HAWASSA UNIVERSITY

COLLEGE OF NATURAL AND COMPUTATIONAL SCIENCE DEPARTMENT OF BIOLOGY POSTGRAGUATE PROGRAM

ASSESSMENT ON COMMUNITY AWARENESS AND PRACTICES TO INDOOR AIR POLLUTION IN JIMMA TOWN AND SURROUNDING RURAL KEBELES, OROMMIA REGIONAL STATE, ETHIOPIA

MSC THESIS

BY: HARUNE ABAFOGI

NOVEMBER 2024

HAWASSA, ETHIOPIA

ASSESSMENT ON COMMUNITY AWARENESS AND PRACTICES TO INDOOR AIR POLLUTION IN JIMMA CITYAND SURROUNDING RURAL KEBELES, OROMMIA REGIONAL STATE, ETHIOPIA

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A THESIS SUBMITTED TO THE HAWASSA UNIVERSITY SCHOOL OF GRADUATE STUDIES NATURAL AND COMPUTIONAL SCIENCE, DEPARTMENT OF BIOLOGY,IN PARTIAL FULFILLMENT OF THE REQUIRMENT FOR THE DEGREE OF MASTER OF SCIENCE IN BIOLOGY

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ADVISORS' APPROVAL SHEET

This is to certify that the thesis entitled "ASSESSMENT ON COMMUNITY AWARENESS AND PRACTICES TO INDOOR AIR POLLUTION IN JIMMA CITYAND SURROUNDING RURAL KEBELES, OROMMIA REGIONAL STATE, ETHIOPIA" submitted in partial fulfillment of the requirements for the degree of Master's with specialization in Master of science in Biology, the graduate program of the Department of Biology, and has been carried out by Harune Abafogi Id. No.Biok/015/09.Under my/our supervision. Therefore I/We recommend that the student has fulfilled the requirements and hence here by can submit the Thesis to the department

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Declaration

I hereby declare that, this thesis is my original work and has not been presented for a degree in any other university, and all sources of materials used for the thesis have been duly acknowledged.

Harune Abafogi ____________________ ____________________

Name of Candidate Signature Date

This MSc thesis has been submitted for examination with my approval as thesis advisor.

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Place and date of submission:_____________

Abbreviations and Acronyms

AAP……………Ambient Air Pollution

AQ……………...Air Quality

AQG……………Air Quality Guidelines

ARI……………..Acute Respiratory Infection;

ASHRAE ………American Society of Heating, Refrigerating, and Air Conditioning Engineers

BC………………Black Carbon

BS………………Black Smoke

EPA …………….Environmental Protection Agency

GBD …………....Global Burden of Disease

HAP ……………Household Air Pollution

HVAC ………….Heating, Ventilation, and Air Conditioning

IAP ……………..Indoor Air Pollution

IAPs …………… Indoor Air Pollutants

IAQ ……………. Indoor Air Quality

IER……………....Integrated Exposure Risk

LPG……………...Liquefied Petroleum Gas

NIEHS ………….National Institute of Environmental Health Sciences

PM ……………....Particulate Matter

PM10 …………....Particles that are 10 micrometers in diameter or less

PM2.5 …………...Particles that are 2.5 micrometers in diameter or less

RCPCH……….... Royal College of Pediatrics and Child Health

SPSS …………....Statistical Package for Scientific solution

UNDP …………...United Nations Development Program

UNEP ……….....United Nations Environment Program

US EPA ………….United States Environmental Protection Agency

VOCs …………....Volatile Organic Compounds

WHO …………….World Health Organization

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ABSTRACT

Most households in Africa including Ethiopia still use biomass fuel to cooking their food and for heating in poorly ventilated houses. Indoor air pollution (IAP) is the presence of one or more contaminants in the indoor environment that has a degree of human health risk. The main objective of this study was to investigate community perception and level of community awareness towards IAP in Jimma town and surrounding rural kebele. Cross-sectional research design was used to achieve the study. Structured questionnaires, FGD and household observation were used as the data collection tools. Representative samples 360 households were included by systematic random sampling. Data were analyzed by SPSS both bivariate correlation and logistic regression was applied for the statistical test. The results majority of respondents (74.45%) the main source of energy for cooking was fire wood (88.6%) and charcoal (74.4), traditional type of stoves was made of cooking by majority (88.6%), in average (71.9%) respondents were aware of the source of IAP, most of (72.5%)household the two social groups were aware of the route of exposure and effects of IAP, largely (84.4%) respondents knew that exposure to IAP can affect human health and cause diseases, and lastly average (57.9%) of respondents knew that to reduce and prevent IAP. Majority (98.6%) of the respondents thinks that using cooking fuel that emits less smoke could prevent IAP. Other preventive mechanisms reported include: prohibiting cigarette smoking in living houses (98.0%), cooking always outside living houses (94.6%), avoiding living with domestic animals (95.2%) and keeping windows/doors open most of the time (91.2%). The households in this study had (71.9%) good awareness about the source of IAP, adverse health effects of IAP exposure and preventing measures of these adverse health effects, however, (84.4%) majority of them were still living with the risk factors associated with IAP in their daily living. There is need to provide education/awareness creation regarding air quality and its effects on health would be important and this can be implemented through community-based organizations that have wide acceptance in the study communities.

Keywords:- *Air quality, Air pollution, Indoor air pollutants, Indoor air quality, Public awareness*

1. INTRODUCTION

1.1 Background of the Study

Air pollution can be defined as the emission of substances released by natural and anthropogenic actions which eventually build up in high concentrations and have the potential to cause direct or indirect damages on any living organisms and their surroundings (Monks *et al.,* 2009). Indoor air pollution (IAP) is defined as an issue that impacts a wide range of enclosed spaces such as houses, office, schools and public transports. Resulting from the use of solid fuels (wood, crop residue, animal dung, coal) for cooking and heating is a significant public health concern in developing countries where a substantial proportion of population relies exclusively on such fuels. In these areas, it has been estimated that IAP resulting from the combustion of solid fuels may be one of the leading contributors to the global burden of disease, among environmental risk factors (Sapkota, 2020).The Environmental Protection Agency (EPA) defines indoor air quality (IAQ) as "the air quality within and around buildings and structures, especially as it relates to the health and comfort of building occupants" (EPA, 2016a).

There are four principal sources of pollutants of indoor air: (i) combustion, (ii) building material, (iii) the ground under the building, and (iv) bio-aerosols (Smith, 2000). Individuals are exposed to different pollutants on a day-to-day basis. Exposure can be elucidated by several characteristics such as duration, magnitude, frequency and the route of exposure (Silins *et al.,* 2011). The duration of exposure can be defined as the total time frame whereby a person is in contact with a specific pollutant; whereas, magnitude refers to the concentration of the pollutant or contaminant of interest to which the individual is exposed (Silins *et al.,* 2011).Exposure to the contact of an agent with an external boundary of a receptor (exposure Surface) for a specific duration (Zartarian *et al.* 2005). Air pollutants enter the human body via three main routes of exposure i.e. inhalation, ingestion and dermal absorption (Kampa and Castanas, 2008).

Domestic indoor air pollution can be impacted by various factors, such as indoor sources, occupant behaviour, housing ventilation and local indoor levels of air pollution (RCPCH, 2020), and changes to these that can modify indoor air pollution. Ethiopian government's strategic drive towards economic development, industrialization, and poverty reduction has not been accompanied by high priority for air quality improvement and indoor air pollution control measures (Etyemezian *et al.* 2005). It appears that public awareness on the state of air quality of a particular area varies from one individual to another (Slovic *et al.,* 2006) and in fact, it is a controversial subject whereby various people have different opinions. (Bickerstaff and Walker, 2001) add on that generally, public awareness is derived from diverse experiences encountered within the physical, socio-cultural world and is often affected by media coverage and other secondary information. Indoor air quality in Ethiopia can be enhanced government effort to improve the awareness and support for environmental protection among the country's citizens.

Studies conducted in Ethiopia on air pollution have mainly focused on the environmental and atmospheric aspects of pollution, particularly with a focus on quantifying the level and nature of pollutants (Avis and Khaemba, 2018), rather than the social aspect of pollution investigating topics such as citizens' attitudes. Improving the educational level and raising environmental awareness are essential for reducing indoor air pollution (Selden and Song 1994). and about determining the understanding of the participants about air pollution/quality (Paulos *et al.,* 2007), no study can be found that is planned and implemented in order to raise air pollution awareness only. Based on these overall backgrounds, researcher has sought to conduct the level of community perception on sources exposure and effects of indoor air pollution in Jimma city and surrounding rural kebeles, Oromia Regional State, Ethiopia.

1.2 Statement of the Problem

World Health Organization (WHO, 2004) estimates that IAP is responsible for 2.7% of the loss of disability-adjusted life years worldwide and 3.7% of high mortality in developing countries. IAP in developing countries is one of the four most critical global environmental problems (Brandon, 2020). Indoor Air Quality (IAQ) has become a growing environmental issue and public health concern. Indoor microenvironments in urban buildings such as offices, schools and residences have been linked to health and comfort problems due to poor building design (Burge, 2019). The awareness about the indoor pollutants and its impact on human is the first step to reduce them (WHO*,* 2018). Therefore, increasing people's Awareness is a corner stone for interventions promoting protective behavior (Sjöberg *et.al.* 2018). It is a crucial element of indoor air pollution control, as little information was available about residents' awareness of indoor air pollution and health (Zahedi, 2014).

Studies have shown in different parts of the world and some parts of Ethiopia that awareness of IAP is high (WHO, 2018), but this has not translated into positive action. This study was designed to get baseline information that can help in programming and developing control strategies to minimize the effect of IAP. The present study was intended to identify the level of community awareness on the issues and source information related to IAP in the study area, to indicate the practices and risk factors associated with IAP in the study area, to examine the level of community awareness on sources and route of exposure to IA pollutants, to show the awareness of community towards potential effects of IA pollutants to human health, and to analysis community knowledge on prevention from indoor air pollution. And recommend possible solutions in Jimma town and surrounding rural Kebeles, Oromia Regional State, Ethiopia.

1.3. Objectives of the Study

1.3.1 General Objectives

The main objective of this study was to investigate community perception and level of community awareness towards IAP in urban and rural area.

1.3.2 Specific Objectives

The specific objectives of this study were:

1. To explore the knowledge of community to words the source, exposure IAP;
2. To identify practices and/or factors that contributes to exposure of the community to the IAP;
3. To assess the level of community awareness to words perceived health effects of IAP;
4. To identify the sources of energy to the community and sources of IAP in the study areas;
5. To assess attitude of the community toward preventive measures of IAP.

1.4. Research Question

To achieve the main objective, the study was addressee the following specific objectives;

1. What is the knowledge of the community toward the source exposure of IAP?
2. What are practices and/or factors that contribute to exposure of the community to the IAP?
3. What is the level of community awareness towards perceived health effects of IAP?
4. What are the sources of energy to the community that are sources of IAP in the study areas?
5. What is the attitude of the community toward preventive measures of IAP?

1.5 Significance of the Study

It is important to understand the source, exposure route, effects and preventive measures of indoor air pollution in the study area. It is also important to suggest a way how to increase the awareness and reduce or preventive measures of households about effects indoor air pollution.

1.6 Scope of the Study

The study was both in scope and depth to manageable size based on the researcher's time availability, budget and other factors. This research focused of on the assessment of community perception on sources exposure and effects of indoor air pollution in Jimma city and surrounding rural kebeles, all data were collected from different households in Jimma city and surrounding rural kebeles.

1.7 Limitation of the study

The limitation of the study might lie in the research participants had showed less interest in filling out the questionnaires, so that they offered responses with little concern and willingness. The interview in FGD also conducted in a speedy condition for the fact that the respondents were much occupied with their own work. The researcher faces the lack of sufficient and well-organized or documented data which related to the study will be one of such limitation.

1.8 Operational definition of terms and Concepts

Some of the most significant terms related to the study, in our study the following definitions were used:

1.Air quality is defined as an indicator which gives an account of the presence of substances or compounds in the air which can present a potential risk to the environment and to the health of the population exposed to them (WHO, 2019).

2. Air pollution is refers to the contamination of the indoor or outdoor environment by any chemical, physical or biological agent that modifies the natural characteristics of the atmosphere (Bruce, 2006).

3. Indoor air pollutants refer to the pollutants found in a wide range of enclosed spaces such as Houses, office, schools and public transports (Slezakova , 2012).

4. Indoor air quality is defined as the physical and chemical measure of pollutant concentrations in the indoor atmosphere (UNEP, 2002).

5. Public awareness is the public's level of understanding about the importance and implications of on source exposure and effects of indoor air pollution (Sjöberg *et. al.*2018).

6. Vulnerability:- refers to characteristics of individuals or populations that place them at increased risk of an adverse health effect (U.S. EPA, 2016).

2. LITERATURE REVIEW

2.1 Air Quality and Air Pollution

Based on location, Air pollutants may be Outdoor Air pollutants or Indoor Air pollutants where: Outdoor air pollutants are often referred to as ambient air pollutants. The common sources of outdoor air pollutants are emissions caused by combustion processes from motor vehicles, solid fuel burning, industries and other pollutants sources include smoke from bush fires, windblown dust, and biogenic emissions from vegetation (pollen and mould spores). Indoor air pollution (IAP) has been described as the presence of one or more contaminants indoors that carry a certain degree of human health risk. IAP has listed as one of the world's worst pollution problems (Osagbemi, 2010).

Indoor air quality is considered to be a major environmental issue given that indoor air pollution has significant detrimental health effects (WHO, 2018). Over the past few decades there has been a decrease in outdoor pollution but an increase in indoor pollution (Mendes *et al.,* 2013). As people built shelters for living, they also brought pollutants into their living space (Schilmann, and Riojas Rodriguez, 2010). IAQ problems arise from interactions between the building materials, activities that occur in the building, climate and the building occupants (Kike-Parsis, 2004). These problems may arise from inadequate temperature, poor ventilation systems, indoor air contaminants, or from insufficient outdoor air intake (EPA, 2016a). It has been shown that air pollutants are commonly two to five times higher indoors compared to outdoors and sometimes 100 times greater than outdoor levels (EPA, 2013).

The most important environment that relates to human health is the indoor environment because people spend as much at 90 percent of their time indoors (Sundell, 2004). According to the World Health Organization (WHO, 2018) polluted air is linked to a variety of health concerns, ranging from short-term irritation to serious diseases or even death. Poor air quality has been shown to exacerbate chronic respiratory diseases, which are diseases of the airway and lungs (WHO, 2018). Indoor air pollutants refer to the pollutants found in indoors (buildings). The common sources of indoor air pollutants are pollutants from natural sources; pollutants from combustion (burning) sources and pollutants from man-made sources (Shamsul, 2004). Air pollution can be described as the presence of a mixture of harmful, natural and anthropogenic substances in the atmosphere, and it is typically differentiated into two categories, that is, indoor and outdoor air pollution (OAP) (NIEHS, 2017). Indoor air pollution (IAP) involves the presence of carbon oxides, particulates and other indoor air pollutants (IAPs) within a building, whereas OAP describes air pollution which takes place outside the built environment (NIEHS, 2017). Outdoor air pollution can be influenced by location, season and the pollution source in an area (ELF, 2013), including emissions from vehicles, manufacturing or power generating facilities and the burning of fossil fuels for various purposes (WHO, 2017).

Moreover, inadequate airflow rates, cleaning products and chemicals emanating from building materials and furnishings could also contribute to rising levels of IAP (Jovanovic *et al.,* 2014). While completely sealing buildings may address energy efficiency concerns, they are problematic in that they may in turn result in elevated levels of indoor pollutants, subsequently, bringing about health risks (Spiru and Simona, 2017). However, outdoor pollutants can infiltrate the indoor environment through open windows, doors and even ventilation intakes (Wangchuk *et al.,* 2015). Indoor air quality can be referred to as the AQ in the nearest vicinity in and around buildings and structures, specifically attributed to the health, comfort, and well-being of building occupants (Badea *et al.,* 2015; USEPA, 2015a).

Most individuals spend their time indoor, including, homes, offices, schools and universities (Lee and Chang, 2000). Consequently, IAQ is imperative for the maintenance of human health, comfort, and wellbeing (Di Giulio *et al.,* 2010). According to (Klepeis *et al*. 2001), people on average spend 87 % of their time indoors. (Spiru and Simona, 2017) and (Al horr *et al.* (2016) also established that individuals spend 80 to 90 % of their time in an enclosed environment. A substantial percentage of total personal exposure to air pollution therefore occurs in the indoor setting, implicating poor IAQ as a cause of health complications (Habermann *et al.,* 2015; WHO, 2002).

