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INDOOR ENVIRONMENTAL QUALITY OF HOUSEHOLDS RESIDENT DISTRICTS WITHIN OGBOMOSO TOWNSHIP, NIGERIA

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***ABSTRACT*—** The study examines the health risk associated with of housing design in three different residential districts located within Ogbomoso, Nigeria. Variables considered as determinants, based on households' survey and used for appraisal in this study include; quality of environment in terms of good layout, type of house/ building, volume of fenestrations and ventilation, mode of cooking and method of waste disposal etc. The goal was to identify the exposed population with rate or highest risk of health risks among residential households in Ogbomoso residential district. Both primary data and secondary data were used for the study. The study had area is Ogbomoso North Local Government area because it provides shelter for various backgrounds, races and ethnic cleavages. It is the seat of Ladoke Akintola University of Technology (LAUTECH) Ogbomoso which is a non- residential type, thus more houses constructed in order to accommodate both students and staff of the institution and the most important factor of development in the town. Making the development began to spread radically and farther away from the core areas of the town. The study area consist of ten wards which have three major district features of housing distinct types that provide shelters and other forms of land use. Thus, the three major residential blocks (areas) of the town were identified and were classified into three distinct density zones – low, medium and high. An area was then randomly selected to represent each residential density/zone to represent high, medium and low density areas respectively. The analysis is based on statistical estimation and concessions are based on the results obtained from these estimations. The findings indicated that different category of residential districts of the township has different housing design and attributes which thus dictate the rate of indoor health related problems peculiar to it hence broad generalization for the whole township could be erroneous.

Keywords: Indoor, residential, pollutants, air quality

I. INTRODUCTION

The health status of every individual is partly determined by the quality of air inhaled. Thus if air is polluted, the human system may become impacted by the range and quantity of pollutants in the atmospheric environment. The indoor spaces such as the main activity areas: sitting room/lounge and the kitchen form the main activity area of a residential building. The bedroom however is also a very vital functional space of which its design be given proper consideration in terms of space and ventilation. Time activity diaries revealed that, of the twenty four hours per day in the United States, most people spend approximately 22 hours indoors representing 92%. Approximately, 73% of this is spent at home (Fuhlbrigge and Weiss, 1997). This implies that a greater proportion of air respired by man is within the indoor. The air within an indoor environment may become as polluted as outdoor leading to different levels of health impairments. The greatest threat of indoor pollution, however, still occurs in the developing countries, where some 3.5 billion people mostly rural areas, continue to rely on traditional fuels for cooking and heating, (Ezzati and Kammen, 2001). Domestic activities such as cooking, heating of air for comfort especially in cold regions, burning and other activities like tobacco smoking in the home can add harmful substances to the indoor air. Among the forms of indoor pollution that may affect humans are tobacco, smoke and cooking fumes (Dodg, 1982). According to Jones *et al*., (1983), there is evidence suggesting that persons who live in

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houses in which LPG is used for cooking may have higher prevalence rates of respiratory symptoms, higher incidence rates of respiratory infections, and lower ventilatory lung function than persons who live in houses where electricity is used. Melia et al., (1977), found that more cough, chest colds and bronchitis were in children from homes where LPG stoves were used for cooking.

Traditionally, women do most of the cooking and their increased risk may be secondary to increased exposure. Studies have shown that environmental exposures can affect males and female differently. This is evidenced and supported by the study carried out by Jarvis *et al*., (1996) which revealed that there was high prevalence of reported exposure to gas cookers (59.4%) and open gas fires 53.9%. The researchers noted a number of important associations among the cross-sectional analysis of a stratified random sample of adults aged 20 – 44 years living in different communities in East Anglia, U.K. The important associations noted were on the use of LPG for cooking and its association within an increased risk of respiratory symptoms. The women who used LPG stove for cooking or who lived in homes with open gas fires had poorer lung functions than those without these characteristics. Of interest is the finding that these effects differed between the sexes with an increased risk being seeing only in women. Hormonal differences could also be another explanation for the effect modification by sex. It has been observed that adolescent girls were more vulnerable than boys to the effects of cigarette smoking on the growth of lung function. These sex differences may relate to the caliber of the airways or to hormonal differences. Muller and Schaeffer (1996) discovered that symptoms associated with chemical irritant are consistent with complaints due to problems with indoor air quality, which may include eye and upper respiratory tract irritation, headaches and nausea. Chronic effects include inflammation of the respiratory tract, which in turn reduces resistance to acute respiratory infections, while these infections in turn enhance susceptibility to the inflammatory effects of smoke and fumes (Hardoy, Mutlin and Satterthwaite, 1992). The effect of a pollutant is often expressed in the form of a dose-response relationship, for most indoor pollutants, the dose can be thought of as the amount of contaminants inhaled and reaching a particular part of the body, the dose is thus dependent upon the integrated exposure, the rate at which the individual takes in air, and the body's clearance rates for each contaminant.

