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Health Implications of Indoor Air Pollution in Oye Local Government Area of Ekiti State, Nigeria

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Abstract This study examined Indoor Air Pollution (IAP) and its health implication in Oye Local Government Area of Ekiti State, Nigeria with emphasis on the major sources, socio-economic factors contributing to IAP, major health effects and susceptible groups to IAP in the study area. The descriptive research design of survey type was used to obtain data for the study. The population used for the study is the residents of Oye Local Government Area. Simple random sampling technique was used to select a total of two hundred samples (200) from the study area. Data obtained were analyzed and presented; using tables, simple percentages and charts. It was discovered from the findings that the use of fuel wood and stoves were the major source of indoor air pollutants in the study area. Findings on the socio-economic factors contributing to Indoor Air Pollution revealed that the people were not aware of Indoor Air Pollution and that low income level was a major factor affecting the nature of their energy consumption. Findings on the health effect revealed that respondents suffer from sore throat, excessive cold/phlegm, wheeze, shortness of breath, nausea, frequent cough due to the presence of smoke in their apartment each time they cook and the presence of dust particles when carrying out their house chores. The major susceptible groups as highlighted in the results were infants. Based on the findings obtained from the study, it was recommended that; proper planning should be considered when building apartments most especially as regards ventilation, cleaner and safer cooking gadgets should be provided by the Government of the day freely or at low cost to people, and that Governmental and Non-Governmental organizations should ensure proper sensitization to increase level of awareness of people on Indoor Air Pollution and its health effects.

Keywords Air Pollution, Contamination, Indoor Air Pollution, Susceptibility

Introduction

Air, the major substance constituting the atmosphere is the most important component of environment health which is necessary for the survival of organisms. The quality of this resource is imperative to human existence. Literarily, Indoor Air Quality (IAQ) is the quality of air in buildings i.e. at place of work or living apartments.

According to Bruce [1] the contamination of indoor air quality gives account for indoor air pollution. Indoor air quality as posited by him means the air quality within and around the buildings and structures, especially as it relates to the health and comfort of building occupants. Indoor Air Quality (IAQ) can be affected by gases (including carbon monoxide, radon, and volatile organic compounds), particulates, microbial contaminants (mold, bacteria) or any mass or energy stressor that can induce adverse health conditions.

Simply put, Indoor Air Pollution means the reduction in the quality of indoor air characteristics which includes physical, chemical and biological component of the environment within home, building, an institution or commercial facilities. As cited by Kjell [2], Indoor Air pollution seriously affects the health of many people, most evident in rural areas in developing countries, where fuels of biomass and coal are used for heating and

cooking in crowded and badly ventilated homes.IAQ is part of indoor environmental quality (IEQ), which includes IAQ as well as other physical and psychological aspects of life indoors (e.g. lighting, visual quality, acoustics, and thermal comfort). Indoor air pollution in developing nations is a major health hazard [1]. Duflo *et al*., [3] noted that the major source of indoor air pollution in developing countries in the burning of biomass (e.g. wood, charcoal, dung, or crop residue) for heating and cooking. The resulting exposure to high levels of particulate matter resulted in between 1.5 million and 2 million deaths in 2000 [4].

Arbitrary idea holds it that while indoor, one is safe from pollutants since most of them are produced from outdoor activities. However, the scientific evidence has shown that indoor air at homes can be more seriously polluted than outdoor air of the largest and most industrialized cities [5-6]. Indoor air quality plays a major role with regard to public health. The main problems are in the developing countries with the indoor burning of biomass for cooking and heating. Reconnaissance survey and observation made in Oye Local Government, Ekiti State, Nigeria revealed that residents in the area are relatively exposed to ambient air pollution some of which can be attributed to socio-economic factors and level of awareness to such occurrence. For some groups of effects, clear relationships with exposure to Indoor Air Pollution have been reported in the world literature. Among these are respiratory disease (particularly among children), allergy (particularly to house dust mites) and mucous membrane irritation (particularly due to formaldehyde).

