KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY,

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SCHOOL OF PUBLIC HEALTH

OCCUPATIONAL HEALTH HAZARDS OF WOODSMOKE AND USE OF PERSONAL PROTECTIVE EQUIPMENT AMONG FISH SMOKERS IN ABUESI.

BY

LOUIS NANA TENE

SEPTEMBER, 2019

KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY,

KUMASI, GHANA

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DECLARATION

I, Louis Nana Tene hereby declare that, except for references to other people's work which have been duly acknowledged, this thesis is my own original work and that this thesis has not been submitted to any institution by any student elsewhere.

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ACADEMIC SUPERVISOR

SIGNATURE…… DATE…….

NAME…….

HEAD OF DEPARTMENT

DEDICATION

This work is dedicated to my family and friends.

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ABSTRACT

This study assessed the occupational health hazards of the use of wood as biomass fuel by fish processors within the Abuesi fish landing site, Western Region of Ghana. The study was carried out from February to December 2017 with 356 fish mongers interviewed using semi-structured interview guides. Results from the study showed that majority of the respondents were exposed to smoke related health disease (90 %), indicating a higher prevalence rate among fish mongers while a few (10 %) reported no incidence of smoke related health symptom. Coughing (51 %), eye disease (17 %), headache (11 %) and respiratory disease (11 %) were some of the symptoms reported by the fishmongers during the study period. Smoking for more than 3 hours (AOR= 16.95, [CI= 6.075 – 47.357]), absence of safety measures (AOR = 1.926, [CI = 0.725 – 5.049]) and frequent fish smoking (AOR= 0.220, [CI= 0.078 – 0.625], p-value < 0.05 were the significant factors that increase the vulnerability of respondents to smoke related health symptoms. Majority of the respondents (93.1 % to 96.3 %) indicated they do not use PPE such as goggles, safety boots, nose masks and aprons. Furthermore, 6% they had received information, largely through the MOFA and Hen Mpoano. There is high rate of vulnerability to smokes related health diseases due to the presence of some significant factors. Epidemiological research with itemized exposure assessments and clinical proportions of these disease symptoms is required in Ghana to validate the findings of this study.

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LIST OF ABBREVIATIONS

ALRI …… Acute Lower Respiratory Infections

COPD ……Chronic Obstructive Pulmonary Disease

CSIR ……. Centre for Scientific and Industrial Research

DALY's ……. Disability Adjusted Life Years

DNA……Deoxyribonucleic Acid

ETS ……. Emissions Trading Scheme

FAO ……Food and Agriculture Organization

HPV ……Human Papilloma Virus

MOFA ……. Ministry of Food and Agriculture

PAH ……. Polycyclic Aromatic Hydrocarbons

PPE ……. Personal Protective Equipment

VOC's ……. Volatile Organic Compounds WHO

……World Health Organization

CHAPTER ONE

INTRODUCTION

1.1 Background of the study

The use of biomass as fuel for cooking exposes women and young children to air pollutants (Po *et al.*, 2011). Pollution from indoor air contains a scope of pollutants that have adverse effect on health, such as volatile organic compounds (VOCs), carbon monoxide (CO), carbon dioxide (CO_2), nitrogen dioxide (NO_2), carbon dioxide (CO_2), sulfur dioxide (SO_2), and particulate matter (Bruce *et al.*, 2000; Zhang and Smith, 2003). These pollutants are capable of crossing the alveolar–capillary barrier and enter deep into the lungs (Tesfaigzi *et al.*, 2005).

Fish smoking is related with some inherent occupational hazards which has effect on the health of the fish smokers. Smoke produces harmful gases which can cause acute health effects for example irritation of the eyes, nose, chest and respiratory tract. Other effects like bronchitis, asthma, pneumonia, decrease lung capacity which is associated with lung cancer are chronic health effects. The heat from the wood fire can lead to burns on exposed skin, eye injuries which can result in reduced vision due to long term exposure (Reese, 2015).

The incomplete burning of biomass produces smoke with health-damaging pollutants, which includes carbon monoxide (CO), volatile organic compounds (VOCs), particulate matter (PM), and polycyclic aromatic hydrocarbons (PAHs). Cardiovascular and respiratory diseases are known to have an association with exposure to wood (Orozco-Levi *et al.*, 2006; Naeher *et al.*, 2007; Fullerton *et al.*, 2008). Biomass fuel combustion produces over 200 different chemical compounds, more than 90% are absorbed into the body through inhalation. These include gaseous air pollutants such as nitrogen dioxide, carbon monoxide, sulfur dioxide, and particulate matter air pollutants such as those less than 2.5 microns (PM

2.5) and those less than 10 microns (PM 10) in aerodynamic diameter, arsenic, chlorinated dioxins polyaromatic hydrocarbons, lead, fluorine, and vanadium; all of which are toxic to the human body (Salvi and Barnes, 2010).

The major constituents of wood smoke including carbon monoxide and particulate matter are considered to be the greatest inhalation hazards (Naeher *et al.*, 2007). Even though many pollutants like carbon monoxide, benzene, formaldehyde, polycyclic aromatic hydrocarbons, and are produced from burning of biomass, particulate matter is considered the best indicator of smoke exposure. In this context, it has been suggested that $PM_{2.5}$ is the best single marker of the health effects of burning of biomass such as wood (Naeher *et al.*, 2007; Pérez-Padilla *et al.*, 2010).

The utilization of solid fuels occurs mostly in developing nations of the world where households prefer the use of wood and crop residues in cooking and warming (Smith *et al.*, 2004). These fuels are utilized in stoves that are not very well designed therefore causing severe air pollution. The burning of biomass indoors is carcinogenic to humans. Many factors come into play regarding respiratory health problems which include vehicular emissions, climate change, poverty, overcrowding, malnutrition, and life style choices.

A research by the World Health Organization has identified biomass solid fuel combustion as the fourth driven risk factor for the burden of disease worldwide (World Health Organization, 2009). A report in the year 2010 showed that indoor air pollution caused 4 million premature deaths which is a significant environmental risk factor globally and also in poor areas of the world (Lim *et al.*, 2012).

Women and Children and known to be highly exposed to biomass smoke as they are mostly at home and in cooking areas. Burning of biomass has significant effects on the respiratory organ when exposed to wood smoke (Pollard *et al.*, 2014). Biomass smoke exposure has

association with acute respiratory infections in children, chronic obstructive pulmonary disease, lung cancer, asthma and cardiovascular disease etc. (Shrestha *et al.*, 2005; Ling and van Eeden, 2009; Clark *et al.*, 2011; Painschab *et al.*, 2013). Among these, chronic obstructive pulmonary disease is the more highly in association with air pollution exposure (Sood, 2012).

Incomplete combustion of carbon-containing biomass fuels also emits carbon monoxide (CO) (Tiwari and Mishra, 2012) Carbon has higher affinity for hemoglobin when contrasted with oxygen thus results in tissue hypoxia. Carboxyhemoglobin and oxygen saturation levels present in the blood are major indicators in knowing the effects of acute CO exposure. Acute exposure to high levels of CO can cause serious neuropsychiatric and can be dangerous (Pollard *et al.*, 2014).

Chronic Bronchitis is understood to be a critical public health problem worldwide, regardless of the fact that it has the potency if being prevented. Its prevalence in developed nation ranges from 3% to 17% while in developing countries the rates are higher, ranging from 13% to 27%. An established fact of a population study from a developed nation has depicted smoking to be one of the basic risk factors for the development of chronic bronchitis. This relates to a higher prevalence rates in men than in women since men are mostly like to smoke (Umoh *et al.*, 2013).

Personal protective equipment though is considered as the last resort for controlling hazard in work area its usage is applied when other possible engineering and administrative controls have been exhausted (Kumar *et al.*, 2013). It is used to reduce or minimize the exposure or contact to injury. Personal protective equipment does not eliminate hazard but reduces the risk of injury.

1.2 Problem statement

Fish serves as an important source of food and capital to numerous people in the developing world. In Africa, five percent of the population (about 35 million people) depend wholly or partly on the fisheries sector (Akhtar *et al.*, 2007; Clark *et al.*, 2011). Traditional methods are used to preserve and process fish for consumption and storage. These include smoking, salting, frying, drying, and fermenting and various combinations of these. The number of people who die out of work related accidents are estimated to be over 2 million by the International Labor Organization (ILO). From literature there is no direct policies for delivering health and safety service to fish smokers thereby limiting access to information and training opportunities. This places the fish smokers at a greater risk to occupational injuries and risk as they are exposed to heat and smoke.

In Ghana, fish smoking is the method practiced widely: practically all species of fish accessible in the country can be smoked and it has been estimated that 70-80 percent of the domestic marine and freshwater catch is consumed in smoked form (Holma *et al.*, 2013). The state of health of the women who engage in fish smoking is at risk, because the smoke enters their eyes and lungs, burns their fingers and they are exposed to direct heat. Smoke from the burning of biomass fuels has been shown to be a major risk factor for several respiratory ailments, such as asthma, respiratory tract infections especially in children and the elderly, and lung cancer (Kodgule *et al.*, 2012). An estimated 50% of the world's population (i.e. around 3 billion people) use biomass fuel for cooking and heating purposes (Gibson *et al.*, 2013).

In the Ghanaian context, there is not much knowledge on the health effect of smoke generated in the occupational environment such as in traditional smokehouses. This gap in the literature is a fundamental motivation for this study.

The common method for fish preservation in Abuesi is fish smoking. Abuesi was selected for study because of their longstanding engagement in fish smoking. The traditional seafishing community of Abuesi, living for ages on the shores of the Gulf of Guinea, reflect in miniature the lifestyle and material culture of the fisher folk of the entire east coast of Ghana. The fish smokers do not use any personal protective equipment when they are undertaking this livelihood activity. Besides, it is unclear how duration of exposure interacts with level of exposure to produce adverse health outcomes for this population. This suggests the need to assess short, medium and long-term exposure to the smoke inhaled within the occupational setting.

There have been calls for more population-based epidemiological studies to investigate the health effects of wood smoke in the fish smoking industry in Ghana. It may be possible that these people also have an increased risk of pulmonary tuberculosis, interstitial lung disease, and lung infections. The findings from this study will help policymakers plan and design interventions to minimize exposure to biomass smoke and the appropriate personal protective equipment to be used for this occupation. This is because it is important to realize that smoking fish may be the only source of livelihood for the people living in the coastal region or along river beds, and it may therefore be difficult to give up this occupation for economic reasons therefore this study will provide depth knowledge on the health implications of biomass smoke generated from fish smoking and the awareness of the usage of personal protective equipment in the coastal areas of Ghana.

1.3 Scope of study

This study is undertaken in order to understand the occupational hazards in burning of biomass fuel and the adverse effects it has on fish smokers and any person who is exposed

to the smoke. The use of biomass fuel by the fish smokers in smoking of the fish is a cheap source of fuel. Data in the form of questionnaire assessment will be collected and analyzed to find out the some of the health effects they are exposed to and also to know their level of knowledge about personal protective equipment in relation to occupational safety.

1.4 Justification

Air pollution which is known to be of global interest due its leading cause in disease and death is preventable. An estimated figure of about 4.3 million deaths are reported annually respective to air pollution, mostly in developing countries and are associated with exposure to household (indoor) air pollution (World Health Organization, 2009).

Findings and recommendations of the study would serve to provide information on knowledge and compliance of personal protective equipment usage and examine the effects of the use of biomass fuel for smoking of fish on the fish smokers and probably people who live closer. This research will identify the adverse health effects of the usage of biomass fuel on the fish smokers irrespective of the economic gains and can help policy makers understand the health effects of air pollution on human exposure which are critical to the discussion on how local, regional and global biomass fuel air pollution affects fish smokers.