Numerous epidemiological studies have shown the relationship between the variation of outdoor airborne pollutant concentration and changes in daily mortality as well as morbidity (Link and Dockery, 2010). However, an ambient environment pollutant is not ideally comparable to exposure in a human community that spends most of its time indoors. Thus, consideration of both indoor and outdoor pollutant measurement in all indoor microenvironments may explain the actual concentrations to which individuals are exposed (Bekoe *et al*. 2011). Indoor pollution levels are significantly influenced by outdoor sources (Amato *et al.,* 2014). This is because outdoor pollutants are easily transported indoors through building ventilation systems (Rivas *et al.,* 2014). Three common types of building ventilation systems: mechanical, natural, and infiltration were described in (Chen and Zhao 2011). Mechanical ventilation involves forced supply of fresh outdoor air into the indoor space (Chen and Zhao, 2011)

2.2 Indoor Air Pollution and Quality Issues

2.2.1 Sources and Causes of Indoor Air Pollution

Anthropogenic emissions end up in the atmosphere from a number of sources generally involving combustion such as road transport, electricity generation, urbanization an residential heating from houses, industries, agricultural practices, quarries, incinerators and waste treatment (Tartakovsky *et al.,* 2013; Venturiri *et al.,* 2013). Here below are three major sources of contaminants affecting indoor air quality: Indoor Factors Personal Activities (smoking or personal hygiene, cooking) Housekeeping (deodorizers, cleaning materials, or dust) Maintenance Activities (remodeling, new furniture/carpet, or pest control) Miscellaneous including: Emissions from office equipment (photocopier machines) Office supplies (toners, carbon-less paper products) Liquid spills or leaks Thermal and/or humidity comfort Room occupant load (EPA 2014).The most important source of fuel used in the households of walita city was firewood 94.6%, charcoal 96.6%, kerosene 11.5%, electricity 14.2%, crop residue 2.02%, dung cake 6% and sawdust 23.7% (Tafese Tadele, 2018).

The primary energy source for the majority of Bhutanese population is biomass which includes firewood, woodchips and animal dung. The residential sector is the highest consumer of energy with 48.7%, and 91% of this constituted biomass. While urban households mostly rely on electricity, LPG and kerosene, rural areas primarily depend on firewood. The amount of firewood used is significant in Bhutan, and country has the highest global per capital firewood usage (DoE, 2009). Sources of IAP can be biological, physical and chemical contaminants. Air pollution can arise from natural and anthropogenic sources such as forest fires, earthquakes, industrialization, tobacco smoking, domestic cooking and vehicular or machinery fuel combustion (Tanimowo, 2000). Exposed individuals or populations can be grouped by various characteristics (e.g., age, sex, culture, behavior, socioeconomic status, location relative to the release of a contaminant, occupation) (USEPA, 2009).

2.2.2Major Indoor Air Pollutants

In general, the types of pollutants that may affect IAQ are biological, chemical, particles and aerosol pollutants. Biological pollutants include bacteria, fungi, pollen, and animal dander. Chemical pollutants include adhesives, cleaners, solvents, combustion by-products and emissions from floor or wall coverings. Particles and aerosols are solids and liquids suspended in air, from dust, construction, smoking, or combustion (EPA, 2016b). Air pollution comprises of both IAP and OAP. Indoor air pollution emanates predominantly from the burning of fossil fuels such as wood, coal, and paraffin for purposes of cooking, space heating, and lighting (Wright and Oosthuizen, 2009). Common IAPs include O_3 (Koponen *et al.,* 2001), SO_2 (Nkosi *et al.,* 2017; Koponen *et al.,* 2001), NO_2 (Meier *et al.,* 2015; Rivas *et al.,* 2014; Kousa et al., 2001), CO_2 (Gao *et al.,* 2014; Mahyuddin *et al*., 2014), non-methane hydrocarbons (Kruglyet *al.,* 2014; Masihet *al.,* 2012); The most common (Masih *et al.,* 2010); Menichini et al., 2007), VOCs (Adgate *et al.,* 2004; Brickus *et al*., 1998) and PM (Nkosi *et al.,* 2017; Meier *et al.,* 2015; Krugly *et al.,* 2014; Rivas *et al.,* 2014). Some of these IAPs are widely used as ingredients in fuels, paints, varnishes, aerosol sprays, building material and furnishes, office equipment (printers and copiers), graphic and craft material (glues, photographic solutions, and permanent markers) and other household products (cleaning, disinfecting, cosmetic, moth deterrents, air fresheners, pesticides, laundered clothing and degreasing products) (USEPA, 2017a).

2.2.3 Human exposure to Air Pollution

Human exposure was first defined by (Ott, 2003) as an event when a person comes in contact with the pollutant. The further elaboration of this definition states a need to account for the duration for which a person comes in contact with the pollutant. However, many past studies have treated measured pollutant concentrations as human exposures. This approach is incorrect since it doesn't account for the duration of contact with the pollutant, which actually drives the health effects. A clear distinction between 'concentration' and 'exposure' has been provided by (Morawska *et al.* 2013).

The pollutant concentration is defined as a "numerical value of the amount of an individual pollutant per unit volume of air at a particular point in time or averaged over a period of time", while exposure is a "product of the pollutant concentration and the time over which a person is in contact with that pollutant". When only concentration data is available to avoid confusion, (Morawska *et al.* 2013) recommend describing it as "concentrations to which a person is/would be exposed" rather than exposure. Further, 'dose' is a different metric and should not be mistaken with 'exposure'. Dose quantifies how much of an ingested pollutant is actually delivered to the target organs leading to physiological effects, which is affected by several factors, for example inhalation rate and size of particles (Smith, 1993 and Morawska *et al.,* 2013). Thus, there can be exposure without dose, but there cannot be dose without exposure (Ott,2003). Health effects in turn depend on the dose received, which is affected by the exposure experienced in various microenvironments (Weijers *et al.,* 2004).

2.2.4 Effects of Indoor Air Pollutants

Health effects related to poor IAQ depend upon several factors: the effect of each contaminant, concentration, duration of exposure, and individual sensitivity (Hess-Kosa, 2010). Indoor air contaminants can cause acute or chronic health problems. Acute health effects are usually from short-term exposure at higher concentrations, whereas chronic health effects are often long-term exposure at lower concentrations (EPA, 2016c). Acute health effects have been correlated with peak particle events (Long, Suh, and Koutrakis, 2000; Diapouli *et al.,* 2011). Acute health concerns of exposure to PM are respiratory issues such as wheezing and coughing (Bentayeb *et al.,* 2013).

Indoor air pollution (IAP) remains a large global health threat. One half of the world population, and up to 95% in poor countries, continues to rely on solid fuels, including biomass fuels (wood, dung, agricultural residues) and coal, to meet their energy needs. Cooking and heating with solid fuels on open fires or on traditional stoves generates high levels of health-damaging pollutants, such as particulates and carbon monoxide (Bruce *et al,* 2000). Air pollution can causes adverse health impacts (Matooane *et al.* 2004).Pollution from the burning of domestic fuel (coal, wood and paraffin) has been described as the single largest contributor to the negative health impacts of air pollution (FRIDGE, 2004) More than 50% of the global population heavily relies on biomass fuel as a source of household (Rehfuess, 2006). Exposure to indoor air pollution (IAP) from the combustion of coal, crop residues, animal dung and biomass fuel is highly affecting the lives of 3 billion people all over the world (WHO, 2007). Moreover, diseases like suffocations on respiratory system, infections in the respiratory tracks and chronic obstructive lung diseases are very common link with indoor and traffic air pollution (WHO, 2018).

2.2.5 Indoor Air Quality in different settings

A) In urban areas

South Asia is among the low-income regions of the world and poverty is wide spread. A sizeable proportion of the population has no access to clean household energy (WHO, 2017).The widespread household use of solid fuels in Pakistan leads to high levels of indoor air pollution with a resultant huge burden of disease According to the Pakistan Strategic Country Environmental Assessment, indoor air pollution is a significant economic burden in Pakistan and annually costs 1% of GDP (World Bank, 2006).

As Addis Ababa grows both economically and spatially, air pollution from vehicle emissions, residential combustion, open burning of waste, and other sources is an increasing health concern in the metropolitan area. The legal basis for air quality management and general environmental policy is included in the Ethiopian Constitution, which ensures that every citizen has the right to a clean environment and that the government will prevent environmental pollution and the associated negative health effects (Tefera worku*,* 2016). Emission source apportionment or source attribution is a quantitative analysis that identifies the share of ambient air pollution that can be attributed to a specific class of emissions sources within a city or region. The results are expressed as percentage contributions for categories such as traffic, industry, or domestic fuel burning (Karagulian *et al.* 2015).

B) In rural

Biomass fuel as the main domestic energy sources for rural Ethiopia for cooking, heating and lightening. Burnt in room without ventilation, inefficient and highly polluting stoves for cooking emits high levels of harmful air pollutants that affect health throughout the life course. The rate of these health burdens remains high in low income and middle income countries like Ethiopia. (Kumie et al. 2009)

C) In homes

In most homes in Africa, cooking with firewood, charcoal or kerosene is the rule rather than the exception (Tanimowo, 2000). Combustion is usually incomplete in most of these cooking devices resulting in substantial emissions which, in the presence of poor ventilation, produce very high levels of indoor pollution (Bruce, 2002). In addition to indoor air pollution concentrations, the extent to which populations are exposed to indoor air pollution in the domestic environment will be determined by the amount of time they spend at home (Dimitroulopoulou *et al*. 2006; Milner *et al.* 2011).

Unemployment is a significant predictor of more time spent at home (Krueger and Mueller, 2012).It is not just the duration of time at home but also the numbers of individuals at home. Low-income households are more likely to be overcrowded or have high levels of occupant density, which are strongly linked to poorer IAQ (Brown *et al.* 1995). This may be due to particle resuspension arising from occupant movement (Klepeis and Nazaroff, 2006) and higher frequencies of pollution generating activities, such as longer cooking durations to accommodate a larger household (Singer *et al.* 2006). Given the amount of time spent at home, housing is an important environment in which unhealthy exposures and health inequalities may arise. Improving housing quality by reducing the risk of home environmental exposures improves population health and has wider reaching benefits of meeting the Sustainable Development Goals of reducing inequality and ensuring sustainable and equitable cities (DfID, 2019).

The scientific evidence has shown that indoor air at homes can be more seriously polluted than outdoor air. It is a common belief that indoors air is safe from harmful pollutants because the general perception which is that, the levels of pollution inside buildings are lower than outside, as the walls protect us from external impacts. However, confined indoor spaces may cause the concentration of pollutants to rise to higher levels. In households with limited ventilation (as is common in many developing countries), exposures experienced by household members, particularly women and young children who spend a large proportion of their time indoors, have been measured to be many times higher than World Health Organization (WHO) guidelines and national standards (Bruce *et al.* 2000).

Americans spend about 90% of their time indoors, the greatest share of which is spent in their homes (Nelson *et al.,* 1994; Klepeis *et al.,* 2006). A number of studies have shown that pollutant concentrations measured via a personal exposure monitor worn by a person are consistently higher than those measured by a stationary monitor located in the person's home (Rodes, *et al.,* 1991; Wallace *et al*., 2007b). One possible cause of the personal cloud is a compartmental effect: closed or partially-closed doors between the rooms in a house cause higher concentrations in

Rooms where both the person and a source are located, compared with a separate room where there is no source (Miller *et al.,* 1997; Ott*et al.,* 2003; Ferro *et al.,* 2009)

D) At schools

The health effects of air pollution are disproportionately higher for children than adults. This is because they breathe more air relative to their body size compared to adults, and their developing system presents less resistance to pollutants (Buonanno *et al.,* 2012b, Zhang and Zhu, 2012, Demirel *et al.,* 2014). Further, breathing through the mouth is very common for children, which leads to direct ingestion of contaminants in the air (Pegas *et al.,* 2011). These vulnerabilities make children the sub-population most sensitive to air pollution (Raysoni *et al.,* 2013). Schools have distinctive indoor and outdoor facilities resulting from specific building structures, ventilation systems and activities conducted (Lee and Chang, 2000).

Given the importance of education, schools host the highest population density of children at any given time, compared to any other environments. Children spend between 28% and 35% of their daily time at schools (both indoors and outdoors), making it the second most important environment, after homes (Sofuoglu *et al.,* 2011, Buonanno *et al.*, 2012a, and Mazaheri *et al.,*2014). A significant portion of their day is spent inside classrooms, where exposure patterns can be different from ambient exposure (Raysoni *et al.,* 2013). However, classroom environments and other indoor facilities in schools have received very little attention as important zones of children's exposure to air pollution (Fromme *et al.,* 2007 and Mullen *et al.,* 2011a). The time children spend outdoors at school is characterized by physically active engagements. The inhalation rate for children is reported to be the highest during playing and sporting, which leads to higher pollutant intake (Buonanno *et al.,* 2011).

Therefore, in a polluted school environment, it is likely that health problems arising from higher pollutant intake may outdo the benefits of outdoor activities for children's learning and development (Mejía *et al.,* 2008). Several studies have highlighted air quality problems in classrooms and other indoor and outdoor facilities in schools. For example, two recent literature reviews have concluded that a substantial portion of children's daily exposure to particles occurs in school environments (Mejía *et al.,* 2011 and Morawska *et al.,* 2013). PM10 concentrations were exceeding the local indoor and outdoor standards, and CO2 exceeding American Society of

Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) standard, indicating congested classrooms and poor ventilation have been reported for schools in Hong Kong (Lee and Chang, 2000).

The absence rate was found to be higher 2 – 3 days after the exposure, reaching the highest rate on day 5. Apart from affecting their overall development, poor air quality in schools could seriously affect children's future career and also the society at large (Mendell and Heath, 2005). Despite all these concerns, there are very minimal regulations even in the United States to protect children from environmental exposure in schools (Mendell and Heath, 2005). Therefore, characterization of air pollution in schools is important to assess exposure and enable a reduction in health risks (Morawska *et al.,* 2013 and Raysoni *et al.,* 2013).

E) In offices

Research on the urban population has confirmed that people spend more than 90% of their daily lifespan in indoor environments. Apart from residential indoor environments, people spend a large proportion of their time in offices, educational institutes, and other different commercial and industrial buildings. Specific research in North America has shown that adults tend to spend 87% of their time in buildings, and the remainder of their time is spent in vehicles (6%) and outdoors (7%). As people spend a majority of their time in indoor environments, exposure to indoor air pollutants has a significant impact on both human health and effectiveness in the workplace. Different life activities cause people to spend a majority of their time in different types of buildings, including residences, offices, schools, and restaurants (Klepeis, 2019).

2.2.6 Prevention and Control of Indoor Air pollution

Three basic methods to reduce pollutant concentrations in indoor air are source control, ventilation, and air cleaning. Air pollution control policies in India, India have many national and sub-national policies aimed at addressing the health burden from air pollution (Sagar *et al.,* 2016). Is a non-exhaustive list of policies in place or being discussed within Indian ministries and agencies relating to air pollution control in India? For the first time, many of these policies are due to be unified within the upcoming National Clean Air Programme (Ministry of Environment Forests and Climate Change, 2018).

The Ministry of Health and Family Welfare at India plays a key role with new targets based on the air pollution pathway aimed at providing the most significant exposure reductions, instead of only reducing pollutant concentrations (Ministry of Health and Family Welfare, 2012). The focus on exposures is important as it considers both ambient and household air pollution, and accounts for the large variations in intake fraction (U.S. National Research Council, 2012).WHO were assisting its Member States in implementing the guidelines, synthesizing the evidence on the most effective approaches to indoor air quality management and on the health benefits of these actions. It were continue encouraging the relevant policy developments and intersectoral collaboration necessary for ensuring access to healthy indoor air for everyone (WHO, 2016).

A/ Ventilation Method

Ventilation is necessary to remove indoor generated pollutants from indoor air or dilute their concentration to acceptable levels. Ventilation may have harmful effects on indoor air quality and climate if not properly designed, installed, maintained and operated as summarized by (Seppänen *et.al,* 2002). Low ventilation may lead to high indoor humidity and moisture accumulation in building structures or materials. That may lead to increased dust mites, and particularly high humidity can increase the risk of microbial growth, and subsequently to microbial contamination and other emissions in buildings. In epidemiological studies, moisture damage in building was associated with a number of health effects including respiratory symptoms and diseases (Adamkiewicz, 2011).

B/ Source Control

Method Source control eliminates individual sources of pollutants or reduces their emission. According to Environmental Protection Agency (EPA) Source control is usually the most effective strategy for reducing pollutants. There are many sources of pollutants in the home that can be controlled or removed. For example, Charcoals or solid wood best categories can be selected during cooking, Smokers can smoke outdoors and Combustion appliances can be adjusted to decrease their emissions (New York State Energy Research, 2016).

C/ Air Cleaning Method

Air cleaning some indoor air pollutants can be removed with an air cleaner. And air cleaning may be useful when used along with source control and ventilation, but it is not a substitute for either method. Some air cleaners are effective at removing dust and particles from the air. However, most air cleaners have no effect on gases or vapors and should not be expected to provide total air purification. Air cleaners should always be used and maintained according to the manufacturer's instructions (New York State Energy Research, 2016).

