RISK FACTORS FOR INDOOR AIR POLLUTION IN PERI-URBAN AREAS OF ADO EKITI, SOUTHWEST, NIGERIA

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Abstract: The level of indoor air pollution in buildings increases when households rely on biomass fuels for energy needs, thereby making them predisposed to health risks as a result of exposure to wood smoke. To examine households' risk factors of exposure to wood smoke, 350 homes in peri-urban areas of Ado Ekiti, Southwest, Nigeria, was selected for study. Using the convenience sampling technique, questionnaires were used to collect data on household characteristics, building types and construction materials, as well as on the ventilation and fuel types used by the householders. Majority (seventy eight percent) of the householders live in mud built corrugated iron roof type houses, with eaves and small windows ventilation. The main source of energy type used by ninety six percent of the householders for cooking activities is largely from wood fuel. The study identified poor ventilation and fuel type as the main risk factors contributing to the health problems of householders' due to exposure to indoor air pollution in the study area, with subsequent short and long term consequences.

Keywords: biomass fuel, indoor air pollution, risk factors, health impacts

INTRODUCTION

Biomass fuels (wood, animal dung, crop residues, sawdust etc.) are relied upon by around 80 percent of the rural households in the global South for their domestic energy source. In rural areas of Nigeria, biomass fuels are primary means of energy source with about 80million cubic metres of fuelwood used annually for cooking and other domestic activities [1], as it is the only accessible and affordable energy type in the area. Although biomass fuels play an important role in these rural areas, they unfortunately compromise air quality when burnt in open fires and poorly ventilated environments. The incomplete combustion of these fuels result in indoor air pollution (IAP) [2] which ranks among environmental risks in developing countries. Smoke emitting from the burning of the biomass fuels contain large amount of particulate matter and gaseous pollutants, and inhalation of these particulates have health consequences. In homes where biomass fuels are burnt for household energy use, the air pollution levels are often higher than the World Health Organisation (WHO) guideline values for 24-hour indoor levels set at 25µg/m^3 and mean annual of 10µg/m^3 for particulate matter ($PM_{2.5}$); carbon monoxide levels at 7mg/m^3 for 24-hours and 35mg/m^3 for 1-hour averages and a 20µg/m^3 sulphur dioxide average level for 24-hour [3]. Dasgupta *et al*. [4] study reveal important determinants of indoor air pollution among poor families in South Asia and Africa include, but not limited to fuel types, construction materials, space configuration, cooking locations and household ventilation. For example findings from Begum *et al*. [5] study in Bangladesh show that users of biomass fuels recorded particulate matter levels between 647µg/m^3 and 1068µg/m^3 in their kitchens. When Dasgupta *et al*. [6] conducted study on the potential sources of IAP with concentration level of particulate matter ranging between 68µg/m^3 and 4864µg/m^3, building construction materials and ventilation apparently contributed to poor ambient levels in buildings in the global South. The situation is further aggravated in buildings where rooms are partitioned in such a way that it did not get to the ceiling, this way there is easier air circulation of particulates within the building [7].

As householders spend some time in the polluted environments where biomass fuels are typically burnt indoors and in poorly ventilated buildings during cooking, exposure to the biomass smoke has overwhelming health risk either over a short term or long term period. There are evidence of association between IAP and health impacts – low birth weight, acute respiratory infections, cataract, chronic obstructive pulmonary disease, increase perinatal mortality and cancer [2, 8, 9]. Akune *et al*. [10] studied health risks from biomass fuel smoke in Burkina Faso and the result found link to acute respiratory infections in children. An association was also found between cooking fuel and ventilation in Bangladesh, which showed an increased risk of acute lower respiratory infections in the area [11]. The carbon monoxide emitted during the burning of biomass fuels when inhaled forms carboxyhemoglobin which reduces oxygen intake into the blood, a situation that causes headaches, shortness of breath, memory impairment and stillbirth [12].

With the magnitude of health impacts associated with IAP, it has not become the central focus of Nigerian government in developing clean energy polices for domestic use. Over the years, the Nigerian government has not taken actions to access, evaluate and control IAP, more so there is a high prevalence of respiratory problems in the country [13]. This survey therefore investigates risk factors contributing to health impacts when householders are exposed to IAP in peri-urban areas of Ado Ekiti, Nigeria.