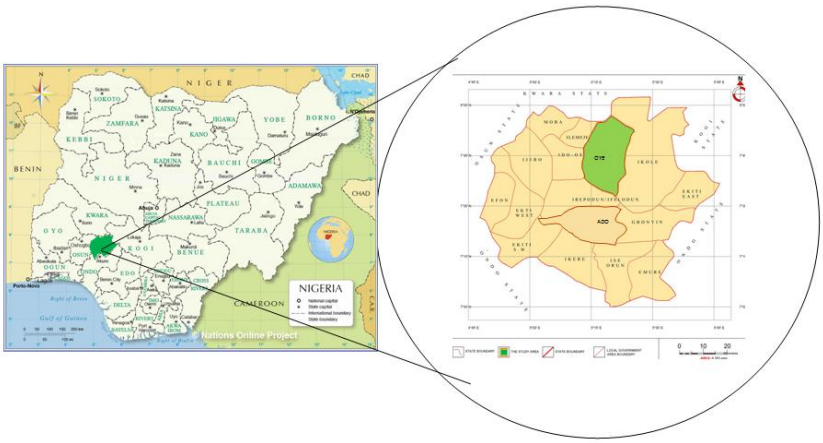
Large numbers of people have been, and are still being affected. For example, an increased risk of developing lung cancer has been linked to exposure to environmental tobacco smoke (ETS) and to radon decay products. Lung cancer is a very serious disease with a high fatality rate; however, the number of people affected is much lower than the number of people contracting respiratory disease or allergies, or experiencing irritative effects due to exposure to indoor pollution.

Aim and Objectives of the Study

This study examines indoor air pollution and its health implication in Oye Local Government Area, Ekiti State, Nigeria. The specific objectives of the study were to:

i) know the various sources or causes of Indoor Air Pollution (IAP) in the study area
ii) to find out the socio-economic factors contributing to Indoor Air Pollution in the study area
iii) determine the health effects of Indoor Air Pollution (IAP) in the study area
iv) find out the major susceptible groups to Indoor Air Pollution (IAP) in the study area

Study Area



Map of the Study Area (Oye LGA, Ekiti State)

Literature Review and Theoretical Framework

Major Indoor Air Pollutants and Health Implications

i. Second-hand Smoke

Second-hand smoke sometimes regarded as Environmental Tobacco Smoke (ETS) or Passive smoking, is sourced from smoking of tobacco and in most cases affects other people other than the active smoker. ETS is found in homes, homes, workplaces and certain public places such as restaurants. Second-hand tobacco smoke

includes both a gaseous and a particulate phase, with particular hazards arising from levels of carbon monoxide. Environmental tobacco smoke consists of mainstream smoke exhaled into environment and side-stream smoke, after dilution and aging [7].

ii. Particular Matter

The term particulate matter (PM) is often used as a synonym for particles in pollutants science. Particulate matter, as defined by World Health Organization (WHO) is a mixture of solid or solid/liquid particles suspended in air [8]. These particles vary in size, shape, origin, and chemical composition. It is usual to classify the particles by their aerodynamic characteristics. Typically these are summarized by aerodynamic diameter, i.e. a diameter of a spherical particle with a density of 1 g cm-3 that has the same inertial properties and settling velocity as the particle in question [9].

iii. Carbon-monoxide (CO)

Carbon monoxide is a toxic tasteless, odorless, and colorless gas that is produced by incomplete combustion of fuels such as wood, petrol, coal, natural gas and kerosene. Indoors, carbon monoxide is produced by these combustion sources (cooking and heating) and is also introduced through the infiltration from outdoor air into the indoor environment. Exposure to high levels of carbon monoxide might be lethal. The major sources of carbon monoxide are tobacco smoke, space heaters using fossil fuels, defective central heating furnaces and automobile exhaust. Since CO is has no odor, color or taste, it cannot be detected by our senses. This means that dangerous concentrations of the gas can build up indoors and humans have no way to detect the problem until they become ill. Furthermore, when people become sick the symptoms are similar to flu, which can cause victims to ignore the early signs of CO poisoning. But in some cases the level of carbon monoxide indoor can rise if carbon producing gadgets or appliances is used very close to the ventilation [10].

