Provisional chapter

Housing Quality and Risk Factors Associated with Respiratory Health Conditions in Nigeria

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Additional information is available at the end of the chapter

Abstract

This chapter presents an overview of the condition and quality of housing in Nigeria and its implication on respiratory health. Addressing housing issues offers public health practitioners an opportunity to assess an important social determinant of health. This chapter detailed the housing characteristics in Nigeria and revealed that respiratory health conditions, especially among children is associated with certain environmental factors that perturb the composition of the indoor air, and thus the housing quality. Drawing on this perspective, this chapter pursues the following questions: (1) What are the factors that affect the quality of housing where people spend most of their time daily? and (2) Given the housing condition in Nigeria, what housing-related factors influence the prevalence of respiratory health conditions especially among children? In the course of the discussion, we described the meteorological conditions of houses in relation to respiratory conditions, established a link between indoor air and housing quality, and elucidated the indicators for evaluating housing quality. Drawing on the associated risk factors, it argues that the quality of housing, including the external and internal structures, as well as the internal environment has a selective force on the respiratory health status of its occupants.

Keywords: housing quality, risk factors, respiratory health conditions, Nigeria

1. Introduction

Housing, as a neglected site for public health action, has been identified as a major risk factor in a number of recent studies globally [1, 2]. The quality of housing where people

spend over 80% (3/5) of their time daily is crucial for healthy living and people's well-being. The notion of housing, however, encompasses a very large number of factors, including biological (mould, cockroaches, dust mites, etc.), chemical (tobacco smoke, paints, etc.) and structural (moisture, ventilation, etc.). Housing is therefore the process of providing a large number of residential buildings with adequate physical infrastructure and social amenities (services) in planned, decent, safe and hygienic neighborhoods to meet the basic and special needs of the population [3, 4]. Housing conditions play a major role in the health status of the individual and a wide variety of housing features have been reported to influence the physical, social, economic and the mental well-being of occupants [5]. WHO [6] stated that housing should provide: protection against communicable diseases, protection against injury, poisoning, and chronic diseases, and reduce psychological and social stress to a minimum. The problem of deficiency in housing quality in Nigeria is common both in the urban and rural areas. The situation is very severe in urban areas due to the fact that most people live in houses that are of poor quality with unsatisfactory environment. The population growth resulting from rural-urban migration and rapid urbanization therefore leads to homelessness, the growth of slums and overcrowding [7–10]. Among the diverse environmental concerns facing developing countries including Nigeria, housing is probably the most fundamental. In the developed countries, numerous studies have associated poor quality housing with increased prevalence of respiratory symptoms in children as well as adults [11]. Drawing on previous studies, there are few studies from the developing countries particularly Nigeria, where a large percentage of the population live in substandard apartment, in which the housing conditions in terms of the building structure and the surrounding environment are unhealthy.

2. Component of housing quality

Components of housing quality are the measures used to assess housing scheme based on quality rather than cost [12]. Quality housing should provide adequate protection from cold, damp, heat, rain, wind, structural hazards, diseases vectors, and other threats to human health. However, the quality of the internal environment is also important. The components of housing quality measurement should ideally include the external structure, the internal structure, the internal environment coupled with an assessment of the neighborhood and environmental sustainability as described in **Figure 1**. The external structure is described by the structural integrity of the building, weathertightness, security, integrity of the external materials and insulation. The presence of basic facilities such as water supply, sewage disposal, power supply and other internal facilities such as closed doors, secured electric wiring, tightened windows explain the internal structure of the building. The internal environment is described in terms of ventilation, lighting, indoor air quality and moisture. A broader assessment of the quality and safety of the neighborhood in terms of community facilities, quality of paths/streets and services coupled with environmental sustainability forms an integral component of housing quality.