It will also educate the fish smokers and increase their scientific knowledge regarding the health effects of exposure to high levels of smoke. This will hopefully prompt them to use protective equipment in their occupation. With a better understanding of these associations it will provide further information to support exposure reduction interventions for biomass smoke generated in smokehouses.

1.5 Main objective

This study is specifically aimed to:

- To determine the prevalence of occupational health hazards and its symptoms among fish smokers.
- To identify the significant factors influencing the prevalence of smoke related symptoms among fish smokers.
- To assess awareness of fish smoking health hazards and use of personal protective equipment among fish smokers in Abuesi.
- To establish some interventions for minimizing exposure and related health implications among fish smokers.

1.6 Hypothesis

H_0: The burning of biomass fuel for the smoking of fish has no adverse health effects on fish smokers and people exposed to it.

H_1: The burning of biomass fuel for the smoking of fish has adverse health effects on fish smokers and people exposed to it.

H_0: Personal protective equipment aid in preventing occupational hazards on fish smokers

H_1: Personal protective equipment does not play any role in preventing occupational hazards on fish smokers.

1.7 Research questions

- What fish smoking related hazards and disease symptoms are present among fish smokers in Abuesi, Ghana?

- Are the fish smokers aware of health effects and the personal protective equipment they should have during fish smoking?
- What personal protective equipment are fish smokers in Abuesi, Ghana using during their work?

1.8 Research goals

In Ghana, where there are many coastal communities who engage in the activities of fish smoking using biomass fuel which pollutes the air and other environmental media. Health effects of wood smoke was my focus in this study since the literature suggests that they pose a greater risk to people who are exposed to it. Response given by the respondents is a baseline to determine the potential adverse effects associated with the exposure.

In addition, an assessment of this nature can help predict adverse health effects and determine if mitigation actions are needed depending on results obtained after the research has been carried out. There are countless benefits of the execution of a project of such nature for coastal communities involved in fish smoking.

- Firstly, the exposure of woodsmoke to the fish smokers will be established to know if the exposure has adverse health effects on them.
- This thesis will also help fish smokers and other people living in an air polluted area by educating them on air pollution (burning of biomass fuel) and to create awareness of the usage of personal protective equipment when working.
- Thirdly, the thesis will pave way for similar project to be conducted in other fishing communities among fish smokers.

1.9 Delimitation

The study was delimited to women age 18 years and older, resident in the sampled fishing community-Abuesi, directly or indirectly involved in fish smoking who consented to partake in the study. The study aims to assess the human health risk associated with smoke exposure from the use of biomass fuel as the main source of energy for the smoking of fish but it is limited to only three hundred and fifty-six fish smokers.

1.10 Study area

The study area is Abuesi, which is a fishing community. Abuesi is located in the Shama district in the western region of Ghana and it is about 5 kilometers from Shama Junction. It is linked on the east by Shama, the north by Inchaban, the west by Ingreisia and the south by the Atlantic Ocean. The primary method for fish preservation is fish smoking. The inhabitants especially the men are mostly fishermen and the women are noted for smoking of fish as their major occupation.

Figure 1: Map of Study area (Abuesi Fish landing community)

CHAPTER TWO

LITERATURE REVIEW

Introduction

In this chapter, review of the literature was on perspective of health effects of woodsmoke use among fish smokers and outlines works done by others related to this area. It additionally recognizes some omissions in existing information in health effects of woodsmoke use among fish smokers and the usage of personal protective equipment. This chapter gives principal knowledge of the theoretical concepts from comparable studies to direct future research. The literature was reviewed, using the following research database sources from the internet Google Scholar, Pub med. The literature has been sorted into factors per the

specific objectives of the study. First was fish smoking, indoor air pollution, biomass fuel and factors influencing it usage, chemical composition of biomass smoke, carbon monoxide exposure, exposure to particulate matter, occupational hazards and health effects related to fish smoking, hazard identification, the use of Personal Protective Equipment as Preventive Measures against Occupational Hazards related to fish smoking and Ghana health laws on occupational health and safety.

2.1 Fish smoking

Fish farming is recognized as the largest extractive wildlife use in the world (FAO, 2007) (Holma *et al.*, 2013) and about 35 million people in Africa depend partially or solely on the fisheries sector for their living (FAO, 2001) (Holma *et al.*, 2013). Fish as an important diet is recommended to be rich in protein which is comparatively cheap to other protein foods and accessible for poorer households (Adeyeye *et al.*, 2015). In Ghana, fish is one of the most vital non-traditional export commodities which nourishes the human body with minerals such as potassium, iron, calcium, iodine, vitamin A, vitamin B2 and other minerals (Ayinsa & Maalekuu, 2013) (Holma *et al.*, 2013).

Fishing in Ghana is done continuously as the major bumper harvest occurs around the seasonal herring catch from July to September every year. Its preservation is essential to have appreciable quantities stored under good condition until it is needed for use specifically during lean season. Processing of fish is mostly carried out by women which include fish scaling for fish with scales, evisceration, washing and draining before drying preservation method like sun-drying or smoke drying (Omodara and Olaniyan, 2012).

There are many traditional methods for fish preservation and processing in Ghana. Smoking, drying, salting, grilling and frying are some of the methods employed in fish

preservation, processing and storage for consumption. Predominantly the type of fish product in any country is dependent on the food habits and the rate at which it is purchased by the population (Holma *et al.*, 2013). Fish smoking is the most widely practiced preservation method of fish in Ghana. According to Ayinsa and Maalekuu 2013 all species of fish in the country can be smoked with an estimation that 70-80 percent of the domestic marine and freshwater catch is consumed in smoked form.

Salting or brining, equilibration, drying on traditional mud ovens are processes combined in fish smoking. Fish smoking is carried in traditional smokehouses made from bamboo or cement using wood species as fuel. The type of fish smoking methods depends on the specie of the fish and the storage duration for future use. Hot- smoked fish and the dry-smoked fish are the two known methods of fish smoking. The hot smoking process could last for about 2- 3 hours at a temperature of 70-800 c leaving smoked fish with a moisture content of about 35% - 45% with a limited shelf- life of 1-3 days. A smoked- dry process takes more hours than the hot smoking. It last for about 10 - 18 hours, and sometimes – 4 days and the resulting smoked fish contains a moisture content of about 10% -15% with a shelf-life of 3 - 9 months when kept under proper storage conditions (Omodara and Olaniyan, 2012).

2.2 Indoor air pollution

The utilization of solid fuels for cooking and warming is probably going to be the biggest wellspring of indoor air pollution on a worldwide scale. About a large portion of the world half the world keeps on cooking with solid fuels such as dung, wood, farming deposit and coal. At the point when utilized in simple cooking stoves, these fuels produce substantial amounts of lethal pollutants. These pollutants, called strong fuel "smoke" in this section, incorporate respirable particles, carbon monoxide, oxides of nitrogen and sulfur, benzene, formaldehyde, 1,3-butadiene, and polyaromatic mixes, for example, benzo(a)pyrene (Smith,

2013) (Smith, 2013). Among the main ten worldwide dangers to general wellbeing is indoor air contamination from biomass fuel as 2.7% is recorded as the level of the worldwide weight of infection explicitly among ladies who invest a large portion of their energy cooking (Faizal *et al.*, 2013). A few research connected with the impact of different factors, for example, tobacco smoking, diet or physical movement have reliably appeared long haul presentation to fine airborne particulates leads to increase rate of untimely mortality because of cardiovascular sickness, interminable obstructive respiratory infections just as lung malignancy. Toxins with the most grounded proof for general wellbeing concern are fine particulate matter and gases (for the most part carbon monoxide, ozone, nitrogen oxides, sulfur dioxide and unpredictable natural mixes) (WHO, 2014) (World Health Organization, 2009).

In houses with constrained ventilation (as is regular in many developing nations), exposures experienced by family individuals, especially women and young children who spend a huge extent of their time inside, have been estimated to be commonly higher than World Health

Organization (WHO) guidelines and international standards (Bruce *et al.*, 2000; Smith, 2013). Most examination into and control of indoor air contamination worldwide has concentrated on wellsprings of specific worry in developing nations, for example, discharges exchanging scheme (ETS), unstable natural mixes from goods and radon from soil (Table 1) (Spengler *et al.*, 2001). In Papua New Guinea, patients with endless lung malady were recognized to have lived in networks that were vigorously contaminated by indoor biomass smoke. A comparative report among grown-ups' populace in Pakistan discovered ladies with more prominent number of interminable bronchitis in spite of their lower smoke rate (Ranabhat *et al.*, 2015).

In spite of the fact that these pollutants have impacts upon health, little is thought about their worldwide dispersion.

Table 1: Major toxic pollutants of indoor air

POLLUTANTS	MAJOR INDOOR SOURCES
Fine particles	Fuel/tobacco combustion, cleaning, fumes from food being cooked, e.g. from cooking oil
Carbon monoxide	Fuel/tobacco combustion
Polycyclic aromatic hydrocarbons	Fuel/tobacco combustion, fumes from food being cooked, e.g. cooking oil
Nitrogen oxides	Fuel combustion
Sulfur Oxides	Coal Combustion
Arsenic and Fluorine	Coal Combustion
Volatile and semi-volatile organic compounds	Fuel/tobacco combustion, consumer products, furnishings, construction materials, fumes from food being cooked e.g. cooking oil
Aldehydes	Furnishing, construction materials, cooking
Pesticides	Consumer products, dust from outside
Asbestos	Remodelling/demolition of construction materials
Lead	Remodelling/demolition of painted surfaces
Biological pollutants	Moist areas, ventilation systems, furnishings
Free radicals and other short-lived, highly reactive compounds	Indoor Chemistry
Radon	Soil under building, construction materials

Source : (Spengler *et al.*, 2001).

Assimilated particles can harm *inter alia* lung function and the cardiovascular framework, through oxidative stress, modification of the electrical procedures of the heart and systemic inflammation, prompting endothelial cell actuation and dysfunction; adjusted circulatory strain and pulse, including heart rate variability; arrhythmia; and deregulated coagulation pathways; and ischemia (World Health Organization, 2009).

2.3 Biomass fuel and factors influencing its usage

Wood is the most seasoned of human fuels, it is actually obvious that exposure to wood smoke is as old as mankind itself. Indeed, even today, biomass as wood and farming squanders is a huge source of energy around the world, with over 10% of all out fuel use.

Of this, about 90% is utilized in its customary structures as family unit warming and cooking fuels in developing nations, the rest being current structures, for example, power plant fuel, basically in developed nations (Vera and Langlois, 2007). Since such family unit use rules all out fuel request in many developing nations, especially in rural areas where half of humankind still lives, today is likely consistent with state as it has been since the control of flame that biomass is the fundamental source of energy for a large portion of mankind. All through the vast majority of history, as today, the biggest exposures happened in families through utilization of wood and different types of biomass as a source of cooking, drying, and space-warming vitality.

In the course of recent decades, rising fossil energy costs, the accessibility of new advances and the longing to utilize inexhaustible sources has prompted increments in the utilization of wood and different biomass energizes in North America. In Canada, such fuels expanded at about 2.4% every year amid the 1990s, the greater part again as quick as by and large

energy request (Goldemberg and Coelho, 2004). Amid this equivalent period, the information of, and resulting worry about, the wellbeing impacts of air contamination has expanded significantly around the globe, prompting stricter air contamination guideline and controls.