iv. Nitrogen dioxide (NO_2)

Nitrogen dioxide is a reddish brown gas with a characteristic pungent odor. It is a key precursor of a range of secondary pollutants whose effects on human health are well documented [6]. The most important indoor sources include tobacco smoke and gas, wood, oil, kerosene and coal-burning appliances such as stoves, ovens, space and water heaters and fireplaces.

v. Sulfur dioxide (SO_2)

Sulfur dioxide is a nonflammable, non-explosive, colorless gas with strong pungent smell. Its concentrations indoors are typically lower than those from outdoors. Inhalation is the major route of exposure to sulfur dioxide. Some studies have demonstrated that sulfur dioxide can cause broncho constriction (airway narrowing) in both healthy and asthmatic adults with clinical symptoms of shortness of breath, wheezing [11], and impaired lung function [12].

vi. Moulds or Molds

Moulds are fungus that grows in the form of multi-cellular filaments called hyphae. They thrive in indoors because they can survive in damp, warm and humid environments, the health impacts of inhaled biological pollutants should not be underestimated [13]. Some of the health effects include: throat irritation, coughing, wheezing eye irritation etc.

vii. Carbon dioxide (CO_2)

Carbon dioxide is a relatively easy to measure surrogate for indoor pollutants emitted by humans, and correlates with human metabolic activity. Carbon dioxide at levels that are unusually high indoors may cause occupants to grow drowsy, to get headaches, or to function at lower activity levels. Human are the main indoor source of carbon dioxide in most buildings. Indoor CO_2 levels are an indicator of the adequacy of outdoor air ventilation relative to indoor occupant density and metabolic activity. Carbon dioxide increase as a result of human occupancy, but lag in time behind cumulative occupancy and intake of fresh air, the lower the air exchange rate, the slower the buildup of carbon dioxide to quasi "steady state" concentrations.

viii. Ozone (O_3)

Ozone is produced by ultraviolet light from the Sun hitting the Earth's atmosphere (especially in the ozone layer), lightning, certain high-voltage electric devices (such as air ionizers), and as a by-product of other types of pollution. Ozone exists in greater concentrations at altitudes commonly flown by passenger jets. Reactions between ozone and onboard substances, including skin oils and cosmetics, can produce toxic chemicals as by-

products. Ozone itself is also irritating to lung tissue and harmful to human health. Outdoor air used for ventilation may have sufficient ozone to react with common indoor pollutants as well as skin oils and other common indoor air chemicals or surfaces. Particular concern is warranted when using "green" cleaning products based on citrus or terpene extracts, because these chemicals react very quickly with ozone to form toxic and irritating chemicals.

Socio-Economic Factors and Indoor Air Pollution

An array of studies has shown a relationship between socio-economic factors and indoor pollution. In a study carried out by Brown [14], it was revealed that households with lower income were more likely to have higher indoor concentrations of formaldehyde, but lower perchloroethylene indoor concentrations. It was also revealed that the major predictors of fungal contamination (moulds) were dampness and absolute humidity which is common among low income earners. On the contrary, the US Environmental Protection Agency [15] revealed that both lower economic, less technically advanced, and higher economic, more highly technical societies experience significant indoor environmental exposures to pollutants and consequent adverse health effects. It is often assumed that people living in lower economic areas are singularly at higher risk for adverse health effects associated with indoor environmental exposures, but social or cultural factors may have as much or more of an influence. For example, social determinants highly influence an individual's decision to smoke tobacco. Such social determinants include overall cultural acceptance of smoking, peer attitudes, family smoking history, advertising, and smoking policies.

