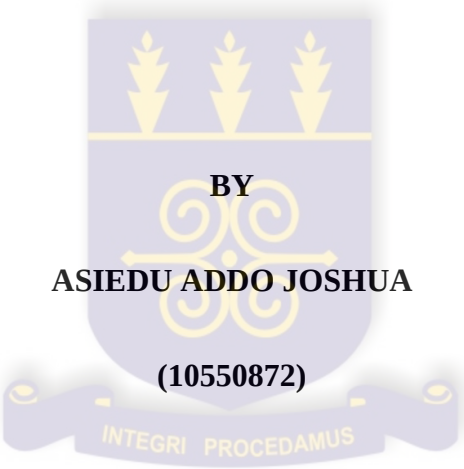
SCHOOL OF PUBLIC HEALTH

COLLEGE OF HEALTH SCIENCES

UNIVERSITY OF GHANA

PESTICIDE EXPOSURE AND SYMPTOMS OF ACUTE RESPIRATORY TRACT INFECTIONS IN UNDER -FIVE YEAR OLDS OF FARMERS IN THE OFFINSO-NORTH DISTRICT



BY

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JULY, 2016

DECLARATION

This is to declare that this work is a result of my own research. Other academic works that have been cited were duly acknowledged. This thesis has not been submitted to this or any other university for any degree.

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DEDICATION

I dedicate this work to my brother Obed Otu Asiedu and my fiancee Bridgette Saffron Abakah whose inspiration and companionship have been very instrumental in getting me this far.

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The greatest thanks and acknowledgement goes to my God for the goodness and favor shown me all these years. I want to also express gratitude to my supervisor for his outstanding insight and assistance with this work. My friends and colleagues in the master of public health program also deserve acknowledgement for helping when necessary. To the School of public health, I am grateful for the opportunity to have studied with them.

ABSTRACT

Background: Exposure to pesticide and its associated health effects in farm children is a major global public health issue. Several studies published in the developed countries have associated pesticide exposure in farm children with acute respiratory infection. However, no data on this subject is available in farm children in Africa.

Objectives: This study investigated the prevalence of acute respiratory infection (ARI) defined as acute lower respiratory tract infection (ALRI) and upper respiratory tract infection (URI) and its association with indicators of pesticide exposure in children under five years living in farming communities in the Offinso-North district of the Ashanti region.

Methodology: The study was derived from the Offinso North district Farm Health study (ONFAHS). ONFAHS is a cross-sectional design involving 300 households (i.e. children under-five and their parent(s)) in the Offinso-North district of the Ashanti region. One hundred and seventy (170) children under the age of five years who met the eligibility criteria of the main study formed the study population. Parents of these children were interviewed with a structured questionnaire.

Results: Bad food handling behavior, bad hygiene practices and contact with pesticide equipment on the farm or home were common among the children. The prevalence of symptoms of ARI, ALRI and URI were high. Bad mouthing behavior and contact with contaminated surfaces in the farm were significantly associated with symptoms of respiratory infection. Contact with pesticide containers, equipment and contaminated surfaces at home were also significantly associated with symptoms of URI and ALRI. Contact with pesticide containers and equipment in the farm and/or at home were also associated with symptoms of ALRI and URI respectively.

Conclusions: The findings of this study suggest that exposure to pesticides through bad hygiene practices; bad mouthing behavior and contact with contaminated surfaces were common among the children. The prevalence of symptoms of ARI was also common. Associations between indicators of pesticide exposure and ARI, ALRI and URI were significant.

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LIST OF ABBREVIATIONS

AChE - acetycholinesterase

ALRI- Acute Lower Respiratory Infection

ARI - Acute Respiratory Infection

ARTI - Acute Respiratory Tract Infection

AVGA - Akumadan Vegetable Growers Association

DDE - Dichlorodiphenyldichloroethylene

DDT - Dichlorodiphenyltricholoroethane

DEET -Diethyl toluamide

IMS -intermediate syndrome

OC - organochlorines

OCPs -Organochlorine Pesticides

OP - organophosphates

POPs - Persistent Organic Pollutants

PCBs -Polychlorinated biphenyl

PCDD/Fs - Polychlorinated dibenzodioxins/furans

PR – Prevalence Ratio

URI – Upper Respiratory Infection

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background of Study

Acute respiratory infection is a major cause of mortality in children under five in developing countries and has been estimated to be responsible for over two million deaths in a year (Lanata, Rudan, Boschi-Pinto, et al., 2004). Acute respiratory infection constitutes both upper and lower respiratory infections. Acute lower respiratory tract infection (ALRI) includes infections in the larynx, trachea, bronchus, bronchioles; and upper tract respiratory infection (URI) which affects the nose, sinuses and larynx. Common examples of URI are influenza and sinusitis (Lanata, Rudan, Boschi-Pinto, et al., 2004). There are several known risk factors of acute respiratory infections: examples being air pollution from indoor fires or cigarettes, humidity, family circumstances (poverty, access to medical care, birth order, overcrowding) and medical circumstances (malnutrition, HIV/AIDs, diarrheal diseases, malaria, micronutrient deficiency) (Sonego, Pellegrin, Becker, & Lazzerini, 2015). More studies on these risk factors have been carried out in the developed world as compared to the developing world due to funding availability, logistics and infrastructure availability (Lanata, Rudan, Boschi-pinto, et al., 2004). Exposure to chemicals especially pesticides has recently been discovered as a risk factor to the development of acute respiratory infections (Payán-Rentería et al., 2012).

Pesticides in recent years have gained much popularity especially through their agricultural use (Corsini, Sokooti, Galli, Moretto, & Colosio, 2013). There is a considerably high incidence of individuals getting exposed directly or indirectly to pesticides in their usage. Pesticide exposure has been shown to result in adverse health effects in humans (Fleming, Bean, Rudolph, & Hamilton, 1999). Two types of these health effects are experienced with the various degrees of

exposure to pesticides – acute effects and chronic effects. High levels of exposure mostly result in acute effects as compared to the chronic effects which are caused by small dose exposures over a period of time (Fleming et al., 1999). Much work is now being done to establish the possibility of chronic health effect development from exposure to pesticides. Studies on chronic health effects are appropriately carried out in occupational exposures of pesticides. This is because workers or individuals through their handling and application of pesticides are at more risk of continuous exposure over a period of time (Fleming et al., 1999). Agriculture is regarded as one of the settings for possible occupational exposure to pesticides. Hence individuals directly linked to farming or agricultural activity have greater chance of being exposed to pesticides or experiencing pesticide poisoning. Chronic conditions resulting from pesticide exposure are cancer, neurological effects, genetic disorders, respiratory diseases, endocrine defects, fetal diseases and diabetes (Andersson, Tago, Treich, & Andersson, 2014). Acute health effects associated with pesticide exposures are: diarrhea, abdominal pain, headaches, nausea and vomiting (Andersson et al., 2014).

About 45% of pesticide poisoning cases were recorded to have taken place in children according to a survey in 2008 (Roberts & Karr, 2012). Common among the outcomes recorded in children as a result of this pesticide poisoning is acute respiratory infections which are known to cause morbidity and mortality in children under five (Cupul-Uicab, Terrazas-Medina, Hernández-Ávila, & Longnecker, 2014). In 1970, a study done showed the first evidence of adverse health effects as a result of exposure to a group of pesticides (Alavanja et. al, 2004). The study recorded altered levels of immune markers and high occurrence of respiratory infections among children and adults (Gascon, Morales, Sunyer, & Vrijheid, 2013). Children however are more susceptible to these effects because of the incomplete development of various systems like the respiratory and the immune system (Gascon et al., 2013).

1.2 Problem Statement

The major cause of mortality in children under five is acute respiratory tract infection (ARTI). In every year almost 4.5 million deaths occur as a result of ARTI with the developing countries recording the majority of these deaths. Pneumonia in particular causes about 1.58 million deaths annually in children under five, which is more than the deaths caused by HIV/AIDs, malaria and measles put together (Cardoso et al., 2015). Communities in the Offinso- North district like several others have recorded high prevalence of ARTI. Well known risk factors include poverty, indoor biomass exposure, malnutrition, lack of breast feeding, overcrowding and air pollution. Exposure to chemical pesticides and other gaseous or particulate air pollutants can also induce airway inflammation thereby causing chronic respiratory diseases (Mamane, Raherison, Tessier, Baldi, & Bouvier, 2015).

Children are not an exemption to the individuals at risk. Children are known to be more susceptible because of their physiological, dietary and developmental factors (Roberts & Karr, 2012). Pesticides persist in the environment for long due to their semi-volatile and non-volatile nature which results in rapid deposition onto surfaces and in the atmosphere. This is a serious cause for concern because children located in an environment where pesticides are used are most vulnerable since the persisting aerosols can easily be absorbed through their respiratory tracts. Such environments include occupational settings of agriculture, fisheries and forestry where exposure to pesticides have resulted in respiratory symptoms such as coughing, wheezing and airway inflammation which are indicative of the presence of acute respiratory infection (Ye, Beach, Martin, & Senthilselvan, 2013). Offinso-North district is a farming community in Ghana known for the cultivation and producing of vegetables and the highest reported use of pesticides. Farmers in this district during their pesticide application use mechanical or hydraulic spraying. The pesticide formulation containing a mixture of water and the chemical is converted

into droplets or tiny almost-invisible particles and released in this state. These toxic droplets do not only pollute the immediate environment of the applicant but also stays in the atmosphere and is moved by the wind to other locations considering the semi-volatile nature of most of these pesticides. These activities expose not only the farmers but their immediate family including the children as well (Ntow et al., 2009). Studies by Ntow and his colleagues found residues of organochlorine (OC) pesticides present in environmental samples at Akumandan and human fluid of the inhabitant. The residues were observed to have originated from agricultural activities and it is expected that a considerable increase of residue with time will occur as a result of the continuous use of pesticides (Ntow, Gijzen, Kelderman, & Drechsel, 2006). Prolonged exposure to pesticides by agricultural workers renders them vulnerable to its health effects, especially when appropriate precautionary measures in handling, transporting, mixing and the application of pesticides are not observed (Panuwet et al., 2008). This study seeks to determine the risk under five year old children in this farming community face and determine if there is a relationship between the prevalence of acute respiratory infection and pesticide exposure in these children.