MATERIALS AND METHODS

The study was conducted in peri-urban areas of Ado Ekiti, Nigeria among 350 households. The area lies between $7^0 40^1$ North of the equator and $5^0 16^1$ East of the Greenwich meridian with an annual temperature and rainfall of 27^0C and 1367mm respectively [14].
Prior to the final data collection in 2011, a reconnaissance survey was carried out in 2010 to have an overall idea of the study site. With the help of the community leaders, access was granted in conducting the study in eighteen communities. The convenience sampling technique was used in selecting the 350 households that participated in the survey. Questionnaires were administered amongst participants within the study area between February and June 2011 for data collection. Using questionnaires in each household, information on building types, construction materials, ventilation and fuel types used by householders were collected. Observations of householder's homes were also made. Research assistants recruited during the survey were daily supervised and debriefed on unclear matter. The data collected were coded and analysed with SPSS 17.0 and descriptive statistics was used to show the results.

RESULTS

The primary type of housing for the 350 households sampled indicates that 60 percent of the buildings are rows of single rooms where not less than four families inhabit. The sitting room and bedroom type of house is occupied by 34 percent householders and a far less common type of house – a bungalow with separate outdoor kitchen is used by 6 percent of the people in the communities. For a typical building where four families are resident, the average number of under-five years is four (range 1 – 4) and the average number of householders per building is 7 (range 1 – 15) in the communities. All households are headed by males in the area. Table 1 shows that houses are mainly constructed with mud and corrugated iron sheet roof (78.9 percent) and only a few buildings used mud/cement and corrugated iron sheet roof (6.3 percent) amongst the householders.
The mud building technique involves the use of adobe bricks (sun-dried-bricks) or wattle and daub (mud wall construction) and, the use of bamboo splints as reinforcements and coconut palm for the rafters. The watt and daub method used for the wall construction it is a mixture of straw, hay and earth and it does not require the use of mould blocks (Figure 1).

The building floors are constructed with mud (64.9 percent). The ceiling materials used by householders include sack (23.7 percent), bamboo with mud mortar (10.6 percent), and asbestos (5.1 percent), while 54.6 percent do cover their ceiling with any material. An observation made in the communities showed buildings have limited number of windows with each room having only one window in exchanging indoor air with outdoor air (Figure 1). The window used by 98 percent of the householders is about 45cm^2 and made of wood frame and shutter. To further increase lighting and aeration in buildings, householders do leave the main door opened during daytime as seen in Figure 1. The other type of ventilation present in the area is eaves (space left in between roof and wall). Most households (74 percent) had eaves of between 10cm to 15cm which is another form of ventilation in the study area. As observed while householders were cooking, the eaves allowed wood smoke to easily infiltrate into buildings.

Table 1: Building construction materials in peri-urban areas of Ado Ekiti

Construction materials	**n**	**percentage**
Mud & corrugated iron sheet roof	276	78.9
Mud & thatched leaves roof	29	8.3
Cement block & corrugated iron sheet roof	23	6.6
Mud/cement block & corrugated iron sheet roof	22	6.3
Total	350	100

Figure 1: A typical mud building

Table 2: Types of kitchen

Kitchen Type	**n**	**percentage**
Open space	253	72.3
Attached to the external building wall	65	18.6
Inside building	22	6.3
Separate building	10	2.9
Total	350	100

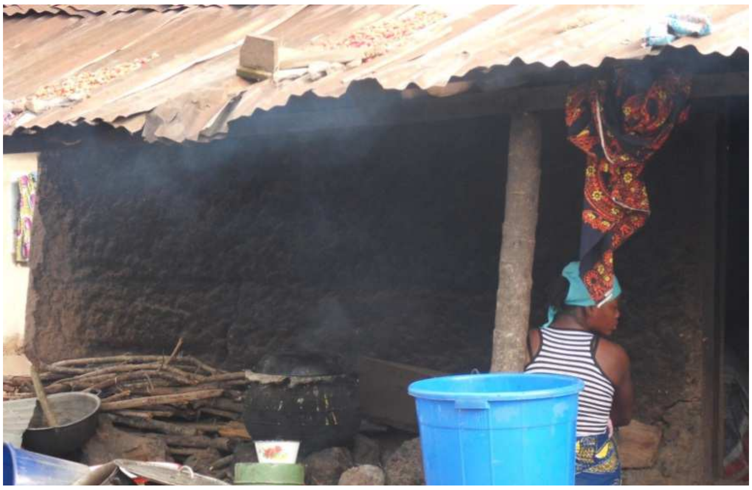

Figure 2: A cooking space attached to the external building wall

It was found that 96 percent of the householders largely depended on biomass fuel (wood) and 4 percent on kerosene for cooking activities. Wood fuel is always preferred by most households because it is freely gathered from the forest. In all the households sampled as indicated in Table 2, 72.3 percent used open spaces around their buildings to cook and 18.6 percent used the outside of the external walls of their buildings for cooking as shown in Figure 2.