The conscientious efforts made by various authors in the areas of indoor air quality and environmental indoor comfort had been noted in developed countries of the world, little information is available in Africa and precisely Nigeria especially as related to the design of residential building and ventilation pattern. Apart from studies by Ellegard (1996, 1997) and others who emphasized on occupational indoor air quality, little is known about the residential environment, design of houses and its relation to indoor air quality and comfort of its residents. Thus there remains yawning knowledge gap of the effect of indoor air pollution in residential environment. This study used direct questions of actual experience of residents of three different residential areas to identify and analyse the major factors considered as determinants of health risks among residential household in Ogbomoso residential district and to use the result to generalize for similar urban areas in South West Nigeria.

II. LITERATURE REVIEW

Indoor air quality is an important aspect of indoor living requirements because of the increased recognition that most people spend between 80% and 93% of their time indoors (Liu and Little, 2012; Guieysse et al., 2008). According to Jelili et al (2020) air quality problems are experienced in both developed and developing countries and epidemiological studies have demonstrated correlation and causal relationship with various ailments. In 2011, Delgado-Saborit *et al.* (2011) studied the time 100 British subjects spent in different environments and confirmed that 87%–91% was indoors. Another study claimed nearly 25% of US residents are affected by poor indoor air quality either at work or home (Guieysse *et al*., 2008). This differentiation between workplace and home is significant, because Delgado-Saborit *et al.* (2011) found on average for their participants that 62% of their time indoors was at home, 16% at work, 12% in other indoor environments,

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and 5%–7% commuting, with the average time outdoors ranging between 2% and 5%. These figures translate to an average of 14–15 hours/day at home and only 30–75 minutes/day outdoors. These proportions signal that indoor air quality at home could be an important factor in people's health. However, more recent studies are indicating indoor air quality in homes is generally poorer than in offices and other public buildings (Nielsen et al., 2013; Wolkoff and Nielsen, 2010). The focus on improving ventilation and air filtration systems still relies on removing the indoor air pollution once it happens, rather than removing the pollution sources. Spaces with poorer ventilation protocols, like dwellings, have not been addressed to the same level, despite the fact as stated above that people spend most of their time at home. Smith et. al., (2003) reiterates that poor indoor air quality has claimed over 1.6 million lives and has left 38.5 million disabled around the world at the dawn of the twenty first century. The situation is so critical that reduction of indoor air pollution is a component of the United Nations' Millennium Development Goals (United Nations, 2005). The World Health Organization (2007) also establishes causal relationships between indoor air pollution and Acute Lower Respiratory Infections (ALRI) among children, Chronic Obstructive Pulmonary Disease (COPD) and lung cancer among adults. Thus the need for increased research efforts on air quality especially on indoor air quality and its associated health risks as it is more harmful inside homes and buildings where people spend most of their time.

A model of air pollution impact (API) assessment by Hertel, De Leeuw, Raaschou-Nielsen, Jensen, Gee, Herbarth, Pryor, Palmgren and Olsen, (2001) where API was applied and the (Drivers, Pressures, State, Impact, Response- DPSIR) model of intervention developed in the Particulate Matters (PM) was used as a surrogate measure of air quality in this study Present Particulate matters are pollutants formed by a complex mixture of organic and inorganic substances. They are released during certain operations, such as transport (movement of automobiles) and open storage of solid materials. They also come from combustion of wood and other biomass fuels. Other sources include exposed soil surfaces, including unpaved roads, dust, aerosols, environmental tobacco smoke (ETS) and building materials.