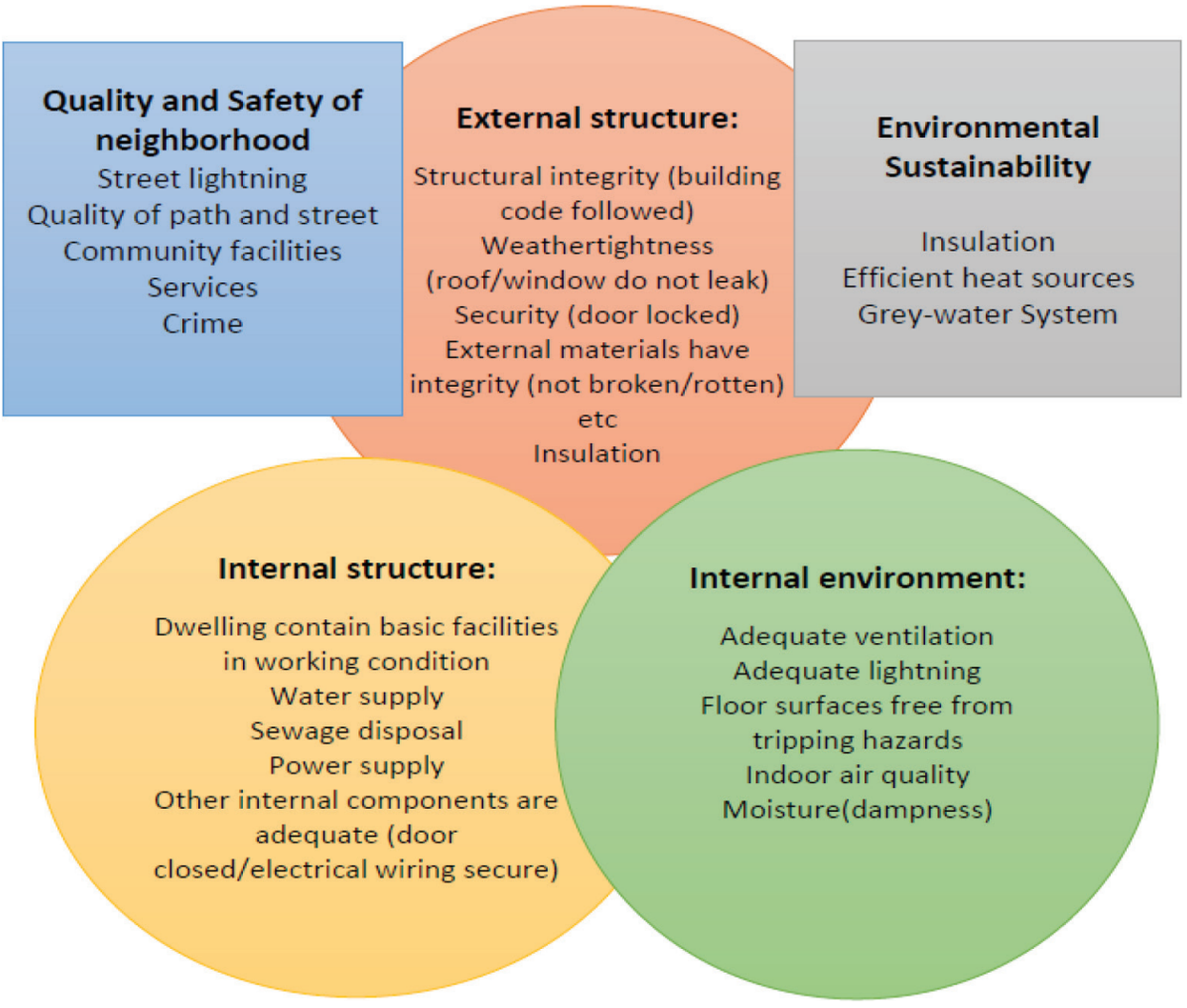


Figure 1. Component of housing quality. Source: Statistics New Zealand Information Centre.

3. Brief profile of Nigeria

Nigeria is the most populous nation in Africa with over 155 million people [13]. Based on 2010 Gross National Income (GNI) per capita, the World Bank classified Nigeria as a "Lower Middle Income Economy," i.e., GNI ranging from $1006 to $3975. Nigeria is situated in western Africa on the Gulf of Guinea and has a total area of 923,768 km^2. It shares a 4047 km border with Benin (773 km), Niger (1497 km), Chad (87 km) and Cameroon (1690 km), with a coastline of at least 853 km. Nigeria is between latitudes 4° and 14°N, and longitudes 2° and 15°E. The country has more than 500 ethnic groups, out of which the Hausa, Yoruba and Igbo are the largest. Nigeria is the 12th main manufacturer of petroleum in the world and the 8th major exporter, and has the 10th largest proven reserves. Petroleum plays a large role in the economy of Nigeria, accounting for 40% of GDP and 80% of Government earnings.

4. Housing conditions in Nigeria

At the national scale, [14] studied 40 cities cutting across various Nigerian city typologies. He noted that as a result of low building technology and absence of durable building materials, not more than 9% of houses were built of mud and bricks which had very short life spans. He further reported that the only cities with a reasonable percentage of buildings older than 80 years were the coastal towns located on sea and river ports and few other hinterland cities that formed contact points for colonial trade and administration [14].

A study carried out by [15] studied the association between housing conditions and health status among households in Nigeria's deserted rural areas, with specific focus on rural Akwa Ibom State. They revealed that rural household in Akwa Ibom State suffered marked deficiency in all the five indicators of housing examined. The safety and security apparatus of the households indicated that 92% of the households lacked fire extinguisher in their homes, 73% had no first aid box while 78% lived in fenceless houses. In terms of indoor temperature/ventilation, 66% reported having no ceiling in their rooms while 41% lived in homes with bedrooms lacking windows on two walls [15]. The study also revealed that 60% of the households live in houses with leaked roof, cracked wall (56%) and broken windows (54%) while 75% of the household lived in houses with broken floor condition (**Plate 1**) [15].

According to a study by [16] in the urban setting of Nigeria, the quality of housing was reported to be very poor due to the quality of building materials used for construction, and poor planning standard in handling the building components. Sun dried blocks and muds accounted for materials mostly used for building in the study area. Only 7.69% of buildings were reported to be in good condition (see **Figures 2** and **3** for details).

A case-control study carried out in Ibadan among under-five children with and without acute respiratory infections [17] revealed that more cases than controls reside in houses with poor housing quality (OR = 2.5; CI = 1.3–5.1, $p < 0.05$) (**Table 1**). A large proportion of houses of cases than controls showed the presence of damp walls (OR = 2.9; 95% CI = 1.1–8.1). Similarly,

(A) **(B)**

Plate 1. (A) Slum houses and (B) a typical building in a riverine community of Nigeria.

a large proportion of houses of cases than controls recorded the presence of algal growth on walls (OR = 6.3; 95% CI = 2.0–19.6). More houses among cases than controls were built using muds (OR = 4.6; 95% C.1 = 1.6–12.8) [17].

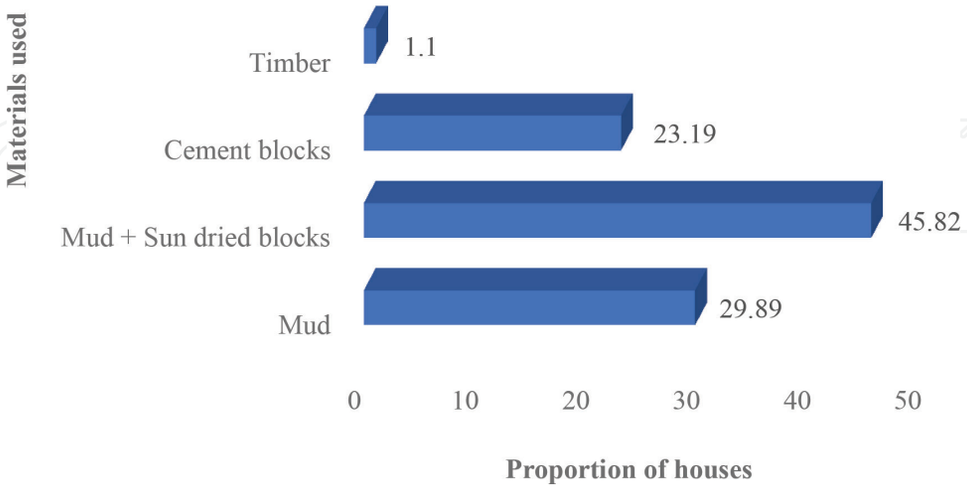


Figure 2. Materials used in building.

Figure 3. Physical conditions of buildings. Source: Owoeye and Ogundiran [16].

Category/score		Control		p-Value
Case		Poor	Good	
	Poor	18 (41.9%)	25 (58.1%)	0.017
	Good	10 (43.5%)	13 (56.5%)	

Source: Fakunle et al. [17]

Table 1. Relationship between housing quality and ARI.