1.3 Conceptual Framework

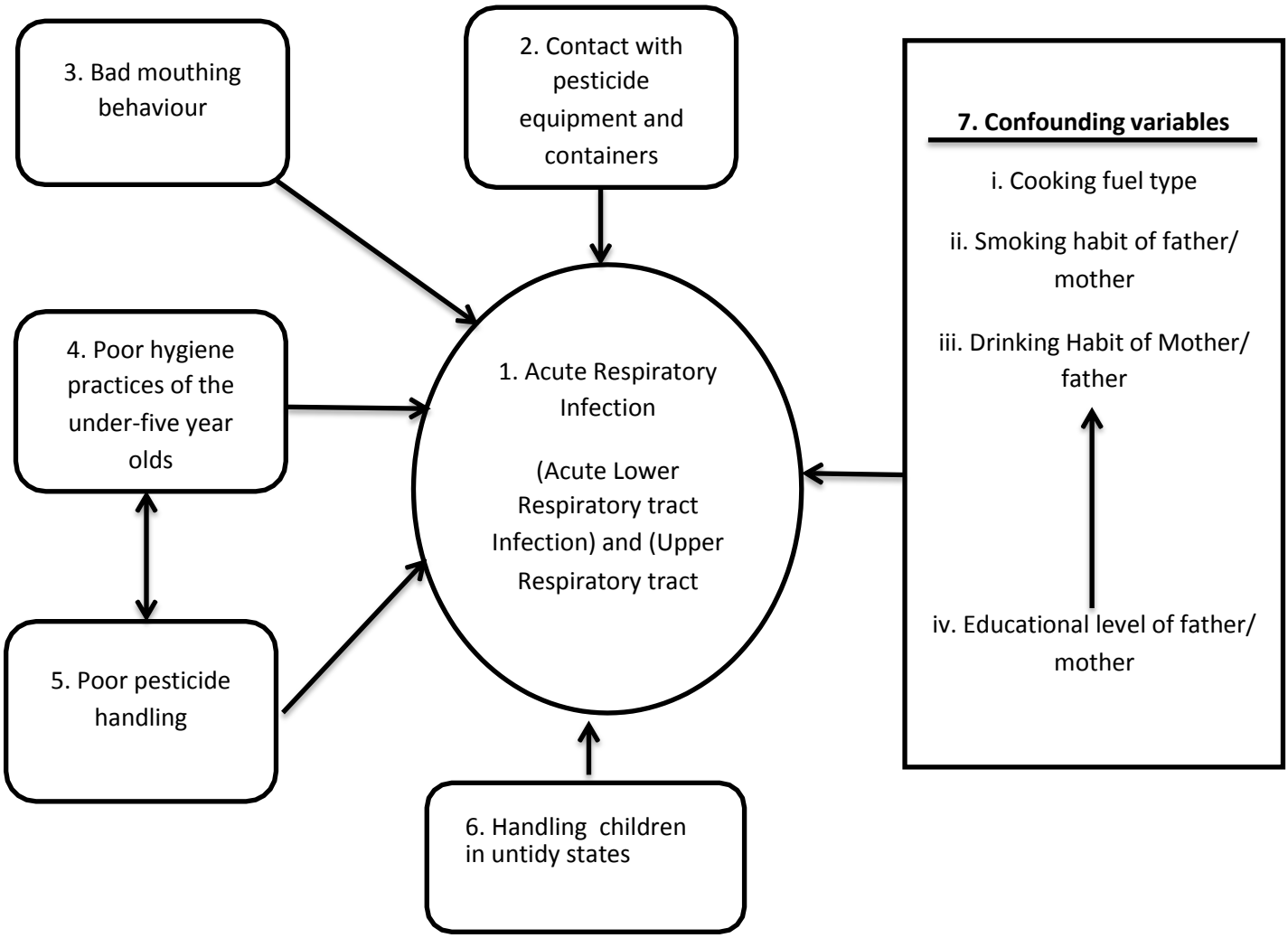

Figure 1. Relationship between pesticide exposure and acute lower and upper respiratory infections

The first box at the center of the figure contains the outcome of interest for the study which was acute respiratory infection defined as both upper respiratory infection and acute lower respiratory infection (Fig 1).

Boxes 2, 3, 4, 5 and 7 contain the determinants being contact with pesticide equipment and containers, bad mouthing behavior, poor hygiene practices, poor pesticide handling and handling of children in untidy states especially by the parents. These independent variables pertain to

both the home environment and the farms hence were investigated separately. The possible confounders are the type of cooking fuel, the smoking and drinking habit of parents and their educational level as outlined in box 6.

The coming into contact with pesticide equipment like the knapsack sprayer and protective clothing as well as used pesticide containers by under five year old children is a key exposure means to pesticide residue. This can henceforth influence the development of acute respiratory infection. Bad mouthing behavior describes the attitude of children seen in the picking up of non-food materials from the floor or around and placing them in the mouth. This could also result in exposure by ingestion if the substance is pesticide contaminated. The poor hygiene practices of the under- five describes the crawling on the floor and eating without hand washing especially when there has been a lot of contact with possible pesticide contaminated surfaces. Poor pesticide handling defines the inappropriate storage and transport of pesticides and associated materials which increase the likely exposure to the under five year old child. Some farmers tend to pick up and play with the children after the day's activity which could have involved pesticide handling or application. Hence either at home or on the farm, the children experience exposure to pesticide residues through these means.

The type of fuel used at home especially biomass can independently result in development of acute respiratory infection in the under five year old children. Smoking by parents could equally expose the children to toxic gases that could result in the outcome of interest. Drinking parents tend to be reckless and careless in the handling of the children creating a situation of less supervision and high exposure to likely pesticide contaminated surfaces. The level of education of the parent is likely to have a strong determining relation on the outcome. This is because parents with higher education tend to have a greater oversight on the child and also make better

choices that would reduce the exposure of the child to pesticides both in the home and the farm.

1.4 Justification

In Ghana, quite a number of studies on pesticides have been carried out but very few have focused on assessing exposure in children. Offinso-North district as indicated is a farming community with 98% of the population actively engaged in the use of pesticides in their farming activities. Exposure to pesticides has been showed to occur through food, air, water and soil (Gascon et al., 2013). Considering that children under five are mostly in contact with all these media and have virtually no knowledge of assessing the risk, it is important to assess exposure to give an idea of the risk involved since infants and young children have greater intake of food than adults on a body weight basis and chemicals may also have permanent effects on developing systems in children which would transient into adulthood (Creel, 2002). The outcome of this research would provide an overview of the crucial state of children in farming communities so stakeholders like the ministry of food and agriculture would be properly motivated to act in the mitigation of these extensive exposures to pesticides.

1.5.1 General Objectives

The general objectives of this study is to assess the prevalence of symptoms of acute respiratory tract infection (ARI) defined as acute lower respiratory infection (ALRI) and upper respiratory tract infection (URI) and its association with indicators of pesticides exposure in the farm or at home or both among children under the age five living in farming communities in the Offinso north district of the Ashanti region

1.5.2 Specific Objectives

The specific objectives of the study are:

1. to determine the prevalence of symptoms of acute lower respiratory tract infection.
2. to determine the prevalence of symptoms of acute upper respiratory tract infection.
3. to identify indicators of pesticides exposure in the farm or at home or both
4. to determine the association between indicators of pesticide exposure (eg. pesticide metabolites) and ARI/ARTI/ URI in under-fives.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Scope of the Review

This review describes pesticides and highlights their effects on human health with emphasis on child health. It is divided into seven main sections with a few sub-sections. An overview of the use of pesticides in Ghana begins the review and further moves on to give a classification of the common pesticides used in the country. The next section is an explanation of how individuals can be exposed to pesticides which is continued with a description of the routes of this exposure. The general health effects are explained and narrowed down to acute respiratory infections which is the outcome of interest of this study. An exposition of the risk level of children to pesticide poisoning is given and ended with the section on conclusion.

2.1 Pesticides Use in Ghana

The introduction of pesticides into agricultural activities has achieved a reduction of crop loss by pest attack and improved yield of crops like cereals, vegetables and fruits (Fianko, Donkor, Lowor, & Yeboah, 2011). Most farmers have been known to apply one or a combination of these pesticides: organochlorines; organophosphates, carbamates and pyrethroids mostly on the vegetables (Bempah, Donkor, Yeboah, Dubey, & Osei-Fosu, 2011). Organochlorines have been noted to be most popular due to the cost-effectiveness and wide influence on a number of target pests (Mrema et al., 2013). Other pesticides in use are lindane for cocoa; endosulfan for cotton, coffee and vegetables. Cypermethrin, dimethoate and endosulfan are employed on vegetable farms with crops like tomato, pepper, okra, egg-plant, cabbage and lettuce. Glyphosate, fluazifop- butyl, ametryne, diuron or bromacil have also found use as herbicides to clear lands off unwanted plants (weeds). The public health sector also makes use of pesticides such as

temephos which was used for the control of black flies in the Onchocerciasis prevention program at the Volta basin. Other insects found in homes like cockroaches, mosquitoes, ticks and various flies have also warranted pesticide use as a public health intervention to rid the environment of them (Bempah et al., 2011). A report by the Northern Presbyterian and Agricultural services and Partners in 2012 highlighted certain unsafe practices that have been noticed among most Ghanaian farmers with respect to pesticide use. Six factors were enumerated in the description of these unsafe practices:

i. A number of restricted and banned chemical pesticides such as aldrin, dieldrin, endosulfan, lindane, DDT and methyl bromide are still very much in use by most Ghanaian farmers.
ii. Other hazardous pesticides like atrazine, paraquat, chloropyrifos have not yet been banned by Government resulting in continual usage on the farms.
iii. Pesticides are sprayed so close to harvest hence the crop produce are contaminated before consumption. The dosage for applying is mostly increased with the erroneous impression of wanting faster results. Other farmers also use pesticides wrongly like using cash crop pesticides for vegetables and the use of expired or different mixtures of pesticides supposedly to achieve a combined effect.
iv. Very few farmers have been observed to use the appropriate protective equipment during pesticide application. Some farmers even make the children do the spraying with very little protection against possible exposure.
v. Pesticide containers are improperly stored. Sometimes placed with food stuffs and also reuse of containers for storing food and water.

vi. Most of these problems and others are attributed to insufficient training by the Ministry of Food and Agriculture and its extension service. Most Ghanaian farmers are illiterate hence cannot read the labels and instructions on the pesticide containers which is the reason for this level of bad handling practice of the pesticides (Presbyterian Services, 2012).

2.2 Pesticides and their classifications

Pesticides are toxic chemical substances which are designed to kill, repel or reduce insects, weeds, rodents, fungi or other organisms that can threaten public health and the economy. They are either extracted from plants or produced by man hence are described as synthetic (Barr & Needham, 2002). Pesticide application is seen not only in agriculture but also occupations and industries like gardening, floristry, veterinary medicine, community health, wood, textile and building material protection, etc.), as well as for domestic purposes at home and in the garden (Mamane et al., 2015). Pesticides are classified in several ways based on their hazard levels, target organisms, and effects. They could also be categorized depending on their chemical properties into organochlorines (OC), organophosphates (OP), carbamates, dithiocarbamates, pyrethroids, phenoxyl, triazine, amide, and coumadin compounds (Ye et al., 2013). Below is a table showing classification of pesticides according to their use or target organism:

Table 1: Classification of pesticides by usage

Pesticide Type	Examples
Insecticides	Acetylcholinesterase inhibitors: Organophosphates, carbamates Organochlorines Pyrethrins and pyrethroids
Herbicides	Dipyridyl pesticides: Paraquat and diquat Chlorphenoxyacetate weed killers: Bromoxynil, 2,4-D
Fungicides	Substituted benzene: Chloroneb, chlorothalonil, Thiocarbamates Organomercurials: Methylmercury, phenylmercuric acetate
Molluscicides	Metaldehyde
Rodenticides	Aluminium phosphide, Zinc phosphide Warfarin and superwarfarin compounds Heavy metal: Thallium-containing pesticides Yellow phosphorus
Insect Repellants	Diethyl toluamide (DEET)
Miscellaneous	

Source: (Goel & Aggarwal, 2007)

2.2. 1 Persistent Organic Pollutants (POPs)

These are toxic, persistent, bio accumulative organic chemical substances which are prone to long range transport (Long, 2012). Human activities over last past decade has resulted in the release of POPs into the environment. The fatty tissue accumulates POPs when they get into the bodies of humans and other wildlife causing adverse health effects to humans and the environment. The Stockholm Convention by 2004 instituted measures to reduce and possibly eliminate the release of POPs into the environment (Aprea et al., 2002; Barr & Needham, 2002). A set of twelve chemicals were initially identified as very important POPs with nine of these being pesticides (i.e. aldrin, dieldrin, chlordane, endrin, heptachlor, hexachlorobenzene, mirex, toxaphene and DDT- dichlorodiphenyltrichloroethane). Other industrial chemicals like PCBs-Polychlorinated biphenyls and PCDD/Fs-Polychlorinated

dibenzodioxins/furans together with the pesticides have been associated with a number of unintentional industrial/combustion emissions (Long, 2012). The physical and chemical properties of the POPs make them resistant ensuring their long stay in the environment and also enabling their long distance travel through various environmental media such as air, water and soil.