2.2.7 Public Awareness on indoor Air pollution

Public perception has very subjective elements and every individual is free to choose, organize, interpret and apprehend his or her views (Bickerstaff and Walker, 2001). Being a resultant intuitive judgment of any specific concept, one can say that each person's opinion may vary (Slovic *et al.,* 1980). This also applies to air quality and this concept is not perceived through the same angle by every individual (Tokushige *et al.,* 2007), so much so (Slovic *et al*. 1980) refer to it as "individual psychology". Perceptions are generally measured by use of social and public opinion questionnaires and surveys. As (Howell *et al.,* 2003) points out these questionnaires mainly focus on the localized level of concern on air quality. Public awareness in terms of air quality may differ due to individual upbringing and social awareness. When speaking of social awareness, one is not only referring to educative schooling but also, to how much a person may be influenced by the media. Previous studies suggest that the majority of the public seem to perceive poor air quality with a number of contributors, namely, motor vehicles and industries (Saksena, 2007).

This is mainly due to the fact that the majority of the people seem to associate poor air quality with health risks and diseases (Bianco *et al.,* 2008). In fact Day (2006) states that approximately a third of the global population identifies poor quality of air as being the major contributor to cardiovascular diseases. According to(Badland and Duncan, 2009). Therefore, it seems that public perception of human health impacts by poor air quality tend to be influenced more by personal experiences rather than by scientifically-proven sources (Saksena, 2007). One could also note that since public perception about air quality seems to be linked with health problems, the fact that it may also affect vegetation may be disregarded. According to (Bickerstaff and Walker, 2001), public perception on air pollution is influenced by a number of factors partly based on real and on virtual truth, which is mainly gathered from second-hand information such as media coverage.

2.3 Indoor Air Quality/Pollution in Ethiopia

Studies assessing indoor air pollution in households of Ethiopia are strictly limited. Only assessing proxies are available in addition to few quantitative attempts with IAP measurements using small samples of households. Over 95% of the Ethiopian rural population relies on biomass fuel as source of household energy (CSA, 2007). Wood and leaves with animal dung are primary sources of fuel for cooking each contributing 81% and 11.5% respectively. The use of cleaner type of cooking fuel is very much limited. Kerosene is only used in about 3%, while electricity with LPG and natural gas is very negligible, <1% (MOH, 2007). DHS of Ethiopia has indicated slightly different figures at national level: about 88% and 7.4% of households use wood and animal dung respectively (CSA, 2007).

The crowding status in housing units is very high. About 90% of the Ethiopian rural households use the same room for cooking as that used for daily and night activities (Kumie et al., 2002). Over 90% of households in rural areas use a three stoned traditional stove which is open and poorly ventilated resulting in high emission of pollutants. The absence of windows in the majority of households (>85%) to ventilate homes is inherent in rural villages of Ethiopia as well (Kebede, 2017).

In the Amhara Region of Ethiopia, 15% of DALY was due to respiratory infections that affected87% of under-five children (Fantahun and Degu, 1998). The two-week prevalence of ARI (cough and rapid breathing symptoms) was 13% among under-five children. WHO estimated that 4.9% of the national burden of diseases (DALY) was attributed to the use of solid fuels in Ethiopia (Abdulahi, et al, 2001) implying that the continued sufferings of children and mothers with acute and chronic respiratory diseases will not end until there is a major change in energy technology and conditions of their use in households.

A rapid assessment using grab sampling of indoor air in rural villages of Ethiopia suggested an excess level of CO, total respirable particulate matter and smoke (Kebede, 2002). Pilot samples in urban (Jargstorf, 2004). The mean concentrations of these pollutants ranged from 640 to 2170μg/$m_3$for PM2.5 and from 22.1 to 70.5 ppm for CO, which by large exceeded the international guideline.

2.3.1 Household energy sources

Households both in rural and urban areas need energy for two basic reasons: cooking and lighting (CSA, 2004). Overall, wood and combination of leaves with dung and crop residues were the predominant types of biomass fuel used for cooking while kerosene and firewood were used for indoor lighting. Households in urban areas are largely dependent on kerosene for cooking. Indoor air pollution from the use of biomass fuel is expected to be high. Wood-fueled traditional stoves were 5 to 10% energy efficient while the figure for electric stoves was 80-90% (Jargstorf, 2004). Generally, biomass fuel and petroleum products meet 94% and 5% of the country's energy needs respectively. Of the total energy demand in Ethiopia, households consumed about 89%, while a mere 4.6% was used by industry. These patterns are expected to continue with a growth rate of 2.6% for biomass, 8% for electricity, and 8.7% for petroleum between the years 2001 and 2010 (Jargstorf, 2004).

2.3.2 The Transport Sector and Traffic Air Pollution

Ethiopia is currently undertaking huge investments to improve its urban and rural road networks. The country's road network has been estimated (at the end 2006) at 39,477 km, of which about 19,313 km are federal roads and 20,164 regional roads (Environmental Protection Authority, 2004). According to PASDEP, the Ethiopian Government is planning to construct about 2,715 kms of new federal roads and 8,226 kms of new regional roads, upgrade 4890 federal roads, and maintain 4152 kms of federal and regional roads ((MoFED,2006).

Addis Ababa is currently undergoing rapid urbanization with huge investment in transport sectors with the purpose of increasing the road network and quality of service. The Ethiopian Road Authority report for the 1990-2002 years indicated that 60% of all national vehicles were automobiles. The overall annual vehicles increase rate was 7.7%, giving about 4700 new on-road vehicles every year (Addis Ababa City Administration, 2007)). Of the total 116,415 vehicles in the country in 2002, only 20.5% had less than ten years of service, while nearly 40% were more than 30 years old. Vehicles with 15 years old produce five times more hydrocarbons and four times nitrogen oxides than those of new ones (WHO,2007). The number of vehicles retired each year in Addis Ababa is very low, as vehicles serve long period of time.

By the end of 2007 there were 184,249 vehicles nationwide, of which 76% were found in Addis Ababa. Petrol engine users were 56% and 60% in the country sides and Addis Ababa, respectively. The on-road vehicle increase rate in Addis Ababa varied from 4 to 6% per year (about 4000-5000 annually). The traffic volume along major roads is increasing at 20% per year, well above the forecasted level (MOFED, 2006).

The increasing street venders, road side shoppers, drivers, commuters, pedestrians, traffic police, and residents within the vicinity of road networks are at the greatest risk to traffic air pollution exposure. According to urban mobility study, 70%, 21%, 8%, and 1% of the total population walk on foot, use public buses, taxis, and private cars, respectively (Addis Ababa City Administration,2007). Nowadays, many streets are over-crowded with pedestrians either waiting for taxis and buses or walking along the foot paths or crossing these streets. Pedestrians sharing the streets are increasing from time to time due to influxes of large population to the city in search of work.

Ambient air pollution assessment on the streets of Addis Ababa is very limited. It was possible to access only one study. This study had ambient air sampling on 12 different sites and concluded that the 24-hourly PM_{10} and 8-hr average of CO were below US-EPA permissible levels, while the annual PM concentrations could exceed the guideline. The study found that the level of PM_{10} ranged from 35 to 97μg/m_3 and peak 1-hr average CO concentrations were less than 7 ppm. The hourly average concentration of CO was less than 2 ppm. The studies had limitations in that the samples were limited and were taken at a distance of 50-100 meters away from streets, many of them representing low traffic densities (Tesfaye, 2007).

The urban infrastructure of Ethiopia is inadequate to accommodate the large and growing number of vehicles. According to the Addis Ababa Road Authority, the city possesses one-laned streets of 3.5 to 4.0 meters wide, with an average of 3.5-meter width. The average speed of vehicles in Addis Ababa is about 20-30 km per hour on many roads, especially at peak hours during 7.50-9:00 am and 14:00-19:00 pm (Addis Ababa City Administration, 2007). The topography in Addis Ababa has a slope varying between 0.5 and 12.0% which also affects the speed and use of fuel. Frequent stopping, repeated accelerations and decelerations reduce engine efficiency, and therefore, increase emissions on the road.

2.4 World Health Organization Air Quality Guidelines

WHO has developed a series of guidelines for both outdoor and indoor air quality, synthesizing the available scientific information from all over the world. The guidelines contain an in depth review of literature and health risks of the relevant air pollutants, and provide recommendations to assist countries in reducing the health impacts of air pollution. The concentrations specified in the guidelines are based "on no observed adverse effect levels" (NOAEL) or "lowest observed adverse effect levels" (LOAEL). Subsequently, based on the new scientific evidences, an update of air quality guidelines for PM, O_3, NO_2 and SO_2 were published in 2005 (WHO, 2006), in recent years, in view of serious indoor air pollution problems (WHO, 2009), followed by guidelines for selected common indoor pollutants, published in 2010(WHO, 2010). Addressing air pollution which is the second highest risk factor for non-communicable diseases is key to protecting public health. Successful policies that reduce air pollution ensuring access to affordable clean household energy solutions for cooking, heating and lighting.

3. RESEARCH METHODLOGY

3.1. Description of the Study Area and Population

3.1.1. Location

Jima was founded in 1837 by Abba Jifar; it is the largest city in south-western Ethiopia. It is surrounded by Jimma Zone, is located in southwest Ethiopia 350 km away from the capital, Addis Ababa. The town is located at an average altitude of 1700 meter above sea level. Its astronomical location is 7º 4' North Latitude and 36º 5' East Longitude. The town has a total area of 46.23 km2 (4623 hectares). (Jimma city administration, 2021)

3.1.2. Demographics

According to Jimma city administration (JCA, 2021) Jimma town had a total population of 207,573, of whom 108,008 were men and 99,565 were women. The three largest ethnic groups reported in Jimma were the Oromo (46.71%), the Amhara (17.14%), the Dawro (10.05%) and all other ethnic groups made up 26.1% of the population. Amharic was spoken as a first language by 41.58% and 46.71% spoke Afan Oromo; the remaining 11.7% spoke all other primary languages reported. The majority of the inhabitants practiced Ethiopian Orthodox Christianity, with 46.84% of the population reporting they observed this belief, while 39.03% of the population were Muslim, and 13.06% were Protestant(CSA, 2007).

3.1.3. Climate

Jimma has a tropical rainforest climate under the Köppen climate classification. It features a long annual wet season from March to October. Temperatures at Jimma are in a comfortable range, with the daily mean staying between 20 °C and 25 °C year-round (JCA, 2021).

3.1.4. Jimma town

Some buildings survive from the time of the Jimma Kingdom, including the Palace of Abba Jifar II. The city is home to a museum, Jimma University, several markets, and an airport. Also of note is the Jimma Research Center, founded in 1968, which is run by the Ethiopian Institute of Agricultural Research. The Center specializes in agricultural research, including serving as the national center for research to improve the yield of coffee and spices (EARI, 2009)

The city also has a city administration, municipality and 17 kebeles (JCA, 2021). The town has two governments and three private hospitals. There are four health centers, many private clinics and drug vendors in the town. The most important source of fuel used in the households of Jimma city is firewood, charcoal, kerosene, electricity, crop residue, dung cake and sawdust. Agriculture coffee is the backbone of Ethiopia's Economy. Coffee is the major economic activity in the Jimma town and Jima zone too (JTAO, 2023).

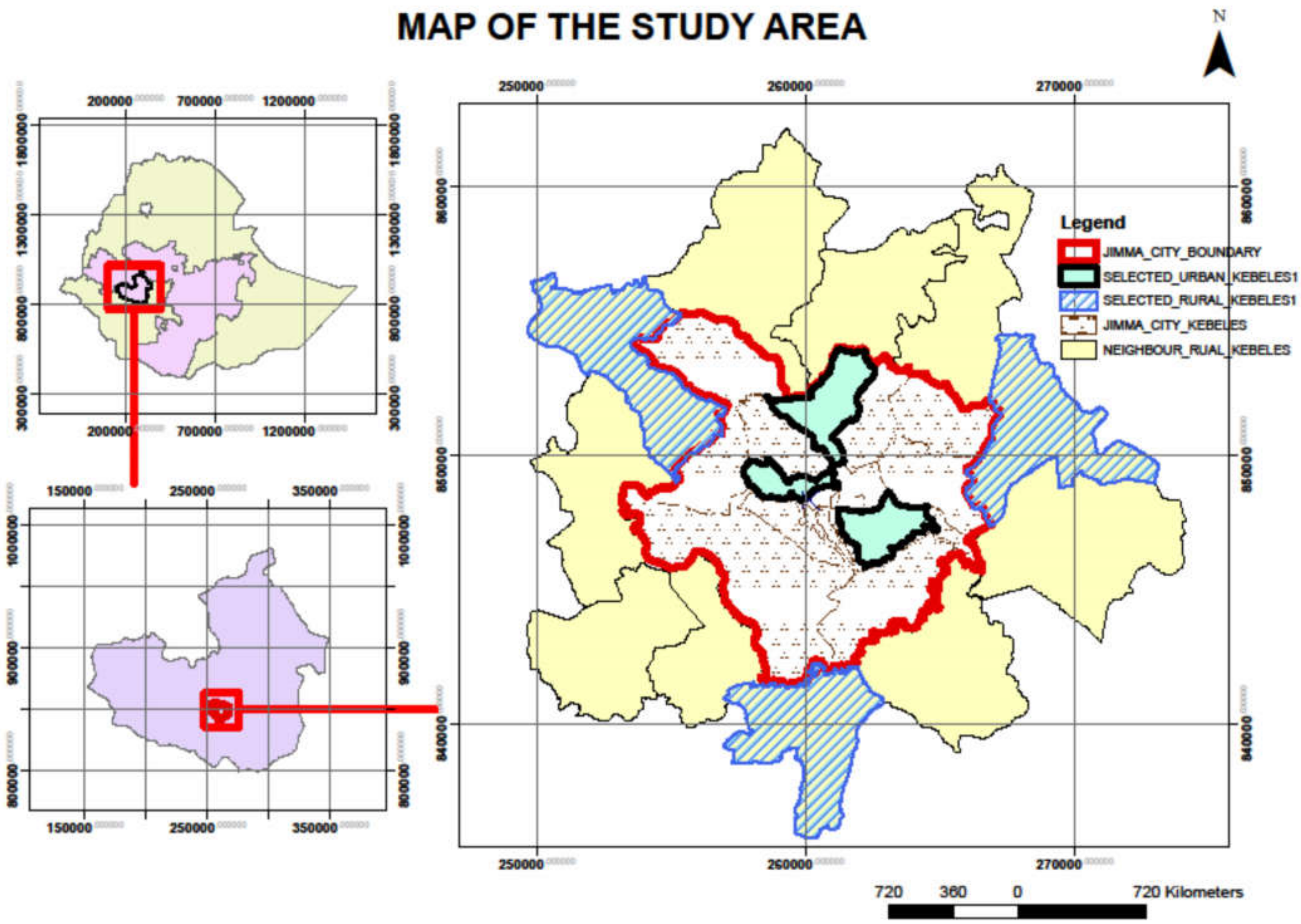

Figure 1: Map of the Study area (Source: Jimma city administration, 2021**)**

3.2 Design and methods of the Study

The study design was a Cross-sectional research design used for this study, because the time scales of the program allowed only a short period to process this research. By using both qualitative and quantitative methods to observe the community perception on sources, exposure, effects and preventive measures of indoor air pollution in Jimma city and surrounding rural kebeles. The target population for this study includes households 360, selected using systematical random sampling and personal from the city health office, kebele leaders and health extensions using purposive sampling.

3.3 Sampling Techniques/procedures and Sample size Determination

Sampling techniques used for this research were simple random sampling and purposive sampling techniques at different stages during the course of research. In simple random sampling every case of the population has an equal probability of inclusion in sample (Ghauri and Gronhaug, 2005). On the other hand purposive sampling is a strategy in which particular setting persons or events are selected deliberately in order to provide important information that cannot be obtained from other choices (Maxwell, 1996).So that the researcher used both simple random sampling and purposive sampling techniques thinking an equal probability of population in the sample inclusion and to collect important information from compulsory personals because of their responsibilities.

In the present study, Jimma was selected using purposive sampling technique because of the researcher was born, grew and has been working in this area as a teacher for the last 28 years. Thus, the skills he acquired enabled him to see the problem of IAP at variety angles. The reason for selection Jimma has to be scientifically justified in relation to the magnitude and frequency of IAP this in turn requires survey or related work (Mulatu, 2024a and b, Farris, 2002, Addisu et al, 2021). Sample size of this study was determined from three kebeles in the city and another three surrounding rural kebeles.Jimma city has 17 kebeles namely Awetu mendera, Becho bore, Bore, Bosa addisketema, Bosa kito, Ginjo, Ginjoguduru ,Hermata, Hermatamentina, Hermata merkato, Horagibe, Ifa bula,Mentina,Jiren,Kofe,Mendera kochi and Seto semero. It also surrounded by 11 rural kebeles such as Bebela kara, Dima serte, Doyo hawaso, Gube muleta, Gudeta bula,Kujo muja, Kunju, Kusaro Merewa, Somodo And Waro kolobo. The researcher took 3 city kebeles such as Becho bore, Hermata merkato and Mendera Kochi and another 3 surrounding rural kebeles including Gudeta bula, Waro kolobo, Merewa, by using simple random sampling technique. The total households of the study was 3635 which comprised of 2215 urban and 1420 surrounding rural households, kebeles'.To determine the sample households from the total households the simplified sampling formula of Yemane (1967) was applied as follow:
n=sample size, N=sample frame and e= the margin of error or the maximum error and for this 5% (0.05) with confidence level 95%

By using this formula the sample of the study are:- $n=N/1+N(e)^2$

$n=3635/1+3635(0.05)^2$

$n=360$

Therefore, the sample size for this study was three hundred sixty (360). The sample size was proportionally allocated in the 6-kebeles. , a simple proportion formula adopted from Cochran (1977), Formula was applied as:- $ni=n\times\frac{Ni}{N}$, Where, i=1, 2, 3...

ni= Sample size of each kebele,

Ni= Household size in each kebele,

n= Total sample size, households,

N= Total household in study area

In addition to the 360 samples size (219 urban households and 141 households from surrounding rural kebeles) who participated to fill the questionnaires 18 households 9 from each site were. Selected to participate in FGD using purposive sampling techniques because they were Key informants composed of 6 Kebele chairman's (from each 6 kebele), 6 health extensions(from each 6 kebele) and 6 health experts(from each 6 kebele). Systematic random sampling used to identify the sample size of households intervals are where every nth case after a random start is selected k= N/n (N is total households and n is simple sizes) therefore urban =2215/219=10 and rural=1420/141=10. For both household interval amount is 10.

