190	23.95	0.00	(0.6606-0.7792)
Perceived Health Threat	163	88.87	0.00	(24.0749-25.1690)
Perceived Susceptibility	185	70.00	0.00	(11.6461-12.3216)
Perceived Severity	167	72.76	0.00	(11.5760-12.2217)

*significance level ($p < 0.05$) when compared to 50% of the population

APPENDIX F

Post Hoc Analysis

Awareness of Most Commonly Used Fuel Source

Influenced by Education

LSD Post Hoc Analysis of Awareness of Most Commonly Used Fuel Source compared to Education

Most Commonly Used Fuel Source vs. Education	1 NS	2 Nurs. to JHS	3 Sec. no diploma	4 Sec. with diploma	5 Some Univer. no degree	6 Trad/Tech	7 BA/BS degree	8 Mast. degree	9 Prof. degree
No Schooling (1)	--	0.139	0.150	0.970	0.323	0.158	0.917	1.00	0.603
Nursery School to JHS (2) 25% stated rubber	0.139	--	0.959	0.006*	0.619	0.774	0.010*	0.273	0.740
Some Secondary School no diploma (3) 34% stated tires	0.150	0.959	--	0.008*	0.651	0.751	0.014*	0.285	0.755
Secondary School graduate, diploma or the equivalent (4) 43% Stated tires	0.970	0.006*	0.008	--	0.135	0.056	0.884	0.978	0.571
Some University credit, no degree (5)	0.323	0.619	0.651	0.135	--	0.538	0.165	0.443	0.926
Trade/Tech/Voc.training (6)	0.158	0.774	0.751	0.056	0.538	--	0.068	0.254	0.650
Bachelor's Degree (7)	0.917	0.010*	0.014*	0.884	0.165	0.068	--	0.940	0.599
Master's Degree (8)	1.00	0.273	0.285	0.978	0.443	0.254	0.940	--	0.642
Professional Degree (9)	0.603	0.740	0.755	0.571	0.926	0.650	0.599	0.642	--

*significance level $p < .05$

Frequency of Awareness of Most Commonly Used Fuel Source distributed by Education

Education	Agreed and Strongly Agreed Percentage
No Schooling	66
Nursery School to JHS	53
Some Secondary School no diploma	65
Secondary School graduate, diploma or the equivalent	52
Some University credit, no degree	50
Trade/Tech/Voc. training	71
Bachelor's Degree	48
Master's Degree	66
Professional	100

APPENDIX G

Post Hoc Analysis of
Social Norms Influenced by Education

And

Frequency of Agreed of Strongly Agreed
Respondents distributed by Education

Social Norms Influenced by Education

Most Commonly Used Fuel Source vs. Education	1 NS	2 Nurs to JHS	3 Sec.no diploma	4 Sec. with diploma	5 Some Univer. no degree	6 Trade/Tech	7 BA/BS degree	8 Mast. degree	9 Prof. degree
No Schooling (1)	--	0.899	0.870	0.353	0.183	1.000	0.199	0.893	0.328
Nursery School to JHS (2)	0.899	--	0.952	0.062	0.042	0.899	0.004*	0.809	0.252
Some Secondary School no diploma (3)	0.870	0.952	--	0.064	0.042*	0.870	0.004*	0.789	0.245
Secondary School graduate, diploma or the equivalent (4)	0.353	0.062	0.064	--	0.415	0.353	0.193	0.636	0.568
Some University credit, no degree (5)	0.183	0.042*	0.042*	0.415	--	0.183	0.982	0.406	0.833
Trade/Tech/Voc. training (6)	1.000	0.899	0.870	0.353	0.183	--	0.119	0.893	0.328
Bachelor's Degree (7)	0.199	0.004*	0.004*	0.193	0.982	0.119	--	0.365	0.832
Master's Degree (8)	0.893	0.809	0.789	0.636	0.406	0.893	0.365	--	0.449
Professional Degree (9)	0.328	0.252	0.245	0.568	0.833	0.328	0.832	0.449	--

*significance level $p < .05$

Frequency of those that Agreed or Strongly Agreed to the Social Norms Scale by Education

Education	Agreed and Strongly Agreed Percentage
No Schooling	42
Nursery School to JHS	57
Some Secondary School no diploma	42
Secondary School graduate, diploma or the equivalent	29
Some University credit, no degree	23
Trade/Tech/Voc. training	42
Bachelor's Degree	22
Master's Degree	0
Professional	50*

*1 of 2 participants