2.2.2 Organochlorine Pesticides (OCPs)

These are chemical pesticides with carbon, hydrogen and chlorine as their main structural constituents. Organochlorines are grouped in the insecticide class of pesticides. They disintegrate very slowly and hence stay long in the environment after application and also remain long in organisms that are also exposed. The popularity of Organochlorine Pesticides (OCPs) increased during their high usage between 1950 and 1960 for agricultural purposes mainly (Aprea, Colosio, Mammone, Minoia, & Maroni, 2002; Long, 2012). The United States for instance increased consumption of organochlorine pesticides almost by double of the quantity before the mid- twentieth century. OCPs were also used in malaria control and other vector-borne diseases like dengue fever, leishmaniasis (Long, 2012). Cases of persistent contamination of the environment as a result of the much use of OCPs caused a discontinuation in many countries across the globe. The persistence of OCPs has resulted in residues being found in foods such as meat, poultry, fish, eggs, vegetable oils, avocado and olives. Organochlorine pesticides can be divided into three groups:

i. Dichlorobenzene hexachloride isomers (e.g. lindane),

ii. cyclodienes (aldrin, dieldrin, endrin, chlordane, heptachlor, endosulfan)

iii. Dichlorodiphenyltrichloroethane (DDT) and analogues (methoxychlor, dicofol, chlorobenzylate) (Aprea et al., 2002; Barr & Needham, 2002).

The mode of action of OCPs and other similar pesticides is to target systems and enzymes in the pest organism to achieve its intended purpose to either kill or incapacitate the organism. Some of these systems and enzymes in the pests are similar to that of humans hence posing a serious risk to human health and the environment (Long, 2012). This has warranted the banning of organochlorine pesticides along with other POPs like aldrin, endrine, chlordane, heptachlor, DDT. Dichlorodiphenyltrichloroethane however is still in use because of its ability to control mosquito growth hence reducing malaria spread. Most public health malaria intervention programs are reported to use DDT (Long, 2012). The detection of the various forms of OCPs are done by either measuring directly or indirectly the metabolite or the specific compound itself in the particular media being investigated. For instance the metabolite of Aldrin, dieldrin is mostly measured with chlordane and heptachlor also monitored as metabolites. Dichlorodiphenyltrichloroethane is measured sometimes as its biodegraded product or metabolite called DDE- Dichlorodiphenyldichloroethylene. Measuring toxaphene in biological samples has posed a challenge because of its chlorinated mixture of camphenes (Barr & Needham, 2002). Organochlorines have been seen to cause acute and chronic health conditions based on the level of exposure. Some of the common indicators of symptoms of acute poisoning are: tremors, headache, dermal irritation, respiratory problems, dizziness, nausea, and seizures (Shaker & Elsharkawy, 2015). Some of the chronic diseases which have been associated with OCPs include various types of cancer, neurological damage, Parkinson's disease, birth defects, respiratory illness and abnormal immune system functions (Shaker & Elsharkawy, 2015).

2.2.3 Organophosphate Pesticides

Organophosphorus (OP) pesticides in structure contain a phosphate (or thio- or dithiophosphate) and an organic component or part. More often the phosphate part (O,O-dialkyl) is substituted (Barr & Needham, 2002). Organophosphorus pesticides (OP) are made up of esters, amides, thiol derivatives of phosphoric or phosphonic acid which are easily hydrolyzed and therefore do not persist in the environment (Shaker & Elsharkawy, 2015). Some common examples of organophosphates include insecticides like: Malathion, parathion, diazinon, fenthion, dichlorvos, chlorpyrifos, ethion; nerve gases such as soman, tabun; ophthalmic agents - echothiophate, isoflurophate, and antihelmintics (trichlorfon). Organophosphorus pesticides act by preventing the function of acetycholinesterase (AChE) in the central nervous system. Acetylcholinesterase is an enzyme responsible for the break down or hydrolysis of acetylcholine and transmission of nerve impulses. The action of this enzyme is in close correlation with AChE in the red blood cells and to a small degree related to pseudocholinesterase or plasma cholinesterase activity (Aprea et al., 2002; Loewenherz et al., 1997). The toxicity (high or moderate) of Ops and their tendency for accumulating especially fat-soluble OPs in animal tissues, milk, and eggs pose risks for human health. After exposure to OP pesticides in humans, they are metabolized to their more reactive form in the body or broken down to dialkyl phosphate and a hydroxylated organic part which is based on the particular pesticide. These metabolites and broken down components are excreted in the urine (Barr & Needham, 2002).

There are three known levels of acute organophosphate insecticide poisoning which portray different toxic effects. These levels are acute cholinergic crisis, intermediate syndrome (IMS) and delayed polyneuropathy (Yang & Deng, 2007).

The initial stage of poisoning is the acute cholinergic crisis which develops after a few minutes to several hours of exposure and affects peripheral muscarinic and nicotinic receptors, as well as

the central nervous system by inhibiting carboxylic esterase enzymes including acetylcholinesterase, the most clinically important.

Some of the common symptoms are nausea, vomiting, diarrhea, abdominal cramp, urinary incontinence, salivation, lacrimation, bronchorrhea, bradycardia, hypotension, fasciculation, muscle paralysis, dizziness, confusion, seizures, coma, and respiratory failure. Individuals could easily die if actions aren't taken promptly especially in situations such as respiratory failure (Yang & Deng, 2007).

The second and third phases are known to record much severe effects such as weakness of proximal limb muscles, neck flexors, respiratory muscles, and motor cranial nerves.

2.2.4 Carbamates

These pesticides are also in insecticide category and have similar effects as the organophosphorus pesticides. Their effects are however more reversible and not as severe as the OP pesticides. Carbaryl (Sevin) and propoxur (Baygon) are the most popular of carbamate pesticides. ldicarb and methomyl are part of the very usual types employed in agriculture (Barr & Needham, 2002). A number of carbamates have also been measured in biological media such as serum and plasma. Carbamates are hydrolyzed to its main metabolite 1-naphthol which is what is mostly measured in biological analysis.

2.2.5 Pyrethroids

Pyrethrins are produced naturally by a plant called chrysanthemums which exhibit pesticidal effect on insects. This naturally occurring pyrethins are made up of number isomeric forms and are categorized as pyrethrin I and Pyrethrin II sets. Man-made chemicals have been designed to mimic the performance of the natural pyrethrins and are described as synthetic pyrethroids. The synthetic pyrethroids are chemically composed of chrysanthemic acid analogue that is esterified

most often with a ringed structure (Barr & Needham, 2002). Pyrethroids are non-systemic in their function but also have a small repellant effect. The last decade has seen the use of pyrethoids increase at the expense of carbamates and OP pesticides which have rather declined(Barr & Needham, 2002). Pyrethroids undergo metabolism in the body during which the chrysanthemic acid ester is attached through esterase or mixed function oxidase activity and resulting alcohol groups converted to their respective acids. The metabolites are hence combined to glucuronide and both the conjugates and free acids are excreted in the urine(Barr & Needham, 2002)

2.3 Pesticide Exposure

Exposure to a substance can be described as any contact between the substance in an environmental media such as air, water, soil and the human body surface (eg. skin, respiratory tract and gut). When the substance finds its way into the human body it is then referred to as dose. The assessment of exposure therefore is the study of the distribution and determinants of substances or factors affecting human health (Mamane et al., 2015). Exposure to pesticides can be direct or indirect. Direct exposure takes place when there is contact of the human surface to pesticides or contaminated materials. Indirect exposure is characterized by contact with residues of the pesticides in various environmental media (Mamane et al., 2015).

Exposure through pesticide residues present in food, water, and the general and personal environment (indoor and outdoor air, soil, house dust, surfaces, etc.) is what takes place mainly in the general population. Residential exposure however depends on proximity of the home to pesticide treated areas, the persistence of ancient pesticides used in or around the home, and domestic uses at home, in the garden, on pets (flies and ticks) and also on humans because of lice and scabies for instance (Ye et al., 2013).

The semi-volatile and non-volatile nature of pesticides causes surface deposition to occur rapidly after use. The skin, digestive and respiratory tracts are the means by which the pesticide substances enter the body. The significance of these varying pathways is due to exposure type, the formulation used (e.g. sprays, wettable powders, diffusive devices or solid forms), the location of use (indoor or outdoor), and many other factors. Occupational exposure as observed in agriculture occurs mainly through the dermal route with the dietary oral route considered to be the most important route of exposure for the general population (Mamane et al., 2015).

The non-dietary and respiratory routes are also very crucial ways of exposure, especially for children. Children could come into contact with pesticides by trans-placental passage and through breast milk contamination, notably with persistent bioaccumulative pesticides. Exposure levels as recorded in workers handling pesticides or treated crops or found in treated environments are mostly regarded to be higher than levels of exposure for the general population. These disparities in exposure makes it difficult predicting health effects in the general population based on those observed in occupational settings. The pesticide exposure of farmers' families, especially children, is believed to be very significant, with a combination of para-occupational, environmental and domestic exposures to the pesticides (Mamane et al., 2015).

Exposure to pesticides in the home; workplace and community results from a variety of behaviors and environmental factors which can be described as determinants. In the workplace, some of the determinants are: the use of personal protective equipment (PPE) and field sanitation, whiles in the home laundry practices and child activity patterns constitute the determinants. Environmental factors which influence these determinants are sometimes referred to as predictors and they include conditions at work (e.g., safety training), at home (e.g., number of farmworkers in residence) and in the larger community (e.g., total farmland treated with

pesticides) (Quandt et al., 2006). The association of these environmental and behavioral factors is influenced by psychosocial factors such as the attitudes, values, beliefs, and knowledge held by farmworkers. For instance some farmworkers who live in densely populated residences might be expected to store soiled work clothing which could present an exposure risk to household residents.

Beliefs that pesticides are harmless also influence the determinants as well as knowledge of recommended laundry practices. Other very influential factors of exposure include genetic factors, body size, and developmental status of the individual at risk of exposure (Quandt et al., 2006). Generally, occupational pesticides exposure takes place during the production, transportation, preparation and application of pesticides in the workplace. Some of the significant factors in occupational pesticide exposures are application intensity, frequency, duration and method, safety behaviors (e.g., use of personal protective equipment), as well as the physiochemical and toxicological profiles of the pesticides in use (Ye et al., 2013).

Persons working directly and frequently with pesticides are groups with the highest risk of exposure in the occupational environment. The family members of pesticide users and the applicators themselves usually have substantial exposures to pesticides especially in cases of accidental spills, leakages, incorrect uses of equipment, and non-compliance with safety guidelines are causes of occupational pesticide exposures (Ye et al., 2013). In environmental pesticide exposures levels tend to be fairly low.

2.3.1 Exposure routes of Pesticides

The primary routes of exposures to pesticide in occupational settings are considered to be respiratory inhalation and dermal absorption. Respiratory exposures normally take place when there is the application of volatile pesticide products, especially by an individual without respiratory protective equipment during application. (e.g., mask with filter) or he or she is in a

poorly ventilated working environment. In agricultural occupations about 10% of total pesticide exposure happens through the respiratory route while the rest is through either dermal absorption or digestion.

Dermal absorption occurs through direct skin contact with pesticides or from clothing and tools that are contaminated with pesticide residues (Ntow et al., 2009).