Smoke from biomass consuming has some one of a kind parts, yet additionally shares numerous physical and chemical qualities with discharges from other burning sources (Fine *et al.*, 2004; Bergauff *et al.*, 2008). Not at all like the customarily directed petroleum product ignition sources that consume explicit fuel types under moderately all around controlled and proficient ignition conditions, biomass consuming can include numerous kinds of energizes (i.e., distinctive woods, grasses, peat, crop buildups, creature manure, and so forth., with fluctuating arrangement and water content) consumed under various conditions (i.e., seething, as opposed to flaring). In like manner, smoke can be created from a wide assortment of combusting modalities (woodstoves, cook-stoves, uncontrolled timberland fires, controlled open consuming, and so on.) over a wide scope of spatial (from an outside wood evaporator to an uncontrolled backwoods flame) and temporal scales (from hours to weeks).

Reliable with the wide scope of materials, conditions, and sizes of starting point and effect, both the gas-and molecule stage piece of outflows are mind boggling and profoundly powerful, so these qualities should be viewed as while evaluating the hazard from introduction to biomass smoke (McKendry *et al.*, 2004; Subramanian *et al.*, 2007). Exposure concentrations and chemical profiles are expected to obviously shift depending on specific situations and human receptors (Fine *et al.*, 2004; Zhang *et al.*, 2008). These can run from the raised, near source inward breath of unvented emanations related with biomass exposure while at the same time cooking inside (average of many creating nations), to the lower

fixation, rehashed occasional exposures experienced inside living arrangements utilizing low-discharge, all around vented woodstoves for private space warming.

The energy ladder begins at the base with low quality biomass fuels, for example, dairy animals waste, climbs through harvest deposits, to wood. Ostensible burning productivity (percent of fuel carbon radiated as CO2) is as low as 80% for the less fortunate fuels and achieves over 99% with vaporous fuels (Smith, 2000). In individual households, however, the circumstance is frequently increasingly confounded, especially amid progress stages when family may straddle a few rungs of the ladder at once by utilizing different fuels relying upon costs, seasons, accessibility, and so on. (Sinton *et al.*, 2004).

2.4 Chemical composition of biomass smoke

Wood comprises basically of two polymers: 50-70 weight percent cellulose, and around 30% by weight lignin (Simoneit *et al.*, 1999). Different biomass fuels (for example grasses, wheat stubble) additionally contain these polymers, despite the fact that their relative extents vary contrasted with wood. In addition, little measures of low atomic weight natural mixes (for example pitches, waxes, sugars) and inorganic salts are likewise present in wood. Amid ignition, pyrolysis happens and the polymers break apart delivering an assortment of minute atoms. Biomass burning is regularly wasteful and a large number of mostly oxidized natural synthetic substances are produced in biomass smoke. Biomass smoke contains a substantial number of synthetic compounds, a significant number of which have been related with antagonistic wellbeing impacts. The significant synthetic compounds present in biomass smoke and their sources are recorded in table 2. These synthetic substances incorporate the two particles and vaporous compounds.

Table 2: Summary of Major Biomass Pollutants

Compound	**Examples**	**Source**	**Notes**
Inorganic gases	Carbon monoxide(CO)	Incomplete combustion of organic material	Transported over distances
	Ozone (O_3)	Secondary product of nitrogen oxides and hydrocarbons	Only present downwind of fire, transported over distances
	Nitrogen Dioxide(NO_2)	High temperature oxidation of nitrogen in air	Reactive- concentrations decrease with distance from fire
Hydrocarbons	Benzene	Incomplete combustion of organic material	Some transport-also react to form organic aerosols
Aldehydes	Acrolein	Incomplete combustion of organic material	
	Formaldehyde (HCHO)	Incomplete combustion of organic material	
Particles	Inhaled particles (PM10)	Condensation of combustion gases; Incomplete combustion of organic material; entrainment of vegetation and ash fragments	Coarse + fine particles. Coarse particles are not transported over long distances and contain mostly soil and ash
	Respirable Particles	Condensation of combustion gases; Incomplete combustion of organic material	For biomass smoke, approximately equal to fine particles
	Fine particles (PM2.5)	Condensation of combustion gases; Incomplete combustion of organic material	Transported over long distances; Primary and secondary production
Polycyclic aromatic hydrocarbons (PAHs0	Benzol [163] pyrene (BaP)	Condensation of combustion gases; incomplete combustion of material	Specific species vary with composition of biomass and combustion conditions

(Simoneit *et al.*, 1999)

2.4.1 Carbon monoxide exposure

Carbon monoxide is colorless and odorless gas framed by inadequate ignition of carbonaceous material, for example, fuel, gaseous petrol, oil, coal, tobacco, and other natural materials. It has been recommended as a less expensive however surrogate proportion of indoor air contamination brought about by consuming biomass fuel (Kurmi *et al.*, 2012).

Carbon monoxide is estimated by utilizing either colour changing dispersion tubes or electrochemical screens. Regularly the measure of carbon monoxide created by these sources isn't a reason for concern. Notwithstanding, whenever utilized in a shut or mostly shut space the carbon monoxide can work to hazardous dimensions. At the point when ones' introduction to carbon monoxide is high, their body replaces the oxygen in the red platelets with carbon monoxide.

Carbon monoxide joins with hemoglobin to shape carboxyl hemoglobin with decreased conveyance of oxygen to tissues and developing fetus. This leads to low birth weight infants and increments perinatal mortality. It aggravates bronchial reactivity prompting wheezing, rehashed respiratory tract diseases and intensifications of asthma.

Side effects of carbon monoxide presentation can incorporate everything from cerebral pains, dizziness and tiredness to nausea, vomiting or tightness over the chest. Extreme carbon monoxide balancing can cause neurological harm, trance state and demise (Fox and Reed, 2011).

2.4.2 Exposure to particulate matter (PM)

Exposure to Particulate matter is connected to various significant health effects. Particles not exactly or equivalent to 10 micrometers in distance across are small to the point that they can get into the lungs and possibly causing genuine medical issues. PM (fine particles) are 2.5 micrometers in distance across or littler and must be seen with an electron magnifying instrument. Created from a wide range of ignition, including engine vehicles, control plants, residual wood burning, woodland fires and some modern procedures. PM is accepted to have the biggest wellbeing hazard. Youngsters and more seasoned grown-ups are increasingly powerless to PM-initiated impacts in light of physiological contrasts. Children are more vulnerable than grown-ups with the impacts of PM due to the more noteworthy measure of time spent both in and outside, action levels and moment volume per unit body weight of the subpopulation that lead to increments in PM portion per lung surface territory and, thusly, increments in the defenselessness of creating lungs to unfriendly impacts.

The elderly is commonly viewed as a helpless populace as a result of the progressive decrease in physiological procedures after some time. Contrasted and kids or more youthful grown-ups, older people have a higher commonness of previous cardiovascular and respiratory infections, which may likewise give defenselessness to PM. Natural the study of disease transmission look into led in late decades has demonstrated that present moment or long haul introduction to surrounding PM expands mortality and bleakness, decreases future and builds the danger of respiratory and cardiovascular infections. Concentrates on asthmatic youngsters have revealed that increments in respiratory side effects, expanded drug use and diminishes in aspiratory work are related with momentary PM introduction.

A case-hybrid investigation in Taipei found that chronic obstructive pulmonary disease (COPD) affirmations are essentially and emphatically connected with higher PM levels amid warm and cool days (Hu *et al.*, 2015). In addition, a lot of harmful compounds, for

example, gases, organic compounds and heavy metals, stick to the outside of PM, bringing about expanded toxic quality, obstruction with chromosomes, DNA and other hereditary material. PM and toxic compounds are likewise ensnared in cancer development. Long term fine particulate air contamination is related with little however quantifiable increment in lung malignant growth mortality (Turner *et al.*, 2011). Reliable proof from epidemiological examinations exhibits that short and long term introduction to PM, explicitly PM2.5, is related with cardiovascular morbidity and mortality (Dockery, 2001). PM focus is likewise connected to myocardial necrosis, heart failure and arrhythmia. The old, diabetics and those with known coronary vein illness show up explicitly defenseless to the destructive impacts activated by PM presentation. Long term introduction to fine particulate air contamination is additionally a vital hazard factor impacting cardiovascular disease through components that incorporate pulmonary and systemic inflammation, quickened atherosclerosis and adjusted heart autonomic function (Fuller *et al.*, 2013).

2.5 Occupational hazards and health effects related to fish smoking

Fish smokers are prone to many hazards which ranges from heat exhaustion, ocular problems, stress related problems and most of all respiratory diseases. The occupational hazards, safety concerns and risks to health among fish smokers are based on their operation and lack/non-adherence to PPE usage during operation.

Hazards are defined as the presence of conditions that have the potential to cause harm or a combination of the severity of consequences which can cause adverse health effect (Erondu and Anyanwu, 2005) . Exposure to heat during fish smoking could lead to increase in body

temperature and headache could results. Direct exposure to smoke especially locally designed smoking kiln that uses wood as fuel causes eye redness. Red eye sometimes causes itching, mucus discharge, pain, or vision problem (blurred vision). Another health implication is burns because they are exposed to naked flames when smoking fish and most burns affect only the skin.

Health effects as a result of indoor exposure to smoke from use of solid fuel were confirmed after evaluating the epidemiological evidence which related with available data on mechanisms for indoor air pollution, exposure and emissions (Smith, 2000; Zelikoff *et al.*, 2003).

2.5.1 Respiratory health effects

Exposure to biomass smoke has negative respiratory impacts, lung cancer is known to be amongst the most driving reasons for mortality representing 1.3 million deaths yearly around the world (Parkin *et al.*, 2005). Smoking is outstanding significant hazard factor and out of various cases announced 25% are not related to tobacco use. Epidemiological investigations have built up that all-inclusive while lung cancer growth in non-smokers is reliably more typical in females than in males with geographical variations considerable. Studies in eastern and southern established 83% of female lung disease cases are nonsmokers, contrasted with 15% in the USA (Sun *et al.*, 2010). The utilization of biomass (wood, charcoal, crop deposits or waste) or coal, aggregately known as solid fuel for cooking and warming in developing countries has an estimate of 2.4 billion individuals (70%) (WHO, 2011). Discharges from burning of solid fuel have been appeared to transmit high concentrations of polycyclic aromatic hydrocarbons (PAHs), benzo[a]pyrene and particulate matter with a diameter of 2.5 mm or less, which thusly have been related with high rates of lung cancer (Sun *et al.*, 2010). In current studies, indoor discharges from household burning of coal and biomass

(generally wood) have been named cancer-causing (Group 1) and presumably cancer-causing (Group 2A) to people (Bruce *et al.*, 2000).

However, information on the extent of lung cancer risk and the histological sub-type of lung disease related with solid fuel use are constrained. All around, the most essential hazard factor for chronic obstructive pulmonary infection is believed to be smoking of tobacco (Pauwels *et al.*, 2001; Vestbo *et al.*, 2013). Various investigations have analyzed different manifestations of chronic respiratory disease in women who cook with open stoves burning biomass (Mortimer *et al.*, 2017). Information on native Americans (Navajos in the southwestern United States of America) demonstrate a solid and significant relationship between acute lower respiratory diseases and utilization of wood stoves, at much lower levels of indoor pollution than found in developing countries (Pope III *et al.*, 1992).