5. Indicators for evaluating housing quality

In assessing the quality or suitability of housing, qualitative studies have identified some criteria as relevant indicators for quality evaluation in residential development. Among such is [18] who acknowledged aesthetics, ornamentation, sanitation, drainage, age of building, access to basic housing facilities, burglary, spatial adequacy, noise level within neighborhoods, sewage and waste disposal and air pollution among others, as related quality determinants in housing. However, [19] concluded that qualitative housing involves the provision of infrastructural services, which could bring about sustainable growth and development through improved environmental conditions and improved livelihood. In determining the quality of residential development, [20] stipulates five basic criteria which include compliance with tolerable standard, free from serious disrepair, energy efficient, provided with modern facilities and services, and that it must be healthy, safe and secure.

There are however indications from these various studies that a single variable may not be sufficient to assess the qualitative nature of residential development; therefore, housing acceptability and qualitative assessment should also take into account type of constructions, materials used, services, spatial arrangement and facilities within dwellings, function and aesthetics, among others [21].

6. Urbanization and housing quality

As a result of urbanization and lack of economic opportunities in rural areas, many people move to the urban areas that are already dealing with issues of overcrowding, infrastructure and high cost of living. As a result, most people are forced to seek shelter in slums and urban fringe. United Nation Habitat in 2006 found that 90% of slum residents are in the developing countries with struggling economies. In addition, most urban settings were not designed to handle millions of people which directly impact the availability and affordability of housing, forcing millions to live in substandard dwellings with poor housing quality [22]. This is mainly because substandard accommodation in the urban areas is very cheap.

7. Indoor air and housing quality

Indoor air is defined as the air within an indoor environment, coupled with the quality of housing that remains as major players in ascertaining the wellness and healthy living of occupants. However, the influence of one in ascertaining the state of the other cannot be overemphasized. Housing is said to be of diminished quality, if it does not have basic facilities, infrastructure and services such as adequate space, ventilation, waste collection and disposal facility, sanitation, electricity, water supply and general environmental quality [23, 24], which are important agents that impair the air quality in an indoor environment. A number of factors that include the origination of indoor pollutants such as human activities, building materials and carpets; and pollutants penetration from outdoor environments by forced ventilation, diffusion or infiltration, have been said to dictate the inevitability of human exposure to air

S/N	Parameters/unit	Range of air quality in study area		Air quality regulatory limit (WHO, 2006)
		Parlor/Living room	Kitchen	
1	SPM_{10} (μg/m^3)	255–391	271–439	250
2	CO (ppm)	12–33	18–41	10
3	NO_2 (ppm)	0.19–0.30	0.18–0.30	0.04–0.06

Source: Rim-Rukeh, 2015.

Table 2. Range of values of indoor air quality in the kitchen and living rooms of selected households in the slum squatter settlements of Warri, and the WHO regulatory limits.

pollutants, considering the amount of time stayed indoor [25]. However, Ana et al. reported that the influence of such pollution on human health may vary, depending on age, sex, nutritional status, physiological conditions, and individual predisposition to the pollutants in question [26]. A study conducted by Rim-Rukeh in a slum squatter inundated area of Warri, Nigeria, reported the measured levels of nitrogen dioxide (NO_2), carbon monoxide (CO) and suspended particulate matter (SPM_{10}) in all sampled households to be above the WHO air quality regulatory limits (**Table 2**) [27]. His report suggests that air quality index (AQI) in areas with poor housing settings such as slums, could be described as unhealthy for active children, women, adults and people with respiratory disease such as asthma, as it is usually associated with poor air quality. This therefore further suggests that impairing air quality in housing setting has an inverse relationship with the housing quality, and thus a negative impact on the health and wellness of its occupant.

8. Prevalence of respiratory diseases in Nigeria

Respiratory problems refer to as the disorders of the airways and lungs that affect human respiration have been reported to be a major cause of mortality and morbidity among Nigerian children (**Table 3**). Acute respiratory infections (ARIs) are group of heterogeneous diseases caused by a diverse group of organisms in which the anatomical site(s) involved consists of the airways from the nostrils, pharynx down to the alveoli [28, 29]. In most developing countries including Nigeria, the burden of respiratory disease is largely unknown; however, on an average, it was reported that every child has about 5 to 6 episodes of ARI in a year accounting for about 30–50% of the total paediatric outpatient visits [30, 31]. Data from national demographic health survey 2013 reported the prevalence of ARIs in Nigeria to be about 2% [32].

In a study conducted by [33] between the year 2000 and 2003, it was reported that pneumonia accounted for 20% of deaths in children under the age of 5 years in Nigeria. However, there is a seasonal variation in acute respiratory infections in Nigerian children with more episodes occurring during the rainy season [34]. Few studies have also investigated the etiology of pneumonia in Nigerian adults. A retrospective study of 3671 adults cases seen at the emergency room at the Federal Medical Centre Ido-Ekiti in South-Western Nigeria showed that 368 adults had respiratory diseases out of which 127 (34.5%) had pneumonia, 108 (29.4%) had complicated and uncomplicated PTB, 90 (24.5%) had acute asthma attack while 38 (10.3%) had acute

Infectious respiratory disease	Adult
	Tuberculosis
	Pneumonia
	HIV-related infections
	Children
	Acute respiratory infection
	Tuberculosis
	HIV-related infection
Noninfectious respiratory disease	Adult
	COPD
	Asthma
	Occupational lung disease
	Pulmonary malignancies
	Sarcoidosis
	Children
	Asthma
	HIV-related malignancies

Source: Akanbi et al., 2009.

Table 3. Classification of respiratory disease.

Respiratory diseases	**N (%)**
Pneumonia	**127 (34.5)**
Pulmonary tuberculosis (All)	108 (29.4)
-Uncomplicated	79 (21.5)
+Cor-pulmonale	14 (3.8)
+Pleural effusion	9 (2.5)
+Massive hemoptysis	4 (1.1)
+Pneumothorax	2 (0.5)
Acute asthma	90 (24.5)
Acute exacerbation of COPD	38 (10.3)
Upper airway obstruction	2 (0.5)
Malignant Pleural effusion	2 (0.5)
Acute chest syndrome	1 (0.3)

Source: Olufemi et al. [35].