Other very significant factors are the physiochemical properties of that pesticide which also influences exposure (eg. temperature, solubility). For instance, organophosphate and carbamate insecticides could be effectively absorbed by the skin due to their high lipid solubility. Certain organochlorine insecticides, such as DDT (dichlorodiphenyltrichloroethane), lindane, aldrin and chlordane, are more lipid soluble than others and thereby more efficiently absorbed by the skin.The low lipid solubility however of pyrethroid insecticides results in their poor absorption by the skin, but can be efficiently be absorbed through inhalation and ingestion (Ye et al., 2013).

2.4 Health Effects of Pesticides

Studies have shown several health effects of pesticides such as cancer, neurologic effects, diabetes, respiratory diseases and genetic disorders (Andersson et al., 2014). Initial studies carried out which investigated the health effects of pesticides focused on the risk of acute intoxication among people with direct exposure. Recent research has also revealed associations between health effects (such as cancer, depression, neurological effects, diabetes and respiratory effects) and individuals indirectly exposed to pesticides. Individuals like family members of farmers and people living in areas with intensive use of pesticides are those regarded mostly to

be indirectly exposed (Andersson et al., 2014). Emphasis has now also been given to chronic health effects and environmental contamination of pesticides.

A typical chronic effect is depression which has been shown to result from cumulative exposure to insecticides and fungicides over a period of time (Andersson et al., 2014). Cancer development in both children and adults has been identified as an exposure effect of pesticides. Quite a number of pesticides possess similar characteristics to the endocrine hormones and may affect multiple organ systems and functions including reproductive health and cancer risk. Data emerged recently, indicating a potential relationship between certain pesticides and asthma (Payán-Rentería et al., 2012).

Lead, solvents, pesticides and polychlorinated biphenyls are described as neurotoxic substances due to their adverse effects on the nervous system of most organisms that are exposed to them. These exposures are known to result in acute as well as chronic health complications or illnesses. Concern has been drawn to small dose exposure of these neurotoxic substances to children and its resultant outcome of permanent learning deficits and behavioral dysfunction too (Philip J. Landrigan, Joy E. Carlson, Cynthia F. Bearer, Spyker Cranmer, Robert D. Bullard, Ruth A. Etzel, Groopman, John A. McLachlan, J. Routt Reigart, Leslie Robison, & Suk, 2005). Pesticides, specifically the chlorinated hydrocarbons have also been shown to have the ability to affect the endocrine system by disrupting the function of estrogen in females and blocking the androgen receptor among other hormones. Children appear to be at a higher risk upon exposure to some of these hormone disruptors and results in the interference of the reproductive system developing (Mrema et al., 2013). Endocrine disruptors like pesticides have also been shown to cause testicular cancer when exposed to at a very early stage. Another study attributes the early onset of puberty in girls as observed in recent times to some of these hormone disruptors (Roberts & Karr, 2012).

2.5.1 Acute Respiratory Infections

Acute respiratory infections is the general name given to all infections of the respiratory system consisting both upper and lower respiratory infections. The first years of the life of most children is characterized by upper respiratory infections (URI) with close to nine episodes taking place. Children in developing countries however mostly experience the progression of upper respiratory infections to acute lower respiratory infections (Hart & Cuevas, 2007). Any infection that affects the airways downwards from the epiglottis is described as acute lower respiratory infection which consists of acute laryngitis, tracheitis, bronchitis, bronchiolitis, pneumonia, tuberculosis and empyema. The WHO defines URI to consist of cough with or without fever, blocked or runny nose, sore throat and ear discharge. Serious infections or both URI and ALRI are mostly caused by bacteria with a few being viral. Air pollutants greatly increase ARI cases by negatively influencing the specific and non-specific host immunity in the respiratory tract against invading pathogens.

The clinical case definition of ALRI is carried out by two main ways. The World Health Organization recommended way evaluates using three signs to determine the severity: rapid breathing, chest in-drawing and inability to feed. This serves as bases for classifying diseases as mild, moderate or severe. The second method of assessment is based on the diagnosis of a physician who uses his or her experience and acumen using chest auscultation (Hart & Cuevas, 2007).

Table 2: World Health Organization Guidelines for Assessment and Management of Acute Lower Respiratory Infections (ALRI).		
Disease Severity	*Clinical features*	*Management*
Mild	*Blocked or runny nose with cough, no tachypnea(<50bpm) no chest in-drawing, sore throat, ear discharge*	*Home treatment, supportive therapy*
Moderate	*Cough and tachypnea but no chest indrawing*	*Home treatment with antimicrobials and supportive therapy*
Severe	*Cough and chest in-drawing, cough and inability to feed or stridor at rest*	*Hospital referral*

Source: (Hart & Cuevas, 2007) bpm- breaths per minute

2.6 Risk Level of Children to pesticides

The size, physiology and behavior of children make them more vulnerable than adults to hazards in the environment when they are exposed. The level of exposure in children is relatively increased as the toxin level in the body places them in long lasting harm or health hazard considering they have a number of years to live should the exposure even be in minute quantities (Creel, 2002).

The under five year old children in particular breathe more air, drink more water, and eat more food per unit of body weight than adults do hence higher rates of exposure to pathogens and pollutants are experienced by them. Certain peculiar childhood behaviors such as crawling and putting objects in the mouth, can also lead to increased risks (Cranmer et al., 1998; Creel, 2002). Five to eighteen year old children may also face higher risks of injuries, including exposure to hazardous chemicals, due to their growing participation in household chores and agricultural

activities including pesticide application.

The metabolic pathways of children especially in the early months after birth are not matured as compared with those of adults hence ability to metabolize, detoxify, and excrete many toxicants is different from that of an adult. They are therefore less able to deal with toxic chemicals and thus are more vulnerable to them. The development of most body systems takes place during the time in the uterus and after when the child is born. These systems are however not well adapted to repair damages caused as a result of exposure to chemicals or environmental toxicants. Hence cells of the immune system, reproductive system or the nervous system damaged by the presence of such toxicants mostly results in a permanent damage to the affected child (Cranmer et al., 1998). Examples of such permanent effects are loss of intelligence, immune dysfunction and reproductive disability (Philip J. Landrigan, Joy E. Carlson, Cynthia F. Bearer et al., 2005). Children also have a greater amount of time to develop chronic conditions after an exposure to a toxicant as compared to adults.

Some common symptoms of pesticide poisoning in children as noticed in adults too include eye, skin, and respiratory irritations and higher rates of long-term health problems such as cancer.

The ability of a child's body to absorb higher amounts of pesticides from food and water is one reason for the severity of effects that is observed (Creel, 2002).

One Barker also hypothesized that information about the maternal environment is communicated to the fetus transplacentally, and to the infant through lactation, thereby determining fetal and early life development (Winans, Humble, & Lawrence, 2011). This situation can lead to subtle alterations in development that permanently affects function if the environment is hazardous. This concept has been demonstrated for a number of diseases, as exposure to pollutants or even alterations in the maternal diet have been associated with increased risk of cardiovascular disease, stroke, obesity and cancer later in life (Winans et al.,

2011). Environmental toxicants have been shown to affect the developing immune system of children. It is very crucial for the immune system to develop properly as even slight changes can reduce resistance to infectious diseases, reduce vaccine efficacy, and diminish tumor surveillance. An unbalanced immune function can also enhance responsiveness to non-pathogenic antigens, as is the case in auto-immune disease and hypersensitivity reactions (Winans et al., 2011). The detection of some pesticide residues in the amniotic fluid during development demonstrates the direct exposure to pesticides by the fetus through ingested food and other sources by the mother. Studies have shown the possibility of an altered immune system after exposure in the early years of the child's life is high. Generally persistent organic pollutants which include most of the pesticides among other environmental pollutants are important factors that can impact susceptibility to infections and the development of allergy and asthma during the first years of life (Gascon et al., 2013).

Pesticides like organochlorines and organophosphates are sometimes described as immunotoxins because of their effect of the immune system (Corsini et al., 2013).

2.7 Conclusion

Most of the documented studies on pesticides have been carried out in the United States and a number of Asian countries like India and Japan. The Developing countries have also recorded an increase in pesticide research interest in recent times with substantial work done in Akumadan, Ghana. In Ghana, the desire for high crop yield has increased considerably the usage of pesticides especially in the cultivation of crops like cocoa, oil palm vegetables and fruits. Study has shown that improper practices with pesticide handling is a major cause of exposure which results in possible and actualised health effects. (Ntow et al., 2009). Exposure has been assessed by environmental media mostly with a few researches assessing biological media too. Ntow in his research on pesticide occupational exposure analyzed blood samples of

individuals in Akumadan. Other types of biological media like breast milk, urine have also been analyzed for pesticide residues in studies done in Ghana (Bergkvist et al., 2012). It is challenging to establish the level of pesticide exposure in humans by analyzing food stuffs or environmental media like soil, water or air. This makes biological monitoring a much suitable means of establishing the levels of pesticide exposure in humans. There is also no documented work done on pesticide exposure in under-five year old infants in Ghana. This makes this study therefore necessary and of great importance since it helps describe the risk level that under five year children in farming communities are in. Much care is needed in the use of biological samples to ensure accuracy of findings from their analysis. Future research should focus on a combination of assessment of exposure in both biological and environmental media to give wholistic overview of the study subjects in terms of the amount of chemical pesticides they might bew exposed to.

CHAPTER THREE

3.0 METHODOLOGY

3.1 Study design

The study reported here is part of the Offinso North district Farm Health study (ONFAHS). ONFAHS is a cross-sectional study involving 300 households (i.e. children under five and their parent(s) in the Offinso-North district of the Ashanti region. The study presented here focused on children below the age of five (5).

3.2 Study area

Offinso North District is about 95km north –west of Kumasi, the capital of the Ashanti region. The district lies between longitudes 10 60 W and 10 45 E and latitudes 70 20 N and 60 50 S. The district is divided into three (3) geographical zones and each zone comprises a major farming community and surrounding villages. The major farming communities are Akumadan (the biggest), Nkenkenso and Afrancho. These farming communities are on the Kumasi-Techiman main road and Afrancho is on the left of Akumadan whiles Nkenkenso is on the right. Offinso North district experiences hetero-ethnic inhabitation with a population of over twenty-five thousand (25,000) of which about 85% are directly involved in farming (Ntow et al 1998). The major vegetables cultivated in the town are pepper, garden eggs, okra and tomatoes (Ntow et al., 1998, Osafo and Frempong, 1998). Other crops cultivated are maize, cassava, plantain and cocoa. There is no statistics on the amount of pesticides Akumadan consumes annually, but evidence has it that vegetable farmers in the Offinso north district utilized pesticides more than any other farming community in Ghana (Ntow et al., 2007). The natural vegetation of the district is semi-deciduous forest type, most of which have been lost to extensive farming and logging activities. The soil type is mainly coarse grain sandstone and deep red clay loam.

The district also lies in the transitional zone of Ghana with two rainfall seasons: major and minor with a mean maximum of 120mm and 200mm respectively. The major season begins from April to July. A short dry season occurs in August and the minor season is from September to October. Extension officers provide technical support to farmers in the district.

3.3 Source Population/Study Population

The source population for the study included all children living in Afrancho, Nkenkenso and Akumadan of the Offinso-North District in the Ashanti Region. The study population included one hundred and seventy (170) under-five year old children (see section 3.5 for sampling procedure and sample size calculation) and was derived from the Offinso North district Farm Health study (ONFAHS). Any child who was included in the study was from a household who met the eligibility criteria (see section 3.3.1 and 3.3.2) of the main study. In the main study a household was defined as home that has a man and/or a woman who are the parents and a child under five.