Women in households utilizing biomass fuels were observed to be 2.7 (95% CI 1.9– 4.0) times bound to have tuberculosis than women in households using cleaner fuels, even after revision for a scope of socioeconomic factors(Cain *et al.*, 2015). Moreover, an unadjusted but significant proportion of 2.5 has been accounted for clinically-confirmed tuberculosis in grown-up male and female householders aging from 16– 60 years utilizing wood or dung cakes as fuel (Cain *et al.*, 2015). In spite of the fact that these investigations were not ready to address smoking as a conceivable confounder, two examinations in Mexico City have discovered a relationship between exposure to wood smoke and occurrence of tuberculosis after taking smoking into account (Pérez-Padilla *et al.*, 2010). An investigation in China likewise discovered exposure to outdoor air pollution to be related with tuberculosis (TorresDuque et al., 2008). Studies in animals have demonstrated that wood smoke causes immune suppression in the respiratory framework (Valavanidis *et al.*, 2013).

2.5.2 Visual Impairment

The world health organization conducted a research that showed that 285 million individuals worldwide are visually impaired with 39 million blind people (WHO 2013). Further research appears, 90% of every visually impaired individual live in developing country (Resnikoff *et al.*, 2004). There are various known reasons for visual deficiency on the planet however the significant ones are glaucoma, corneal opacities, and trachoma (Resnikoff *et al.*, 2004). Comparatively women are bound to be visually impaired than men, and to experience the ill effects of the real reasons for eye diseases, cataract and trachoma. Majority of people who use solid fuel (biomass and coal) specifically for cooking and warming belong to the developing country and around three billion individuals worldwide about a large portion of the World's populace are users of biomass fuel (WHO 2011). An ongoing audit of ailments related with the utilization of biomass fuels did include cataract and a connection with condensate of biomass smoke (Kim *et al.*, 2011). A report of the Surgeon General 2004, demonstrated a solid connection among Cataract and cigarette smoking as detailed by the United States Surgeon General has sufficient proof to name smoking as a causal factor for cataract. This focuses to a system for breathed in harmful substances that either specifically or by implication affect lens tissues. While it is not possible to distinguish the accurate compound(s) in tobacco smoke that are in charge of lens toxicity is restricted however there are various likely constituents, for example, naphthalene, that are likewise present in biomass fuels. Lead exposure is related with protein aggregation diseases like cataract and lead is known as a condensate of biomass smoke (Susaya *et al.*, 2010).

Exposure to constant heat is a conceivable component by which household cooking and warming flames could incite cataract. Dry eye sickness, which is anything but a noteworthy reason for visual deficiency, is related with substantial ocular pain and discomfort and can

result in fluctuating visual effect (Miljanović *et al.*, 2007). It is a typical eye condition, and is pervasive in many developing countries.

Biomass components for example particulate matter could initiate oxidative stress and modify the cytokine substance of tears and visual surface, causing inflammation and dry eye disease (Yoshihara *et al.*, 2014). Moreover, exposure to wood smoke have been related with indications of visual distress (Viswanathan *et al.*, 2006). Further information demonstrates that increase ambient levels of particulate matter and carbon monoxide in air contamination might be related with meibomian organ brokenness a little sebaceous cyst of the eyelid (Meena *et al.*, 2012).

2.6 Hazard identification

As summarized in a few audit articles (Lewtas, 2007; Naeher *et al.*, 2007), there is a developing collection of proof from human and animal studies that wood smoke exposure represents a hazard to human health. These negative health effect range from irritancy to severe respiratory infections, including chronic obstructive airway disease and lung cancer. A few sorts of impacts known to be related with wood smoke are much the same as those of mixed, urban ambient PM for both cancerous and non-cancerous endpoints (Mishra *et al.*, 2004; Gerlofs-Nijland *et al.*, 2007).

The idea that wood smoke, being a natural and old substance, must be benign to humans is still heard sometimes. It is currently entrenched, in any case, that wood burning stoves and chimneys just as wild land and agricultural fires radiate significant amounts of known health damaging pollutants, including cancer-causing and other toxic organic compounds, for example benzene, polyaromatic compounds and aldehydes; respirable particulate matter with diameters enabling it to enter into the deep lung; carbon monoxide (CO); nitrogen oxides (NOx) and free radicals, among numerous different toxins (Dubick *et al.*, 2002;

Smith, 2013). The fundamental gas pollutants in woodsmoke, for example, carbon monoxide and nitrogen oxides, add to the atmospheric levels of these regulated gases originating from other ignition sources and along these lines have dependably been controlled alike with them.

2.7 The use of personal protective equipment as preventive measures against occupational hazards related to fish smoking.

Identification of hazards is first procedure to undertake before the commencement of any work and is constantly acknowledged in the control of any working field hazards. This procedure helps in the determination of appropriate preventive measures. Elimination is viewed as the best method for prevention of workers' exposure to hazards, in spite of the fact that the elimination method may not generally be applicable in many work circumstances. Different methods for prevention include engineering controls i.e. a kiln that channels the smoke away from the fish smoker, administrative controls for example some period out of work and safe work techniques. Prevention is the last resort, when there is absence of achievability in alternate techniques is by the utilization of Personal Protective Equipment (PPE) as methods for preventing hazard exposure (Alli, 2008). The general objective of PPE is to give a boundary against hazards for example goggles to protect the eye and apron or overcoat which are heat resistant to protect the skin. Ear plugs are used to protect the ears from noise exposure. Nose mask protect the fish smoker from exposure of wood smoke (Jiang *et al.*, 2016).

The eye needs to be protected from the wood smoke with eye goggles and the use of gloves will aid in prevention of cut on the hand or abrasive.

The use of a Personal Protective Equipment (PPE) requires the enforcement by active cooperation and compliance by the worker (Alli, 2008). It is fundamental for laborers to know about the hazards that are present in their workplace and the reason of using the PPE. Besides, for the compelling use of PPE it is of significance to guarantee that the specialists know the correct sort of PPE to be used and that it is used in the right way for the periods when the worker is exposed to potential hazards at the workplace. (International Labour Office, 2011). The Risk Assessment and the nature of the environment of the work activity determines the particular type of PPE to be used.

2.8 Ghana Health Laws

Ghana needs policies or guidelines that specifically address health and safety of fish smokers in the nation and based on literature it was obvious Ghana lacks policies in that direction. Fish smoking in Ghana is for the most part independently employed business and falls under small scale business. Ghanaian employees are secured under the Ghana Labor Act 651 (2003) which ensures that employees are not exposed to health hazards. Workers are additionally required to display their obligation of consideration in guaranteeing that they fill in according to the employers' standard working strategies which must fuse Safety and Health prerequisites. The Nation has distinctive agencies under various jurisdictions which monitor various industries for working environment and representative wellbeing, in any case, there is no national body, arrangement nor process that administer Occupational Safety and Health management in the country. The Minerals Commission has the Mining

Regulations 1970 (LI 665), which contains a few guidelines in Occupational Safety and Health however only for the Mining Industry and the Factories, Offices and Shops Act 1970, Act 328 for the labor sectors which has a limited scope in reference to the industrial scope of the country. There are other regulations which in an indirect way sway on Occupational Safety and Health and these incorporate the Environmental Protection Agency Act 490 1994, the Ghana Health Service and Teaching Hospital Act 526, 1999 and the National Road Safety Commission Act 567 1999.

Ghana is part of the 183 member nations of International Labour Organization (ILO), which requires, according to the ILO convention number 155 1981, that its members implement and periodically review a reasonable policy on occupational safety and health and the working environment. Ghana is yet to rectify this convention and yet to have an established body dedicated to occupational health and safety as a guide and to facilitate the implementation of Occupational safety and health at the national level based on a recommendation in the R164 Occupational Safety and Health Recommendation, 1981. However, the labor Act 2003 (Act 651), Part XV, segments 118 to 120 clearly coordinates employers and employees in their roles and responsibilities in the management of Occupational Health, Safety and Environment in the country. There is the need to show total commitment in implementing occupational safety and health standards policy as a nation.

CHAPTER THREE METHODOLOGY

Introduction

In this chapter an account of research design, analysis and handling of data is given. This gives a basis for evaluating the quality of the data used in the study and the validity of the findings.

3.1 Research design

A quantitative approach was employed in the study. The use of well-structured survey questionnaire was used find out the type of biomass fuel used for the smoking of fish in Abuesi and also to find out the perception of fish smokers on health outcomes associated with the use of biomass fuel as the main source of energy for the smoking of fish.

3.2 Population

The source population included all smokehouse helpers who smoked fish in enclosed houses. Three hundred and fifty-six participants were randomly selected for this study and a well-structured questionnaire was administered to the three hundred and fifty-six subjects.

3.3 Sampling Technique

Both purposive and random sampling was employed to select participants from the fish landing site in Abuesi. The purposive sampling technique helped in reaching the target sample quickly thus fish smokers who have been in the fish smoking business for quite some time and out of the fish smokers about three hundred participants was randomly selected for the monitoring. A well-structured questionnaire was administered to about 356 respondents to beseech their views on the health effects connected with the burning of biomass fuel as the main source of energy for the smoking of fish.

3.3.1 Sample size

The final sample size for each of the category or group was determined with Saunders et al., (2009) formula below:

$$n = \frac{N}{1+N\,(a^2)}$$

Where:

n = sample size,

N= population universe and a=

the confidence level

The formula adopted a confidence level of 95% and the margin of error is therefore 5% which is acceptable in social science research. Thus, the sample size was calculated as follows:

$$n = \frac{3236}{1+3236\,(0.05^2)} \Rightarrow n = \frac{3236}{1+8.09} \Rightarrow n = \frac{3236}{9.09} \Rightarrow n = 356$$

Therefore, the sample size for the study was 356 respondents.

3.4 Data collection instruments

A survey was conducted through the use of a well-structured questionnaire made up of both close-ended and open-ended questions to assess the type of biofuel used and also find out the general perception of fish smokers about their exposure and health risks to smoke.

Plate 1: Researcher interviewing a fish processor at the Abuesi fish landing site

3.5 Data Analysis

Data obtained from the field was subjected to statistical analysis using the computer software the Statistical Package and Service Solution (SPSS version 21.0). The human health evaluation computerized software-RISC 4.02 was employed in the evaluation of various health hazards.

3.6 Protection of privacy

Study participants had the right to answer or not to answer any survey questions that they felt will compromise their privacy. Also, all data captured was not subject identifiable and participants are assured of the security of their privacy.

3.7 Informed consent

Informed consent was sought and obtained from study participants. An oral script introducing the study was issued to the study participants and also was read out to those who cannot read and write by a translator. A written consent for the study was issued to interested participants and read out to these participants by a translator and the questions raised were addressed. Individuals who agreed to participate were then interviewed.

3.8 Provision to prematurely end a particular subject's participation in the study

Study participants opted to be interviewed in a location of their choice to increase privacy. There was no instance of an adverse event or situation of distress.

3.9 Record storage and protection

All research records and data have been protected against illegal use, or accidental loss or destruction in order to protect the confidentiality of subject data. All data and any other study-related material is under restricted assess on a laptop. Routine electronic back up and encryption of digital data have also been done together with the provision of an updated anti-virus software to ensure the security of the data stored on the laptop.

3.10 Data status at the end of the study

The responses solicited from the subjects will be deleted from their storage device (digital format) after 10 years' retention. The study survey forms will be destroyed at the end of the study. It is anticipated that retention period may change, although the samples will be retained until the completion of the study. It is also necessary to collect and maintain data linked to subjects' identities in anticipation of the need to be able to return the $PM_{2.5}$ and CO analysis results to those who desire it, and also advice those with levels above the recommend limit to abstain from the work while seeking the medical attention for a while for the sake of their health.