The energy type (wood fuel) and ventilation used by householders in the study areas are among risks factors contributing significantly to health effects of exposure to particulates from IAP. During cooking activities, the incomplete combustion of the wood fuel usually result in high level emissions of particulates; these are inhaled by householders which has health effects on them over time.

DISCUSSION

Householders' in the study area have an average family size of 7 and with not less than 4 under-fives children per building occupied by at least 3 families. The single room building mostly occupied by householders in the communities is likely to be crowded as the number of windows in each is only limited to one per room and, with 74 percent of houses having eaves, indoor air is often polluted with outdoor air. Information gathered on fuel types used for cooking in the study area indicate that most households (96 percent) depend on wood fuel in meeting their domestic energy needs. Cooking is usually done in open spaces over traditional three stone stoves, a combustion process that is characterised by incomplete combustion resulting in emissions particulates and other inorganic compounds which breakdown as partially oxidized compounds usually result from this causing indoor air pollution in homes [15]. The use of wood fuel for cooking in open space by most of the householders in the study area allowed wood smoke to penetrate because houses mostly have large eaves; also wood smoke from neighbour's fireplace infiltrate into buildings because houses layouts are clustered which may not allow aeration of buildings in the communities. This result is comparable with Massey *et al*. [16] study in India where cracks and spaces in buildings allows particulates from the burning of biomass fuels to penetrate into buildings. In addition, the materials used for the construction of walls and roofs in this Ado Ekiti study is another way through which wood smoke leak from outdoors to indoor environment which further echoes Dasgupta *et al*. [4] finding. As earlier described, window size and its limited number contribute to inadequate aeration in buildings, this Ado Ekiti result further substantiate Moturi [17] study in Kenya. Poor aeration in buildings is one of the leading causes of acute lower respiratory infections in children [11] especially where biomass fuel is used as domestic energy, which is the case amongst households studied in Ado Ekiti. Housing characteristics according to Zuk *et al*. [18] is one factor that increases the risk of exposure to IAP in homes which the Ado Ekiti findings further confirm.

Studies in relation to wood smoke have found health impacts on householders. The inhalation of particulates from the burning of wood fuels has associated health risk; more so measured particulate matter levels for buildings in the study area exceeded the WHO acceptable limit for indoor air (33µg/m^3 - 541µg/m^3). As exposure to wood smoke has been associated with acute respiratory infections amongst children in Tanzania where biomass fuel is predominantly used for cooking [19], therefore children in the study area are predisposed to contacting acute respiratory infections. Annually in the world, acute respiratory lower respiratory infections account for more than 1 million deaths in under-five children who are exposed to biomass fuel smoke with symptoms of cough, convulsion, pneumonia and fast breathing [20, 21]. Though, hospital records of householders in the study area were not available to indicate the various diseases in Ado Ekiti, but, extrapolating from health impacts of exposure to IAP from studies in other developing countries point towards the same health risks in the area. Further work is needed to adequately characterise diseases among biomass fuel users in Ado Ekiti.

CONCLUSION

The present study shows that dependence on biomass fuel for cooking and the state of housing in Ado Ekiti contributed to risks factors promoting incidence of indoor air pollution in the area. While it is extremely difficult for the householders to make away with biomass fuels, cleaner fuels are not readily accessible and available in the study area, which make it difficult for them to overcome health risks associated with exposure to wood smoke. One of the short term mitigation against indoor air pollution in Ado Ekiti is to encourage the construction of separate kitchen and that which incorporates smoke hood in fireplace. In increasing aeration in buildings, more and bigger windows should be design for houses. Health impacts of IAP should be at core of providing intervention for the householders in other to improve and achieve healthier air quality amongst the householders.

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