3.3.1 Inclusion criteria

The eligibility criteria for any household selected into the study included (i) there is a man and/ or a woman who was above 18 years, (ii) at least the man or the woman or both is/are a farmer(s) (iii) the man or woman or both is/are permanent residents in the study area, (iv) both the man and/ or the woman had a biological child who is below the age of five years, (v) the man and/or the woman was willing to follow the study protocol and complete the study

3.3.2 Exclusion criteria

The exclusion criteria included (i) none of the household member is a farmer, (ii) a man and/or a woman in a household was below 18 years (iii) a man and/or a woman was/were non-

permanent residents in the study area, (iv) no child in the household below five years and (v) a child below the age of five had severe illness (eg. dysentery, typhoid fever).

3.4 Study Variables

3.4.1 Main determinants of Interest

The main determinants of interest include (i) six (6) pesticide exposure indicators in the farm, (ii) seven (7) pesticide exposure indicators at home and (iii) four (4) pesticide exposure indicators in the farm and/or at home. Exposure indicators in the farm were defined as mouthing behaviour, food handling practices, hygiene practices, contact with pesticide containers, contact with pesticide equipment and contact with contaminated surfaces; whereas exposure indicators at home include mouthing behaviour, food handling practices, hygiene practices, contact with pesticide containers, contact with pesticide equipment, contact with contaminated surfaces, and parent-take home pesticide. Exposure indicators in farm and/or at home was also defined as mouthing behavior, food handling practices, hygiene practices and contact with contaminated surfaces) were included. The definition of each indicator is attached (Appendix E)

3.4.2 Outcome Variables

The main outcome of interest was self-reported symptoms of acute respiratory infection (ARI). Acute respiratory infection is defined as acute lower respiratory tract infection (ALRI) and upper respiratory tract infection (URI). Acute lower respiratory tract infection refers to cough accompanied by short and rapid breathing at any time in the 2-week period preceding the survey interview; and URI defined as symptoms of runny nose, wheezing, cough, phlegm production and breathlessness at any time in the 2-weeks period preceding the survey interview. These definitions were in agreement with literature (Misra, 2003; Bautista et al., 2009; WHO).

3.4.3. Confounding variables

The following variables were considered as potential confounders; type of cooking fuel used; level of parental education; smoking habit of parents; drinking habit of parents; age of child, gender of child, age of parent, gender of parent; and was based on literature (Smith, Samet, Romieu, & Bruce, 2000)

3.5 Sample size calculation and sampling procedure

3.5.1 Sampling Procedure

The Offinso north district has been divided into 3 geographical zones. The original ONFAHS used convenience sampling to select 300 households including 300 children under-five, and their parents (i.e. their 300 mothers and 300 fathers) from these zones. A List all 300 children was developed in alphabetical order and by each geographical zone. Numbers were allocated to the children on the list. Using a random number generator, 170 children were selected for this study.

3.5.2 Sampling Size Collection

The sample size calculation was based on Yamane's formula (Polonia, 2013). The focus of the study is the under five year old children and hence the sample size is calculated based on the estimated proportion of children in the Offinso-North district. Data was not available on the population of under-five year old children of farmers in the district hence an estimation based on the Census report in the Ashanti Region was employed.

Estimated farming population = 2295 (Ntow et al., 2009)

Estimated percentage of under five year olds = 11.6% (Kumasi District Population Report, 2010) = 12%

The estimated population of children under five born to farmers is therefore about 276. (ie. 12% of 2295)

Using the Yamane equation,

$$N = \frac{N}{1+Ne^2}$$

$$= \frac{276}{1+276(0.05)^2}$$

= 163.31

Where n is the sample size, N is the population, e is the precision of 0.05

Taking into consideration 5% non-responsiveness, the population size of the proposed will be **170**

3.6. Data Collection Procedure

As indicated in section 3.1, this study is part of the Offinso-North Farm Health study (ONFAHS). The field study was implemented in three (3) phases: (i) stakeholder meeting, (ii) enrollment of study participants, (iii) data collection.

Stage 1: Stakeholder meeting: The research team (including the principal investigator) first had a meeting with the director of agric and agriculture extension officers to discuss the study after which the principal researcher and research assistants met the chief, assembly man and other relevant heads of the community. The extension services department which is an active institution involved in farming issues was met as well for the purpose of introducing the project and its details to them so the needed permission and assistance was made available.

Stage 2: Participants Enrolment: Prior to enrollment into the study, a written consent form was read to the parent(s) of the children in a local language and any questions raised by them

were answered. The parents who agreed to be part after the consent had been explained and their questions answered were made to sign the consent form before they were enrolled in the study. This and more is explained in the inclusion and exclusion criteria explained in section 3.6.2 and 3.6.3.

Stage 3: Data Collection

Each parent was interviewed with a structured questionnaire to ascertain relevant information on indicators of pesticide exposure and symptoms of respiratory infections. Information was also collected on the age of child; gender of child; age of parent; gender of parent; level of parents' education, smoking habit of parent, drinking habit of parent, type of cooking fuel, ethnic origin, mouthing behavior of child, child hygiene practices, contact with pesticide containers and equipment among others. The questionnaire is attached (Appendix A).

3.7 Data analysis

Proportions were computed for categorical variables. A generalized linear model with binomial distribution and log link function was used to assess the association between pesticide indicators in the farm and symptoms of respiratory infection and pesticide indicators at home and symptoms of respiratory infection. A model was also fitted including four exposure indicators at home and/or in the farm combined. The effect measure is prevalence ratio (PR). The following confounders were adjusted for in the analysis: type of cooking fuel used; level of parental education; smoking habit of parents; drinking habit of parents; age of child, gender of child, age of parent, and gender of parent. The analysis was carried out using STATA 13.

3.8 Ethical Consideration

Approval letters from the relevant places being the Ghana Health Service Ethical Review Board and the School of Public Health were made available to the authorities (chief and the district assembly) of the community. The details of the research were explained properly for their

comprehension so the needed permission and support was made available. Consent was sought from all prospective participating families during which the purpose of the study and the merits of its outcome were highlighted. Informed consent was developed on the WHO guidelines and it contained an information sheet detailing the (researcher background and contact information, purpose of the study, procedures, confidentiality, risks, voluntary participation and benefits of participating in the study) and a certificate of consent which was signed or thumb printed by respondent to indicate voluntary participation. They were informed about the purpose, procedures, risks and benefits of participating in the study. There were no risk involved in participating in this study and there was no conflict of interest. Informed consent was obtained from respondents in the language he/she understood and confidentiality was assured before their engagement in the study. Participants were informed that there will be no consequences, like loss of benefit or care to them if they chose to withdraw from the study. Only the researcher and the project supervisor had any access to the data.

3.9 Quality Assurance

To ensure quality control research assistants were trained before administering the questionnaire. The training was done primarily to ensure that they understood the research topic, objectives and the sensitivity of the topic and the need for confidentiality. The training also ensured that they were adequately equipped to undertake the data collection. Supervision was carried out by the principal investigator during the entire period of the field work.

CHAPTER FOUR

4.0 RESULTS

4.1 Socio-demographic characteristics

The socio-demographic characteristics of the study population are illustrated in Table 3 below. Most of the children 62.36% were between 1 to 3 years. Majority were boys 114 (67.1%), had a parent who was between 45 and 55 years, were Akan 71(46.4%), had parents who not been to school and were non-smokers – fathers 137 (81.6%); mothers 159 (93.5%). The most utilized fuel type was wood 99 (58.2%).

Table 3: Characteristics of study population of children under five, the Offinso-North district farm Health Study (n=170)

Characteristics of study population	N	Percentage (%)
Age of child (years)		
≤ 1	26	15.3
1-3	106	62.4
>3	38	22.3
Gender of child		
Boy	114	67.1
Girl	56	32.9
Age of parent who filled the questionnaire (years)		
≤35	25	14.8
35-45	66	38.9
45-55	74	43.3
>55	5	3.0
Ethnic origin		
Akan	71	46.4
Ewe	7	4.6
Hausa	17	11.1
Others*	58	37.9

* – Gas, Kokonba, Sisala, Moshi,etc.

Table 3 continued.

Characteristics of study population	N	Percentage (%)
level of education of mother		
Have not been to school	88	51.8
JSS/middle school/primary school	74	43.5
SSS/secondary school/vocational or technical education	8	4.7
Level of education of father		
Have not been to school	87	51.2
JSS/middle school/primary school	77	45.3
SSS/secondary school/vocational or technical education	6	3.5
Cooking fuel type used		
Liquid Petroleum Gas (LPG)	4	2.4
Charcoal	64	37.7
Wood	99	58.2
Combination of fuels	4	1.8
Smoking habit of father		
Never smoked	137	81.6
Past smoker	19	10.7
Current smoker	14	7.7
Smoking habit of mother		
Never smoked	159	93.5
Past smoker	8	4.7
Current smoker	3	1.8
Drinking habit of father		
Never drank	106	62.4
Past drinker	44	25.9
Current drinker	20	11.7
Drinking habit of mother		
Never drank	141	83.9
Past drinker	7	3.6
Current drinker	22	12.5

* – Gas, Kokonba, Sisala, Moshi,etc.

4.2 Exposure indicators

On the farm, 47.6% of children engaged in bad mouthing behavior while 88.2% and 86.5% were exposed by bad handling of food and bad hygiene practices respectively. Exposure by contact with pesticides equipment (72.4%) was more common than exposure by contact with pesticide

containers (35.9%) on the farm. 39.4% were also exposed through contact with contaminated surfaces on the farm. Exposures which took place at home were mostly common among the participants: bad mouthing behavior (91.8%), bad food handling behaviour (94.7%), bad hygiene practices (89.4%) and parent take home of pesticides (85.9%). Contact with pesticide containers (31.8%) and equipment (43.5%) were however not that common at home. The most rarely occurring exposure at home was contact with contaminated surfaces (9.42%) which was less frequent when measured on the farm and at home (4.1%). Exposures by bad mouthing behaviour (94.1%), bad food handling (92.9%) and bad hygiene practices (92.4%) reported to have taken place on both the farm and home were very high among the study participants.

Table 4: Prevalence of Exposure Indicators in the farm, at home and in the farm and/or at home, the Offinso-North district Farm Health Study (n=170)

in the Farm	N	Percentage (%)
Mouthing behavior		
Bad	81	47.6
Good	89	52.4
Food handling behavior		
Bad	150	88.2
Good	20	11.8
Hygiene practices		
Bad	147	86.5
Good	23	13.5
Contact with pesticide containers		
Yes	61	35.9
No	109	64.1
Contact with pesticide equipment		
Yes	123	72.4
No	47	27.6
Contact with contaminated surfaces***		
Yes	67	39.4
No	103	60.6

*** - Combination of exposures by contact with pesticide containers and equipment

Table 4 continued.

in the Farm	**N**	**Percentage (%)**
at home		
Mouthing behavior		
Bad	156	91.8
Good	14	8.2
Food handling behavior		
Bad	161	94.7
Good	11	5.3
Hygiene practices		
Bad	152	89.4
Good	18	10.6
Contact with pesticide containers		
Yes	54	31.8
No	116	68.2
Contact with pesticide equipment		
Yes	74	43.5
No	96	56.5
Contact with contaminated surfaces***		
Yes	16	9.4
No	154	90.6
Parent-Take Home Pesticide		
Yes	146	85.9
No	24	14.1
in the farm and/or at home		
Mouthing behavior		
Bad	160	94.1
Good	10	5.9
Food handling behavior		
Bad	158	92.9
Good	12	7.1
Hygiene practices		
Bad	157	92.4
Good	13	7.6
Contact with contaminated surfaces***		
Yes	7	4.1
No	163	95.9

*** - Combination of exposures by contact with pesticide containers and equipment

4.3 Prevalence of acute respiratory infection (ARI), acute lower respiratory infection (ALRI) and acute upper respiratory infection (AURI)

The prevalence of ARI, ALRI and AURI were 45%, 33.95% and 31.33% respectively in the study participants (Table 5). With respect to ARI, it was common (70.42%) in children between 1 to 3 years and boys (56.14%). Prevalence of ARI - 48.48% and AURI – 51.02% were high in participants whose mothers had no education or had never been to school. The same pattern was identified in the case of participants whose fathers had not also been to school. Participants whose fathers smoked also recorded a prevalence of 12.73% in ALRI which was lesser in participants whose mothers smoked (1.82%). Participants in whose homes wood was bent for fuel during cooking recorded high prevalence for ARI – 61.11%, ALRI – 58.18% and AURI – 61.54%.