3.11 Retention of data and/or specimen details

There may be the retention of data by the investigator for future research and/or the creation of repository. In the situation where it becomes necessary for future research in the same study area, a longitudinal study can be done to show how conditions have changed over the period. Also, in order to deliver individual subjects' results on a subsequent visit, there will be the need to retain these data.

3.12 Compensation of subjects

All study subjects who successfully completed the proposed data collection received a scratch card worth of 5 Ghana Cedis (5 GH).

CHAPTER FOUR

RESULTS

Introduction

In this Chapter, the results of the analysis are presented. A description of the study sample in terms of its demographic characteristics is first provided and the contribution fuelwood type to these findings.

4.1 Demographic characteristics

Table 1 shows the various demographic characteristics of respondents interviewed at Abuesi fish landing community. From Table 1, majority of the respondents (42 %) had more than 10 years of working experience while a few of the respondents (3 %) were with less than 1 year working experience. However, 26 % and 29 % of the respondents indicated '1-5' and '6-10' years of working experience respectively (Table 1). Regarding marital status, majority of the respondents (75 %) were married while a few of the respondents (7 %) were single. However, 12 % and 5 % of the respondents were divorced and widowed respectively. Meanwhile 1 % of the respondents were separated. (Table 1).

In reference to the level of education, minority of the respondents (48 %) had no formal education while majority of the respondents (52 %) had formal education. However, out of the respondents with formal education, 34 %, 18 % and 0 % attained primary, junior high

school and senior high school respectively. (Table 1). The age ranging between 41-50 years had the majority of respondents' percentage (35 %) with a few of the respondents within 61-100 years were (2 %). The minimum age group which was '21-30' years accounted for 20 % whereas the age groups of '31-40' years and '51-60' years were 32 % and 10 % respectively. (Table 1).

Referring to religion, majority of the respondents were Christians (79%), followed by Muslims who accounted for 20% of the respondents. Few of the respondents belonging to other religion covered 1%.

Table 3: Characteristics of respondents

Variables	Options	Frequency (n)	Percent (%)
Years of experience	< 1 year	9	3
	1-5 years	94	26
	6-10 years	103	29
	> 10 years	150	42
Marital status	Single	25	7
	Married	268	75
	Divorced	41	12
	Widowed	18	5
	Separated	4	1
Level of education	No formal education	170	48
	Primary	121	34
	Junior High School	64	18

	Senior High School	1	0
Age groups	21-30	72	20
	31-40	114	32.
	41-50	126	35
	51-60	37	10
	61-100	7	2
Religion	Christian	281	79
	Muslim	71	20
	Others	4	1
Total		356	100

4.2 Smoking oven and fuelwood type

Figure 1 shows the various materials used in building the smoke oven at Abuesi fish landing community. From Figure 1, majority of the respondents (82 %) used clay materials while a few of the respondents (16 %) used mud as building material for the smoke oven. However, 1 % and 1 % of the respondents used metal and burnt bricks for building of the smoke oven respectively (Figure 1).

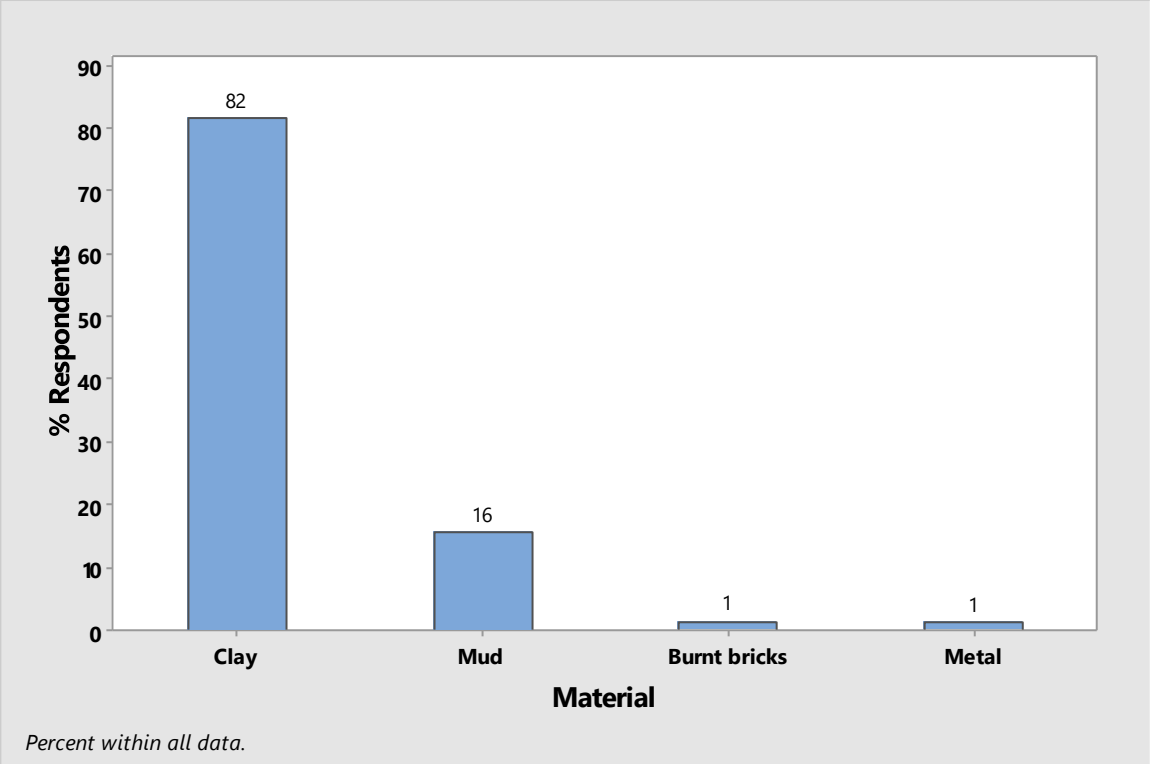

Figure 2: Materials used in building smoke oven by respondents at Abuesi fish landing community.

Figure 2 shows the various fuelwood type materials used in fish smoking at Abuesi fish landing community. From Figure 2, majority of the respondents (65 %) used rubber tree as their main fuelwood type for smoking fish while a few of the respondents (5 %) used Funtum as their main fuelwood type for the smoking fish (Figure 2).

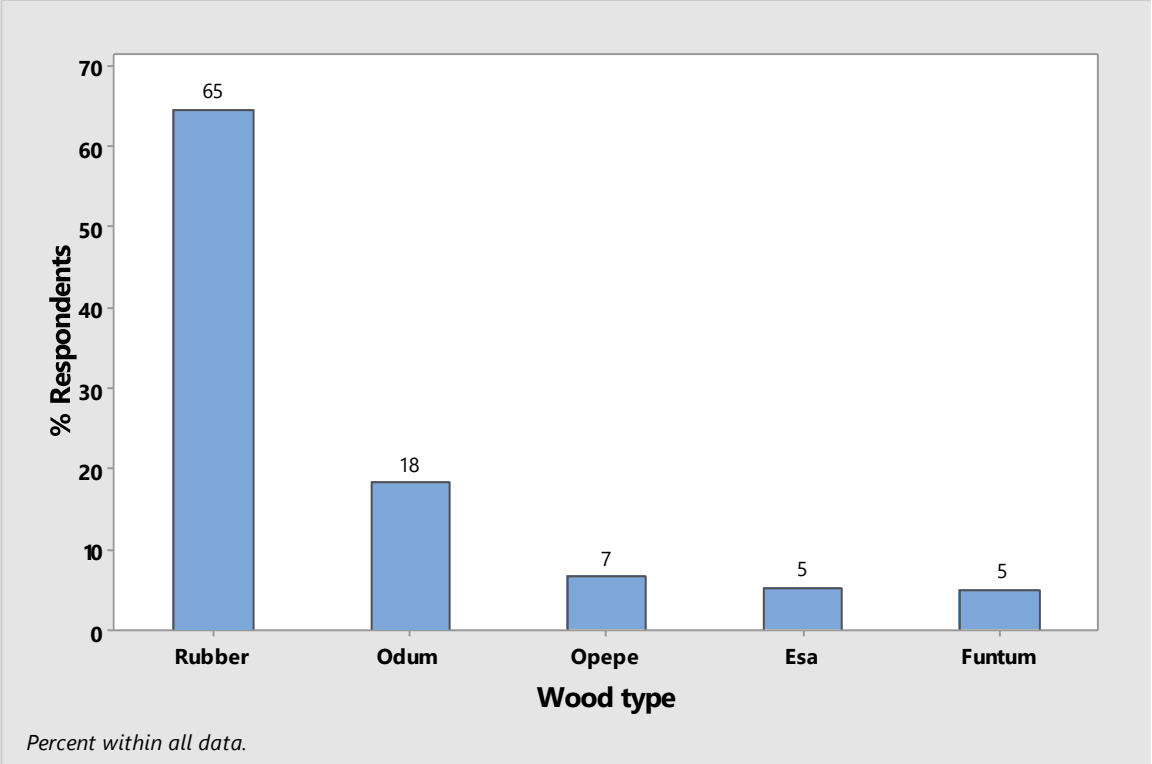

Figure 3: Fuel wood type used by respondents at Abuesi fish landing community

4.3 Smoke health related issues

4.3.1 Prevalence of smoke health related issues

Figure 3 shows the occurrence of heath related issues among respondents in Abuesi fish landing community. From Figure 3, majority (i.e. 300 out 355) of the respondents within all the age groups expressed concerns on health-related issues whiles minority (i.e. 55 out of 355) of the respondents indicated no health-related issues. (Figure 3).

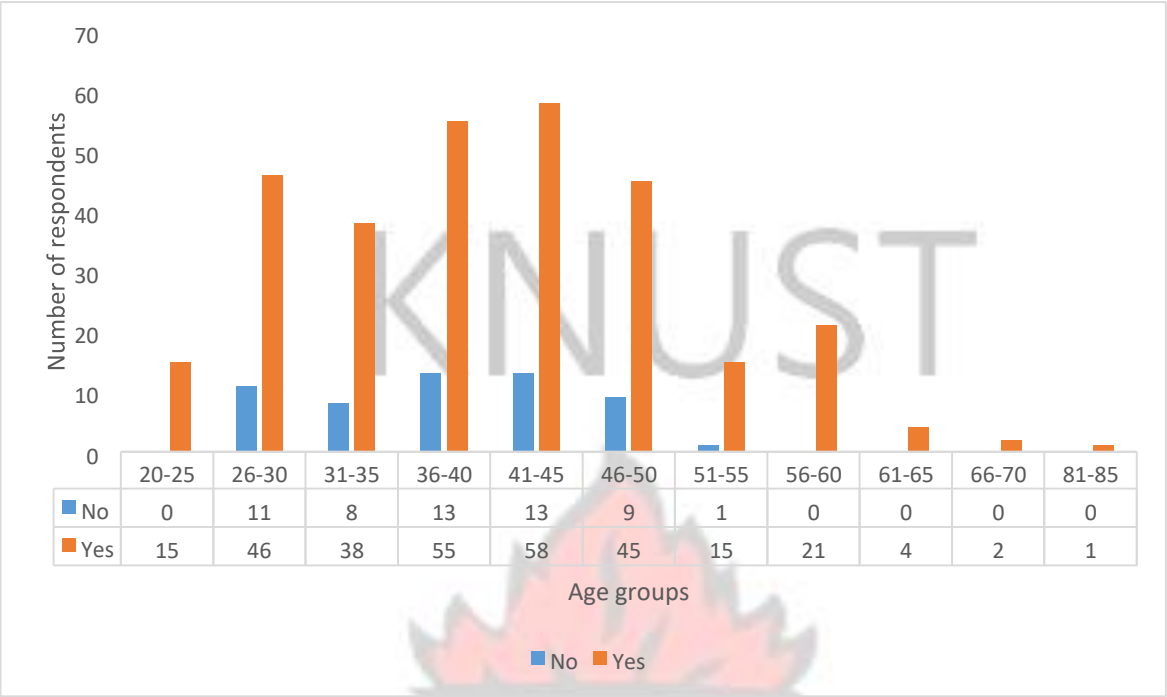

Figure 4: Occurrence of smoke-related health issues among respondent based on age groups

4.3.2 Symptoms of smoke related health issues

Figure 4 displays symptoms of smoke related health issues among respondents in Abuesi fish landing community. From Figure 4, more than half of the respondents (51%) experienced cough as a symptom of fish smoking. Minority of the respondents (17%) reported eye disease as a symptom of smoke health related issues whiles others (32%) complained of headache (11%), phlegm/wheezing (10%) and respiratory diseases (11%) as symptoms of health-related issues. (Figure 4).