A series of studies have found that the unusually high levels of pollution caused by the fires had significant negative impacts on health. Frankenberg and Emmanuel (2000) found an increase in respiratory related hospitalizations in nearby Singapore. McKee and Thomas (2005) compare adults in high and low smoke areas, both before and after the fires, and find that pollution impacted individuals' abilities to perform strenuous activities and other health outcomes. Jayachandran (2006) also found that the smoke caused by the fires led to an increase in infant mortality rates and estimated that the pollution that was induced by the fire led to approximately 16,400 fewer surviving infants in Indonesia. Ambient particulate matter (PM) is a useful measure of air quality within residential environments. According to Lee *et. al.* (1996) particulate matter includes a wide variety of substances including dust, pollen, dander, airborne smoke, and pollen, dander, airborne smoke, and combustion. The air quality group (2020) described particulate matter (PM) as condensed phase (solid or liquid) particles suspended in the atmosphere and it is categorized by size, specifically by aerodynamic diameter in microns (millionths of a meter). A study in Lagos using an air quality index derived from computations with set standards revealed very poor air quality from suspended PM across selected sampling locations and zones within the state (Njoku *et al*, 2016).

III. METHODOLOGY

Types and Sources of Data

Two major types of data were used for this study. These include primary and secondary data. Primary data is the data collected by the researcher from the field through questionnaire survey, and administration, direct observation, oral interview, reconnaissance survey and participant observation. The secondary data were obtained from books and journals and magazines. These however are works of other persons other than the researcher this are not original

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work of the researcher but have been adopted and used by the researcher to make the work more useful and applicable.

Method of Data Collection

Ogbomoso, the second largest town in Oyo state, Nigeria after the capital city Ibadan, is a town situated within the derived savannah region. It is the boundary to Ilorin; the gateway to the Northern part of Nigeria. From the south Ogbomoso is 57km South-West of Ilorin(capital city of Kwara state), 53km North-West of Osogbo(capital of Osun state) and 104km North-East of Ibadan(capital of Oyo state). The Lagos-Ibadan –Ilorin North bound trunk A road passes through Ogbomoso, so also is the proposed Ibadan-Ilorin expressway still at the construction stage. The town was divided into two local government areas in September, 1991 to form Ogbomoso Northern and South Local Government Areas (Oyeyinka, 2008).

This study however had chosen Ogbomoso North Local Government area as its study area. The town provides shelter for various backgrounds, races and ethnic cleavages. It is seat of Ladoke Akintola University of Technology (LAUTECH) Ogbomoso which is probably the most important factor of development in the town. This is because the University is a non – residential type thus more houses constructed in order to accommodate both students and staff of the institution. Therefore development began to spread radically and farther away from the core areas around the institution, at the outskirts of the town and towards Ilorin.

The Ogbomoso Local government area consist of ten wards which have three major district features of housing distinct types that provide shelters and other forms of land use. Thus during the reconnaissance survey for this study, the three major residential blocks (areas) of the town were identified and were classified into three distinct density zones – low, medium and high. An area was then randomly selected to represent each residential density zone. Areas selected were, Papa Alajiki, Oke – Aanu and Isale General to represent high, medium and low density areas respectively.

IV DATA ANALYSIS / RESULTS & DISCUSSION

In Table 2 shows that 38.61% are males; while female respondents accounted for 61.39% of the total population. This implies that the female genders who are mostly users of home based activities were well represented in this study, thus one expects a high level of information concerning the experiences as related to indoor environments quality of household's residents districts in the study area. However, the occupation distribution as shown in Table 3 reflected that a larger percentage of the respondents fall under public/government jobs (28.5%). These include teachers, bankers, company workers lecturers and administrative workers. This is followed by professionals and traders which accounted for 48.4% of the respondents. 10.0% of the respondents are students while 7.6% are not yet employed.

Table 4 revealed that 48.2% of the buildings in the study area were Brazilian type, 10.0% were of duplex type while 28.5% and 13.3% were flat and storey type respectively. This shows that Brazilian and storey building were many in the study area. Only 12.03% of the buildings were of standard while majority 61.39% were sub-standard. The table also revealed that half (50.0%) of the buildings were between 0-10years of age. Only 7.59% were above 30 years. Majority 52.53% of the buildings were fairly accessible while 20.25% were not accessible at all. Only 21.22% have good accessibility which shows that there is need for proper road connectivity and maintenance in the study area.