Table 4. Respiratory diseases seen at the emergency room of the Federal Medical Centre Ido-Ekiti, south western, Nigeria, from November 2004 to December 2010.

exacerbation of Chronic Obstructive Pulmonary Diseases (COPD) (**Table 4**) [35]. A study of 74 patients with pneumonia in Zaria, Northern Nigeria, however, showed that 50% had positive pneumococcal polysaccharide antigen and 16.2% had *Mycoplasma pneumonia* [36]. A prospective cohort study carried out in Ilorin, Nigeria, reported that the rate of acute respiratory infection was three episodes per child per year with pneumonia being responsible for 1.3 episodes per child per year [33]. In another hospital-based study in Ibadan, 28.4% of children admitted to the hospital with acute lower respiratory tract infection had acute bronchiolitis with respiratory syncytial virus being the most common viral etiological agent [35]. WHO [37] reported that about 20% of all deaths in children under 5 years are due to Acute Lower Respiratory Infections (ALRIs - pneumonia, bronchiolitis and bronchitis); 90% of these deaths are due to pneumonia.

9. Meteorological conditions of houses in relation to respiratory conditions

Meteorological conditions refer to the prevailing environmental conditions as they influence the prediction of weather. A case-control study carried out among children under the age of 5 years with and without ARI in Ibadan revealed that a higher proportion of houses visited recorded a relative humidity (RH) value above the comfort level (30–60%) (**Table 5**) [17]. This high RH (above comfort level) observed among a large proportion of houses among cases could be as a result of high moisture content. With such high relative humidity levels, microorganisms such as fungi and bacteria can survive on non-living materials including dusts [38]. High relative humidity above 70% also tends to favour the survival of viruses that infect the membrane of the respiratory tract.

Measurement	**Category/score**		**Case**		
			Comfort	**High**	***P***
Temperature	Controls	Comfort	4 (50.0%)	4 (50.0%)	0.00
		High	42 (72.4%)	16 (27.6%)	
Relative humidity	Controls	Comfort	2 (50.0%)	2 (50.0%)	0.00
		High	40 (64.5%)	22 (35.5%)	

Source: Fakunle et al. [17].

Table 5. Relationship between meteorological condition of the indoor environment and ARI.

10. Housing risk factors for respiratory conditions

Numerous studies have shown that people who live in poor housing are at increased risk of exposure to the determinants of respiratory diseases [39]. A substandard housing may increase exposures to biological (e.g., moulds, mites, roaches), chemical (e.g., lead, carbon monoxide, volatile organic compounds), and physical (e.g., extreme temperature, fine particles, radon) hazards leading to a wide range of adverse health outcomes, especially respiratory diseases [40–43]. Adequate

housing therefore remains critical to human health, comfort and general well-being [43]. Thus, understanding the link between housing and respiratory health condition is of importance in designing effective strategies to improve quality of life. Crowding, poor air quality within homes as a result of inadequate ventilation, and the presence of mould and smoke contribute to poor respiratory health in general and have been implicated in the spread and/or outcome of tuberculosis (TB) [44–46]. Therefore, housing risk factors for respiratory conditions can be broadly classified into three namely; structural, biological and chemical factors. Specific aspects of these risk factors are described below:

10.1. Structural factors

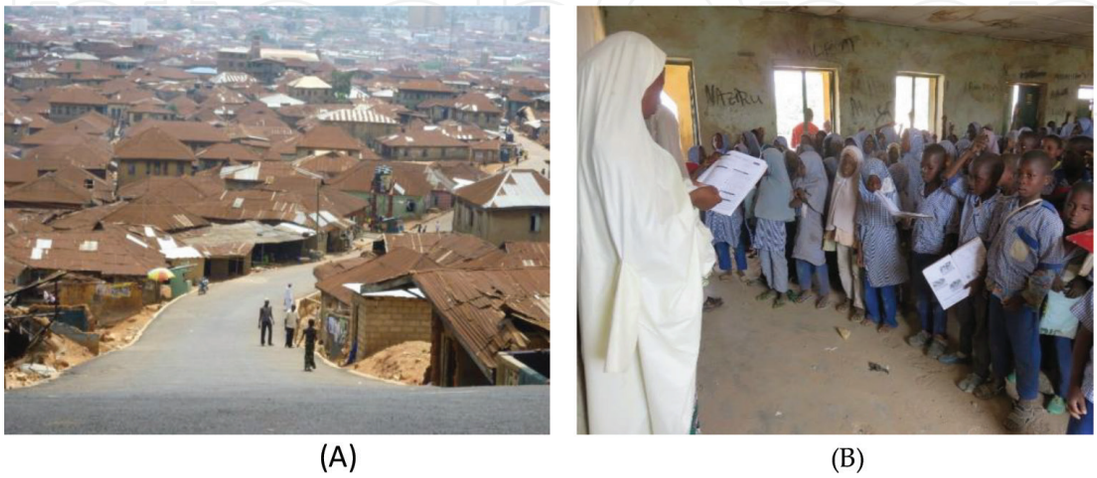
10.1.1. Overcrowding

Limited air movement in an enclosed place have been known to be a contributory housing risk factor to respiratory challenges in developing countries as shown in **Plate 2**. Udoh and Uyanga reported that the major predictor for bronchitis and cough in a study carried out in Akwa Ibom Nigeria was overcrowding [15]. Lienhardt reported that overcrowding is a risk factor for respiratory infection and for increased risk of disease after infection [47].

Studies in developing countries have found that the average area of habitable space per person is well below the WHO recommendation of 12 m^2 [48]. As reported by Ana and Umar, the mean number of occupancy among children under the age of 5 admitted in a tertiary health facility for ARIs was 6.0 ± 1.5 as compared to 4.0 ± 1.0 among controls [55]. A positive association was found between the level of occupancy and indoor total bacterial count. This suggests that the number of persons in the household is directly proportional to the level of bacteria build-up in the indoor environment.

10.1.2. Inadequate ventilation

Transmission of *respiratory condition* to a non-infected person is more likely if there is poor ventilation. Inadequate ventilation is associated with a higher risk of airborne infectious



(A) (B)

Plate 2. (A) Overcrowding condition in a typical community in Nigeria. (B) Overcrowding condition in a typical school setting in Nigeria.

disease transmission, including tuberculosis, as well as the accumulation of indoor pollutants and dampness, which are factors in the development of allergies and asthma [49]. Room ventilation is usually expressed in terms of air changes per hour [45, 50]. Studies in hospitals and health care facilities have shown that poor ventilation design or construction have contributed to the transmission of infection, particularly among clinical personnel in patient rooms with fewer than two air changes per hour [51]. Poor ventilation have been associated with failing respiratory health [40, 52]. In the same wise, Livebuga et al. also found that the presence of mould proved to increase the risk of Asthma and Bronchitis [53].