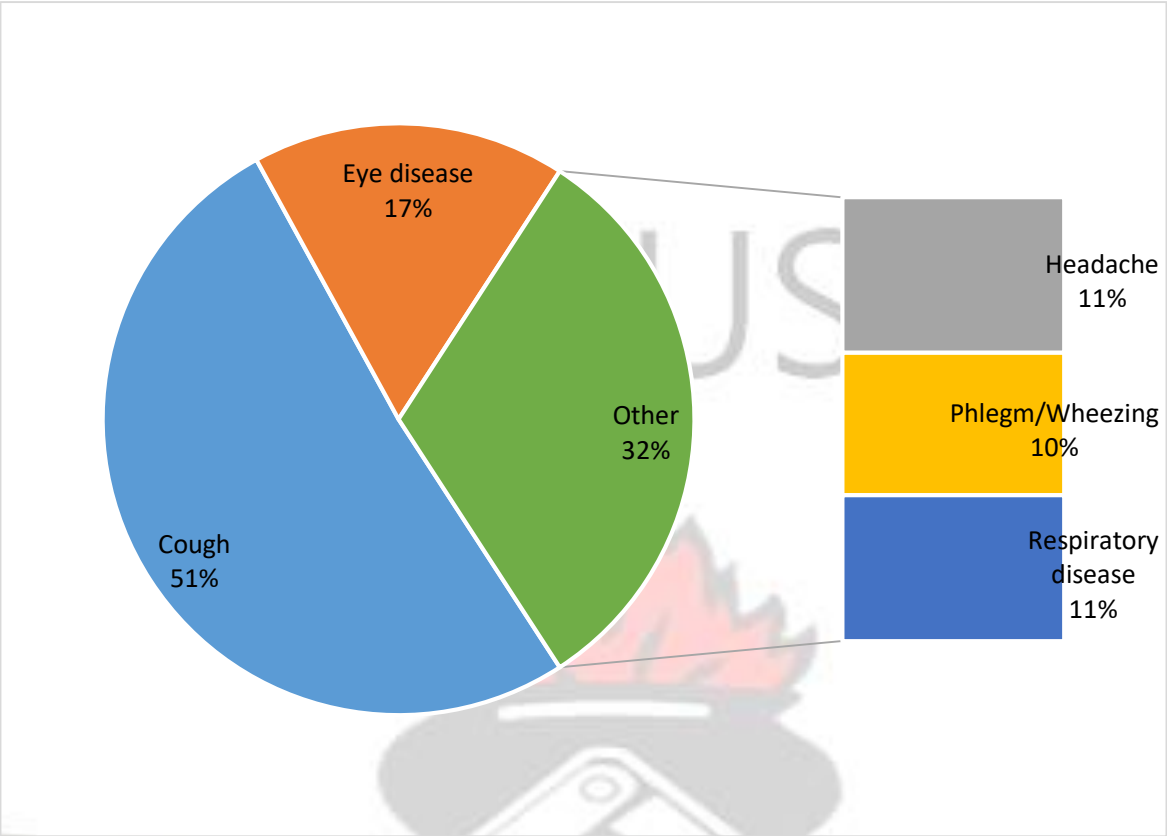

Figure 5: Symptoms of smoke- health related issues among respondents

4.3.3 Use of Personal Protective Equipment

Table 2 portrays the various safety precautions respondents interviewed at Abuesi fish landing community practice. From Table 4, majority of the respondents (93 %) do not wear safety boot when smoking fish while only few of the respondents (7 %) put on safety boot during smoking of the fish. Concerning the use of safety goggles by the respondents, 92 % do not use safety goggles while few of the respondents (8 %) put on safety goggles when smoking fish. (Table 4). Majority of the respondents (92 %) do not use hand gloves in fish smoking whereas minority of the respondents (8 %) use gloves during fish smoking. (Table 4). Referring to protective clothing, a greater percentage of the respondents (96 %) do not wear any form of protective clothing when working whiles the respondents (4 %) wear protective clothing in smoking of the fish.

Table 4: Measures to control hazards during fish smoking among respondents

Variables	Responses	Frequency	Percent
Safety boot	No	332	93
	Yes	24	7
	No	328	92
Safety goggles	Yes	28	8
	No	328	92
Hand gloves	Yes	28	8
	No	343	96
Protective clothing	Yes	13	4
	No	343	96
Total		356	100

4.4 Factors for prevalence of smoke related health diseases

Factors associated with prevalence of smoke related health diseases among respondents were determined using independent variables which were significant with dependent variable (prevalence) through correlation analysis.

Applying the adjusted odd ratio as the reference, it was observed that respondents who spent more than 3 hours of smoking fish were significantly 16.95 times more likely to experience smoke related health issues (AOR= 16.95, [CI= 6.075 – 47.357], p-value < 0.05).

Respondents who do not have any measures in place regarding fish smoking were 1.926 more times likely to suffer implications from fish smoking (AOR = 1.926, [CI = 0.725 – 5.049], p-value > 0.05), though not significant.

Respondents who do not always smoke fish were 0.220 times less likely to be vulnerable to smoke related health issues (AOR= 0.220, [CI= 0.078 – 0.625], p-value < 0.05).

Table 5: Binary logistic regression model of smoke related health implication to fish smokers in Abuesi

Independent variable	N	Crude OR	95% CL	p-value	Adjusted OR	95%CL	p-value
Hours spent							
> 3	365	18.657	7.245 – 48.047	0.000	16.957	6.075 – 47.357	0.000
1 -3		1.000			1.000		
Any measures in place							
No	365	3.446	1.603 – 7.410	0.002	1.926	0.735 – 5.049	0.182
Yes		1.000			1.000		
Frequency of use							
Not always	365	0.383	0.144 – 1.015	0.054	0.220	0.078 – 0.625	0.004
Always		1.000			1.000		

4.5 Awareness creation

4.5.1 Access to Education on healthy fish smoking practices

Figures 6 and 7 display access of education on practices of healthy fish smoking in Abuesi fishing community based on age groups and education status. From Figure 6, majority of the respondents in each of the age groups (i.e. 333 out of 355 respondents) had no knowledge of healthy fish smoking practice with few respondents indicated knowledge of healthy fish smoking practice (i.e. 22 out of 355 respondents).

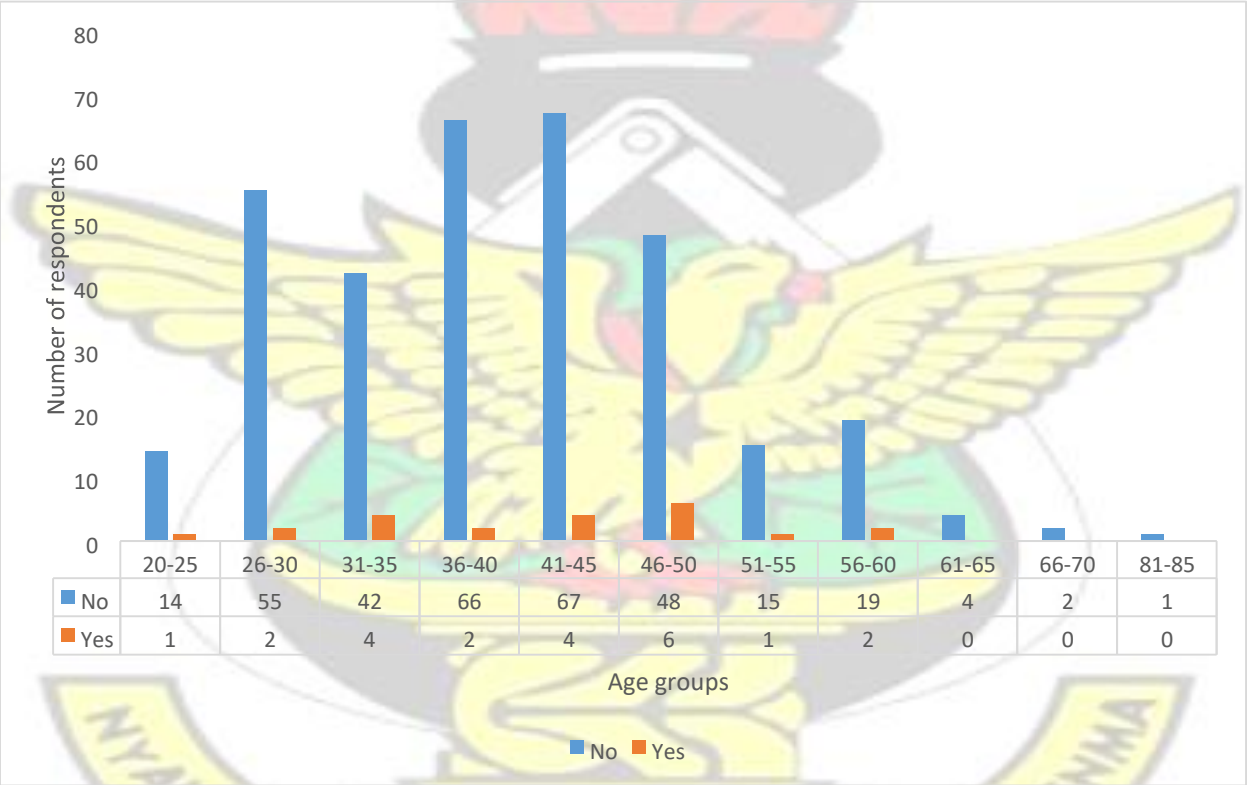

Figure 6: Respondents knowledge on access to safe fish smoking practices based on age groups

From Figure 7, majority of the respondents (both educated and not educated) representing. 160 out of 170 and 174 out of 186 respondents respectively expressed no knowledge of healthy fish smoking practice. Few respondents admitted having knowledge of healthy fish smoking practice

(i.e. 10 out of 170 and 12 out of 186 for respondents with 'no' education and education respectively).