Table1: Sample size of household heads and proportional description

Located kebeles	Name of Kebeles	Total households in the study area	Sample size of households ($n\times\frac{Ni}{N}=ni$)	Present (%)
Urban	Mendera kochi	737	360(737÷3635) = 73	20.28
	Becho bore	780	360(780÷3635) = 77	21.38
	Hermata merkato	698	360(698÷3635) = 69	19.17
	Total	**2215**	**360(2215÷3635) = 219**	**60.8**
Rural	Gudeta bula	475	360(475÷3635) = 47	13.06
	Merewa	480	360(480 ÷3635) =48	13.33
	Warokolobo	465	360(465÷3635) = 46	12.77
	Total	**1420**	**360(1420÷3635) = 141**	**39.2**
Total		**3635**	**360**	**100**

3.4. Tools for data collection

In this part closed ended questionnaires were designed and presented to households to determine whether they linked indoor air pollution and their effects. And then FGD was conducted with kebeles leaders, health extensions and health expert's households in the study area for triangulation purposes.

3.4.1. Household questionnaires

The data from household were obtained through questionnaire for the reason of number of sample and administered easily. For the households data in relation to socio-demographic information (including gender, age, marital status, education level, employment status, family size, and monthly income), types of cooking stoves and fuels used, availability and use of ventilation at home and kitchen, women's smoking status and their exposure to domestic activities injera baking, wot preparation and coffee ceremony have be shown to increase the exposure indoor air pollutants with the highest pm2.5 and CO mean concentration during coffee ceremony (Faris 2002). The maximum pm2.5 concentration reported was in Adama city, 1170μg/m3 during coffee ceremony with a stove ignited indoor and incense use (Edlund, 2019). Data were collected with the aid of data collectors who administered the questionnaires, extent and types of on source exposure and its risk awareness after eviction collected through household survey. To generate information at household level.

3.4.2. Focus group discussions

To obtain in-depth information on perceptions of the groups; the researcher organized 2 groups of households (one in each site) to participate in FGD. As a result, in this research, two focus group discussions(one in each site) were conducted with 18 key household informants composed of 6 Chairmens, 6 health extensions and 6 health experts in the six kebeles, i.e. 9 households in each site were involved in the Focus Group Discussion.

3.4.3 Observation check-list

Indoor situation observation walkthrough of each house hold was performer to collect information specific to each indoor location. Information was collect included: the distance of kitchen from living house, the location of cooking area, type of fuel used, types of stove used, presence or absence of window, type of your kitchen(in side house or outside of house), your house found/located near dusty road, types of your house/building and types of floor.

3.5. Data Quality Assurance

The quality of data is an important thing to pay attention, as the quality of data lead to research to be more significance with positive impact on the society. To assure the quality of the data, high emphasis was given to designing data collection instrument. Prior to the data collection, a pre-test was conduct on 5% of the total sample size in two non- selected Kebeles (Bosa addis ketema from city kebeles and Bebela kara from the surrounding rural kebels).The questionnaire were primarily prepare in English and were translated in to Afan Oromo and Amharic then back to English to check its consistency. As a result a total of four data collectors who can speak Afan Oromo and Amharic were used to facilitate the study. Information related to household demographic and socio-economic characteristics, Regular supervision and follow-up was making by supervisors and the principal investigator. The filled questionnaire was collect and sign by supervisors after being check for any missing value, correctness and consistency.

3.6 Data management and Analysis

3.6.1. Analysis of quantitative data

Questionnaire data were entered into statistical package for scientific solution (SPSS) version 20 statistical in preparation for analysis. The primary outcome was a composite measure of the perception of respondents about the source of IAP and adverse health effects of biomass smoke exposure. The composite scores calculated for each respondent was converted to percentages such that scores of less than 50% was categorized as poor perception while a score of 50% and above was categorized as good perception respectively. Categorical data were presented as frequency tables while inferential analysis was done at bivariate level with Chi-square test and at multivariate level with binary logistic regression. The level of statistical significance was set at $P < 0.05$

3.6.2. Analysis of qualitative data

The qualitative data that were gathered through FGD from 9 households in each site were analyzed qualitatively by reviewing the notes taken, narrating, interpreting and reflecting on key points that are related to the objectives of the research. Based on the questions in the guide, thematic analysis was used both in the first and the second objectives, to assess the convergence and divergence of perceptions of persons towards sources of IAP and on adverse health effects of IAP exposure. Convergence of perceptions indicates an overlap of perceived health effects in the two communities (urban and surrounding rural communities) while divergence points to the differences in perceptions refined ending up with two themes.

3.7 Ethical Consideration

The study was conducted after obtaining ethical approval from Research Ethics Committee of College of natural and computational science department of biology postgraduate program, Hawassa University. The committee provided ethical approval after assessing informed verbal consent submitted with all components of the research protocol. The verbal consent was included on the front page of the questionnaire below briefing statements of the study. After data collectors read the briefing statements of the study to the participants, the study participant willingness/unwillingness was confirmed by marking their yes/no response. When the participant confirmed his/her willingness, data collection was carrying out. Confidentiality and privacy was insuring for information collected from study participants by recording data anonymously. The respondents provide consent to participate in the study by completing the questionnaires (see Appendix I). On the first page of the questionnaire, participants were: (i) introduce to the research activities involved in the study; (ii) provide with descriptions of risks and benefits of the study; (iii) assure of their anonymity and confidentiality; and (iv) inform of their right to withdraw from the study at any time. To ensure confidentiality, respondents were assigned code on the questionnaires so that they could not be identified and any identifying information about participants such as names was not recorded.

4. RESULTS AND DISCUSSION

This chapter has three parts; the first part deals with the demographic characteristics of the respondents; the second considers Respondents practices that are potential factors of exposure to IAP and third deals of knowledge of the respondents towards issues related to IAP. For details see sections below.

4.1. Demographic characteristics of respondents

This section provides some basic background information pertaining to sample population that helps to know the overall information of the respondents with the assumption that it might have some kind of relationship on the community perception toward sources, effects and preventing harmful effects of IAP in the study area in relation to socio-demographic characteristics such as respondents' residence place , sex ,age, educational level, marital status, occupation, family size and income level.

A total of 360 households, 219 (60.8%) from three kebeles in Jimma town and 141 (39.2%) from three surrounding rural kebeles were participated in this study. In terms of gender 216 (60.0%) were male and 144 (40.0%) female. More than half (57.2%) of the respondents were at younger age group (18 – 35 years), the middle age group (35 – 50 years) account about two-third (33.9%) and the older group was only 8.9%..The mean (SD) age was 39.8 (10.8) years. Most of the respondents completed primary (23.3%) and secondary (23.9%) education. There were respondents that holding diploma (`7.8%), first degree (16.1%) and post graduate degree (4.2%). Only 5.6% of them had no formal education during the study.

Majority (73.1%) of them had got married and only 12.8% were single. Most of them (29.7%) were farmers followed by 23.9% government employee. There were also merchants (17.8%) and daily laborers (17.7%). Large proportion (45.3%) of the households had a family size of five and above. Above average of the households (58.1%) earned less than 1500 Ethiopian Birr (ETB) (29 US$) a month (US$1 = 51 ETB).(Table 2).

Table 2: Socio-demographic characteristics of the respondents

Characteristics	Description	Urban (n=219)	Rural (n=141)	Total (n = 360)
Sex	Male	137 (62.6%)	79 (56%)	216 (60.0%)
	Female	82 (37.4%)	62 (44%)	144 (40.0%)
Age	18-35	120 (54.8%)	86 (61%)	206 (57.2%)
	36-50	81 (37%)	41 (29.1%)	122 (33.9%)
	>50	18 (8.2%)	14 (9.9%)	32 (8.9%)
Level of education	No formal education	6 (2.7%)	14 (9.9%)	20 (5.6%)
	Read and write	18 (8.2%)	18 (12.8%)	36 (10.0%)
	Primary	46 (21%)	38 (27%)	84 (23.3 %)
	Secondary	55 (25.1%)	31 (22%)	86 (23.9%)
	Diploma	43(19.6%)	21 (14.9%)	64 (17.8%)
	First degree	39 (17.9%)	19 (13.5%)	58 (16.1%)
	Post graduate	12 (5.5%)	3 (2.1%)	15 (4.2%)
Marital status	Single	24 (11%)	22 (15.6%)	46 (12.8%)
	Married	157 (71.7%)	106 (75.2%)	263 (73.1%)
	Divorced	28 (12.7%)	7 (5%)	35 (9.7%)
	Widowed	10 (4.5%)	6 (4.2%)	16 (4.4%)
Occupation	Merchant	61 (27.8%)	3 (2.1%)	64 (17.8%)
	Farmer	5 (2.3%)	102 (72.3%)	107 (29.7%)
	Government employee	70 (32%)	16 (11.3%)	86 (23.9%)
	Daily laborers	63 (28.8%)	8 (7.8%)	71 (17.7%)
	Microenterprise	20 (9.1%)	12 (16.3%)	32 (8.9%)
Family size	1	24 (11%)	22 (15.6%)	46 (12.8%)
	2	33 (15.1%)	11 (7.8%)	44 (12.2%)
	3	38 (17.4%)	12 (8.5%)	50 (13.9%)
	4	41 (18.7%)	16 (11.4%)	57 (15.8%)
	5	47 (21.5%)	44 (31.2%)	91 (25.3%)
	>5	36 (16.4%)	36 (25.5%)	72 (20.0%)
Monthly income	<1500 Birr	111 (50.7%)	98 (69.5%)	209 (58.1%)
	1501 -3000 Birr	42 (19.2%)	24 (17%)	66 (18.3%)
	>3000 Birr	66 (30.1%)	19 (13.4%)	85 (23.6%)

4.2. Respondents practices that are potential factors of exposure to IAP

4.2.1 Living and/or housing conditions of the respondents

Table 3 below shows the distribution of the housing condition and the prevalence of various factors that expose people in the study to IAP. Among the total respondents, the majority (76.4%) were living in bungalow houses during the study, the highest proportion (91.5%) being rural in habitant respondents. Very small proportion of them live in well-constructed houses such as Villa house(13.3%) and Story-building(8.1%). Even though majority (73.1%) of the respondents revealed presence of windows on their houses, about one-quarter (26.9%) of them had houses without windows (Table 3). Poorly constructed living houses would be risk factor of IAP because they are without adequate ventilation/window, smokes and other particulate materials produced during cooking can be concentrated in house and decrease the IAQ. The floor of majority (41.4%) of the respondents was mud/earthed that is expected to be dusty as they live in. Furthermore, during sweeping, mud –floored houses may produce/emit large amount of dust or particulate matter in the house that would decrease the IAQ

All of the respondents reported that they have kitchen, but household observation study on the area clearly revealed that most rural living houses had no kitchens. Although majority (80.6%) of the respondents reported presence of outdoor kitchens, considerable proportion (19.4%) of them had kitchens within their living houses. About one-third (36.4%) of the kitchens were located at very short distance (only less than 5 meters) away from the living house. This would provide higher opportunities for the diffusion of smoke into living area there by reducing indoor air quality. These findings were similar to that reported by Oybanji et al. (2010). Nearly half (51.4%) of the respondents houses were located nearby dusty roads or areas, which may lead to entry of outdoor dust and particulate matters into living houses, and may consequently contribute to IAP. Some of the respondent (12.8%) reported, particularly those from rural areas, living together with domestic animals such as cattle, goats, sheep, etc. this domestic animals release wastes likes urine and feces can also can affect your homes air quality. Waste can bring discomfort due to odor and this lead to allergies and asthma

Similarly, one of a 55 year FGD discussant rural farmer said "……*most of us live in poorly constructed house (grass roof) without window houses with domestic animals and in almost all cases cooking using firewood takes place within our living houses*". These inconsistent results of qualitative study show that there was a respondent/informants bias in providing true information to the interviewers.

Table 3. Living and/or housing conditions that are risk factors associated with IAP

Living and/or housing conditions		Study area		Total (n=360)
		Urban (n=219)	**Rural (n=141)**	
Living house building type	Bungalow	146 (66.7)	129 (91.5%)	275(76.4%)
	Straw hut	-	8(5.7%)	8(2.2%)
	Story-building	29(13.2%)	-	29(8.1%)
	Villa house	44 (20.1)	4(2.8%)	48(13.3%)
Floor type of living room	Mud	61 (27.9%)	88 (62.4)	149(41.4%)
	Concrete	72(32.9%)	15(10.6%)	87(24.1%)
	Tile	30(13.7%)	12(8.5%)	42(11.7%)
	Carpet	24(11.0%)	17(12.1%)	41(11.4%)
	Rug	32(14.6%)	9(6.4%)	41(11.4%)
Living house with window	Yes	178 (81.3%)	85 (60.3%)	263(73.1%)
(n=360)	No	41(18.7%)	56 (29.1)	97(26.9%)
Have kitchen for cooking	Yes	219(100%)	141(100%)	360 (100%)
	No	-	-	-
Type of kitchen for cooking	Indoor kitchen with partition	12(5.5%)	58(41.1%)	70 (19.4%)
	Kitchen outside living house	207(94.5%)	83(58.9%)	290 (80.6%)
Distance of kitchen to living area (m) (n=290)	<5m	87 (39.7%)	44 (31.2%)	131(36.4%)
	5-10m	84(38.4%)	25(17.7%)	109(30.3%)
	>10m	36(16.4%)	14(9.9%)	50(13.9%)
House located near dusty road	Yes	127(58.0%)	58(41.1%)	185(51.4%)
or area(n=360)	No	92(42.0%)	83(58.9%)	175(48.6%)
Domestic animals live together	Yes	4 (1.8%)	42 (29.8%)	46(12.8%)
in living house	No	215(98.0%)	99(70.2%)	314(87.2%)

***Note**: Numbers in parenthesis/bracket is percentage of the respondents*

4.2.2 Type of energy sources and stove used for cooking in the study area

A) Fuel and/or energy sources

Table 4 shows the type/kind of energy or energy source used for cooking in the study areas. Among the total respondents, majority of the respondents (74.4%)reported the main source of energy for cooking was firewood(88.6%)and charcoal was the second most used cooking fuel(74.4%), with the highest proportion being rural(91.5%) and urban(95%) respondents, respectively. These findings are in line with the findings of (Dasgupta et al, 2007) that have considered cooking inside the living house using smoking sources of fuels such as fire wood as the major contributing factor for IAP. The use of biomass fuel such as firewood, charcoal and cow dung would be risk factor of IAP because they increased the risk of exposure to indoor air pollutants from biomass burning.

Considerable proportions of households using electricity (45.3%), buta gas (LPG) (7.2%) and Kerosene fuel (6.4%) as cooking fuel. the highest proportion being (67.1%), 24(11%) and15 (6.9%) were urban inhabitant respondents. Higher number of the respondent (44%) reported, particularly those from rural areas using cow dung as cooking fuel. Thus, the use of biomass fuel as the first choice in the present study suggests that majority of respondents was found at the lowest economic class. This was happened by the fact that about slightly more than half (58.1%) of the respondents in the study area earn below 1,500 Ethiopian Birr (ETB) monthly, which was below 50 ETB per day. In addition to the use of high-emission cooking and lighting fuel sources and living in less ventilated houses practice, indoor cigarette smoking habit was also found as risk of IAP exposure IAP in the study area.

This study indicated that considerable proportion of the respondents reported that they are using electricity, buta gas (LPG) and Kerosene fuel as the main cooking fuel, but observation study on the area confirmed that there was also substantial fuel mixing within homes (i.e. the simultaneous or subsequent use of different fuels on the same day). For instance, households reported using charcoal even when they mainly relied on electricity and vice versa; indicating that the sources of indoor emissions were mixed in the same household even in a single day (higher in urban than rural community). This would provide higher opportunities for the diffusion of smoke into living area there by reducing indoor air quality. This study finding agrees with the study by Admase et al. (2019) conducted in Adama town, but the use of biomass fuel is higher than findings of a similar study conducted by Smith (2000).This indicates that rural community is at higher risk of exposure to indoor air pollutants from biomass burning than urban in the study area.