In many instances, tobacco smoking is the most important contributor to high-levels of pollutants indoors. These pollutants are known to have carcinogenic, reproductive and/or acute or chronic respiratory effects. In most cases socio-economic factors often determine the type of stoves and fuels used for indoor cooking and heating, which in turn greatly affects the levels and type of pollutants released into the indoor air. Candles, incense and mosquito oil burning emit significant levels of particulate matter that has been associated with respiratory symptoms and other adverse health effects. Social customs and ideas influence personal activities that in turn may affect indoor exposures. Considering educational factor as a socio-economic determinant of exposure to indoor air pollution, the level of education might determine level of exposure to these harmful gases. Income level and education therefore affects the purchasing power of cleaning materials and building supplies. Poor building maintenance may lead to water intrusion, which encourages mold growth and deteriorating building structures, which provides access to the interior of the building and optimal nesting sites for rodents and insects.

Indoor Air Pollution Susceptible Groups

i. Children/Infants

Studies have shown that exposure of little children and infants to Indoor air pollution such as Nitrogen-dioxide (NO_2), Carbon-monoxide and Second-hand smoke cause respiratory issues such as cough, wheeze, shortness of breath and phlegm etc. Long term exposure of children to indoor fossil fuel burning can lead to chronic diseases such as Obstructive Pulmonary Diseases (Asthma). This is because the respiratory system of young children is considered to be more susceptible to environmental insults than that of adults. Environmental Tobacco Smoke is mostly harmful to children because their bodies are still developing.

ii. Elderly people

Elderly people with impaired pulmonary function and/or weakened defense systems may be at risk when exposed to Indoor Air pollutants. Exposure of elderly people to Formaldehyde and Second-hand smoke can lead to chronic respiratory diseases which might reoccur till the time of their demise. In elderly people over concentration of Carborn monoxide and particulate matter leads to cardiovascular diseases (diseases that results from narrowed or blocked vessels that can lead to a heart attack, chest pain (angina) or stroke.

iii. People with Existing Medical Problems

Smoking may also increase susceptibility to indoor air pollutants. In addition, patients already suffering from Chronic Obstructive Pulmonary Disease (COPD) are considered to be more susceptible than healthy individuals. Another susceptible group is people exhibiting an increased degree of nonspecific bronchial reactivity and/or asthma. Another group susceptible to contracting respiratory infections are those with any impaired ability to

fight off infections including persons with immuno-depressive conditions as associated with, for instance, AIDS and cancer; young children; the elderly; persons with existing disease such as chronic obstructive lung disease; and possibly those who may be more susceptible to infections due to exposure to irritating agents such as NO_2 which may damage mucocifiary cells etc. Persons with angina pectoris or with obstructed coronary arteries are susceptible to diseases resulting from carbon-monoxide.

iv. Women

The last susceptible group people are women. As highlighted by Krieger, (2003) there is clear distinction between exposure and susceptibility, there still exists a relationship between them. When a particular person is exposed to indoor air pollution, there is possibility of being affected by such pollution as compared to one that is not too exposed to it. Women seem to be more exposed to indoor air pollution because of their involvement in long cooking periods.

Theoretical Consideration

i. Epidemiological Triad Theory (ETT)

The Epidemiological Triad Theory (ETT) has three corners (called vertices). Each corner is referred to as vertex; (i) Agent, or microbe that causes the disease, (ii) Host, or organism harboring the disease (iii) Environment, or those external factors that cause or allow disease transmission. The agent is the cause of the disease. Hosts are organisms, usually humans or animals, which are exposed to and harbor a disease. The host can be the organism that gets sick, as well as any animal carrier (including insects and worms) that may or may not get sick. The environment is the surroundings and external conditions that cause or allow the disease to be transmitted. Some diseases live best in dirty water. Others survive in human blood. Still others, like molds, thrive in warm temperatures and moist environment. The theory revealed that diseases lie static in the environment but the way human interact with the environment determines how they contract the disease.