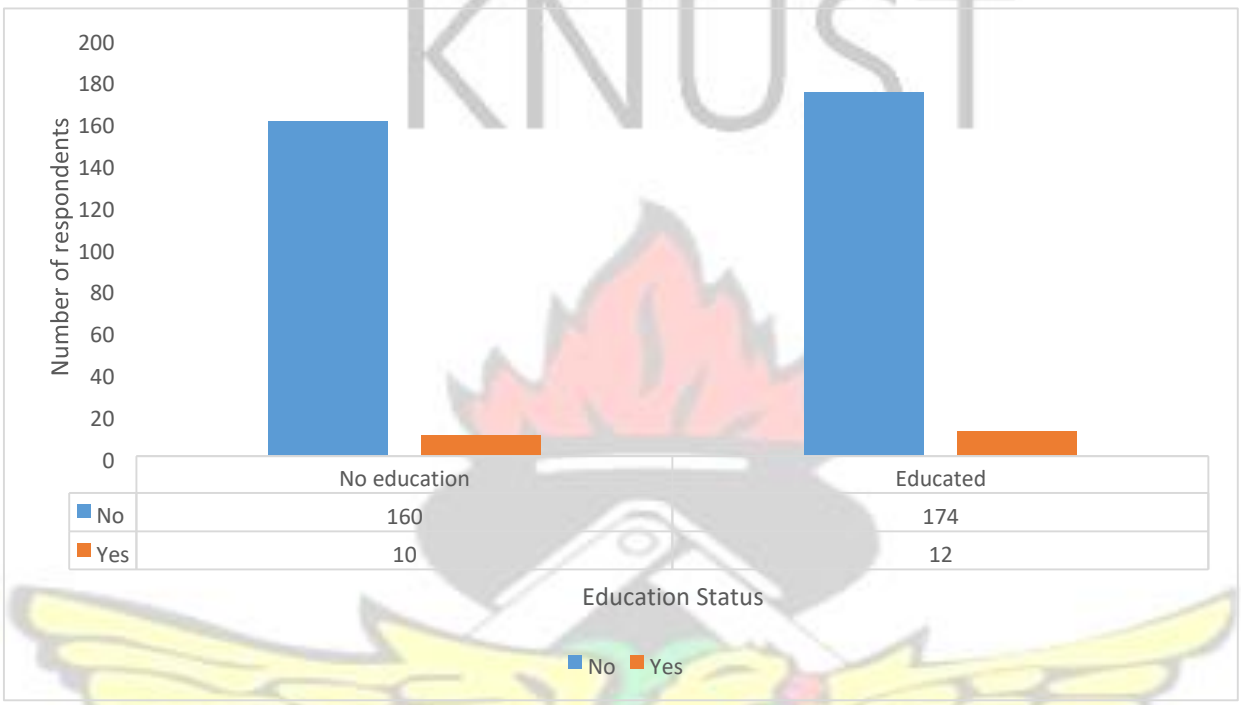

Figure 7: Respondents knowledge on access to safe fish smoking practices based on education status

4.5.2 Frequency of access to education on healthy fish smoking practices

Figure 6 shows the frequency of access to education on practices of healthy fish smoking in Abuesi fishing community. From Figure 6, a vast number (335 out of 356) of the respondents never get

access to education on practices of healthy fish smoking. Only (10 out of 356) respondents always get access to education on healthy practices of fish smoking and (11 out of 356) respondents were previewed to education on healthy practices of fish smoking once in a year.

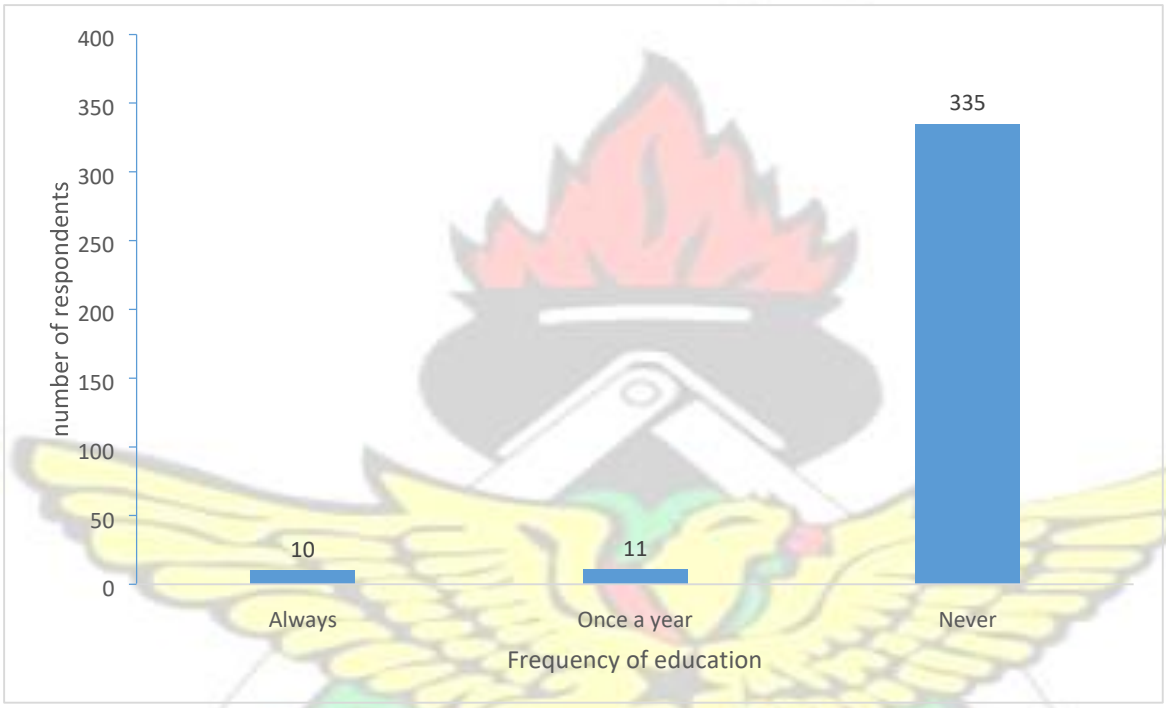

Figure 8: Respondents knowledge on frequency of access to education on safe fish smoking practices.

4.5.3 Sources of frequency of access to Education on healthy fish smoking practices Figure 7 indicates the source of frequency of access to education on practices of healthy fish smoking in Abuesi fishing community. From Figure 7, 33% and 67% of the education on healthy practices was by MOFA and Hen Mpoano respectively.

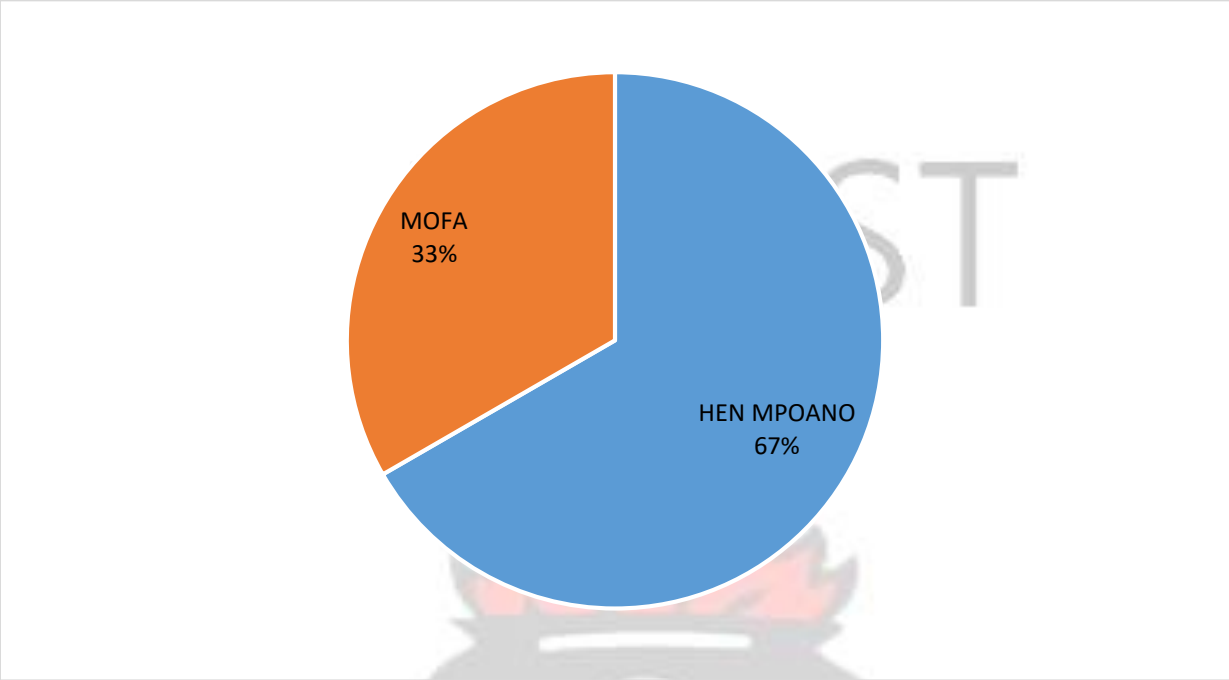

Figure 9: Sources of knowledge on frequency of access to education on safe fish smoking practices.

CHAPTER FIVE

DISCUSSION Introduction

This chapter discusses a detailed result of the work and compared with similar work found in the literature on health hazards of woodsmoke.

5.1 Smoking oven and fuelwood type

The popularity of clay used in the construction of the smoking oven among fish smokers in Abuesi could be due to a plethora of factors including accessibility, comfort and cost. For instance, the use of clay in stove construction reduces emission of heat to fish smokers than the other materials hence it popularity among them (Folaranmi, 2009). Again, clay is highly available at a reduced cost in Abuesi community which is endowed with clay, accounting for its acceptance among fish smokers.

Regarding the choice of fuelwood, it usage depend on several factors such as availability, durability (how long it last in fire), cost and its impact on smoked fish products quality. Impacts of fuelwood on smoked fish product quality include colour, attractiveness and moisture reduction. From the present study, the high usage of rubber tree along with odum, opepe and funtum was largely due to availability and its ability to make the smoke fish products attractive. Potential reasons for reduced acceptance of Esa fuelwood among Abuesi fish smokers was due to the price and unavailability – mostly sourced from Adanse and Manso in the Ashanti region (Hansen *et al.*, 2015).

5.2 Smoke health related issues

Some of the occupational hazards identified in the study include red eye (eye hazards), headache, respiratory diseases and others. These symptoms of smoke related health issues are similar to findings by other researchers. For instance, Yolande et al 2014 in their studies on description of risk factors in the formation of hydrocarbons during the traditional fish smoking in Abidjan identified the following symptoms (colds, headaches, eye stinging) noted during among fish smokers. Dienyne et al., (2016) in their respiratory effects of biomass fuel combustion reported of

the symptoms like sneezing, catarrh, cough, breathlessness and chest pain among rural fish smokers in a Nigerian fishing community. Feke and Manzano (2008) in their studies on the implications of wood exploitation for fish smoking on mangrove ecosystem conservation in the South West Province in Cameroon attributed the occurrence of series of health problems among women and children in fishing communities to the presence of heat and smoke fumes from mangrove trees (woodsmoke).

The presence of these occupational hazards could be attached to factors like constant exposure to smoke, increased temperature, poor ventilated fish smoke house and consistent contact with iced fishes mostly before smoking (Ijatuyi *et al.*, 2016). These symptoms are the direct effects of air pollution which emit toxic and irritant substances (Bølling *et al.*, 2009). Studies by Olaojo et al. (2015) on occupational hazards and injuries associated with fish processing in Nigeria highlighted that extra work places fish processors at greater risk which serves a launchpad for occurrence of other occupational hazards. The presence of these symptom may indicate the presence of a serious or even life-threatening pathologic condition since they are largely nonspecific and gradual in onset (Mannino *et al.*, 2002; McLean *et al.*, 2010).