Table 4. Type/kind of energy or energy source used for cooking in the study areas

Type of energy/fuel used for cooking	Study area	Frequency of use			Total users*
		Not at all	Sometimes)	Always	
Fire wood/biomass	Urban (n=219)	41 (18.7)	138 (63.0%)	40 (18.3%)	178(81.3%)
	Rural (n=141)	-	26 (18.4%)	115 (81.6%)	141(100%)
	Total (n=360)	**41 (11.4%)**	**164 (45.6%)**	**155 (43.0%)**	**319 (88.6%)**
Cow dung	Urban***	213(97.3%)	6(2.7%)	-	6(2.7%)
	Rural**	79(56.0%)	48(34.0%)	14(9.9%)	62(44%)
	Total	**292(81.1%)**	**54(15.0%)**	**14(3.9%)**	**68(18.9%)**
Charcoal	Urban***	11(5.0%)	33(15.1%)	175(79.9%)	208(95%)
	Rural**	81(57.4%)	38(30.0%)	22(15.65)	60(42.6%)
	Total	**92(25.6%)**	**71(19.7%)**	**197(54.7%)**	**268(74.4%)**
Electricity	Urban***	72(32.9%)	79(36.1%)	68(31.1%)	147(67.1%)
	Rural**	125(88.7%)	12(8.5%)	4(2.8%)	16(11.3%)
	Total	**197(54.7%)**	**91(25.3%)**	**72(20.0%)**	**163(45.3%)**
Buta gas (LPG)	Urban***	195(89.0%)	24(11.0%)	-	24(11%)
	Rural**	139(98.6%)	2(1.4%)	-	2(1.4%)
	Total	334(92.8%)	26(7.2%)	-	26(7.2%)
Kerosene fuel	Urban***	204(93.2%)	15(6.8%)	-	15(6.9%)
	Rural**	133(94.3%)	8(5.7%)	-	8(5.7%)
	Total	337(93.6%)	23(6.4%)	-	23(6.4%)

Note: ***Total users** = those use sometimes + always; ** Rural (n=141); ***Urban (n=219);
Numbers in parenthesis/bracket is percentage of the respondents

Survey result indicated that In these two communities (urban and rural), this should be used difference in urban and rural household. Therefore firewood, biomass and cow dung used higher in rural while charcoal and electricity used higher in urban and also Butagas and kerosene generally low (< 10%) in both urban and rural. The qualitative study results were also consistent with these. For example observation study on the area clearly revealed that in these two communities, the main source of energy for cooking were biomass fuels such as charcoal, wood saw dust and animals dag. Petroleum and electricity were the second and most used cooking fuel. There was also substantial fuel mixing within homes (i.e. the simultaneous or subsequent use of different fuels on the same day). For instance, households reported using charcoal even when they mainly relied on electricity and vice versa; indicating that the sources of indoor emissions were mixed in the same household even in a single day (higher in urban than rural community).Similarly, one of the youngest FGD discussant health extension said " …… *majority of us almost all of us cooking inside home using smoking sources of fuels such as fire wood, charcoal, or other forms of biomass such as saw dust or crop residues…that releases large quantity of smoke. We have been also using of different fuels on the same day ……"*

The qualitative data revealed that there were deterrents to the use of ventilation, especially in the evening. There were concerns about insecurity and therefore residents chose to close doors and windows and bear the IAP. One of the 48 years old FGD discussant kebele chairman added that *"……..the lamps we use emit smoke, you find such things in a house made of corrugated sheet and at night may be you can't open the door for fear of cold and thieves so you just bear with the smoke until it finds a way out of the house….."*These consistent results of qualitative study show that there was no respondent/informants bias in providing true information to the interviewers.

B) Stove types used

Table 5 shows the cooking stove type used by respondents in the study area. Among the total respondents, the majority (88.6%) using different type traditional cooking stoves made of three stone in the study area. Proportion of the respondents using this type of stove in the present study was much higher than that reported by Osagbemi*et al.* (2010). And the different versions of such stoves used included open three stone traditional stove made of three stone not plastered with mud (39.5%),the highest proportion (81.4%) being rural inhabitant respondents. traditional stove made of three stone plastered with mud but without chimney (30.4%), and traditional stove made of three stone plastered with mud and with chimney (18.8%). The improved stove with chimney which is expected to be accessible and affordable were reportedly used by only 10.0%the households.

This study revealed that open/traditional type of stoves was the mode of cooking by majority (88.6%) of the households in the study area. These findings are also in line with the findings of Dasgupta, et al., (2007) that have considered the use of traditional fuel (cooking inside the living house using smoking sources of fuels such as fire wood) using open/traditional type of stoves as the major contributing factor for IAP.

The other major stoves used by respondents in the study area were modern cooking stoves such as electricity stove (45.3%), but gas stoves (7.2%) and kerosene stoves only by 6.4% respondents. The highest proportion (59.6%) being urban inhabitant respondents. Such difference in the type of stoves used could be due to the shortage and inaccessibility and availability of power supply to people in the rural areas, as well as its high cost. This study finding was similar to that of Stanley et al. (2010).

Survey result indicated that almost all of communities (urban and rural) have stoves, majority with traditional cooking stoves made of three stone and low proportions with modern cooking stoves. The qualitative study results were also consistent with the survey's finding. For example observation study on the area clearly indicated that in these two communities, the major stoves used were traditional cooking stoves made of three stone. Modern cooking stoves such as electricity stove, but gas stoves and kerosene stoves were the second used cooking stoves. There was also substantial stove mixing within homes (i.e. the simultaneous or subsequent use of different stoves on the same day). For instance, households reported using three stone traditional stove even when they mainly relied on electricity stoves and vice versa; indicating that the sources of indoor emissions were mixed in the same household even in a single day (higher in urban than rural community).Similarly, one of a 35 year FGD discussant health expert said *"……most of us using three stone traditional stove made of three stone and in almost all cases cooking using firewood takes place within our living houses". Majority of us almost all of us aware of the three stone stoves are traditionally not vented and have high emissions due to their low combustion efficiency so what can we do we have no choice to use the modern one. We simultaneously used of other stoves and fuels. For instance, we used charcoal stoves to heat our* *homes even when we mainly relied on electric stove and vice versa because electric stoves are relatively expense. Some people heating their homes mostly using charcoal stoves. You cannot command someone when they are in their house, because you are in your house and they are in their house. You see someone has a charcoal stove but they don't use charcoal and they buy firewood and you can't command them to use such and such a thing…they can only afford firewood to cook with, so that smoke is still there, and if you complain, they will say you are looking down on them or you are proud…..*" indicating that the sources of IAP were mixed in the same household even in a single day. These consistent results of qualitative study show that there was no respondent/informants bias in providing true information to the interviewers.

In general, household cooking methods were found to be the major respondents practices associated with risk of exposure to IAP. Majority (74.4%) of them burn charcoal in living house. Nearly one-third (35.3%) of them live in houses lack enough ventilation, about (19.4%)of them burn fire wood and dung in living house, (12.8%) of the respondents live together with domestic animals in living house, about (29.2%) of them burn kerosene stove/lamp inside home. Based on the household energy ladder of Hiemstra-van-der-Horst and Hovorka, (2008), households reliant on wood and charcoal remain on the lower stages of the ladder in the study area, and the results indicate that wood/charcoal using households had some of the highest levels of particulate pollutants. Furthermore, the observation study revealed that the presence of substantial stove stacking in most of the households included in the study, with kerosene and charcoal being common combinations of fuels used either simultaneously or at different times in a single day.

Table 5. Cooking stove type used by respondents in the study area

Kind of cooking stove used	Residence		Total (n=360)
	Urban(n=219)	Rural(n=141)	
Open traditional stove made of three stone	38 (17.4%)	88 (62.4)	126(39.5%)
Traditional stove made of three stone plastered with mud	66(30.1%)	31(22.0%)	97(30.4%)
Traditional stove made of three stone plastered with mud with chimney	43(19.6%)	17(12.1%)	60(18.8%)
Improved stove with chimney	31(14.2%)	5(3.5%)	36(10%)
Kerosene stove	15(6.8%)	8(5.7%)	23(6.4%)
Butagas stove	24(11.0%)	2(1.4%)	26(7.2%)
Electricity stove	147(67.1%)	16(11.3%)	163(45.3%)

***Note**: Numbers in parenthesis/bracket is percentage of the respondents*

4.2.3 Practices associated with risk of IAP exposure

Table 6 below shows respondents practices associated with risk of exposure to IAP. Among the total respondents, nearly three-fourth (74.4%) of them reported that they burn charcoal in living house during the study, the highest proportion (95.0%) being urban households. Nearly one-third (35.3%) of them live in houses lack enough ventilation, about (29.2%) of them burn kerosene stove/lamp inside home (Table 6).

About nineteen percent (19.4%) of them burn dung in living house and (12.8%) of the respondents live together with domestic animals in living house. Survey result indicated that households use a range of cooking fuels such as wood, charcoal electricity and kerosene. The kinds of stoves on which these fuels are combusted are not very efficient, leading to emissions into the living space.

Based on the household energy ladder Hiemstra-van-der-Horst and Hovorka, (2008), the energy ladder was designed as a hierarchical households rise in economic status and the fuel types they use for cooking and heating, households reliant on wood and charcoal remain on the lower rungs of the ladder, and the results indicate that wood/charcoal using households had some of the highest levels of particulate pollutants. Further, there was substantial stove stacking in most of the households included in the study, with kerosene and charcoal being common combinations of fuels used either simultaneously or at different times in a single day. The qualitative study results are also consistent with these. For example observation study on the area clearly indicate that fuel choice in these settings is driven by a household's resident conditions, meaning that the majority of rural households would rely on wood, charcoal, animal dung and non-conventional fuels like plastic waste, leading to higher levels of indoor pollutants from resultant emissions, while majority of the urban households would rely on charcoal, wood, electricity, kerosene which is higher up on the energy ladder and though it is thought to be a cleaner option, the results indicate kerosene using households were also exposed to high levels of IAP more so if kerosene was used as both the lighting and cooking fuel. Similarly, one old women FGD discussant rural resident said *"……most of us used simultaneously other stoves and fuels even though our main fuel is firewood. For instance, I used charcoal and animal dung even when I mainly relied on fire wood and vice versa; so that the sources of indoor emissions in my house were mixed in a single day......"*Considerable amount of households had members who smoked inside the house. Smoking was also mentioned in FGD as being one of risk factor of IAP.one Old man FGD discussant rural resident who used to smoke cigarette for the last twenty years said "...... *Most of the time I smoke in the house, for instance I don't go outside to smoke, I come to the house and I do not care; I will smoke inside the house. You will find that the house is crowded and when I lights the cigarette, the air does not circulate.....*" These consistent results of qualitative study show that there was no respondent/informants bias in providing true information to the interviewers.

Table 6. Respondents practices associated with risk of exposure to IAP

Practices		Study area		Total
		Urban (n=219)	Rural (n=141)	(n=360)
Charcoal burning in living house	Yes	208(95.0%)	60(42.6%)	268(74.4%)
	No	11(5.0%)	81(57.4%)	92(25.6%)
Kerosene stove/lamp burning	Yes	20(9.1%)	85(60.3%)	105(29.2%)
	No	199(90.9%)	56(39.7%)	254(70.6%)
Fire wood &dung burning in living	Yes	12(5.5%)	58(41.1%)	70(19.4%)
house	No	207(94.5%)	83(58.9%)	290(80.6%)
Presence of cigarette smoker in house	Yes	32(14.9%)	69(48.9%)	101(28.1%)
	No	187(85.7%)	72(51.1%)	259(71.9%)
Domestic animals live together in	Yes	4(1.8%)	42(29.8)	46(12.8%)
living house	No	215(98.5)	99(70.2%	314(87.2%)
Not always opening doors & windows	Yes	41(18.7%)	86(61.0%)	127(35.3%)
(Lack of enough ventilation)	No	178(81.3%)	55(39.0%)	233(72.2%)

In addition to the use of high-emission cooking and lighting fuel sources and living in less ventilated houses practice, indoor cigarette smoking habit was also found as risk of IAP exposure IAP in the study area. Considerable proportion (28.1%) of households had members who smoke cigarette inside the home in the study area. It is well documented that non-smokers living with smokers can be exposed to cigarette smoke related health risks. Rodgman and Perfetti (2009) indicated that cigarette smoke contains 7,357 different chemical compounds such as benzene, CO, heterocyclic amines, formaldehyde, nicotine, phenols and heavy metals. Burning one cigarette emits 7 to 23 mg PM.

4.3. Knowledge of the respondents towards IAP

4.3.1 Overall knowledge towards IAP

Table 7 shows the respondents distribution according to their perception and awareness of IAP. Among the total respondents, the majority (219 or 60.8%) of households across social groups have high awareness towards issues related to IAP. Analysis of the level of positive response to perception and awareness of IAP revealed that independent variables urban 137(62.6%) were significantly related with the highest awareness score. The proportion of respondents reported having IAP knowledge in this study is much lower compared with the 83.9% that reported by Osagbemi (2009) in Gonder town, Amahara regional state, Ethiopia.

Table 7. Respondents distribution according to their perception and awareness of IAP

Study area	**Categories (Range)**	**Total Respondents (n=360)**
Urban **n=**219(60.8%)	Have high awareness (>50%)	137(62.6%)
	Have low awareness (<50%)	82(37.4%)
Rural **n=141**(39.2%)	Have high awareness (>50%)	85(60.3%)
	Have low awareness (<50%)	56(39.7%)

4.3.2 Respondents knowledge towards sources of IAP

Among the total respondents, large majority (94.2%) of respondent reported that using smoking sources of fuel inside living house for cooking is the primary source of IAP, the highest proportion (95%) being in rural inhabitant respondents. Considerable proportion of them (73.9%) reported presence of house nearer to dusty road which may lead to entry of outdoor dust and particulate matters into living houses is the major source of IAP. Nearly three-quarter (73.6%) of respondents reported that dust out of sweeping house floor dusty/mud floor is the possible sources of IAP in the study area. About 262 (72.8%) of them believed spraying insecticide/other chemicals indoor/in house can be the major sources of IAP. Above average of them (68.6%) think that living together in living house with domestic animals and Smoking cigarette in living house(66.7%) are the source of IAP. Nearly half (53.3%) of the respondents believed that outdoor pollutant entering into house are the possible sources of IAP would be risk factor of IAP because while smokes and other particulate materials inter to the house through poor constructed windows and doors can be concentrated in house and become the source of IAQ (Table 8).

This study found that, in average, 71.9% of the respondents were aware of the source of IAP (Table 8). This was lower than the 83.9% the finding of Osagbemi, Adebayo, Aderibigbe, (2010) and the 73.0% reported by Azizi, Zulkifli, Kasim, 1995).This might be the present study included surrounding rural kebeles in Jimma city where the awareness of IAP was expected to be low. However, this reported level of awareness of IAP sources in the current study is higher compared with findings of similar study by Jones (1999).

Table 8. Knowledge of respondents towards potential sources of indoor air pollution

Potential sources of IAP	Residence		Total	Rank
	Urban(n=219)	Rural(n=141)	(n=360)*	
Live together in living house with domestic animals	171(78.1%)	76(53.9%)	247(68.6%)	6
Using smoking sources of fuel inside living house for cooking	205(93.6%)	134(95%)	339(94.2%)	1
Smoking cigarette in living house	158(72.1%)	82(58.2%)	240(66.7%)	7
Spraying insecticide/other chemicals indoor/in house	171(78.1%)	73(51.8%)	262(72.8%)	4
Dust out of sweeping dusty floor	178(81.3%)	87(61.7%)	265(73.6%)	3
Presence of house nearer to dusty road	195(89%)	71(50.4%)	266(73.9%)	2
Not always opening doors & windows	174(79.5%)	85(60.3%)	259(71.9%)	5
Outdoor pollutant entering into house	132(60.3%)	60(42.6%)	192(53.3%)	8
Average proportion of respondents towards knowledge of IAP sources	**79.0%**	**59.2%**	**71.9%**	

Note: Numbers in parenthesis/bracket is percentage of the respondents

Quantitative result revealed majority of the community (urban and rural) were being aware of the source of IAP. They think the reliance on polluting fuels for cooking and lighting such as charcoal and kerosene was faulted for polluting indoor air. In these two communities, the main

Source of energy for cooking were biomass fuels such as wood, charcoal, sawdust and animals dag. Petroleum and electricity was the second and most used cooking fuel; while there was also substantial fuel mixing within homes (i.e. the simultaneous or subsequent use of different fuels/stoves on the same day).However qualitative study results not consistent with these. For example observation study on the area clearly revealed that majority of rural community live with domestic animals. Similarly, one health extension worker FGD discussant from rural kebele said "……*"... the housing condition is the major source of IAP. Majority of us have been cooking our food inside, using dung, with no ventilation. Considerable amount of us have been cooking our food inside the living house using smoking sources of fuels such as fire wood that releases large quantity of smoke. We have been using of mosquito coil to avoid mosquito. We are also vulnerable to dust out of sweeping floor and gases (methane) coming out of cattle in house we are living to gather with animals. I think the perfume we are using is also another source exposure of...."*These inconsistent results of qualitative study show that there was a respondent/informants bias in providing true information to the interviewers.