10.1.3. Housing quality and dampness

Moisture damages on walls, roofs, floors, leaking pipes, cracked walls, broken window seals are all platforms for occurrence of house hazards and for the growth of visible moulds and mildews leading to poor housing quality. About 60% of households suffer roof leakage, cracked walls and broken floors with increased risk of pneumonia due to mould and damp development [54]. Dampness has been repeatedly linked to a number of health outcomes, including respiratory symptoms, nausea and vomiting and general ill health. Fakunle et al. [17] in a study reported that housing quality and conditions among cases were major contributory factors to ARI when compared with the controls (**Table 6**). The study reported that more cases than controls reside in houses with poor housing quality (OR = 2.5; CI = 1.3–5.1, $p < 0.05$). In a large proportion of houses of cases than controls, there were presence of damp walls (OR = 2.9; 95% CI = 1.1–8.1). Children under five living in houses with presence of old/deteriorated furniture were found to be thrice more likely to develop ARIs than children residing in houses without such furniture. More houses among cases than controls were built using muds (OR = 4.6; 95% C.1 = 1.6–12.8) [17]. This study suggests that a link exists between housing quality and the prevalence of respiratory conditions among children under 5 years.

10.2. Biological factors

10.2.1. Bioaerosols

A study carried out by Ana et al. [55] showed that the genera of fungi isolated in the indoor environment of day care centers included *Aspergillus, and Penicillum* spp., which have been related to asthma and other allergic respiratory diseases. Some of these species, such as *Penicillium* and *Aspergillus* can also induce type III allergy (IgG mediated), while at high concentrations, may also initiate combined type III and IV reaction manifested as hypersensitivity

Building condition		Cases	Control	OR (95% CI)	p-Value
Presence of damp roof	Yes	15 (22.7%)	6 (9.1%)	2.9 (1.1–8.1)	0.03
	No	51 (77.3%)	60 (90.0%)		
Presence of algal growth on walls	Yes	19 (28.8%)	4 (6.1%)	6.3(2.0–19.6)	0.001
	No	47 (71.2%)	62 (93.9%)		

Source: Fakunle et al. [17].

Table 6. Condition of houses visited among children under-five with and without ARI.

pneumonitis [56]. Airborne fungi may be harmful to human health, but may also destroy the building itself (**Plate 3**), particularly wooden parts, such as roofs and walls. Inadequate ventilation is one of multiple factors that contribute to the development of mould in a home [57]. Household humidity and encumbered space may also contribute to mould growth in a house. However, mould have been implicated in increased susceptibility to respiratory infection, asthma and allergies among children [58]. Dales et al. found an association between exposure to indoor fungal contamination and altered T-cell differentiation in children [59].

A recent study by Ana et al. [60] designed to determine the burden of airborne microbes in houses that predispose children under the age of 5 years to acute respiratory infections revealed that the indoor airborne bacterial load in houses of children under-5 years with ARI (9.6×10^2 cfu/m^3) was higher than the acceptable limit ($\leq 5.0 \times 10^2$ cfu/m^3) proposed by the American Industrial Hygiene Association (AIHA) for residential locations compared to houses of children under-five without ARI (3.5×10^2 cfu/m^3) (**Figure 4)**.

10.3. Chemical factors

10.3.1. Tobacco smoke among parents

It has been postulated that cigarette smoke may impair the pulmonary defense mechanism, resulting in airways that are more susceptible to infection; however, there are no published studies to support this hypothesis [61]. A study carried out by Adegoke et al. [62] investigated the effect of tobacco smoking on lung function indices among male undergraduate students. They revealed that smokers had significantly reduced FVC (3.42 ± 0.42 vs. 3.87 ± 0.4 liters; p = 0.03), FEV1 (2.39 ± 0.37 vs. 3.22 ± 0.38 liters; p = 0.001) and FER (%) (70.7 ± 7.58 vs. 82.3 ± 4.05; p = 0.01). Among the smokers, a relationship was observed between years and numbers of cigarettes smoked and lung function. The proportion of participants with FER below the age-matched reference was significantly higher among smokers than non-smokers

(A) (B)

Plate 3. (A) Damped roof in a building in Bere Area of Ibadan, and (B) mould growth on wall and ceiling of a typical house in Ibadan.

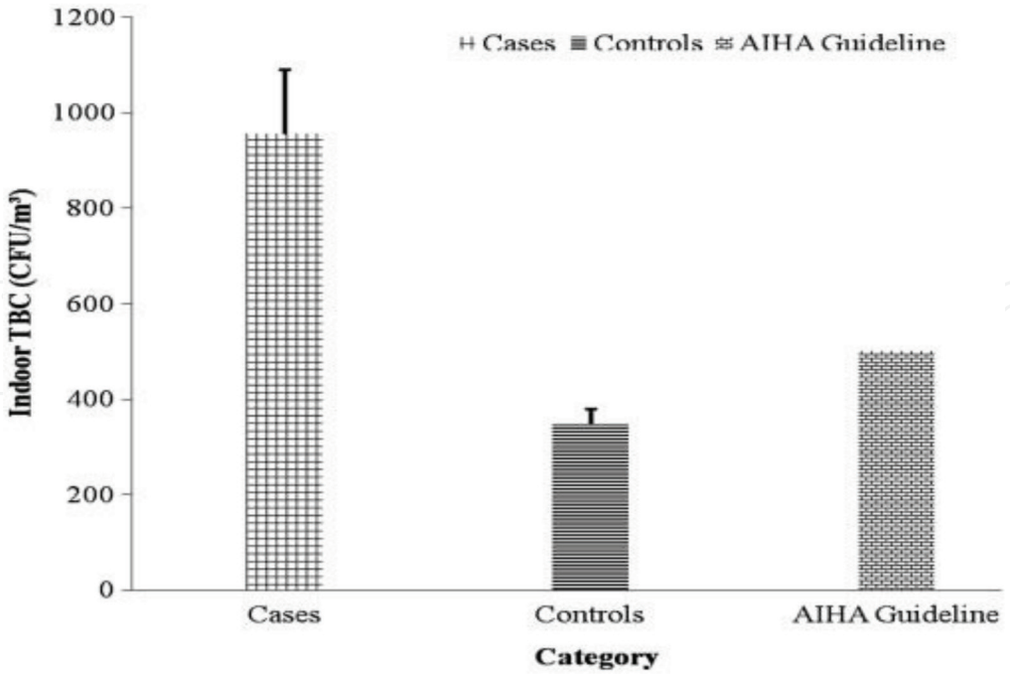


Figure 4. Mean indoor TBC among cases and controls as compared to AIHA Guideline. Source: Ana et al. [60].

