Health Risk Assessment of Residential Characteristics and Indoor Air Quality of Naturally Ventilated Homes in Nigeria

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1 - INTRODUCTION

Nigeria as a developing country has a growing population of over 191 million people. More than one-third live below the poverty line in areas and houses with low environmental standards. According to Krieger and Higgins (2002), houses built to low environmental standards tend to have poor ventilation and indoor air quality, which exacerbate indoor airborne disease transmission and other health-related problems. This is linked to changing patterns of disease transmission particularly among low-income people residing in unplanned traditional core areas of towns and cities (Frumkin, 2002).

AIM

The study aims to obtain pilot data on the relationships between IAQ, housing design and health in Nigeria, with a longer term goal to develop a framework assessment to support future residential building design.

2 - METHODS

The study was conducted in Bauchi metropolis, Nigeria (Fig.1). A signed informed consent was obtained from each participating household (n = 116) before collecting data:

- building characteristics through an audit
- questionnaire on indoor environment and health complaints
- indoor CO_2, PM2.5 and PM10 particulate matter recorded in a bedroom with Airnode sensors.

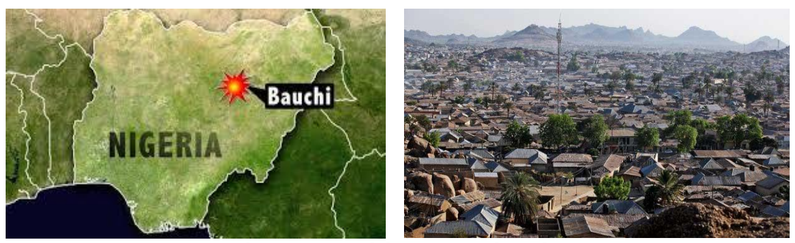

Fig 1: Bauchi state, Nigeria

Analysis compared measured data to building characteristics and reported health issues. IBM SPSS Statistics 23 was used for descriptive analysis, Odds ratios, and Pearson Chi-Square test and the Fisher exact test where the cell size was less than five. The critical level of significance of 5% for all statistical tests (two-tailed) was used.

3 - RESULTS

The majority (47.6%) of the households earned below N20, 000 ($50) monthly (i.e. about $ 1.25 per day) for a household with an average size of four family members. A wide range of house types were surveyed including traditional compound, flats, detached, semi-detached and informal

The measured CO_2 (mean 584 ppm, range 403-2201ppm) indicated that the ventilation was generally good. Many houses were in secured fenced compounds with a courtyard design so occupants could safely leave their windows open (Fig.2).

High level of particulate matter (PMs) was found within most of the buildings (79.5%) indicated by the mean concentrations of PM2.5 (63 µm/m^3) and PM10 (228 µm/m^3). These values exceeded the WHO Guidelines (i.e. 24-h mean) for PM2.5 (25µg/m^3) and PM10 (50 µg/m^3). More than 50% of the households used kerosene, firewood and charcoal for cooking purposes.

Table 1: Correlation between indoor air quality ($PM_{2.5}$ and PM_{10})/ventilation (CO_2) and effects on health

Variables	Participants' Responses	F	%	$PM_{2.5}$		PM_{10}		CO_2		Remarks	
				R_{pb}	Sig	R_{pb}	Sig	R_{pb}	Sig	No response	Total
Incidence of Tuberculosis	No	63	45.3	0.093	0.452	0.097	0.431	-0.047	0.703	48	116
	Yes	5	4.3								
Incidence of Pneumonia	No	52	44.8	-0.080	0.510	-0.044	0.714	0.136	0.257	45	116
	Yes	19	16.4								
Incidence of Asthma	No	63	54.3	-0.074	0.541	-0.068	0.577	0.085	0.482	46	
	yes	7	6.0								
Incidence of Meningitis	No	52	44.8	0.050	0.683	0.003	0.982	-0.008	0.948	48	116
	Yes	16	13.8								
Incidence of Measles	No	48	41.4	-0.35	0.777	-0.114	0.360	0113	0.362	49	116
	Yes	19	16.4								
Incidence of Chickenpox	No	49	42.2	0.177	0.133	0.285	0.014	0.081	0.494	43	116
	Yes	24	20.7								
Incidence of Influenza	No	28	24.1	-0.115	0.299	0.055	0.622	-0.161	0.146	33	116
	Yes	55	47.4								
Incidence of Malaria	No	3	2.6	-0.072	0.470	0.022	0.827	-0.008	0.939	12	116
	Yes	100	86.2								

The PMs and CO_2 was negatively correlated to most of the health issues reported but positively correlated to the incidence of tuberculosis, meningitis and chicken pox. In most of the cases none of the relationship has its p-value as being less than 0.05 except in the case of chicken pox where R_{pb} = 0.285, $p < .05$ (Table 1).

Fig 2: Houses built around courtyard within fenced walls with windows left open

4 - CONCLUSIONS

This study demonstrates the potential influence of residential building characteristics on occupant health in Nigeria. Results suggest high PM concentrations and building characteristics such as the type of housing unit, materials and window type may influence health, including risk for some diseases such as tuberculosis, asthma and meningitis.

Although the study is limited by small sample size and self-reporting of health issues, data suggests a need for more in depth research to explore potential correlations. Despite this, the high incidence of health symptoms and poor IAQ measured indicate residential building characteristics in Nigeria require attention for public health action.

5- ACKNOWLEDGEMENTS

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