4.3.3 Knowledge towards route of exposure and effects

Table 9 shows knowledge of respondents towards route of exposure and effect of IAP. Majority (72.5%) of the householder residents across the two social groups (urban and rural) were aware of the route of exposure and effect of IAP, the highest proportion (80.4%) being urban in habitant respondents and 60.3%in rural know the route of exposure to IAP, considerably higher %(40%) do not know the route of exposure. Thus it is essential to raise awareness in rural group. Large proportion (78.5%) of the participants were said inhaling smoke from burning sources contribute to the poor state of air. Considerable proportion (58.2%)of them expressed inhaling dust/particulate matter in air, could have an impact on air quality in the surrounding areas. Substantial proportion 49.8%) of study participants expressed inhaling insecticide sprayed in door and small proportion of them (43.7%)think inhaling smoke from kerosene lamp contributes to extreme concentrations of pollutants in the home. Moreover, majority of respondents (94.1%) in rural and(85.2%)in urban mentioned eye is body organs more contact with indoor air pollutant, while(56.5%) in rural and (51.1%) in urban think skin is other body organ being related to air pollution. Similarly, majority of respondents (71.9%) in both rural and urban community mentioned eye is the body organ more affected by IAP. Other body organs being affected by air pollution include heart (71.6%), breathing organ (63.2%) and skin (51.7%) respectively.

Table 9. ***Knowledge of respondents towards route of exposure and effect of IAP***

Exposure Routes	Residence		Total
	Urban(n=219)	**Rural(n=141)**	**(n=360**
Know exposure routs of IAP (n=360)			
Yes	176(80.4%)	85(60.3%)	261(72.5%)
No	43(19.6%)	56(39.7%)	99(27.5%)
Routes of IAP exposure you know (n= 261)			
Inhalation			
• Inhaling smoke from burning sources	137(77.8%)	68(80%)	205(78.5%)
• Inhaling dust/particulate matter in air	111(63.1%)	41(48.2%)	152(58.2%)
• Inhaling insecticide sprayed indoor	86(48.9%)	44(51.8%)	130(49.8%)
• Inhaling smoke from kerosene lamp	65(36.9%)	49(57.6%)	114(43.7%)
Skin contact with indoor air pollutant	90(51.1%)	48(56.5%)	138(52.9%)
Eyes contact with indoor air pollutant	150(85.2%)	80(94.1%)	230(88.1)
Body organs more affected (n=261)			
Breathing organ	106(60.2%)	59(69.4%)	165(63.2%)
Eye	150(85.2%)	78(91.8%)	259(71.9%)
Skin	92(52.3%)	43(50.6%)	135(51.7%)
Heart	124(70.1%)	63(74.1%)	187(71.6%)

Survey result indicated that majority of communities (urban and rural) have aware of the route of exposure and effect of IAP. However qualitative study results not consistent with these. For example observation study on the area clearly revealed that most rural living houses had less understanding towards route of exposure and effect of IAP, almost most of the rural living residence belief that indoor air is less polluted and majority of them widely deepened on them.

Similarly, one of a 68 year FGD discussant rural housewife said "……*I think wood / charcoal/animals dang/being natural products and harmless, and I used to cook using these products within my living house "throughout my life....."* These inconsistent results of qualitative study show that there was a respondent/informants bias in providing true information to the interviewers.

4.3.4. Knowledge towards potential human health effect of IAP

Table 10 below shows the knowledge of the respondent towards human health effect of IAP. Among the total respondents, majority (84.4%) were thinking IAP can affect human health and cause diseases, not much differences were noted in the perceptions of health risks between the two communities, but relatively with urban residents raising more concerns on the IAP health effects compared to their rural counterparts (86.3%).Large proportion (86.1%)of the participants believes IAP can cause eye disease. Other diseases being caused by IAP in the study area include headache (72.5%), dray throat (71.9%), breathing organ diseases (63.9%) and skin irritation (51.7%) respectively (Table 10).

Several studies (Florig, 1997; Smith, et.al., 2000; Bruce et.al., 2000; and Ezzati and Kammen, 2001) revealed that exposure to IAP pollution from the combustion of biomass/solid fuels has been implicated with varying degrees of evidence, as a causal agent of several diseases in developing countries including acute respiratory infections (ARI) and otitis media (middle ear infection),chronic obstructive pulmonary disease (COPD), lung cancer (especially for coal smoke), asthma, nasopharyngeal and laryngeal cancer, tuberculosis, perinatal conditions and low birth weight (as a result of maternal exposure), and diseases of the eye such as cataract and blindness. However, many people in developing countries, particularly in rural areas, are unaware of consequences of exposure to IAP.

The results from the quantitative study point out that residents in the two communities had awareness that IAP could cause ill health. However the results from the qualitative study point to incorrect information available to residents in the two communities regarding the health effects of IAP. For example FGD study on the area clearly revealed that most rural living houses had less understanding towards human health effect of IAP, almost most of the rural living residence belief that indoor air is less polluted and majority of them widely deepened on them. Similarly, one of a 54 year FGD discussant rural chairman said *"...the problem is where I can get help* *because I live in a poor area. For example I don't have any idea as such indoor air is high pollutant. If the community could be educated about the effects of these things- you see there are things people do out of ignorance e.g. you can find while people may smoking cigarettes in the state where the windows and doors may closed. If the community can be educated on the health effects of these things so that they have that knowledge; that will really help. The issue of IAP was not given significant attention by our Medias and other community forums. The dark economy and poorly developed social services hinders us to protect ourselves from the effect of IAP, what can we do and where we can live..."*These inconsistent results of qualitative study show that there was a respondent/informants bias in providing true information to the interviewers.

Table 10. Knowledge of the respondent towards human health effect of IAP

Potential health effects	Study area		Total
	Urban(n=_219__)	**Rural(n=_141__)**	**(Frequency +%**
Do you think IAP can affect human health and cause diseases (n=360)			
Yes	189(86.3%)	115(81.6%)	304(84.4%)
No	30(13.7%)	26(18.4%)	92(25.6%)
Potential health effects caused by exposure to IAP (n=360)			
Eye irritation	183(83.6%)	127(90.1%)	310(86.1%)
Breathing organ disease	131(59.8%)	99(70.2%)	230(63.9%)
Dry throat	156(71.2%)	103(73%)	259(71.9%)
Headache	164(74.9%)	97(68.8%)	261(72.5%)
Skin irritation	114(52.1.5%)	72(51.1%)	186(51.7%)
Heart (cardiac problem)	124(70.1%)	63(74.1%)	187(71.6%)

Regarding the adverse potential human health effect of IAP, majority (84.4%) participants knew that exposure to IAP can affect human health and cause diseases (Table 10). These findings are consistent with finding of Mobarak et (2012), which found that there was a high knowledge about the harmful health effects of IAP. Eye disease, headache, breathing organs, dray throat and skin disease were found the major health effects exposed to IAP exposure in the study area. The bivariate analysis (Table 11) of knowledge composite score against independent variables revealed that positive score to the adverse health effects of IAP exposure were associated with rural residence (p=0.039), male gender (p<=0.039), older age (p = <0.041), post graduates education (p=0.043), being married (<0.040), being government employee (p<0.041), large family size with greater than five years (p<0.042), and those who are earning <1500 ETB (p=0.038)monthly

Table11.Bivariate variables for household's knowledge of harmful effects of IAP.

Characteristics	Description	Response Yes (positive)	Response No (Negative)	p-value
	Urban	169(77.2%	50(22.8%)	0.039
	Rural	110(78%)	31(22%)	0.039
Sex	Male	161(78.2%)	45(21.8%)	0.039
	Female	118(76.6%)	36(23.4%)	0.038
Age	18-35	156(75.7%)	50(24.3%)	0.038
	36-50	97(79.5%)	25(20.5%)	0.04
	>50	26(81.3%)	6(18.7%)	0.041
Level of education	No formal education	15(75%)	5(25%)	0.038
	Read and write	27 (75%)	9(25%)	0.038
	Primary	62(73.8%)	22(26.2%)	0.038
	Secondary	67 (77.9%)	19(22.1%)	0.039
	Diploma	50(78.1%)	14(21.9%)	0.039
	First degree	45 (81.8%)	10(18.2%)	0.041
	Post graduate	13 (86.7%)	2(13.3%)	0.043
Marital status	Ever married	160(79.2%)	42(20.8%)	0.04
	Never married	119(75.3%)	39(24.7%)	0.038
Occupation	Merchant	48(75%)	16(25%)	0.036
	Farmer	63(75.9%)	20(24.1%)	0.038
	Government employee	70(81.4%)	16(18.6%)	0.041
	Daily laborers	65(77.4%)	19(22.6%)	0.039
	Micro enterprise	33(76.7%)	10(23.3%)	0.038
Family size	1	120(75.9%)	38(24.1%)	0.038
	2	17(73.9%)	6(26.1%)	0.04
	3	20(74.1%)	7(25.9%)	0.037
	4	26(78.8%)	7(21.2%)	0.039
	5	52(77.6%)	15(22.4%)	0.04
	>5	44(84.6%)	8(15.4%)	0.042
Monthly income	<1500 Birr	92(76%)	29(24%)	0.038
	1501 -3000 Birr	68(78.2)	19(21.8%)	0.039
	>3000 Birr	119(78.3%)	33(21.7%)	0.039

*Statistically significant at $p<0.05$

4.3.5 Knowledge towards reduction or prevention of IAP exposure

Among the total respondents, 59.7% of them think that IAP can be prevented or reduced, the highest proportion (67.1%) being urban inhabitant respondents than rural (48.2%). In the present study area, the knowledge base of all studied respondents was lower than the proportion (64.0%) reported from Beijing, China (Sheng and Luan. 2006). However, t it was comparable with the result (67.1%) reported by urban respondents. Although the reported overall IAP prevention knowledge level was low, the respondent's knowledge towards individual methods of IAP prevention was remarkably high (≥90.0%) (Table12).

Majority (98.6%) of the respondents thinks that using cooking fuel that emits less smoke could prevent IAP. Other preventive mechanisms reported include: prohibiting cigarette smoking in living houses (98.0%), cooking always outside living houses (94.6%), avoiding living with domestic animals (95.2%) and keeping windows/doors open most of the time (91.2%)(Table 12). These findings were similar to that reported by Oyebanji *et al*. (2010). In Odeda LGA of Ogun State above average (51.4%) of the respondents had awareness on mechanisms to mitigate the effect of IAP. The results from the quantitative study point out that above average residents in the two communities had awareness that IAP could be prevented. However qualitative study results were not consistent with these. For example observation study on the area clearly revealed that most living houses both in rural and urban community had little or no awareness weather poor air quality could be improved or not. Similarly, one of the FGD discussant health expert said ".......most living houses both in rural and urban community had little or no awareness on how their actions contributed to poor air quality; and on what they could do to bring change in their communities. For me, improving the life condition of the community is needed so that people could understand how their actions contributed to poor air quality; and what they could do to bring change in their communities........"These inconsistent results of qualitative study show that there was a respondent/informants bias in providing true information to the interviewers.

Table 12. Knowledge of respondent towards reduction and prevention of IAP

Possibility of IAP prevention and method	Residence		Total (n=360)
	Urban (n=219)	Rural(n=141)	
Do you think IAP can be prevented? (n=360)			
Yes	147(67.1%)	68(48.2%)	215(59.7%)
No	72(32.9%)	73(51.8%)	145(40.3%)
Which of the followings can be considered as prevention measure?			
1. Using cooking fuel that emit less smoke (n=215)			
Yes	145(98.6%)	65(95.6%)	210(97.7%)
I don't know	2(1.4%)	3(4.4%)	5(2.3%)
2. Using stoves that reduce release of smoke (n=215)			
Yes	145(98.6%)	63(92.6%)	208(96.7%)
I don't know	2(1.4%)	5(7.4%)	7(3.3%)
3. Prohibit cigarette smoking inside living house (n=215)			
Yes	144(98%)	62(91.2%)	206(95.8%)
I don't know	3(2%)	6(8.8%)	9(4.2%)
4. Cooking always outside living house(n=215)			
Yes	139(94.6%)	63(92.6%)	202(94%)
I don't know	8(5.4%)	5(7.4%)	13(6%)
5. Avoid living with domestic animals (n=215)			
Yes	140(95.2%)	60(88.2%)	200(93%)
I don't know	7(4.8%)	8(11.8%)	15(7%)
6. Keep window/doors open most of the time (n=215)			
Yes	134(91.2%)	59(86.8%)	193(89.8%)
I don't know	13(8.8%)	9(15.2%)	22(10.2%)

The bivariate analysis of attitude score (Table 13) in relation to independent variables revealed that positive score towards preventive measure of health hazards of IAP exposure were associated with urban residence (p<0.045), female gender (p<0.043), old age (p = <0.045), post graduates (p<=0.047), being married (p=0.043), government employee (p<0.045), large family size with greater than five (p<0.045) and earning >3500 Birr (p<0.044)

Table 13. Bivariate variables for household's knowledge towards preventive measure of IAP

		Response		
Characteristics	**Description**	**Yes (positive)**	**No Negative)**	**p value**
House holds' residence area	Urban	196(89.5%)	23(10.5%)	0.045
	Rural	115(81.6%)	26(18.4%)	0.041
Sex	Male	177 (85.9%)	29(14.1%)	0.043
	Female	134(86.4%)	21(13.6%)	0.043
Age	18-35	177(85.9%)	29(14.1%)	0.043
	36-50	106(86.9%)	16(13.1%)	0.043
	>50	30(90.6%)	3(9.4%)	0.045
Level of education	No formal education	16(80%)	4(20%)	0.043
	Read and write	31 (86.1%)	5(13.9%)	0.043
	Primary	72(85.7%)	12(14.3%)	0.043
	Secondary	74 (86%)	12(14%)	0.043
	Diploma	55(85.9%)	9(14.1%)	0.043
	First degree	49 (89.1%)	6(10.9%)	0.045
	Post graduate	14(93.3%)	1(6.7%)	0.047
Marital status	Ever married	175(86.6%)	27(13.4%)	0.043
	Never married	136(86.1%)	22(13.9%)	0.043
Occupation	Merchant	55(85.9%)	9(14.1%)	0.043
	Farmer	71(85.5%)	12(14.5%)	0.043
	Government employee	78(90.7%)	8(9.3%)	0.045
	Daily laborers	72(85.7%)	12(14.3%)	0.043
	Micro enterprise	35(81.4%)	8(18.6%)	0.042
Family size	1	133(84.2%)	25(15.8%)	0.042
	2	20(87%)	3(13%)	0.044
	3	23(85.2%)	4(14.8%)	0.043
	4	29(87.9%)	4(12.1%)	0.044
	5	59(88.1%)	8(11.9%)	0.044
	>5	47(90.4%)	5(9.6%)	0.045
Monthly income	<1500 Birr	103(85.1%)	18(14.9%)	0.043
	1501 -3000 Birr	75(86.2%)	12(13.8%)	0.043
	>3000 Birr	133(87.5%)	19(12.5%)	0.044

*Statistically significant at p<0.05

5. CONCLUSION AND RECOMMENDATIONS

5.1. Conclusion

Based on the findings, it was concluded that both urban and rural communities face potentially high levels of IAP mainly arising from biomass fuels and poor quality cooking stoves. These high levels are causes for concern and there is need for action to address the indoor air pollution challenge. Further, residents are aware of indoor air pollution sources and perceive indoor air pollution as an issue. They also have knowledge regarding possible health effects and knowledge towards reducing household indoor air pollution from sources such as biomass smoke exposure, considering the negative consequences of indoor air pollution in urban and rural area such as eyes irritation, breathing problem, headache, dry throat, skin irritation and heart(cardiac problem) was crucial to make a campaign toward mitigating indoor air pollution, majority of them were still living with the risk factors associated with IAP in their daily living probably due to their low socio-economic status. This would empower individuals to embrace actions aimed at reducing pollution and/or exposure while also equipping them with skills to push for government action to improve their environment.

This study revealed that persons who used cooking gas and electricity had significantly better knowledge of the harmful effects of biomass fuel. In addition, earning larger income significantly improved awareness towards the harmful effects of biomass fuel. This is a strong indication that having more economic power improves health seeking behaviors.