(40.4 vs. 6.7%) p = 0.021. [25] in their study reported parental smoking or any other smoker in the house as a risk factor for ARIs in children under the age of 5 (OR = 4.7; CI = 0.9–2.17, $p < 0.05$). This could be due to the accumulation of emissions from cigarette smoking in the indoor environment as a result of inadequate ventilation [63]. Furthermore, indoor air pollution, arising from tobacco smoking in the home showed significant effects on respiratory symptoms (Cough, Wheezing, Pneumonia, Bronchitis and Asthma) among children [64, 65]. Tobacco and cigarette smoking emits sulfur dioxide (SO_2) and nitrogen dioxide (NO_2) which impair phagocyte functioning of the lower respiratory system and thus reduce immunity. A systematic review of 33 papers indicated that passive smoking (second hand smoking) and smoking were associated with an increased risk of tuberculosis. The review further revealed that compared to non-smokers, smokers had an increased risk of having active tuberculosis and testing positive on tuberculin skin test [66].

10.3.2. Exposure to Biomass fuel used for cooking and heating

About 3 billion people in developing countries including Nigeria rely on firewood or charcoal for their daily cooking purposes [67]. According to the World Health Organization (WHO), smoke-induced diseases are responsible for the death of 4.3 million people every year, making it one of the most lethal environmental health risks worldwide [68]. The largest burden of mortality due to biomass fuel is borne by women and young children (**Figure 3**). Among the 4.3 million who die from the consequences of smoke emission each year, 500,000 are children under five that die due to acute respiratory infections (ARI). Young children are particularly vulnerable for two reasons: First, they are usually with their mothers during the cooking process and thus inhale large loads of particulate emission. In a recent systematic review, it was

(A) (B)

Plate 4. Mother and child exposed to biomass emissions.

found that children's particulate emission exposure is similar to their mothers' [69]. Second, in comparison to adults, the still growing bodies of young children are more susceptible to ARI, leading to a high death rate in this age group [70].

In a study on the concentration of indoor air pollutants due to the use of firewood for cooking and its effects on the lung function of women living in the selected homes in Nigeria, Ana et al. [71] reported that the concentration of PM_{10} and gaseous emissions such as CO and NO_2 significantly exceeded the WHO limits by several folds. Chronic exposure to such high levels of indoor air pollutants particularly the respirable particulate matter as shown in **Plate 4** could possibly compromise the lung function status of women [71]. Olufunmilayo and Chi [72] reported that there is increased likelihood of ARI symptoms associated with children aged 1–2 years old in communities where indoor-biomass is used by households in North-Western and South Southern Nigeria Communities. A majority of households burn biomass fuels in open fireplaces, consisting of simple arrangements as three rocks, a U-shaped hole in a block of clay, a pit in the ground or in poorly functioning earth or metal stoves. However, the process of combustion in most of these stoves is incomplete, resulting in substantial emissions, which in the presence of poor ventilation produce very high levels of indoor pollution [73]. A case-control study carried out by Fakunle et al. [74] in Ibadan revealed that Children under-five carried by their mothers while cooking were 3.2 times more likely to develop ARIs.

11. Conclusions

That a man requires good quality housing has become a fact that cannot be entirely invalidated if he must enjoy a healthy life and wellness. However, several studies have reported that as opposed to the intents of man, built environment does not usually protect their inhabitant from various physical, social, economic and mental hazards, especially housing with poor quality. This therefore suggests that the quality of housing plays a major role in the health status and overall well-being of its resident, even though everyone has the right to decent and good standard of living. Overcrowding, poor ventilation, use of biomass fuel, mould growth in houses, dampness and poor quality have been identified as major predictors that have

been implicated in the prevalence of respiratory conditions and morbidity among humans, especially children under the age of 5 years in Nigeria. Therefore, against the backdrop of these effects of poor housing quality, it is imperative that measures such as health policy changes regarding construction of homes, better ventilation of kitchens and homes, and use of environmentally friendly, low-emission and energy-efficient cooking stoves should be put in place, if the prevalence of respiratory conditions among Nigerian children must be mitigated. Also, more should be done in the aspect of strengthening community health program, raising housing awareness, encouraging good self-help environmental sanitation among households, and the development of good and effective master/development plan for physical planning.

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References

[1] Bornehag CG, Sundell BJ, Bonini S, Custovic A, Malmberg P, Skerfving S, Sigsqaard T, Verhoeff A. Dampness in buildings as a risk factor for health effects, EUROEXPO: A multidisciplinary review of the literature on dampness and mite exposure in buildings and health effects. Indoor Air. 2004;**14**:243-257

[2] Breysse P, Farr N, Galke W, Lanphear B, Morley R, Bergofsky L. The relationship between housing and health children at risk. Environmental Health Perspectives. 2004;**112**(15):1583-1588

[3] Federal Ministry of works and Housing (FMNandH). Report on the launching of Global Campaign for Good Urban Governance in Nigeria, Abuja. Nigeria: Urban and Regional Planning Department, Federal Ministry of Works and Housing; 2002

[4] Kuroshi PA, Bala K. Development of housing finance in Nigeria. Nigerian Journal of Construction Technology and Management. 2005;**6**(1):7-18

[5] Turunen M, Panala A, Villmen J, Nevalainen A, Haverinen-Shaughnessy I. Evaluating housing quality, health and safety using an internet based data collection response: A cross-sectional study. Environmental Health. 2010;**9**:69. DOI: 101186/1476-069x-9-69

[6] World Health Organization. Health principles of housing. Geneva: World Health Organization. 1989. http://www.who.int/iris/handle/10665/39847

[7] Mabogunje AL. Prolegomenon to urban poverty in Nigeria. In: Proceedings of the 1975 Annual Conference of the Nigeria Economic Society; 1975. pp. 66-94