Table 5: Prevalence of ARI, ALRI and URI among under-fives in the Offinso- North Agriculture Health Study (n=170)

Characteristics of study population	**Outcomes of Interest**		
	ARI	**ALRI**	**AURI**
	N(%)	**N(%)**	**N(%)**
	72 (45)	55 (33.95)	52 (31.33)
Age of child (years)			
≤ 1	10 (14.08)	9 (16.98)	12 (23.53)
1-3	50 (70.42)	28 (52.83)	27 (52.94)
>3	11 (15.49)	16 (30.19)	12 (23.53)
Gender of child			
Boy	32 (56.14)	23 (52.27)	27 (65.85)
Girl	25 (43.86)	21 (47.73)	14 (34.15)
Age of parent who filled the questionnaire (years)			
≤35	11 (15.28)	10 (18.18)	7 (13.46)
35-45	21 (29.17)	22 (40.00)	18 (34.62)
45-55	37 (51.39)	23 (41.82)	27 (51.92)
>55	3 (4.17)	-	-

Table 5 continued.

Characteristics of study population	Outcomes of Interest		
	ARI N(%)	**ARI N(%)**	**ARI N(%)**
Ethnic origin			
Akan	25 (40.32)	23 (48.94)	15 (36.59)
Ewe	3 (4.84)	2 (4.26)	1 (2.44)
Hausa	7 (11.29)	6 (12.77)	6 (14.63)
Others*	27 (43.55)	16 (34.04)	19 (46.34)
Level of education of mother			
Have not been to school	32 (48.48)	25 (45.45)	25 (51.02)
JSS/middle school/primary school	31 (46.97)	28 (50.91)	23 (46.94)
SSS/secondary school/vocational or technical education	3 (4.55)	2 (3.64)	1 (2.04)
Level of education of father			
Have not been to school	35 (50.00)	25 (46.30)	26 (52.00)
JSS/middle school/primary school	33 (47.14)	28 (51.85)	24 (48.00)
SSS/secondary school/vocational or technical education	2 (2.86)	1 (1.85)	-
Cooking fuel type used			
Liquid Petroleum Gas (LPG)	2 (2.78)	1 (1.82)	-
Charcoal	24 (33.33)	22 (40.00)	19 (36.54)
Wood	44 (61.11)	32 (58.18)	32 (61.54)
Combination of fuels	2 (2.78)	-	1 (1.92)
Smoking habit of father			
Never smoked	60 (83.33)	42 (76.36)	45 (88.24)
Past smoker	7 (9.72)	6 (10.91)	6 (11.76)
Current smoker	5 (6.94)	7 (12.73)	-
Smoking habit of mother			
Never smoked	69 (95.83)	51 (92.73)	50 (96.15)
Past smoker	2 (2.78)	3 (5.45)	2 (3.85)
Current smoker	1 (1.39)	1 (1.82)	-
Drinking habit of father			
Never drank	41 (56.94)	30 (54.55)	32 (61.54)
Past drinker	25 (34.72)	16 (29.09)	18 (34.62)
Current drinker	6 (8.33)	9 (16.36)	2 (3.85)
Drinking habit of mother			
Never drank	58 (82.86)	45 (83.33)	43 (84.31)
Past drinker	2 (2.86)	3 (5.56)	-
Current drinker	10 (14.29)	6 (11.11)	8 (15.69)

* – Gas, Kokonba, Sisala, Moshi, etc.

4.4 Association between pesticide exposure indicators and respiratory infections

Bad mouthing behavior in the farm was significantly associated with acute respiratory infection (Prevalence ratio (PR) = 1.40, (95% confidence interval (CI) 0.99-1.98); acute lower respiratory infection (2.29, 1.46-3.58) and acute upper respiratory infection (2.01, 1.25-3.22). Bad hygiene practices in the farm were also significantly associated with acute respiratory infection (2.76, 1.31-5.80) and acute upper respiratory infection (2.39, 1.02-5.57). A significant association was noticed between contact with pesticide containers in the farm and acute lower respiratory infection (2.10, 1.31-2.87) as well as upper respiratory infection (1.64, 0.98-2.72). Contact with pesticide equipment also had a significant association with acute respiratory infection (2.00, 1.25-3.21). Contact with contaminated surfaces in the farm was significantly associated with all three respiratory conditions – ARI (1.67, 1.01-2.78), ALRI (1.57, 1.02-2.40), AURI (1.28, 1.09-1.50). The significant associations between exposures at home and the respiratory infections are as follows: contact with pesticide containers and acute upper respiratory infection (1.66, 1.00-2.76), contact with contaminated surfaces and acute lower respiratory infection (1.67, 1.14-2.46), take home exposure and acute respiratory infection (2.71, 1.29-5.70). The following are also the significant associations observed between exposures in the farm and/ or at home and the respiratory infections: contact with pesticide containers and acute lower respiratory infection (1.37, 0.97-2.31), contact with pesticide equipment and upper respiratory infection (1.96, 1.18-3.24), contact with contaminated surfaces and acute lower respiratory infection (1.54, 1.07-2.27) and upper respiratory (1.29, 1.09-1.52).

Table 6: Association between pesticide exposure indicators and outcomes of interest- ARI, ALRI, AURI

Exposure Indicators	ARI		ALRI		URI	
(95% CI) for all	Crude PR	Adjusted PR***	Crude PR	Adjusted PR***	Crude PR	Adjusted PR***
in the Farm						
Mouthing behavior						
Good	1.00	1.00	1.00	1.00	1.00	1.00
Bad	1.29 (0.92-1.83)	1.40 (0.99-1.98)	2.06 (1.37-3.10)	2.29 (1.46-3.58)	1.77 (1.13-2.76)	2.01 (1.25-3.22)
Food handling behavior						
Good	1.00	1.00	1.00	1.00	1.00	1.00
Bad	2.08 (0.97-4.48)	1.88 (0.87-4.07)	0.86 (0.55-1.34)	0.89 (0.63-1.42)	2.08 (0.97-4.48)	1.88 (0.87-4.07)
Hygiene practices						
Good	1.00	1.00	1.00	1.00	1.00	1.00
Bad	2.78 (1.31-5.87)	2.76 (1.31-5.80)	0.92 (0.57-1.47)	0.98 (0.60-1.60)	2.50 (1.07-5.82)	2.39 (1.02-5.57)
Contact with pesticide containers						
No	1.00	1.00	1.00	1.00	1.00	1.00
Yes	1.26 (0.90-1.78)	1.32 (0.85-2.04)	1.75 (1.22-2.52)	2.10 (1.31-2.87)	1.70 (1.12-2.60)	1.64 (0.98-2.72)
Contact with pesticide equipment						
No	1.00	1.00	1.00	1.00	1.00	1.00
Yes	1.94 (1.22-3.07)	2.00 (1.25-3.21)	0.74 (0.51-1.08)	0.81 (0.55-1.38)	1.05 (0.66-1.67)	1.01 (0.62-1.65)
Contact with contaminated surfaces**						
No	1.00	1.00	1.00	1.00	1.00	1.00
Yes	1.74 (1.14-2.65)	1.67 (1.01-2.78)	1.69 (1.17-2.44)	1.57 (1.02-2.40)	1.23 (0.98-1.43)	1.28 (1.09-1.50)
at home						
Mouthing behavior						
Good	1.00	1.00	1.00	1.00	1.00	1.00
Bad	3.21 (0.87- 11.80)	2.76 (0.76-9.97)	0.83 (0.43-1.60)	0.85 (0.71-1.80)	2.17 (0.58-4.58)	1.96 (0.54-7.14)

ARI – Acute respiratory Infection, ALRI – Acute lower respiratory infection, URI – Upper respiratory infection

** - Combination of exposures by contact with pesticide containers and equipment

PR – Prevalence ratio, *** - Confounding variables: Age, Sex, Age of Parent, Smoking habit of parent, Drinking Habit of parent, Type of cooking fuel NA – Few cases of ARI reported hence not enough to be analysed

Table 6 continued.

Exposure Indicators	ARI		ALRI		URI	
(95% CI) for all	**Crude PR**	**Adjusted PR*** **	**Crude PR**	**Adjusted PR*** **	**Crude PR**	**Adjusted PR*** **
Food handling behavior						
Good	1.00	1.00	1.00	1.00	1.00	1.00
Bad	2.50 (0.70-8.97)	2.09 (0.60-7.23)	0.79 (0.39-1.60)	0.84 (0.41-1.71)	1.10 (0.67-7.24)	1.19 (0.65-8.22)
Hygiene practices						
Good	1.00	1.00	1.00	1.00	1.00	1.00
Bad	3.94 (1.06-14.74)	3.62 (0.98-13.30)	0.74 (0.42-1.29)	0.76 (0.51-1.41)	4.10 (0.67-27.34)	4.22 (0.65-28.23)
Contact with pesticide containers						
No	1.00	1.00	1.00	1.00	1.00	1.00
Yes	0.95 (0.76-1.19)	0.97 (0.82-1.21)	1.56 (1.02-2.38)	1.50 (0.98-2.46)	1.34 (0.85-2.11)	1.66 (1.00-2.76)
Contact with pesticide equipment						
No	1.00	1.00	1.00	1.00	1.00	1.00
Yes	1.02 (0.72 -1.18)	1.00 (0.82-1.23)	1.09 (0.44-2.32)	1.08 (0.53-3.29)	1.10 (0.93-1.30)	1.11 (0.95-1.30)
Contact with contaminated surfaces**						
No	1.00	1.00	1.00	1.00	1.00	1.00
Yes	1.04 (0.76-1.20)	1.04 (0.79-1.31)	1.63 (1.13-2.36)	1.67 (1.14-2.46)	1.04 (0.88-1.23)	1.09 (0.98-1.31)
Take home exposure						
No	1.00	1.00	1.00	1.00	1.00	1.00
Yes	1.78 (1.10-2.86)	2.71 (1.29-5.70)	0.63 (0.45-1.65)	0.64 (0.45-1.63)	0.97 (0.60-1.58)	1.57 (0.77-3.22)

ARI – Acute respiratory Infection, ALRI – Acute lower respiratory infection, URI – Upper respiratory infection

** - Combination of exposures by contact with pesticide containers and equipment

PR – Prevalence ratio, *** - Confounding variables: Age, Sex, Age of Parent, Smoking habit of parent, Drinking Habit of parent, Type of cooking fuel

NA – Few cases of ARI reported hence not enough to be analysed

Table 6 continued.