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Table 1: Selected Residential Density area and Sample Size

Selected Locality within the residential density area		No of streets within the localities	No of street selected (10%)	No of houses within the streets	Sample Size (20%)
High:	Papa Alajiki	29	3	317	64
Medium	Oke Anu	35	4	238	48
Low	Isale general	29	3	126	26
Total		93	10	681	158

Table 2: Sex of Respondents

Sex	Frequency	Percentage (%)
Male	61	38.61
Female	97	61.39
Total	**158**	**100**

Table 3: The occupation distribution of Respondents

S/N	Type of occupation	Frequency	Percentage
I	Public/government	45	28.5
Ii	Professionals	38	24.1
Iii	Trader/Business tycoon	38	24.1
Iv	Retiree/Pensioner	16	10.0
V	Student	12	7.6
Vi	Unemployed	6	3.8
Vii	No response	3	1.9
Total		**158**	**100%**

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Table 4: The Housing characteristics of the Respondents

S/N	Variables	Frequency	Percentage
a.	Types of building		
	(i) Brazillian	76	48.2
	(ii) Duplex	16	10.0
	(iii) Flat	46	28.5
	(iv) Storey building	21	13.3
b	State of building		
	(i) Standard	19	12.03
	(ii) Substandard	97	61.39
	(iii) Dilapidated	42	26.58
C	Age of dwelling		
	(i) 0-10	79	50.0
	(ii) 11-20	54	34.18
	(iii) 21-30	13	8.23
	(iv) above 30	12	7.59
d.	Accessibility of buildings		
	(i) Highly accessible	43	27.22
	(ii) Not accessible	32	20.25
	(iii) Fairly accessible	83	52.53
e.	Quality of buildings		
	(i) Good	7	4.43
	(ii) Very good	21	13.29
	(iii) Satisfactory	38	24.05
	(iv) Fair	34	21.52
	(v) Poor	58	36.71
Total		**158**	**100%**

Table 5: Demographic presentation of respondents with various types of cooking fuel

	LPG	Kerosene	Fire wood	Charcoal	Total
Male	13	35	-	13	61
Female	11	30	32	24	97
Total	24	65	32	37	158
Percentage %	15.2	41.1	20.3	23.4	100%

Table 6: Kitchen type in the residence

	Low density	Medium	High	Total	Percentage (%)
Indoor type	18	20	14	52	32.91
Outdoor type (detached)	7	32	34	73	46.21
Improvised type	-	13	20	33	20.88
Total	25	65	68	158	100.0%
%	15.82	41.14	43.04	100%	100%

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Table 7: Method of waste disposal

Mode of waste disposal	Low	Medium	High	Total	%
Open dump	13	25	35	73	46.2
Incineration	-	-	-	-	0
Gutter	-	6	7	13	8.23
Approved waste collection site		18	5	23	14.56
Burning	8	15	19	42	26.58
Drum/sack and later collected by collectors	3	2	2	7	4.43
Total	24	66	68	158	100%
Percentage %	15.19	41.77	43.04	100%	

Table 8: Prevalence of Pulmonary and Non – Pulmonary symptoms among respondents with various cooking fuel

Symptoms	LPG	Kerosene	Firewood	Charcoal
	24	65	32	37
Pulmonary symptom				
Tears while cooking	4	6	23	1
Eye irritation	2	12	15	-
Eye discharge	-	6	12	-
Conjunctivitis	-	4	9	1
Non – pulmonary symptoms				
Nasal – catarrh	4	10	20	1
Wheeze	1	3	5	-
Shortness of breath	2	3	4	-
Cough	6	9	15	3
Sputum/Phlegm production	2	5	12	2
Tightness of chest	1	2	11	1
Chest pain (for 3 months)	1	7	6	1
Heamoptysis	-	-	-	-
At least a respiratory symptom	1	5	15	2

The type of cooking fuel used in each of the household among the respondents is shown in Table 5. This however may be due to the high cost of purchase of LPG and its availability. Majority (41.1%) used kerosene cooking fuel while 23.4% used charcoal. This is followed by the use of kerosene which accounted for 20.3% of the respondents while only 15.2% of the respondents use LPG for cooking. This may be due to the high cost of purchase of LPG as cooking fuel. Majority of the residents in the high density area of the study area use kerosene and charcoal since these are the cheapest and easiest type of cooking fuel used in the type of rooming houses (Brazilian type/face to face) they live. Table 5 below shows the type of kitchens available in the study residences of the respondents in the study area. Majority, (46.21%) of the respondents use outdoor kitchens for their cooking while 32.91% of the kitchens are indoor type. Only 20.88% use improvised kitchens. These include corridors, common passages and verandah/balcony of the respondents' houses. The implication of this is the fact that since majority 43.7% of the respondents from Table 5 use firewood and charcoal