[8] Olotuah AO, Adesiji OS. Housing Poverty, Slum Formation, and Deviant Behaviours. Online Proceedings of the Housing Studies. UK: Association Conference, University of Lincoln; 8-9 September; 2005

[9] Lawanson. Challenges of sustainabilitand urban development in Nigeria: Reviewing the Millennium development goals. Africa Insight; 2006

[10] Adeleye AO, Anofojie AE. Housing quality in Festac town, Lagos state, Nigeria. Ife Research Publication in Geography. 2011;**10**(1):154-163

[11] Smith K, Smart J, Romieu I, Bruce N. Indoor air pollution in developing countries and acute respiratory infections in children. Thorax. 2000;**55**:518-532

[12] Clark EJ. The housing quality questionnaire: A new self-report measure for public health assessment. ProQuest Dissertation and Theses; 2009

[13] United Nation Department of Economic and Social Affair Population Division. World Population Aging. ESA/P/WP/212, December, 2009

[14] Abumere SI. Urbanization and urban decay in Nigeria in urban renewal in Nigeria. In: Onibokun, Adepoju, Olokesusi, Egunjobi, Layi, editors. NISER/CURP Urban and Regional Planning Series. Vol. IV. 1987

[15] Udoh U, Uyanga J. Housing conditions and health in rural Nigeria: A study of Akwa Ibom state. Research on Humanities and Social Sciences. 2013;**3**(18):34-41

[16] Owoeye JO, Ogundiran AO. A study on housing and environmental quality of Moniya community in Ibadan, Nigeria. International Journal of Physical and Human Geography. 2015;**3**(1):31-45

[17] Fakunle G, Ana G, Olaiya T. Housing quality and risk of acute respiratory infections among hospitalized children under five in Ibadan Nigeria: Indoor built. Environment. 2015;**25**(8):1259-1266

[18] Ebong MO. The perception of residential quality: A case study of Calabar, Nigeria. Third World Planning Review. 1983;**5**(3):273-284

[19] Hanmer L, Booth D, Lovell E. Poverty and Transport: A Report Prepared for the World Bank in Collaboration with Overseas Development Institute; 2000

[20] Neilson E, Tam JS, Yu LM, Li AM, Chan PKS, Sung RYT. Assessing disease burden of respiratory disorders in Hong Kong children with hospital discharged data and the linked laboratory data. Hong Kong Medical Journal. 2007;**13**:114-121

[21] Jiboye A. An assessment of the influence of socio-cultural factors on Housing quality in Osogbo, Nigeria. Unpublished M.Sc. Thesis, Department of Urban and Regional Planning. Ile-Ife, Nigeria: Obafemi Awolowo University; 2004

[22] Amao A. Urbanization, housing quality and environment in Nigeria. Journal of Geography and Regional Planning. 2012;**5**(16):422-429

[23] Krieger J, Higgin D. Housing and health, time again for public health action. American Journal of Public Health. 2002:158-768

[24] WHO Regional Office for Europe. Mould and Moisture, Health and Environment Briefing Pamphlet Series 42. Copenhagen: WHO Regional Office for Europe; 2004

[25] Anyanwu EC. Advances in Environmental Health Effects of Toxigenic Mould and Mycotoxins. New York: Nova Science Publishers, Inc.; 2011

[26] Ana GR, Morakinyo OM, Fakunle GA. Indoor air quality and risk factors associated with respiratory conditions in Nigeria. In: Nejadkoorki F, editor. Handbook of Current Air Quality Issues. Croatia: IntechOpen; 2015. pp. 547-568. DOI: 10.5772/59864

[27] Rim-Rukeh Akpofure. An assessment of indoor air quality in selected households in squatter settlement warri, Nigeria. Advances in Life Sciences. 2015;**5**(1):1-11

[28] Akanbi MO, Ukoli CO, Erhabor GE, Akanbi FO, Gordon SB. The burden of respiratory disease in Nigeria. African Journal Respiratory Medicine. 2009;**4**:10-17

[29] Simeos EAF, Cherian T, Chow J, Shahid-Salles SA, Laxminarayan R, John TJ. Acute respiratory infections in children. In: Jamison DT, Breman JG, Measham AR, Alleyne G, Claeson M, Evans DB, Jha P, Mills A, Musgrove P, editors. Disease Control Priorities in Developing Countries. 2nd ed. Washington (DC): World Bank; 2006. Chapter 25

[30] Acharya D, Prasanna KS, Nair S, Rao RS. Acute respiratory infections in children: A community based longitudinal study in South India. Indian Journal of Public Health. 2003;**47**(1):1-13

[31] Zaman K, Baqui AH, Yunus M, Sack RB, Bateman OM, Chowdhury HR, Black RE. Acute respiratory infections in children: A community based longitudinal study in rural Bangladesh. Journal of Tropical Pediatrics. 1997;**43**(3):133-137

[32] National Population Commission (NPC) (Nigeria) and ICF International. Nigeria Demographic and Health Survey. Abuja, Nigeria, and Rockville, Maryland, USA: NPC and ICF International; 2014

[33] World Health Organization. Public Health and the Environment. Geneva: WHO; 2007

[34] Fabule D, Parakoyi DB, Spiegel R. Acute respiratory infections in Nigerian children: Prospective cohort study of incidence and case management. Journal of Tropical Pediatrics. 1994;**40**:279-284

[35] Olufemi OD, Ololade OO, Olusegun AB, Abayomi F. Pattern of respiratory diseases seen among adults in an emergency room in a resource-poor nation health facility. The Pan African Medical Journal. 2001;**9**:24. DOI: 10.11604/pamj.2011.9.24.814

[36] Macfarlane JT, Adegboye DS, Warrell MJ. Mycoplasma pneumonia and the aetiology of lobar pneumonia in Northern Nigeria. Thorax. 1979;**34**:713 19Ide

[37] World Health Report. Reducing Risks, Promoting Healthy Life. Geneva: World; 2002

[38] Choa HJ, Schwartz J, Milton DK, Burge HA. Populations and determinants of airborne fungi in large office buildings. Environmental Health. 2004;**110**:117-782

[39] Makene. Housing Related Risk Factors for Respiratory Diseases in Low Cost Housing Settlements in Johannesburg, South Africa: A Research Report. Johannesburg: University of the Witwaterstrand; 2007

[40] Bonnefoy X. Inadequate housing and health: An overview. International Journal of Environment and Pollution. 2007;(3):411-429