For instance air as one of the major component of environmental health if not properly interacted with can lead to different ailments in the environment. When air is contaminated by human activities and natural processes, the way one interacts with such component (air) determines if one will be affected by the disease or not. A good example is the availability of particular matter (PM) in the house, it is quite impossible not to have certain amount of PM in the environment but contracting the diseases depends to a great extent how we deal with the agent and how humans interact with their environment.

ii. Causal Pie Model (CPM)

This theory was proposed by Ken Rothman (1976) a member of the epidemiological faculty at BUSPH. He recognized that diseases outcomes have multiple contributing determinants that may act together to produce given instance of diseases. For example exposure to someone who as Tuberculosis does not necessarily result in the occurrence of Tuberculosis. Moreover, the set of determinant that produce Tuberculosis is in one individual may not be the same of conditions that were responsible for the occurrence of Tuberculosis in others. Rothman defined a sufficient cause as a complete causal mechanism that inevitably produces disease. According to him a sufficient cause is not a single factor, but a minimum of factors and circumstances that, if present in a given individual, will produce the disease.

Owing to the facts in this theory, when an individual is affected by an indoor pollution such as Asthma, there are factors that must have contributed to this which includes; exposure to air borne disease (Environmental Tobacco Smoke, Nitrogen-dioxide etc.), socio-economic factor (lack of ventilated buildings, inability to get pollution free cooking gadgets or energy source, cultural factors, level of illiteracy etc.), poor hygiene andabsence of steroid drugs to prevent asthma etc.

Methods

The descriptive research design was employed in this study. A total of two hundred (200) samples were selected using the quota sampling technique. Samples were selected from selected towns and villages under the Oye Local Government Area. Data was collected through the the use of questionnaire containing variables on sources of indoor air pollution, socio-economic factors contributing to indoor air pollution, health effects of

indoor air pollution and major susceptible groups to indoor air pollution. Result obtained was analyzed using the tables and charts.

Results and Discussion

Results on sources of pollutants revealed in figure 1a(see appendix) that, the condition of the houses and buildings in the study area constitutes primarily to the dusty nature of their apartments. This is because of the building materials used for their houses. In places like Imojo and Itaji-Ekiti where the houses there were predominantly mud houses, there seem to be more dust than the houses that are built with cement and other materials. It was also shown in figure 1brevealed that majority of the respondents get their cooking done through fuel-wood. As obtained in table 1a on the socio-economic factors contributing to Indoor Air Pollution in the study area, it was revealed that majority of the people were making use of firewood and unventilated stoves because they could not afford clean and safer cooking gadgets. Houses with low economic level make use of candles, incenses and mosquito coil which contributes significantly to the level of indoor air pollution.

Major health effects as shown in figure 2a revealed that the major irritation effects of Indoor Air Pollution (IAP) experienced in the environment were sore throat and excessive cold/phlegm which can be attributed to the presence of smokes in the indoor environment much of which can be sourced from the use of fuel wood and stoves. Exposures are increased most especially when the occupants do cook in their apartment and do not provide proper ventilation in their apartment. Data presented in figure 2b showed that the major respiratory diseases experienced in the environment wheeze and shortness of breath which was primarily due to the presence of particulate matter such as dust in their apartments. Other health issues experienced as presented in figure 2c include nausea, dizziness and frequent cough.

Results presented in table 2 revealed that the major susceptible groups to Indoor Air Pollution (IAP) were infants. This is because exposure to pollutants can easily cause damage to their cells and tissues since their immune system were not yet well developed to fight against such pollutants. In addition, infants cannot leave a polluted environment even when they are feeling uncomfortable. Result obtained also showed that people with existing medical conditions were also easily affected upon exposure to IAP. For example someone who already suffers from asthma; such person will be badly affected when exposed to pollutants and can aggravate such health issue.