Exposure Indicators (95% CI) for all	ARI		ALRI		URI	
	Crude PR	Adjusted PR***	Crude PR	Adjusted PR***	Crude PR	Adjusted PR***
in the farm and/or at home						
Mouthing behavior						
Good	1.00	1.00	1.00	1.00	1.00	1.00
Bad	1.57 (0.48-5.14)	1.48 (0.45-4.81)	1.10 (0.45-4.81)	1.39 (0.65-4.52)	1.01 (0.73-1.39)	1.00 (0.73-1.37)
Food handling behavior						
Good			1.00	1.00	1.00	1.00
Bad	N.A	NA	0.82 (0.37-1.81)	1.23 (0.47-3.93)	0.84 (0.65-1.02)	0.83 (0.63-1.05)
Hygiene practices						
Good	1.00	1.00	1.00	1.00	1.00	1.00
Bad	1.83 (0.54- 6.16)	1.81 (0.54- 6.07)	1.25 (0.37- 4.25)	1.65 (0.49- 5.56)	0.88 (0.62-1.16)	0.90 (0.66-1.18)
Contact with pesticide containers						
No	1.00	1.00	1.00	1.00	1.00	1.00
Yes	1.19 (0.84- 1.67)	1.22 (0.82- 1.81)	1.35 (0.89-2.07)	1.37 (0.97-2.31)	0.99 (0.62- 1.58)	1.11 (0.66- 1.87)
Contact with pesticide equipment						
No	1.00	1.00	1.00	1.00	1.00	1.00
Yes	1.25 (0.85- 1.80)	1.25 (0.84- 1.85)	1.22 (0.83-1.77)	1.24 (0.91-1.92)	1.66 (1.05- 2.62)	1.96 (1.18- 3.24)
Contact with contaminated surfaces**						
No	1.00	1.00	1.00	1.00	1.00	1.00
Yes	0.85 (0.58-1.33)	0.91 (0.58-1.33)	1.52 (1.05-2.21)	1.54 (1.07-2.27)	1.26 (1.09-1.45)	1.29 (1.09-1.52)

ARI – Acute respiratory Infection, ALRI – Acute lower respiratory infection, URI – Upper respiratory infection

** - Combination of exposures by contact with pesticide containers and equipment

PR – Prevalence ratio, *** - Confounding variables: Age, Sex, Age of Parent, Smoking habit of parent, Drinking Habit of parent, Type of cooking fuel

NA – Few cases of ARI reported hence not enough to be analysed

CHAPTER FIVE

5.0 DISCUSSIONS

5.1 Main Findings

This study investigated whether exposure to pesticides in under five year old children in farming communities in the Offinso-North district is associated with the risk of acute respiratory infection. Behaviors and practices at home or in the farm or at home and/or in the farm adopted by the children that related to pesticide exposure pathway were examined. Bad food handling behavior, bad hygiene practices and contact with pesticide equipment in the farm were common. In the home environment, bad mouthing behavior, bad food handling behavior, bad hygiene practices and parent take home pesticide were also common. The prevalence of symptoms of respiratory infection was high. Bad mouthing behavior and contact with contaminated surfaces in the farm were significantly associated with symptoms of respiratory infection. Contact with pesticide containers was associated with ALRI and URI. Exposure by contact with contaminated surfaces in the farm was significantly associated with symptoms of ARI, ALRI and URI. At home contact with pesticide containers, equipment and contaminated surfaces was also seen to be significantly associated with symptoms of URI and ALRI respectively. Contact with pesticide containers and equipment in the farm and/or at home were also associated with symptoms of ALRI and URI respectively. Contact with contaminated surfaces was significantly associated with both ALRI and URI.

5.2 Methodological Validity

This study has a number of strengths. To the best of my knowledge, it is the first among children living in farming communities in Africa. The study population was derived from a

large population- based cross-sectional study, that is the Offinso North Farm Health study (ONFAHS) involving over 900 individuals; and couple with the high participation rate (approximately 100%) minimizes the potential influence of selection bias. The source population included all children under five in the designated geographical area. The use of questionnaire enabled me to collect information on potential confounders which were accounted for in the analysis. Data was taken by the use of questionnaires administered by well-educated agricultural extension officers who functioned as research assistants. Prior to the collection of the data, an extensive orientation and training was held to explain the study and need for accuracy in data gathering. The large sample size enhanced precision on the estimates. It is necessary to state that despite attempt to undertake a very rigorous survey there were a few limitations to the study. As expected from early investigations about the farming seasons it was assured that farmers would be readily available to participate in the study. This was however not the case as the delay of the rains totally changed the farming calendar for the farmers in the Offinso-North sdistrict making it difficult to have access to them. The size of the study area is quite large and it was challenging to adopt a probability sampling procedure when farmers were dispersed on their distant farms away from the main town settlement. It is therefore possible that sensitive individuals in the farming population were missed due to this challenge. More time was used in the collection of data than expected which affected the smooth carrying out of the survey. The cross-sectional nature of the study makes it impossible to ascertain any causal relationship between the exposure indicators and the outcomes of interest. The prevalence of ARI varies by age of the child and is common among children between 6 to 11 months. This population was very few in the present study and we could not conduct any age-specific analysis

5.3 Comparing this study with previous studies

Exposure to pesticides in farm children is a major public health concern globally (Roberts & Karr, 2012; van Wendel de Joode et al., 2012). A systematic search of the literature did not identify any study that had evaluated the effect of pesticides on farm children in Africa. However, closely related studies have been reported in developed countries (Gascon et al., 2012; Dallaire et al., 2006; Koch et al., 2003; Stølevik et al., 2011; Amato, Cecchi, Amato, & Liccardi, 2010; Nigatu, Bråtveit, Deressa, & Moen, 2015) . A survey to assess the effect of prenatal exposure to polychlorinated biphenyls on incidence of acute lower respiratory infection in preschool children was undertaken in Canada. Medical charts of 343 under five year children were reviewed and associations of the presence of PCB-13 in the umbilical cord plasma and incidence rates of acute lower and upper respiratory infection evaluated. No significant association was identified between prenatal exposure and upper respiratory infection as against lower respiratory infection (Dallaire et al., 2006). Koch et al. (2003) embarked on a prospective cohort study of 288 children between ages 0 and 2 to identify risk factors for the development of upper and lower respiratory tract infections. Attending a child care center and sharing a bedroom with adults were risk factors for developing upper respiratory infection; being a boy, attending a child care center, exposure to passive smoking; sharing a bedroom with children aged 0 to 5 years were also identified as risk for developing acute lower respiratory infection but breastfeeding has a protective effect. The Norwegian Institute of Public Health after a cohort study investigating the association between prenatal exposure to polychlorinated biphenyls and dioxins to the risk of wheeze and infections in infants reported prenatal exposure to dioxins and polychlorinated biphenyls was associated with increased risk of upper respiratory tract infection and wheeze (Stølevik et al., 2011).

This current study was undertaken in rural Ghana and specifically in one of the main popularly acclaimed farming communities- the Offinso-North district. The survey did not use a cohort of children as had been done by Stølevik et al., 2011 and Koch et al., 2003. The data used was only primary data different from the mentioned studies above which either used secondary data from hospital records only or in addition to their primary data. This study could not report on incidence of the respiratory infection but rather prevalence of its symptoms. This is because of the cross-sectional nature of the survey. Pesticide exposure was described using indicators which captured various practices and behaviors common in the farm, at home and in the farm and or home. To the best of my knowledge, this is the first kind where such indicators have been used to assess the exposure to pesticides. The outcomes of interest were symptoms of acute respiratory infection further defined as upper respiratory and acute lower respiratory infection. This study therefore based on its results suggests that exposure to pesticides in under five year children through indicators such as bad hygiene practices, bad mouthing behavior and contact with contaminated surfaces increases the risk of symptoms of acute respiratory infection, upper respiratory infection and acute lower respiratory infection.

CHAPTER SIX

6.0 CONCLUSION AND RECOMMENDATION

6.1 CONCLUSION

The findings of this survey show significant positive associations between pesticide exposure indicators like hygiene practices, contact with pesticides containers and contaminated surfaces on the farm and symptoms of acute respiratory infection. This indicates that exposure to pesticides can influence symptoms of respiratory complications in under-five year old children. This study also suggests that low parental supervision of children is likely a common situation in most Ghanaian homes and could result in adverse state of their health as shown in this study The greater proportion of children in the study were reported to engage in most of the activities used as indicators for pesticide exposure. This survey has a lot of relevance to countries in the developing world who depend on farming as a source of income and livelihood. Children of farming families can hence be protected from exposures that predispose them to respiratory infection and possible mortality as a result.

6.2 RECOMMENDATION

Knowledge of pesticide exposure as a risk to the development of ARI is important in helping relevant stakeholders to take informed decisions in the form of policies that would serve as a stronger protection on innocent victims. These would ensure more informed actions on the part of farmers and parents of children to reduce the exposure to pesticides to the children by avoiding improper practices. By way of actions, the following can be done:

Public education of good practices in child care should be undertaken by the ministry of health to avert the development of preventable diseases such as acute respiratory infections. Government under the agriculture ministry should making training a must before the use and

applications of pesticides. This would also be an avenue to give good instruction on the bad practices which are to be avoided in the use of pesticides and help avoid creating residual levels of pesticides in the environment where children are exposed to. Strict measures should be put in place under the agricultural extension services to avoid the use of banned pesticides which are mostly persistent in the environment and have a stronger tendency to be absorbed after several moments of pesticide application. This is necessary as children are more vulnerable to absorbed residues of the pesticides in the atmosphere.

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APPENDIX A: INFORMED CONSENT

Institutional Affiliation

Department of Biological Environmental and Occupational Health Sciences (BEOHS): School of Public Health, College of Health Sciences, University of Ghana-Legon.

Background

Dear participant, Asiedu Addo Joshua is my name, a student of the School of Public Health, University of Ghana, Legon. I am undertaking a studying pesticide exposure and acute lower and upper respiratory infections in under five year old children. The study hopes to assess the relationship between pesticides exposure and acute respiratory infections among the under five year old children of vegetable farmers in Offinso-North District.

Procedures

The study will involve answering questions from a structured questionnaire. Urine sample will be taken from children for laboratory analysis. This is purely an academic research which forms part of my work for the award of a master of public health degree. I would be very grateful to have u 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 better protecting the children of farming families from incidences of these respiratory infections and other possible diseases.

Right to refuse

Participation in this study is voluntary and parents of the children 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.

Dissemination of results

The result of this study will be mailed 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 on 0503334278/ 0200794294.

Consent

I……., declare that the purpose of the study have been thoroughly explained to me in English language and I have understood. I hereby agree to answer the questions

Signature……. Date……

Thumb print ☐

Interviewer's Statement

I, the undersigned, have explained this consent form to the subject in the English language 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……

Contact of GHS-ERC Administrator

(Hannah Frimpong - 0507041223).

APPENDIX B: QUESTIONNAIRE

I am student of the School of Public Health, University of Ghana, Legon, conducting a study on pesticide exposure and acute lower and upper respiratory infections in under five year old children. The questionnaire seeks to collect information on the demographics, pesticide use and hopes to assess the relationship between pesticides exposure and acute respiratory infections among the under five year old children of vegetable farmers in Akumadan. All information will be treated with maximum confidentiality.

No.	QUESTIONS	Codes	Coding categories	answers
SECTION 1: CHILD DEMOGRAPHICS:				
1	Age at last birthday	Age		……..
2	Gender	Sex	1. Male 2. female	
3	Level of education	Edu	1. crèche 2. kindergarten 3. Lower Primary 4. No education	
4	On the average how many hours does the child spend per week on the farm	ahof		……
5	What type of crop is cultivated?	tocc	1. Vegetables 2. Maize 3. Cassava 4. Others Specify……	
SECTION 2: GUARDIAN'S DEMOGRAPHIC INFORMATION				
6.	Age of Guardian			……
7.	Gender of guardian		1. Male 2. Female	
8.	Relationship to the child			……..