[41] Hood E. Dwelling disparities. How poor housing leads to poor health. Environmental Health Perspectives. 2005;**113**:A310-A317

[42] Jacobs DE. Environmental health disparities in housing. American Journal of Public Health. 2011;**101**(1):S115-S122

[43] Habib R, Mayfond Z, Fawazi M, Basma S, Yeretzian J. Housing quality and ill- health in a disadvantage urban community. Public Health. 2009;**123**:174-181

[44] Wanyeki I, Olson S, Brassard P. Dwellings, crowding, and tuberculosis in Montreal. Social Science & Medicine. 2006;**63**:501-511

[45] Beggs CB, Noakes CJ, Sleigh PA. The transmission of tuberculosis in confined spaces: An analytical review of alternative epidemiological models. The International Journal of Tuberculosis and Lung Disease. 2003;(7):1015-1026

[46] Clark M, Riben P, Nowgesic E. The association of housing density, isolation and tuberculosis in Canadian first nations communities. International Journal of Epidemiology. 2002;**31**:940-943

[47] Lienhardt C. From exposure to disease: The role of environmental factors in susceptibility to and development of tuberculosis. Epidemiologic Reviews. 2001;**23**:288-301

[48] Cardoso MR, Cousens SN, De Goes Siqueira LF, Alves FM, D'Angelo LA. Crowding: Risk factor or protective factor for lower respiratory disease in young children? BMC Public Health. 2004;**3**(4):19

[49] WHO. International Workshop on Housing, Health and Climate Change: Developing Guidance for Health Protection in the Built Environment Mitigation and Adaptation Responses. Geneva; 2010

[50] Health Canada. Guidelines for preventing the transmission of tuberculosis in Canadian health care facilities and other institutional settings. CCDR. 1996;**22**:S1

[51] Menzies D, Fanning A, Yuan L, et al. Hospital ventilation and risk for tuberculosis infection in Canadian health care workers. Annals of Internal Medicine. 2000;**133**:779-789

[52] Man K. Analysis on the links between housing and respiratory health of residents in Hong Kong. Unpublished B.Sc. Thesis. The University of Hong Kong; 2005

[53] Livebuga-Mukasa J, Oyane T, Wydro P. Risk factors influencing asthma prevalence and chronic respiratory illnesses among residents of different neighborhoods in buffalo: New York. Journal of Epidermiology and Community Health. 2004;**58**:951-957

[54] Koskinen O, Husman T, Meklin A, Nevalainen. The relationship between moisture or mould observation in houses and the state of health of their occupants. European Respiratory Journal. 1999;**14**:1383-1367

[55] Ana GREE, Umar ZO. Indoor air quality and respiratory symptoms experienced among under-five children in daycare centres in Ibadan North Local Government Area, Oyo State, Nigeria: An unpublished Master's dissertation in the Department of Environmental Health Sciences, University of Ibadan, Nigeria; 2013

[56] Shah A, Panjabi C. Allergic Aspergilosis of the respiratory tract. European Respiratory Review. 2014;**23**:8-29

[57] World Health Organisation (WHO). WHO Guidelines for Indoor Air Quality: Dampness and Mould. WHO Regional Office for Europe; 2009

[58] Dales R, Zwanenburg H, Burnett R. Respiratory health effects of home dampness and molds among Canadian children. American Journal of Epidemiology. 1991;**134**:196-203

[59] Dales R, Miller D, White J. Influence of residential fungal contamination on peripheral blood lymphocyte populations in children. Archives of Environmental Health. 1998;**53**:190-195

[60] Ana GR, Fakunle GA, Ogunjobi AA. Indoor Airborne Microbial burden and risk of acute respiratory infections among children under-five in Ibadan, Nigeria. Indoor and Built Environment. SAGE Publisher; 2015;**24**(3):308-314

[61] Singh M, Mynak ML, Kumar L. Prevalence and risk factors for transmission of infection among children in household contact with adults having pulmonary tuberculosis: Archives of disease in childhood. Tuberculosis: A Systematic Review and Meta-Analysis. 2005;(90):624-628

[62] Adegoke BO, Akinremi AA, Akintobi AE. Effects of tobacco smoking on pulmonary function indices among undergraduate students. Nigerian Journal of Medical Rehabilitation. 2015;**18**(1):1-14

[63] Brims F, Chauhan AJ. Air quality, tobacco smoke, urban crowding and daycare modern menaces and their effects on health. Journal of Pediatrics Infectious Disease. 2005;(11):152-156

[64] Burr M. Indoor air pollution and the respiratory health of children. Pediatric Pulmonology. Supplement. 1999;(18):3-5

[65] Godish T. Indoor Environment Quality. New York: CRC Press; 2001

[66] Lin HH, Ezzati M, Murray M. Tobacco smoke, indoor air pollution and tuberculosis: A systematic review and meta-analysis. PLoS Medicine. 2007;**4**(1):e20

[67] WHO. World Health Organization. Burden of Disease from Household Air Pollution for 2012

[68] WHO. World Health Statistics. World Health Organization; 2014

[69] Balakrishnan K, Mehta S, Ghosh S, Johnson M, Brauer M, Zhang J, et al. Population levels of household air pollution and exposure. In: WHO, World Health Organization, editor. Indoor Air Quality Guidelines, Household Fuel Combustion. Geneva, Switzerland; 2014

[70] Barnes BR. Behavioural change indoor air pollution and child respiratory health in developing countries: A review. International Journal of Environmental Research and Public Health. 2014;**11**(5):4607-4618

[71] Ana G, Adeniji B, IgeO, Oluwole O, Olopade C. Exposure to emissions from firewood cooking stove and the pulmonary health of women in Olorunda community, Ibadan, Nigeria. Air Qual Atmos Health. 2013;**6**(2):465-471. DOI 10.1007/s11869-012-0183-6

[72] Oluwafunmilade AA, Chi C. Environmental risks associated with symptoms of acute respiratory infection among preschool children in north-western and south-southern Nigeria communities. International Journal of Environmental Research and Public Health. 2017;**14**(11):1396

[73] WHO. The World Health Report – Health Systems: Improving Performance. Geneva: World Health Organization; 2000

[74] Fakunle GA, Ana GR, Ayede AI. Environmental risk factors for acute respiratory tract infections in hospitalized children under-five years of age in Ibadan, Nigeria. Paediatrics and International Child Health. 2014;**34**(2):120-124