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for cooking it follows that these set of people will always have such activities done in the open or detached area from living areas in order to prevent air pollution and to avoid prevalence of pulmonary and non – pulmonary symptoms of cooking with the use of these types of fuel. The improvised (20.88%) cooking areas in the study area include; passages/corridor of the residences (as common with face – to – face rooming apartments-Brazillian) and verandah/balcony of some houses especially in the residences of the students (hostels). Table 7 shows the different types of mode of waste disposal in the study area according to the density area studied. Almost half (46.2) of respondents get rid of their wastes by open dump system while 26.58% of them get rid of their domestic waste by direct open burning. Only 14.56 of the respondents use approved waste collection site by the local waste management board.8.23% respondents dispose their waste in the open drainage(gutter) while raining while the rest 4.43% use drum and sack to store their waste and dispose them later in approved site or through the waste collection truck that comes to the neighbourhood weekly. The implication of the above is that many of the respondents in the study area are still primitive with their mode of waste disposal. There is therefore the high probability of air pollution in the study area irrespective of the density area.

In addition to this, the odour level requirement for minimum health ventilation usually involves a greater air supply than would be indicated by the oxygen and carbon dioxide levels and thus, is the more suitable criterion for ventilation although more difficult to measure. The level of odour contributes considerably to comfort and well – being of the occupants of a house generally. The fresh air supply to an occupied room should be sufficient to remove perceptible odours. The amount required varies according to the social standards of acceptability the number of occupants, their cleanliness and habits, particularly of smoking. Minimum ventilation requirements are of special importance in internal kitchens bathrooms and lavatories, away from direct outside connection through windows.

Since level of odour is difficult to measure quantitatively the researchers had tried to use qualitative means to determine perceived level of effect of ventilation and odour in the residences of the respondents as related to different types of pulmonary and non – pulmonary symptoms associated with indoor ventilation and odour. This is as shown in Table 8. The highest complaint of the respondents is tears while cooking. This is followed by nassar –catarrh with the users of firewood experiencing the symptoms, followed by users of kerosene. Cough and eye irritation are other prevalent symptoms of the users of fire wood cooking fuel.

V. CONCLUSION

This paper revealed that of all the commonly used cooking fuel, firewood has a high potential of increasing air pollution in indoor environments as compared to LPG and kerosene fuel and charcoal. Cooking with firewood which often times is a function of economic and social status of the subjects requires adequate and proper ventilation in order to control indoor pollution during and after cooking. The culture of using open (exposed) kerosene lamp as alternative to electricity in some of the residences where kerosene is used for cooking should be discouraged for the purpose of improved public health and to prevent fire hazard. Majority of the residences of respondents lack cross ventilation which signifies/ implies the presences of high level of unpleasant odour within the indoor of the houses. It is recommended that adequate window width/wall width ratio and window area/wall area ratio be adopted before any building could be approved by the planning authority in the future. This however, should be adhered to during erection and construction stages of all building. The issue of a change in use of some residential units to commercial use should be looked into. Some of the already constructed buildings for residential purposes are being converted or additional structures being added to disfigured and truncate the proper ventilation of the buildings. There is need for the planning authority to enforce the ‘Stop work’ action on any of properties that has not undergone proper approval through them. The government can enforce this by carrying out demolition exercise on unapproved structures in the town.

Lastly, there is need for proper waste management and more enlightenment of respondents on the advantages of proper disposal of domestic wastes. A certain amount should be introduced as 'fine' to curb indiscriminate disposal of wastes. This is with a view to eradicate any outdoor pollutants that can affect the healthy living of the residents. There is need to investigate more on the effects of outdoor air quality (environmental quality, pollutants from automobile, waste disposal and the likes) and its effects on the residents of the area of study.

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BIOGRAPHY

Dr. Adeoye D. O. is the lead author of the manuscript. She initiated the research and had pilot survey to the study area, conducted oral interviews with the occupants of the building.

Mr. Oladimeji S.B wrote the section on the literature review and the information on study area.

Mr. Alabi Abimbola saw to the research methodology and provided a framework for the analytical tools for the study. He also assisted in the analysis of the data collected during the research.

Arc. Akindele O.A assisted in the interpretation of the analysed data and the write up for the research report with other researchers.