5.2. Recommendations

1. This study found that households are aware of indoor air pollution sources and they also had knowledge regarding adverse health effects exposed to IAP and had good knowledge on methods used to mitigate the harmful effect of Indoor Air Pollution, however this information in both urban and rural communities for the reason that majority of them were still living with the risk factors associated with Indoor Air Pollution and there is need to provide education/awareness creation regarding air quality and its effects on health would be important and this can be implemented through community-based organizations that have wide acceptance in the study communities.
2. Knowledge of the harmful effects of biomass fuel was a significant predictor of positive awareness in this study. Special and routine trainings and education needs of these two communities (urban and rural) should be a priority to public health officials.
3. Switching to cleaner household cooking and lighting systems is encouraged; government policies on pricing of clean cooking and lighting options should consider those living in the lower end of the income bracket to ensure affordability preventing exposure to biomass fuel is a very important principle of prevention. An example of this principle is replacing the use of biomass fuels with less harmful fuel such as cooking gas or electricity.
4. This study was focused only on three kebeles in Jimma city and three surrounding rural kebeles, however to gain good perceptions into potential socio-economic differentials in pollutant levels, it would be important to conduct wide study covering different residential areas.
5. It would be important to conduct operational research on switching to cleaner cook stoves, and incorporate a qualitative assessment of enablers and barriers to the adoption of this clean cooking and lighting technologies, both at the household and community levels
6. An assessment of the best approaches to educate communities on such a technical field like indoor air pollution is warranted. This assessment should focus on what the content of such an initiative would be, who should offer this education and how to ensure program continuity.

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APPENDIXES:

APPENDIX 1

HAWASSA UNIVERSITY

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Questionnaire to be filled by households from three kebeles in Jimma city and one surrounding rural kebeles.

Dear respondent; this is an MSc research paper. The purpose of this questionnaire is to collect data on assessment of the community perception toward on sources, exposure and effects of indoor air pollution in three kebeles of Jimma city and three surrounding rural kebeles out of the city. This questionnaire is designed to obtain your perceptions and views on various aspects of source exposure and effects of indoor air pollution in your locality. The information provided in the questionnaire will be handled confidentially and used for academic purpose only. Hence, your genuine contribution will be enabling the research to be a successful one. Please, give your response after reading the instruction carefully for each section and answer every question.

Note that:-*no need of writing your name anywhere.*

Thank you in advance for your genuine opinion.

Part I. Socio-demographic characteristics of the respondents.

1. Sex: - A/ Male B/ Female-

2. Age of respondents ___________years

3. Residence: -A/ Urban B/ Rural

4. Educational level: -

A/no formal education B/primary education

C/secondary D/Diploma

E/First degree F/Second degree

G/Doctorate

5. Marital status: A/Single B/Married C/Divorced D/Widow/widower

6. Occupation: -

A/Farmer C/ Civil servant E/ Daily laborer

B/ Student D/ Merchant F/ Unemployed

7. Household family size:

A. <5 B. 5 and above 5

8. Monthly income:

A. <1500 Birr

B. 1501 -3000 Birr

C. >3001

Part II. Questionnaires:

The following are statements all about the level of public awareness on the sources exposure to IAP, public awareness risk factors associated with IAP, knowledge of the households towards potential effects of IAP to human health and knowledge of the households towards mechanism of IAP prevention in Jimma city and the surrounding rural kebeles. Please rate each statement with yes (positive response) and No (negative response) and tick (√) the response which most closely represent your opinion.

1. Respondents practices that are potential risk of exposure to IAP

1.1Living and/or housing conditions of the respondents

Item		**Response Category**	
		Yes	**No**
Living house building type	Bungalow		
	Story-building		
	Straw hut		
	Villa house		
Floor type of living house	Mud		
	Concrete		
	Tile		
	Carpet		
	Rug		
Have kitchen for cooking			
Type of kitchen for cooking	Indoor kitchen with partition		
	Kitchen outside living house		
Distance of kitchen to living area	<5m		
	5-10m		
	>10m		
House located near dusty road or area			
Living house with widow			
Domestic animals live together in living house			

1.2 Type/kind of energy or energy source used for cooking in the study areas

Item		Response Category		
		Not at all	**Sometimes**	**Always**
Fire wood/biomass				
Cow dung				
Charcoal				
Electricity				
Buta gas (LPG)				
Kerosene fuel				

1.3 Cooking stove type used by respondents in the study area

Item	Response Category	
	Yes	**No**
Traditional stove made of three stone		
Traditional stove made of three stone plastered with mud		
Traditional stove made of three stone plastered with mud with chimney		
Improved stove with chimney		
Kerosene stove		
Butagas stove		
Electricity stove		

1.4Respondents practices associated with risk of exposure toIAP

Item	Response Category	
	Yes	**No**
Charcoal burning in living house		
Kerosene stove/lamp burning		
Presence of Cigarette smoker in house		
Domestic animals live together in living house		
Not always opening doors & windows		

2. Knowledge and perception of the respondent towards IAP

2.1 Knowledge and perception of the respondent towards IAP

Item	Response Category	
	Yes	**No**
Have high awareness (>50%)		
Have low awareness (<50%)		

2.2. Respondents knowledge towards sources of IAP

Item	Response Category	
	Yes	**No**
Live together in living house with domestic animals		
Using smoking sources of fuel inside living house for cooking		
Smoking cigarette in living house		
Spraying insecticide/other chemicals indoor/in house		
Dust out of sweeping dusty floor		
Presence of house nearer to dusty road		
Not always opening doors & windows		
Outdoor pollutant entering into house		

2.3. Knowledge of respondents towards route of exposure and effect of IAP

Item		Response Category	
		Yes	**No**
Know exposure routs of IAP			
Routes of IAP exposure you know	• Inhaling smoke from burning sources		
	• Inhaling dust/particulate matter in air		
	• Inhaling insecticide sprayed in door		
	• Inhaling smoke from kerosene lamp		
	• Skin contact with indoor air pollutant		
	• Eyes contact with indoor air pollutant		
Body organs more affected by IAP	• Breathing organ		
	• Eye		
	• Skin		
	• Heart		

2.4.Knowledge of the respondent towards human health effect of IAP

Item	Response Category	
	Yes	**No**
Do you think IAP can affect human health and cause diseases		
Potential health effects caused by exposure to IAP		
• Eye irritation		
• Breathing organ disease		
• Dray throat		
• Headache		
• Skin irritation		

2.5. Knowledge of respondent towards reduction and prevention of IAP

Item	Response Category	
	Yes	**No**
Do you think IAP can be prevented?		
Which of the followings is possible prevention method of IAP?		
• Using cooking fuel that emit less smoke		
• Using stoves that reduce release of smoke		
• Cooking always outside living house		
• Keep window/doors open most of the time		
• Prohibit cigarette inside living house		
• Avoid living with domestic animals		

APPENDIX II

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FGD guide questions for health extension, Kebele administrators and health experts (n=18)

This interview intended for 6 health extensions, 6 Kebele administrators and 6 health experts a total of 18 who were purposively selected to find out additional ideas and perception of toward on sources exposure, effects and preventive measure of indoor air pollution in of Jimma city and the surrounding rural kebeles, while responding to the three basic research questions. The responses given according to these three research questions are added to the thesis in a narrative manner. Here are the questions:

Part I. Socio-demographic characteristics of the respondents.

1. Sex: - A/ Male B/ Female-

2. Age of respondents __________years

3. Educational level: -

A/no formal education B/primary education C/secondary
D/Diploma E/First degree F/Second degree

G/Doctorate

4. Marital status: A/Single B/Married C/Divorced D/Widow/widower

5. Occupation: -

A/Farmer C/ Civil servant E/ Daily laborer

B/ Student D/ Merchant F/ Unemployed

6.Monthly income: Birr _______________per month.

PART II- FGD GUIDING QUESTIONS

1. Do communities know what air pollution is?
2. If yes, how define air pollution in the community?
3. Do communities know the major sources of IAP? Can you specify them?
4. Can you tell me the major risk factors towards IAP?
5. Do you have knowledge about perceived health effects of IAP? Can you specify them? Which are common to your locality?
6. What is/are your sources of information about IAP?
7. What are the major preventive measures of IAP to you?

APPENDIX III

HOUSE HOLD OBSERVATION CHECKLIST

Observation checklist for data collection in the assessment of household indoor air pollution practice in Jimma town. This check list is required by the researcher to conduct an in-depth observation in order to assess the challenges in household indoor air pollution in Jimma town. The main target is to cross-check the truthfulness of the collected data through interview questionnaires with that actual situation in the ground and to get the original information.

No	**Source, exposure indoor air pollution**	**Yes**	**No**
1	The distance of kitchen from living house		
2	The location of cooking area		
3	The type of fuel they used for cooking		
4	Presence or absence of window		
5	Presence or absence of soot in the kitchen		
6	The type of your stove they used		
7	The type of your kitchen		
8	Your house found/located near dusty road/highway		
9	The type of your house/building		
10	The type of floor		

APPENDIXIES IV: Household Questionnaire (Amharic version)

ሐዋሳ ዩኒቨርስቲ

በተፈጥሮ ሳይንስ እና ኮምፐትሽናል ኮለጂባዮሎጂ ትምህርትክፍል
ድረ-ምረቃ ፕሮግራም

መጠየቅ

የመኖሪያ ቤት ውስጥ የአየር ብክለት መንስኤ የሚያስከትለው ችግር እና የህብረተሰቡ ግንዛቤ ምን ደረጃ እንዳለ ለመለየት ለተሳታፊዎች መጠይቅ የቀረበ፡ ይህን መጠየቅ ለመመለስ መጠይቁን በጥንቃቄ

ያንብቡትና ይመልሱ።
መጠየቅ ስለተባበሩ አመሰግናለሁ::

ክፍል-1አጠቃላይየተሳታፊዉመረጃ

1) ፆታ ሀ/ወንድ ለ/ሴት
2) ዕድሜ-----------------------
3) መኖሪያ ቦታ ሀ/ከተማ ለ/ገጠር
4) የትምህርት ደረጃ
ሀ/ መደበኛ ትምህርት አልተማርኩም ሠ/ የመጀመሪያ ዲግሪ
ለ/ አንደኛ ደረጃ ትምህርት ረ/ ሁለተኛ ዲግሪ
ሐ/ሁለተኛ ደረጃ ትምህርት ሰ/ ዶክተር
መ/ዲፕሎማ
5) የትዳር ሁኔታ ሀ/ያላገባ ለ/ያገባ ሐ/የፈታ መ/ባል የሞተባት /ሚስት የሞተባት
6) የስራሁኔታ
ሀ/ገበሬ ለ/ተማሪ ሐ/የመንግስት ሰራተኛ መ/ነጋዴ ሠ/የቀንሰራተኛ ረ/ስራአጥ
7) የቤተሰብ ብዛት ስንት ነው? ሀ/<5 ለ/5 እና ከ5 በ**ላ**ይ
8) የወርገቢብር ሀ/ 1500 ለ/1501-3000 ሐ/> 3001

ክፍል-2 ለተሳታፊዎች መጠየቅ

ከዝህ በታች በተመለከተ ሁሉ ተሳታፊው የመኖሪያ ቤት ውስጥ የአየር ብክለት ተግባር እና የችግሩ ምክኒያትተዛማች ጉዳዮችን በተመለከተ; ተዛማች ጉዳዮችን በተመለከተ የተሳታፊው ግንዛቤ; አጋላጭ እና የሚያስከትለዉ ችግር በተመለከት የተሳታፊዉ አመለካከት; የመኖሪያ ቤት ዉስጥ የአየር ብክለትን መቀነስን ወይም መከላከልን በተመለከት የተሳታፊዉ አመለካከት::በከተማ እና በገጠር ቀበለ ይህን ምልክት‹‹√››ከታች የሚገኝዉን ሰንጠረዥ ላይ አዎ ወይም አይደለም ይሙሉት::

1.መኖሪያ ቤት ውስጥ የአየር ብክለት መነሻ (መንስኤ) እናአጋላጭ በተመለከተየተሳታፊውግንዛቤ

1.1መኖሪያ ቤት አይነት ተሳታፊው

ጥያቄ		**መልስ**	
		አዎ	አይደለም
መኖሪያቤት አይነት የተገነባዉ	ትንሽ ቤት		
	ቆርቆሮ ቤት		
	የሳር ቤት		
	ቭላ ቤት		
የቤቱ ወለል	መሬት		
	ሊሾ		
	ላስቲክ የተነጠፈ		
	ስጋጃ የተነጠፈ		
	ምንጣፊ የተነጠፈ		
የምግብ ማብሰያ ኩሽና አሎት?			
ኩሽና ቤት የኩሽና አይነት	መኖሪያቤትውስጥ		
	ከመኖሪያቤትጀርባ		
በኩሽናእናበመኖሪያቤትመካከልያለውርቀት(ሜ)	**<5**		
	5-10		
	>10		
መኖሪያ ቤቶ ለአቧራ መንገድ ወይም መኪና ለሚበዛበት መንገድ ቅርብ ነዉ			
መኖሪያቤትመስኮት አለዉ			
በመኖሪያ ቤት ውስጥ የቤት እንስሳት (ላም!ፍየል!በግ!አህያ ወይም ፈረስ) አብሮት ይኖራል?			

1.2 **ምግብ ለማብሰል ምን አይነት ሀይል ይጠቅማሉ (ከአንድ መልስ በላይ ይቻላል) ይህን ምልክት** ‹‹ √ ››ያድርጉ

የሀይል ዓይነት	የሚጠቀሙበት ጊዜ		
	ሁል ጊዜ	አልፎ አልፎ	አልጠቀምም
እንጨት			
ከሰል			
የከብቶች ኩበት			
ቡታ ጋዝ			
ነጭ ጋዝ			
ኤሌክትሪክ			
ኤሌክትሪክ			

1.3 ምግብ የሚያበስሉበት የምድጃ ዓይነት

ጥያቄ	**መልስ**	
	አዎ	አይደለም
ባለ ሶስት ምድጃ (ባህላዊ)		
ባለ ሶስት ምድጃ ሆኖ በጭቃ ተመርጎ የተያያዘ		
ባለ ሶስት ምድጃ ሆኖ በጭቃ የተመረገና ከመሬት ከፍ ያለ		
ባለ ሶስት ምድጃ ሆኖ በጭቃ የተመረገና ጭስ ማውጫ ያለው		
ዘመናዊ ምድጃ ጭስ ማውጫ ያለው		
ቡታ ጋስ እስቶቭ እጠቀማለው		
ኤሌክትሪክ እስቶቭ እጠቀማለው		

1.4 .ተሳታፊው የመኖሪያ ቤት ውስጥ የአየር ብክለት ተግባር እና ™Ï?Ü የችግሩ ምክኒያትተዛማች ጉዳዮችን በተመለከተ

ጥያቄ	**መልስ**	
	አዎ	አይደለም
እንጨት፣ ኩቤት በቤት ዉስጥ ይጠቅማሉ		
ነጭ ጋዝ በቤት ዉስጥ ይጠቅማሉ		
ከሰል በቤት ዉስጥ ይጠቅማሉ		
ኩቤት በመኖሪያ ቤት ውስጥ የቤት እንስሳት አብሮት ይኖራል?		
በቤት ዉስጥ ስጋራ የሚያጬ አለ/ይጠቀማሉ		
በርና መስኮት ቀን ቀን ሁሌ ክፍት አይደለም		

2. እውቀት እና ግንዛቤ .መኖሪያ ቤት ውስጥ የአየር ብክለት

2.1.ተሳታፊው እውቀት እና ግንዛቤ የመኖሪያ ቤት ውስጥ የአየር ብክለት

	መልስ	
	አዎ	አይደለም
ከፍተኛ ግንዛቤ(>50%)		
ዝቅተኛ ግንዛቤ(<50%)		

2.2 ተሳታፊው እውቀትየመኖሪያ ቤት ውስጥ የአየር ብክለት መነሻ (መንስኤ)

	መልስ	
የብክለት ማሻ (መንስኤ)	አዎ	አይደለም
አየር በካይ ከውጪ ወደ መኖሪያ ቤት ይገባል		
በመኖሪያ ቤት ውስጥ ምግብ በምናበስልበት ጊዜ የምፈጠረዉ ጭስ የብክለት ማሻ ልሆን ይችላል		
በመኖሪያ ቤት ውስጥ ፀረ–ተባይ ይጠቀማሉ?		
መኖሪያ ቤትን ስጠርጉ አቧራ ይነሳል		
በቤት ዉስጥ ስጋራ የሚያጬአለ		
ኩቤት በመኖሪያ ቤት ውስጥ የቤት እንስሳት (አብሮት ይኖራል?		
በርና ማስኮት ቀን ቀን ሁሌ ክፍት		
መኖሪያ ቤት ለአቧራ መንገድ ወይም ሚኪና በምበዛበት መንገድ ላይ ቅርብ ነዉ		

2.3 ተሳታፊው እውቀትየመኖሪያ ቤት ውስጥ የአየር ብክለት መነሻ እና የችግሩ ምክኒያትተዛማች

ሰዉን በቤት ዉስጥ የአየር ብክለት የሚያጋልጡ		መልስ	
		አዎ	አይደለም
ሰዉን በቤት ዉስጥ የአየር ብክለት የሚያጋልጡ	ጭስ በአፍንጫ እና በአፍ በመግባት		
	አቧራ በአፍንጫ እና በአፍ በመግባት		
	ለፀረ–ተባይ የሚረጩ በአፍንጫ እና በአፍ በመግባት		
	መኖሪያ ቤት ዉስጥ በቂ አየር እንዲገባ ሁል ጊዜ በር ና ማስኮት ክፍት መሆን አለበት		
የትኛዉን የሰዉን አካል ይጎዳል?	ስራተ ትንፈሳ አካን		
	አይን		
	ቆዳን		
	ልብን		

2.4. የህብረተሰቡን ጤንነት እና ለበሽታ ምክኒያት ልሆን ይችላል::

ጥያቄ	መልስ

	አዎ	አይደለም
ራስ ምታት		
የትንፈሳ አካል በሽታ (ሳምባ ካሰር፣አስም)		
ማስነጠስ እና ከአፍንጫ ዉስጥ ዉሃ ማፋሰስ		
ማሳል		
የቆዳ መቆጣት		
የአይን ችግር (በሽታ)		

2.5 የመኖሪያ ቤት ዉስጥ የአየር ብክትን መከላከል ይቻላል ብለዉ ያስባሉ?