5.3 Factors for prevalence of smoke related health diseases

Binary logistic analysis from the study showed that long exposure to biomass smoke during fish smoking is associated with the development of smoke related health diseases (particularly pulmonary diseases). This finding corroborates with other studies done elsewhere. For example, Umoh et al. (2013) undertook studies on psychological distress in women with chronic bronchitis in a fishing community in the Niger Delta Region of Nigeria and reported that increased exposure to biomass smoke increases vulnerability of fish smokers to respiratory symptoms and chronic bronchitis. Umoh et al. (2013) undertook studies on psychological distress in women with chronic

bronchitis in a fishing community in the Niger Delta Region of Nigeria and reported that increased exposure to biomass smoke increases vulnerability of fish smokers to respiratory symptoms and chronic bronchitis (Umoh *et al.*, 2013). Findings by Kurmi et al. (2012) indicate the risk of wheeziness increased with frequent exposure to biomass smoke suggesting that fish smokers not always exposed to fuel smoke are less susceptible to smoke related health diseases (Kurmi *et al.*, 2012).

The presence of high susceptibility to pulmonary diseases and other smoke related health diseases could be attached to the alteration in pulmonary host defense mechanism (Olloquequi and Silva O, 2016). To support this assertion, studies on the toxicology of inhaled woodsmoke reported of higher susceptibility to infections with *Staphylococcus aureus* in rats exposed to wood smoke in the range of 3 hours to 2 weeks (Van Den Heuvel *et al.*, 2018).

5.4 Awareness creation

The higher rate of ignorance among respondents on impact of fuelwood smoke on the health of fish smokers maybe due to the fact that impact of fuelwood on the health of fish smokers is not fully understood. On the other, the minority of respondents who claimed to have knowledge on issues concerning fuelwood smoke and its consequences on the health of fish smokers by MOFA and Hen Mpoano may be due to the fact that these respondents are fish mammies who get the opportunity to attend such occasions. However, their inability to share with fish wives (women who do the smoking) who form the majority may have also contributed to the high rate of ignorance among fish smokers.

5.5 Limitation

This study has several limitations: first of all, the instrument used in the study is a self-administered tool but interview was undertaken because of the low literacy level of the respondents. It is expected that subjects may underreport symptoms when interviewed but since all response was as a result of long exposure, whatever bias that may be introduced will have a negligible overall effect. Secondly, we did not document exposure period to biomass smoke from smoking because it was expected that biomass smoke exposure from smoking fish in Abuesi will not be selective and will therefore not introduce bias. Thirdly, level of air pollution resulting from burning firewood could not be measured directly. This would have provided the pollution levels at fish smoking shed in time. Finally, the design of the study, cross-sectional observation makes it impossible to show whether a particular fuelwood precipitates the symptoms reported or is a result of it.

CHAPTER SIX

CONCLUSIONS AND RECOMMENDATIONS

Introduction

In this chapter, the conclusion of the study is presented and discuss the potential policy implications of these findings

6.1 Conclusions

The study examined the effect of wood smoke among fish smokers in Abuesi fish landing community in Ghana and non-adherence to PPE usage. From the study:

1. The occurrence of smoke health related diseases was 90% while 10% have not experienced any smoke related health disease.
2. Fish smokers with more hours of exposure, practiced no safety measure (use of PPE) and frequently smoking fish were more likely experience smoke health related diseases.
3. Most dominant symptoms of smoke health related diseases among respondents was coughing and eye diseases.
4. Majority of the respondents (94%) had no access to education on the impact of biomass smoke on the health of fish smokers while 6% indicated access to biomass implication fish smoker health.
5. The main sources of education on issues pertaining to the health of fish smokers were MOFA and Hen Mpoano.

6.2 Recommendations

Based on the findings from the present study, the following actions for key stakeholders (fish smokers, government and NGOs) are recommended below:

1. Collaboration among respective stakeholders in informing and educating the fish smokers with the correct information.

2. Again, in cases where 'trainer of trainee' strategy is employed, monitoring and evaluation should be done to ensure that trainees (fish wives) are well informed and the necessary precautions are applied.
3. All fish processors should be well-informed and trained on the associated risks and hazards of their vocation and re-orientation of fish processors so as to inculcate safety consciousness.
4. Personal protective wears should be used by the fish processors and enforced to reduce risks of accidents or other workplace hazards and there should be the provision of first aid kits at all fish processing zones with adequate instructions on their usage.

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APPENDICES

Appendix 1: Fuelwood used in fish smoking at Abuesi fish landing site

Appendix 2: Smoke emission from fish smoking process at Abuesi fish landing site

Appendix 3: Safety measures missing at the fish smoking shed in Abuesi fish landing site

TOPIC: OCCUPATIONAL HEALTH HAZARDS OF WOODSMOKE AND USE OF

PERSONAL PROTECTIVE EQUIPMENT AMONG FISH SMOKERS IN ABUESI.

This study seeks to identify the health implications of fish smoking and the adherence of PPE usage among fish smokers in Abuesi, Ghana. This research is for study purposes for the completion of Msc. Environment and Public health. Hence all responses will be held confidential.

Thank you.

SECTION A: DEMOGRAPHY OF RESPONDENT

1	What is your Age?	15-25years	1
		26 - 36years	2
		37 - 47 years	3
		Above 47years	4
2	What is your Marital status?	Single	1
		Married	2
		Divorced	3
		Widow / Widower	4
		Separated	5
3	What is your highest level of formal education?	No Education	0
		Primary Education	1
		Junior High School	2
		Senior High School / Vocational School	3
		Tertiary	4
4	Number of years experienced smoking	Less than 1 year	1
		1-5 years	2
		6-10 years	3
		Above 10 years	4
5	What is your religion?	Christian	1
		Muslim	2
		Traditional	3
		Other	4

SECTION B: TYPE OF FUEL WOOD USED FOR SMOKING

6	Material used in constructing smoking stove	Clay	1
		Burnt bricks	2
		Mud	3
		Metal	4
		Others	5
7	Type of wood fuel used for smoking	Rubber	1
		Esa	2
		Opepe	3
		Odum	4
		Funtum	5
8	What is the reason for your choice?		
9	How often do you use it?	Always	0
		Not always	1
10	Duration of hours spent smoking	< 1 hour	1
		1-3 hours	2
		4-6 hours	3

SECTION C: SAFETY ISSUES IN FISH SMOKING

11	Do you protect yourself during smoking? If No skip to question 15.	No	0	
		Yes	1	
12	Which of these safety materials do you use during smoking?	Safety boots	No	0
			Yes	1
		Safety goggles	No	0
			Yes	1
		Hand gloves	No	0
			Yes	1
		Protective clothing	No	0
			Yes	1
		Nose mask	No	0
			Yes	1
13	Do you practice any other safety measures during smoking?	No	0	
		Yes	1	
14	If Yes mention any three			
15	If No why?			
16	Do you have any other alternative livelihood?	No	0	
		Yes	1	

SECTION D: HEALTH IMPLICATIONS OF FISH SMOKING

17	Are you aware high exposure to fire can affect your health?	No	0
		Yes	1
18	Have you ever encountered any health hazard on the field of work?	No	0
		Yes	1
19	If yes, what was the symptom?	Headache	1
		Cough	2
		Phlegm/Wheezing	3
		Breathlessness	4
		respiratory disease (Chest cold, chest illness)	5
		Eye disease (redness, eye irritation etc.)	6
		Others Specify	
20	Are the disease related to the job?	No	0
		Yes	1
21	If yes, what is the relationship?		

\

SECTION E: FREQUENCY OF FISH SMOKE RELATED SYMPTOMS

22		**0**	**1**	**2**	**3**
	Symptoms	None	1-2 times in a week	3-4 times in a week	>4 times in a week
A	Headache				
B	Cough				
C	Phlegm/Wheezing				
D	Breathlessness				
E	Respiratory disease (Chest cold, chest illness)				
F	Eye disease (redness, eye irritation etc.)				

SECTION F: EDUCATION OF FISH SMOKING IMPLICATION

23	Have you received any education on the health implication of woodsmoke?	No	0
		Yes	1
24	If yes, from where?		
25	How often do you receive education on health education?	Always	1
		Once a week	2
		Once a month	3
		Once a year	4
		Never	5
26	Any limitations in your fish smoking activity?		

Appendix 2: **INFORMED CONSENT**

Institutional Affiliation

KNUST-African Institute of Sanitation and Waste Management

Background

Dear participant, Louis Nana Tene is my name, a student of the KNUST-African Institute of Sanitation and Waste Management. I am undertaking a study on HEALTH EFFECTS OF WOODSMOKE USE AMONG FISH SMOKERS WITHIN COASTAL COMMUNITIES IN GHANA.

The study will be aimed at identifying health effects to the exposure of woodsmoke among fish smokers in Abuesi.

Procedures

The study will involve answering questions from a structured questionnaire. This is purely an academic research, which forms part of my work for the award of a master of environment and public health degree. I would be very grateful to have you as part of this study.

Risks and Benefits

The study will not cause any discomfort to participants. It is hoped that results obtained for this study will be used by policy makers and the community in particular to either improve upon existing safety measures or to enforce existing ones with the objective of protecting fish smokers from the harmful effects of woodsmoke.

Right to refuse

Participation in this study is voluntary and one can choose not to answer any particular question or all questions. You are at liberty to withdraw from the study at any time. However, it is encouraged that you to participate since your opinion is important in determining the outcome of the study.

Anonymity and Confidentiality

I would like to assure you that whatever information provided will be handled with strict confidentiality and will be used purely for the research purposes. Your responses will not be shared with anybody who is not part of the research team. Data analysis will be done at the aggregate level to ensure anonymity. Data collected cannot be linked to you in anyway. No name or identifier will be used in any publication or reports from this study. However, as part of our responsibility to conduct this research properly, we may allow officials from Ghana Standard Authority,

Supervisors, and Committee on Human Research Publication and Ethics (CHPRE) of KNUST to have access to your records for 3-5 years upon completion of the research.

Dissemination of results

The result of this study will be sent to you if you provide your address below.

Before taking the consent, do you have any question you wish to ask about the study?

Yes (if yes, questions to be noted bellow)

No

……

……

If you have questions later, you may contact me on 0246024401.

Your rights as a Participant

Further, if you have any concern about the conduct of this study, your welfare or your rights as a research participant, you may contact:

The Office of the Chairman Committee on Human Research and Publication Ethics
Kumasi Tel: 03220 63248 or 020 5453785

CONSENT FORM

Statement of person obtaining informed consent:

I have fully explained this research to _____ and have given sufficient information about the study, including that on procedures, risks and benefits, to enable the prospective participant make an informed decision to or not to participate.

DATE: _____ NAME: _____

Statement of person giving consent:

I have read the information on this study/research or have had it translated into a language I understand. I have also talked it over with the interviewer to my satisfaction.

I understand that my participation is voluntary (not compulsory).

I know enough about the purpose, methods, risks and benefits of the research study to decide that I want to take part in it.

I understand that I may freely stop being part of this study at any time without having to explain myself.

I have received a copy of this information leaflet and consent form to keep for myself.
NAME:_____

DATE: _____ SIGNATURE/THUMB PRINT: _____

Statement of person witnessing consent (Process for Non-Literate Participants):

I _____ (Name of Witness) certify that information given to (Name of Participant), in the local language, is a true reflection of what l have read from the study Participant Information Leaflet, attached.

WITNESS' SIGNATURE (maintain if participant is non-literate): _____

Interviewer's Statement

I, the undersigned, have explained this consent form to the subject in English or Twi that he/she understands the purpose of the study, procedures to be followed as well as risks and benefits involved. The subject has freely agreed to participate in the study.

Interviewer's signature…… Date:……..……..

Address:……..……