9.	Level of education of the guardian		1. Lower primary leaver 2. Junior high school leaver 3. Senior high school leaver	
10.	Average income of the household			……
11.	Specific role on the farm			……
SECTION 3 PESTICIDES EXPOSURE **Pesticides Handling**				
12.	Do you use pesticides in your farms?	upif	1. Yes 2. No	
13.	If yes how long have you been using pesticides (in years)	lopu		……..
14.	How often does the child come in to contact with pesticides?	ccp	1. Everyday 2. Once a week 3. Once a month	
15.	What activity makes you come into contact with pesticides?	amup	1. transportation of the pesticides 2. mixing 3. spraying 4. storage	
16	Where are the pesticides stored before and after use?	psba	1. Home 2. farm	
17.	Do children have contact with stored pesticides?	chcp	1. Yes 2. No	
18.	If yes, how often do they come into contact with these stored pesticides?	hosp	1. Everyday 2. Once a week 3. Once a month 4. Other Specify……..	
19.	Where are pesticides mixed before application?	pmba	1. Home 2. Farm 3. both	
20.	Are there spillages during the mixing process?	spill	1. yes 2. no	
21	If yes, how often do these spillages occur?	hoso	1. Not often 2. Often 3. Very often	
22.	Do children have contact with such spillages?	chss	1. Yes 2. No	
23.	If yes, how often do the children come into contact with spillages?	hocs	1. Not often 2. Often 3. Very often	
24.	Do pesticides come with specific instructions on how to use?	pcsi	1. Yes 2. No	
25.	If yes, in what form?	iwf	1. MSDS 2. Label on container 3. Others Specify……	
26.	Are you aware of any adverse health effects of pesticide?	awep	0. No 1. Yes	
27	If yes to the above what are preventive measure put in place?	wpmi	1. Utility gloves 2. Goggles 3. safety boot 4. others specify……	
28.	How often do you use personal protection when coming in to contact with pesticides?	uppc	1. Regularly 2. Sometimes 3. never	

29.	If no to question 28 any reason for not using any preventive measure?	ntqr	1. discomfort 2. I don't have them 3. others specify……..	
Proximity of child to contaminated /exposure surfaces				
30	Does the child come into contact with the used protective attire/equipment?	ccue	0. No 1. Yes	
31	Does the child come into contact with contaminated surfaces such as used containers or dresses	cccs	0. No 1. Yes	
32	Does the child play on the ground in the home?	cpgh	0. No 1. Yes	
33	Does the child ingest soil materials at home or farm?	Cish/f	0. No 1. Yes	
SOCIOCULTURAL FACTORS				
34	How many people live in the home	hmph		
35	Does any member of the family smoke in the home	dmfs	0. No 1. Yes	
36	Is the child in the home when this person is smoking	Chwps	0. No 1. yes	
3.RESPIRTORY SYMPTOM COUGH				
37	Does the child usually have a cough?	Cuhc	0. No 1. Yes	
38	Does he usually cough as much as 4 to 6 times a day, 4 or more days out of the week?	cm4w	0. No 1. Yes	
39	Does the child usually cough at all on getting up, or first thing in the morning?	Ucgu	0. No 1. Yes	
40	Does the child usually cough at all during the rest of the day or at night?	Ucdr	0. No 1. Yes	
41	Does the child cough like this on most days for 3 consecutive months or more during the year?	clom3	0. No 1. Yes	
42	For how many months has this cough been present?	Hmmc		……..
4.PHLEGM				
43	Does the child usually bring out phlegm from the chest?	Cbpc	0. No 1. Yes	
44	Does he usually bring up phlegm like this as much as twice a day, 4 or more days out of the week?	Bplm	0. No 1. Yes	
45	Does the child bring out phlegm first thing in the morning or on getting up?	Bpfm	0. No 1. Yes	
46	Does the child usually bring up phlegm at all during the rest of the day or at night?	Bpad	0. No 1. Yes	
	IF NO TO ALL, SKIP TO NEXT QUESTIONS			
47	Does the child bring up phlegm	Dcbp	0. No	

	like this on most days for 3 consecutive weeks or more during the month?		1. Yes	
48	For how many months has child had trouble with phlegm?	Hmcp	1. Months now 2. 1-2 years 3. 3 years and more	
49	Have there been periods/ episodes of (increased) cough and phlegm lasting for 3 weeks or more each month?	ecl3	0. No 1. Yes	
.WHEEZING				
50	Does your child's chest ever sound wheezy or whistling?	Ccsw	0. No 1. Yes	
51	Does your child's wheezing occur when he/she have a cold?	Wocc	0. No 1. Yes	
52	Does the wheezing occur most days and nights?	Dwmd/n	0. No 1. Yes	
	IF YES TO 45,46, OR 47			
53	For how many months has the wheezing been present?	Hmwp		……
54	Has child ever had an attack of wheezing that had caused shortness of breath?	Cews	0. No 1. Yes	
	IF YES TO C:			
55	For how long has child had such an episode per year?	Hlsl	1. Several months 2. I year 3. 2 or more years	
56	How old was your child when he/she had the first such attack?	Hocf		……..
57	How many such attacks has your child had since the first attack?	Hmac	1. One 2. Two 3. Three or more	
. BREATHLESSNESS				
58	Does your child suffer from shortness of breath when hurrying on the level or walking up a slight hill?	Csfs	0. No 1. Yes	
59	If yes to 53, does your child have to walk slower than children his/her age because of breathlessness?	Iycw	0. No 1. Yes	
60	Does child ever have to stop for a breath when walking?	Cesb		
61	If your child gets a cold, does it usually go to the chest?	Dcgc	0. No Yes	
62	During the past 3 months, has your child had any chest illnesses that have kept him/her indoors at home, or in 0.nobed?	hchc3	0. No 1. Yes	
63	Did your child produce phlegm with any of these chest illnesses?		0. No 1. Yes	
64	In the last 3 month, how many such illnesses, with (increased) phlegm, did your child have which lasted a week or more?	i3hi		…….
. PAST ILLNESSES				
65	Has your child ever had any of the following?		1.	

66	If yes to 61, was it confirmed by a doctor	Iywc	0. No 0. Yes	
67	At what age (in months) did your child first have it	Wadc	1.	……
68	Pneumonia?	Pneu	0. No Yes	
69	If yes to 67, was it confirmed by a doctor	Iywc	0. No 1. Yes	
70	At what age (in months) did your child first have it	Wadc	1.	……
71	Have you ever had emphysema?	Huhe	0. No Yes	
72	If yes to 70, was it confirmed by a doctor	Iywc	0. No 1. Yes	
73	At what age (in months) did your child first have it	Wadc	1.	……
74	Does your child still have it?	Dcsh	0. No Yes	
75	Has your child ever had asthma?	Hcha	0. No 1. Yes	
76	If yes to 74, was it confirmed by a doctor?	Iywc	0. No 1. Yes	
77	At what age (in months) did your child first have it	Wadc	1.	
78	Any other chest disease?	Aocd	0. No Yes	
79	If yes, specify the type of chest disease.	Stcd	1.	……

APPENDIX C: WORK SCHEDULE

ACTIVITY / TASK	DURATION (WEEKS)	PERSONNEL RESPONSIBLE	NO OF DAYS
Proposal submission for ethical clearance	November, 2015	Researcher	
Training of research assistants	Week 1	Researcher	3 days
Data and sample collection	Week 2 and 3	Researcher and Field assistants	14 days
Laboratory analysis on samples and data classification	Week 4	Researcher and laboratory assistants	7 days
Report writing and finalization	Week 5-7	Researcher	14 days
Termination of Report	June, 2016	Researcher	

APPENDIX D: BUDGET

ITEM	PURPOSE	UNIT COST	TOTAL
PERSONNEL	Allowance for research assistants in the community		600
EQUIPMENTS	Propylene containers , ice chests and other relevant sampling collection materials		400
Printing/binding/ photocopying			250
Cost of sample analysis			1700
Pens, paper files etc.			50
Communication	Communicating with field assistants, supervisor and the school authorities		300
Phone calls			200
Internet			150
Transportation	Movement from Accra to Akumadan and within Akumadan		1000
Dissemination			200
Miscellaneous			100
TOTAL			4950

APPENDIX E – VARIABLES FOR ANALYSIS

Mouthing behavior

on the farm

When the child accompanies the parent to the farm, how often does the child place thumb/fingers in the mouth?

a. Never b. Rarely c. Sometimes d. Most of the time e. Always

When the child accompanies the parent to the farm, how often does the child put nonfood items in the mouth?

a. Never b. Rarely c. Sometimes d. Most of the time e. Always

When the child is at home, how often does the child eats soil on the floor at home?

a. Never b. Rarely c. Sometimes d. Most of the time e. Always

at home

When the child is at home, how often does the child eats soil on the floor at home?
a. Never b. Rarely c. Sometimes d. Most of the time e. Always

When the child is at home, how often does the child places thumb/fingers in the mouth?
a. Never b. Rarely c. Sometimes d. Most of the time e. Always

When the child is at home, how often does the child pick nonfood items from the floor into the mouth?
a. Never b. Rarely c. Sometimes d. Most of the time e. Always

Food handling practices

on the farm

When the child accompanies the parent to the farm, how often does your child eat food dropped on floor in the farm?
a. Never b. Rarely c. Sometimes d. Most of the time e. Always

When the child accompanies the parent to the farm, how often does the child eat food with fingers?
a. Never b. Rarely c. Sometimes d. Most of the time e. Always

at home

When the child is at home, how often does the child eat food dropped on floor?
a. Never b. Rarely c. Sometimes d. Most of the time e. Always

When the child is at home, how often does the child eat food with fingers at home?
a. Never b. Rarely c. Sometimes d. Most of the time e. Always

Hygiene practices

On the farm

When the child accompanies the parent to the farm, how often does the child crawl on the ground?
a. Never b. Rarely c. Sometimes d. Most of the time e. Always

When the child accompanies the parent to the farm, how often does the child wash hands before eating?
a. Never b. Rarely c. Sometimes d. Most of the time e. Always

at home

When the child is at home, how often does the child wash hands before eating?
a. Never b. Rarely c. Sometimes d. Most of the time e. Always

When the child is at home, how often does the child crawls on the floor?
a. Never b. Rarely c. Sometimes d. Most of the time e. Always

Contact with contaminated pesticides containers/equipment

On the farm

When the child accompanies the parent to the farm, how often does the child come into contact with empty pesticide containers/pesticide containers?
a. Never b. Rarely c. Sometimes d. Most of the time e. Always

When the child accompanies the parent to the farm, how often does the child come into contact with pesticide contaminated equipment (e.g. nose mask, googles, etc)?
a. Never b. Rarely c. Sometimes d. Most of the time e. Always

When the child accompanies the parent to the farm, how often does the parent hold or carry the baby when he has not changed into clean clothes?
a. Never b. Rarely c. Sometimes d. Most of the time e. Always

At home

When the child is at home, how often does the child come into contact with pesticide contaminated equipment (e.g. nose mask, googles, etc)?
a. Never b. Rarely c. Sometimes d. Most of the time e. Always

When the child is at home, how does the father hold or carry the baby when he has not changed into clean clothes?
a. Never b. Rarely c. Sometimes d. Most of the time e. Always

When the child is at home, how does the mother hold or carry the baby when she has not changed into clean clothes?
a. Never b. Rarely c. Sometimes d. Most of the time e. Always

Child location during pesticides handling

Off the farm

Inside the building

Outdoor on the farm

Mixed locations