Conclusion and Recommendations

It was discovered from the findings that the use of fuel wood and stoves are the major source of indoor air pollutants in the study area. Although majority of them cook outside their apartment, the smoke find their way into the rooms and constitute major pollutants in their apartments. Findings revealed that there are economic reasons behind their nature of energy consumption and most of the people were not aware of Indoor Air Pollution and its health effects. Health issues such as sore throat, excessive cold/phlegm, wheeze, shortness of breath, nausea, frequent cough were experienced due to presence of smoke in their apartment each time they cook and the presence of dust particles in their apartments when carrying out their chores. The major susceptible groups as highlighted in the results are infants which is because of their developing cells and tissues and not having the ability to fight against such pollutants. It was also discovered that people with existing medical conditions are also badly affected.

Based on the findings obtained it was recommended that proper planning should be considered when building apartment most especially as regards ventilation. In other words, the houses or apartment should be properly vented to allow the passage of air in order to reduce the concentration of pollutants in the apartments. Cleaner and safer cooking gadgets should be provided by the Government of the day freely or at low cost to people most especially to the people residing in rural communities due to their level of exposure and income level to promote good health. Governmental and Non-Governmental organizations should also ensure proper sensitization to increase level of awareness of people on Indoor Air Pollution and its health effects. Infants and little children should be taken away from apartments where there is presence of pollutants such as dusts and smokes while people with existing medical conditions should avoid being exposed to IAP.

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APPENDIX I

1. Source of Indoor Air Pollutants

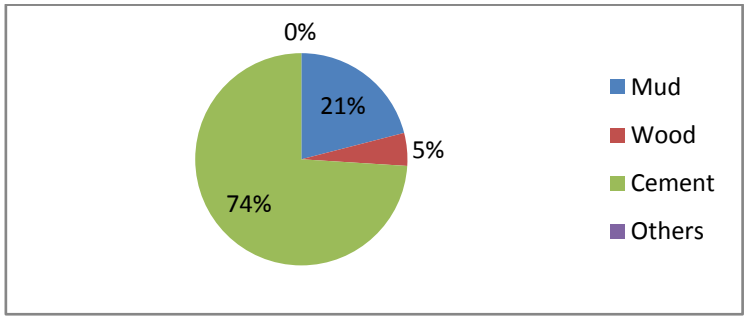

Figure 1a: Apartment Building Materials

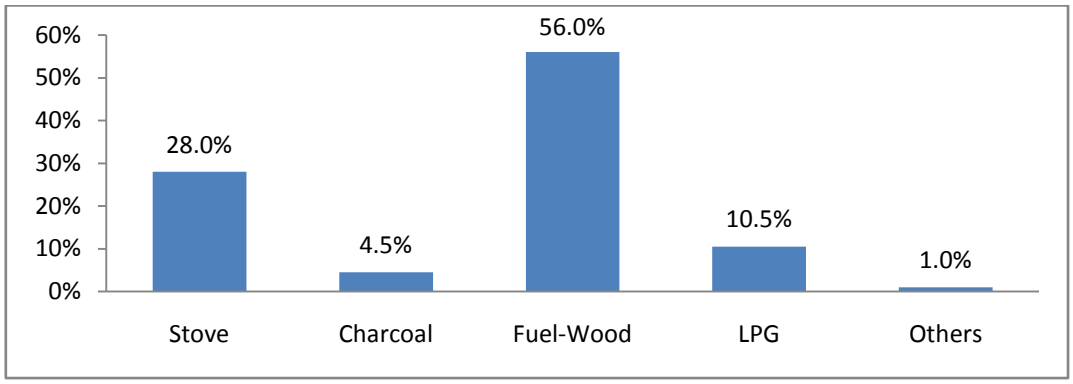

Figure 1b: Sources of cooking energy

2. Indoor Air Pollution and Socio-Economic Factors

Table 1: Socio-Economic Factors and IAP

Variable	Items	*f*	%
Job nature increases level of exposure to IAP	Yes	40	20.0
	No	160	80.0
There are cultural reasons behind type of apartment and cooking gadgets used	Yes	26	13.0
	No	174	87.0
There are economic reasons behind type of apartment and cooking gadgets used	Yes	133	66.5
	No	67	33.5