የቤት ዉስጥ አየር ብክለት መከላከይ ዘዴ	**መልስ**	
	አዎ	**አይደለም**
ጭስ የሚቀንስ የምግብ ማብሰይ ሀይል መጠቀም		
ጭስ የሚቀንስ ዘመናዊ መድኝ		
ምግብ ለማብሰል ሁል ጊዜ ከመኖሪያ ቤት ወጭ መጠቀም እንጨት ፣ ከሰል ነጭ ጋዝ የመሳሰሉት በብዛት ጭስ አላቸዉ		
መኖሪያ ቤት ዉስጥ በቂ አየር እንዲገባ ሁል ጊዜ በር ና መስኮት ክፍት መሆን አለበት		
በመኖሪያ ቤት ዉስጥ ስጋራ አለማጬስ		
ኩቤት በመኖሪያ ቤት ውስጥ የቤት እንስሳት አብሮት ይኖራል?		

APPENDIXIES V: FGD leading questions

ሐዋሳ ዪኒቨርስቲ

በተፈጥሮ ሳይንስ እና ኮምፕትሽናል ኮለጂባዮሎጂ ትምህርት ክፍል ድረ-ምረቃ ፕሮግራም

ቃለ-መጠየቅ

ቃለ-መጠይቅ የቀረበው፡ ለጠናኤክስተሽን: ለቀበለ መስተዳድር እና ለጠና ባለሙ-ያ የመኖሪያ ቤት ውስጥ የአየር ብክለት መንስኤ የሚያስከትለው ችግር እና ለመቀነስ ወይም ለመከላከል የህብረተሰቡ ግንዛቤ ምን ደረጃ እንዳለለመለየት ለተሳታፊዎች ቃለ-መጠይቅ የቀረበ፡ ይህን ቃለ-መጠየቅ ለመመለስ ቃለ መጠይቁን በጥንቃቄ ያዳምጡና ይመልሱ።

ለቃለ-መጠየቅ ስለተባበሩ አመሰግናለሁ::

ክፍል-1አጠቃላይ የተሳታፊዉ መረጃ

1) ፆታ ሀ/ወንድ ለ/ሴት

2) ዕድሜ-----------------------

3) የትምህርት ደረጃ

ሀ/መደበኛ ትምህርት አልተማርኩም ሠ/የመጀመሪያዲግሪ

ለ/አንደኛ ደረጃ ትምህርት ረ/ሁለተኛዲግሪ

ሐ/ሁለተኛ ደረጃ ትምህርት ሰ/ዶክተር

መ/ዲፕሎማ

4) የትዳርሁኔታ ሀ/ያላገባ ለ/ያገባ ሐ/የፈታ

መ/ባል የሞተባት /ሚስት የሞተባት

5) የስራ ሁኔታ

ሀ/ገበሬ ለ/ተማሪ ሐ/የመንግስት ሰራተኛ መ/ነጋዴ

ሠ/የቀን ሰራተኛ ረ/ስራአጥ

6) የወር ገቢ ብር_________________

ክፍል-2

1) የአየር ብክለትን ህብረተሰቡ ያዉቃሉ?

2) አዎ ካሉ ምን ብለው ፍች ይሰጣሉ በህብረተሰቡ ውስጥ? ………………………

3) የመኖሪያ ቤት ውስጥ የአየር ብክለት በህብረተሰቡ ውስጥ መነሻ ነገሮችን ያውቃሉ?

የመኖሪያ ቤትውስጥ የአየር ብክለት መነሻ ነገሮች ምንድናቸዉ?

4) የመኖሪያ ቤት ውስጥ የአየር ብክለት ተግባር እና የችግሩ ምክኒያት ተዛማች ጉዳዮችንሰዉን በቤት ዉስጥ የአየር ብክለት የሚያጋልጡ ነገሮችን ያዉቃሉ?

5)የመኖሪያቤትዉስጥየአየርብክለትየህብረተሰቡንጤንነትእናለበሽታምክኒያትልሆንይችላልብለዉያስባሉ?

6)የመኖሪያ ቤት ውስጥ የአየር ብክለት ጉዳዮችን እንፎርመሽን ከየት ያገኛሉ?

7) የመኖሪያቤትዉስጥየአየርብክትንበህብረተሰቡዉስጥመከላከልይቻላልብለዉያስባሉ?

APPENDIXIESVI: Household Questionnaire (Afan Oromo Version)

Universitii Hawaassa

Kooleejii saayinisi umaamaa fi kompiteshinaalii dipaartimanitii baayolojii saganta digiri lammaffaa

Gaaffii hermatotaa

Seensa

Qorannoon kun wa'ee **''Fallama qilleensa mana jireenya keessati madda isa, rakkoo fidu, waannama saaxilu fi hubanno Hawaasa''** addaa baasuuf gaaffii hermatotaa dhihate. Gaafannoo kanaaf deebii kenuuf **gaaffii** Sirriti dubbisa. Yaada keessan haaluma gaafatameen deebii keessan akka naaf kennitanu kabajaan isin gaaffacha, attooma naaf gootaniif isin naan galateeffadha.

kutaa 1ffaa Odeeffannoo Dhuunfaa hermatota

1. Salaa A. Dhira B. Dubara
2. Umuri ____________
3. bakka jireenya A.magaalaa B.baadiyaa
4. Sadarkaa barnootaa
   A. Barumsa idilee hin barane B. Sadarke tokkoffaa C. Sadarka lammaffaa
   D. Diploma E. Digiri jalqaba F. Digiri lammaffaa G. Doktereti
5. Haala ga'eela A. hin funee/hin herumne B. Kan fudhe
   C. Kan hikte/kan hikke D. Kan abbanmana irra du'ee ykn kan hattimana irra duttee
6. Haala hojii A. qonnan balaa B. Barataa C. Hojjata mootummaa
   D. Daldaalaa E. Hojjataa guyyaa F. Kan hojii hin qabne
7. Baayina maatii mana keessa kan waliin jiratu meqaa? A.<5 B. 5 fi 5 ol
8. Galii ji'aan argatan birr ;- A.< 1500 B. 1501- 3000 C. >3001

kutaa 2ffaa

kan armaan gadii hunda isaan sadarka hubannoo fi madda oddeeffannoo fallama qilleensa mana keessaa itti argatanu, gochaa fi dhibee fallama qillensa mana keessa, wa’ee fallama qilleensa mana jireenya keessa saxili bahu hubannoo hermatota, wa’ee fallama qilleensa mana keessa fayyuuma nama irrati rakkoo fidu ilaalchise, fi wa’ee fallama qilleensa mana jieenya keessa hirsuu ykn ittisuuf danda’amu irrati hubannoo hermatota. Magaalaa Jimmaa fi gandaa badiya argamuti yaada keessaan eeyee yookiin lakkii jechuun maallatoo(√) jechuun deebsa.

1. wa’ee fallama qilleensa mana jireenya keessa saxili bahu hermatota

1.1 Gosa mana keessa jiratu/ijaarsaa

Gaaffii		Deebii	
		Eeyee	Lakkii
Gosa ijaarsaa mana	mana xiqqoo		
	Mana qorqooroo		
	Mana citaa		
	Mana villaa		
Gosti ogiddini mana keessa	lafa		
	Simintoodha		
	Lastikiin irraa bu’ee		
	Minxaafi(sigajaa)		
	Minxaafii xiqqoo		
Kushina qabdu			
Gosti kushina keessaanii	Mana keessa		
	Manaan alaa		
Fageenyi kushinaa fi mana gidduu	<5m		
	5-10m		
	>5m		
Manni jireenya keessaan daandi dhukee qabuuti dhihoo dha			
Balbaalii fi foddaan mana keessa jiratanu yeroo guyyaa bannaa dha			
Mana jireenya keessati Beeladoonni mana waliin jiraaratu?			

1.2 Nyaataa qopheessuuf humna maalii fayyadamti?(deebii tokko ol ni danda'ama) mallattoo"right √ " ka'a

Gosa humna fayyadamtanu	Haala fayyadama		
	Yeroo hunda	**Darbe darbe**	**Hin fayyadamu**
A.Qoorani			
B. Kaassala(cilee)			
C. kobootaa loonii			
D. Sakatura			
E. Nafixaa adii			
F. Elekitrikii			
G.Butaa gaazii			

1.3 Gosti gemmoo nyaataa ittin bilcheffaatanu isa kamii?

gaaffii	Deebii	
	eeyee	**lakkii**
Abbaa gemmoo sadiiti kan aadaa		
Abba gemmoo sadii ta'ee kan biyoo suphaan waliqabate		
Abba gemmoo sadii ta'ee kan biyoo suphan waliqabata fi lafa irraa olka'ee		
Abba gemmoo sadii ta'ee kan biyoo suphan waliqabate fi qawwa arraa baassu kan qabu		
Gemmoo ammaaya kan qawwa arraa baassu kan qabu		
Baayoo gaasii fayyadamu		
Baayoo gaasii fayyadamu		
Istovi electirikii		

1.4 **Hermatonni gochaa fi saaxil bahu fallama qillensa mana keessa walqabatatu ilaalchise.**

Gaaffii	Deebbii	
	Eeyee	Lakkii
Qoqaan ykn kobota fayyadamu		
Nafita adii fayyadamtu		
Cilee fayyadamtu		
Sigaaraa ykn tamboo mana jireenyaa keessati xuuxuu fayyadamtu ?		
Mana jireenya keessati Beeladoonni mana waliin jiraaratu?		
Balbaalii fi foddaan mana keessa jiratanu yeroo guyyaa bannaa dha		

2.Beekumsaa fi Hubannoo rakkoo saaxil bahu fallama qillensa mana keessa

2.1 Beekumsaa fi Hubannoo hermaatota

Gaaffii	deebii	
	eeyee	lakkii
Hubannoo gaha qabach (>50%)		
Habannoo gad-aanaa qabachu (<50%)		

2.2 Beekumsaa maddaa fallama qilleensa mana keessaa hermaatota

Maddaa fallama	Deebii	
	eeyee	**lakkii**
Faltootiin qilleensa alaa gara mana jireenyati ni seenu?		
Mana jireenya keessati yeroo nyaataa bilcheefatanu aarii uumamu maddaa fallama ni ta'aa?		
Farra-ilbisota ni biftu(ni fayyadamtu) mana jireenya keessati		
Mana yeroo qulqulleestanu awwari(dhukeen) ni ka'aa?		
Mana jireenya keessaniti sigaraa(tamboo) kan xuuxuu ni jiraa?		
Mana jireenya keessati Beeladoonni mana waliin jiraaratu?		
Balbaalii fi foddaan mana keessa jiratanu yeroo guyyaa bannaa dha?		
Manni jireenya daandii awwari(dhukkeen) daandii konkoolaata baayatuuti dhihoo dhaa?		

2.3 Beekumsaa maddaa fallama qilleensa mana keessaa fayyuuma nama irraatii fi sababa dhukkuba

Fallama qilleensa mana keessaa fayyaa nama irraati hubaati(midhaa) fidu		deebii	
		eeyee	lakki
Wantota fallama qilleensa mana keessaa nama saaxilu beektu	Aaraa qoraan boba'uu funyaanii fi afaaniin seenuu		
	Dhukkee(awaaraa) funyaanii fi afaaniin seenuu		
	Farra-ilbisootaa biifamu funyaanii fi afaaniin seenuu		
	Aaraa kurazi funyaanii fi afaaniin seenuu		
	Tutuqa gogaa		
	Tutuqa ijaa		
Qaama kamtu midhama	qamaa hargansuu		
	gogaa		
	ijaa		
	onnee		

2.4 Beekumsaa fayyuuma nama irraatii fi sababa dhukkuba ni ta'aa

Fallama qilleensa mana keessaa fayyaa nama irraati hubaati(midhaa) fidu	deebii	
	eeyee	**lakki**
Rakkoo ijaa		
Gognsaa qonqoo		
Dhukkubi mataa fi sammu		
Dhukkuba qamaa hargansuu (kaansaari sombaa, asiimii)		
Haxifoo fi funyaan keessa bishaan ya'uu		
Qufa'uu		
Hargaansu ykn hirni qilleensaa somba mudachuu		
Rifana gogaa		

2.5.Beekumsa hermatota fallama qilleensa mana keessa hirsuufi ittisuun

Haalaa ittisaa fallama qilleensa mana keessa	**deebii**	
	eeyee	**lakkii**
Humna nyaataa bilcheesuu aaraa xiqqeessuu fayyadamu		
Gemmoo ammayyaa aaraa xiqqeessaa fayyadamu		
Nyaataa bilcheesuuf yeroo hunda amana jireenyaan alaati fayyadamu fkn quraan, kasala(cilee) nafixaa adii,fi k.k.f aaraa bayyee gadii lakkisu		
Qilleensa gahaan akka mana jireenya keessa seenu yeroo hunda foddaa fi balballi mana bana ta'uu qaba		
Kushinaan mana jireenyaa irraa bayyee fagachuu qaba		
Yeroo manni haramu dhukkee(awwari) ka'uu xiqqeessuu		
Farra-ilbisota mana jireenyaa keessati biifuu dhisuu keemikaalaa kamiyuu		
Sigaaraa ykn tamboo mana jireenyaa keessati xuuxuu dhisuu		

APPENDIX VII

Universitii Hawaassa

Kooleejii saayinisi umaamaa fi kompiteshinaalii dipaartimanitii baayolojii saganta digiri lammaffaa

Qajjeeltowwan garee marii xiyyefannoo (FGD) kun eksiteenshiin fayyaa, hoggantota gandaa fi oggeestota fayyaa(n=18)

Af-gaaffii kun 6 eksiteenshiin fayyaa, 6 hoggantota gandaa fi 6 oggeestotafayyaa walgaalati 18 Qorannoon kun wa'ee **''Fallama qilleensa mana jireenya keessati madda isa, rakkoo fidu, waannama saaxilu fi hubanno Hawaasa''** addaa baasuuf Af-gaaffii hermatotaa gandaa magaalaa Jimmaa sadii fi gandaa badiyaa tokkoo dhihate. Gaafannoo kanaaf deebii kenuuf **garee marii xiyyefannoo** Sirriti mari'achuun deebi kenaa. Yaada keessan haaluma gaafatameen deebii keessan akka naaf kennitanu kabajaan isin gaaffacha, attooma naaf gootaniif isin naan galateeffa dha.

kutaa 1[ffaa] Odeeffannoo Dhuunfaa hermatota

1. Salaa A. Dhira B. Dubara
2. Umuri ____________
3. Sadarkaa barnootaa
   A. Barumsa idilee hin barane B. Sadarke tokkoffaa C. Sadarka lammaffaa
   D. Diploma E. Digiri jalqaba F. Digiri lammaffaa G. Doktereti
4. Haala ga'eela A. hin funee/hin herumne B. Kan fudhe
   C. Kan hikte/kan hikke D. Kan abbanmana irra du'ee ykn kan hattimana irra duttee
5. Haala hojii A. qonnan balaa B. Baratаa C. Hojjata mootummaa
   D. Daldaalaa E. Hojjataa guyyaa F. Kan hojii hin qabne
6. Galii ji'aan argatan birr ;- A.< 1500 B. 1501- 3000 C. >3001

kutaa 2ffaa

I. Garee marii xiyyefannoo(FGD) Hermatotni sadarka hubannoo fi madda oddeeffannoo fallama qilleensa mana keessaaitti argatanu.

1.hawaasin fallama qilleensaa mana keessa beekaa?

2.yoo eeyee jeetan akkamiti ibsama hawaasa keessati?

3.Hawaasni madda fallama qilleensa mana keessaa beekaa? yoo eeyee jeetan ibsa.

4. Fallama qilleensa mana keessatiif kan nama saxiluu ni beektuu?

5 wa'ee fallama qilleensa mana keessa fayyuuma nama irrati rakkoo fidu beektu? Ibsu dandeessuu? Akka naannooti beekamu maalii?

6.maddi oddeeffannoo fallama qillensa mana keessa ittin argatanu maali?

7. wa'ee fallama qilleensa mana jieenya keessa hirsuu ykn ittisuuf tarkanfiin fudhatamu danda'amu maali?