3. Health Effects and Major Susceptible Groups

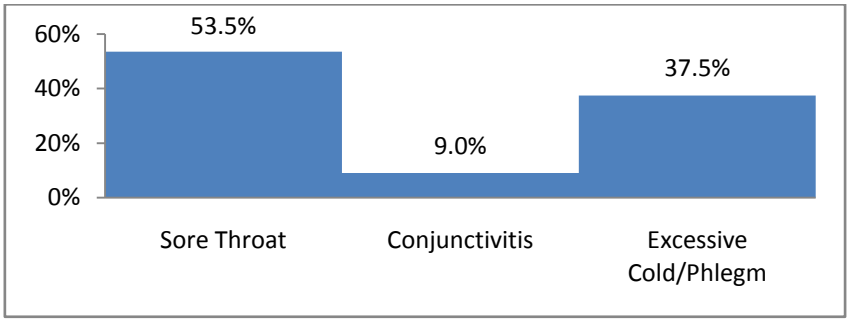

Figure 2a: Major Irrational Effect of IAP

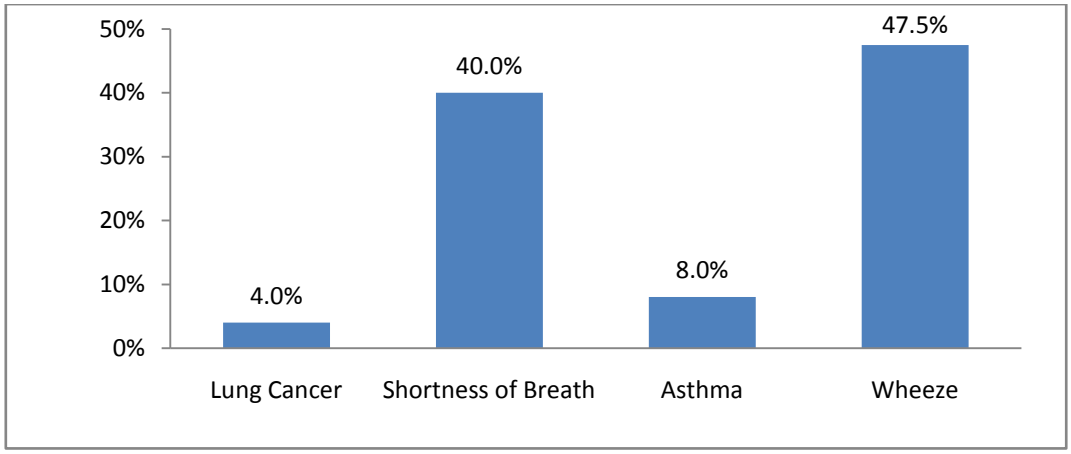

Figure 2b: Major Respiratory Effect of IAP

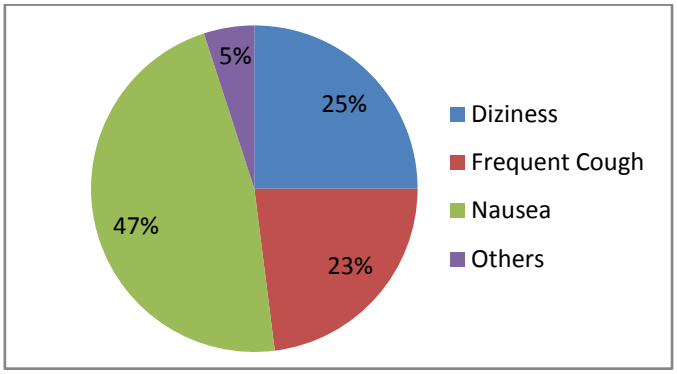

Figure 2c: Other health-related issues

Table 2: Major Susceptible Groups to IAP

Items	Frequency	Percentage (%)
Elderly People	34	17.0
Infants	105	52.5
Women	16	8.0
People with existing Medical Conditions	45	22.5
Total	**200**	**100.0**