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The Influence of Housing and Waste Management Facilities on Public Health

Ifyalem K. J. [1] *, Jakada Z. A. [1]

[1]*Department of Water Resources and Environmental Engineering, Faculty of Engineering, Ahmadu Bello University Zaria, P.M.B.06, Nigeria*

**Corresponding author, Email address: ifyalemkator@gmail.com*

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Abstract: Housing and waste management facilities play an important role in determining the health status of individuals within a community. This is explained by the fact that poor housing conditions can cause worsening health issues and can affect the overall productivity of individuals occupying those spaces. In Nigeria, the prevalence of respiratory disorders and morbidity, particularly in young children under the age of five, have been linked to overcrowding, poor ventilation, the use of biomass fuel, mould growth in homes, dampness, and poor quality of building materials. Therefore, measures such as health policy changes regarding the construction of homes, better ventilation of kitchens and homes, and use of environmentally friendly, low-emission and energy-efficient cooking stoves must 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 programs, raising housing awareness, encouraging good self-help environmental sanitation among households, and developing of good and effective master/development plan for physical planning. Health hazards associated with poor municipal solid waste management are real and pose serious public health threats ranging from the transmission of endemic zoonoses to the emergence and re-emergence of new zoonoses arising either from direct or indirect effects of poor waste management. It is pertinent that all human settlements regardless of their sizes and locations develop sustainable and efficient methods for proper waste management which will preserve the environment and promote the health of the residents.

1. Introduction

1.1 Housing

One cannot overstate the importance of improving people's quality of life in any society. The residential space of a person's house plays a crucial part in their everyday life because it is at the centre of where their livelihood is derived (Pollack *et al.,* 2008) and it contributes to shaping their health and well-being (Murphy, 2006). The health status of the people has serious consequences on the economy of the country where they reside. A healthy workforce is a requirement for a vibrant economy. An unhealthy individual is not only unproductive but also cannot take care of himself and his dependents; he may eventually become an economic and security burden to society. Research such as (Easterlow, 2000; Morris, 1994; Harker, 2007) have shown that there is a link between the health status of people and their housing conditions. According to a WHO assessment of Nigerians' health in 2005, there is

evidence that the major health indicators have either stayed the same or gotten worse. Many Nigerians suffer from one health situation or the other. The National Strategic Health Development Plan (NSHDP) for the period 2010 to 2015 reported that the health status indicators for Nigeria are among the worst in the world and that the health status of the population has declined when compared with the indicators of a decade earlier (NSHPD, 2010). (Tanaka *et al*., 1996; Lowry, 1989; Malmström *et al*., 1999; Bonnefoy, 2007) various studies highlighted the health implications of poor housing conditions on people. According to (Lowry, 1989), there is no argument about how housing affects people's health. He listed the fundamental health requirements that houses should serve as shelter, warmth, sanitation, and privacy. Dangerously constructed houses can directly harm residents' health, individuals, and the community in general. It reflects the cultural, social, and economic value of a society, as it is the best physical and historical evidence of civilization in a country. To address the fundamental and specific needs of the population, housing is defined as "the process of permanently establishing a significant number of residential buildings with suitable physical infrastructure and social services in planned, decent, safe, and sanitary neighbourhoods" (Kuroshi *et al.*, 2005). The Australian Bureau of Statistics in 2006 however affirmed that inadequate housing can pose serious health risks. Housing conditions play a major role in individual health status, as a wide variety of housing features have been reported to influence the physical, social, economic, and mental well-being of occupants (Turunen *et al*., 2010).

1.2 Waste management facilities

Municipal waste is a waste type consisting of everyday items that are discarded by the public with variation from one place to the other. Municipal waste changes significantly with time and may include durable goods, non-durable goods, containers and packaging, food wastes and yard trimmings, and miscellaneous inorganic wastes. They are classified based on their composition as biodegradable, recyclable (glass, plastics, metals), electrical (electrical appliances and electronics), hazardous (paints, chemicals), and toxic (pesticides, herbicides) wastes. Four hierarchy ranking strategies have been developed by the United States of America for municipal waste management based on environmental friendliness from the most to the least preferred methods. These include source reduction and reuse, recycling or composting, energy recovery as well as treatment and disposal (Thapa *et al.,* 2013). The management of this waste is gradually becoming a major challenge in developing countries because of industrialization, urbanization and the increasing human and animal populations. The increasing demand for food and other life essentials arising from the increasing global population results in an increased amount of waste which is not adequately managed in Nigeria resulting in the contamination of air, water, and soil. These environmental contaminations pose serious public health threats. In developed countries, waste management is tightly regulated and so the generation, collection, processing, transportation, and disposal of waste are closely monitored thus reducing its risk to the public (Raji *et al.,* 2007). In the United State of America, 254.1 million tonnes of municipal solid waste were generated in 2007, 63.3 million tonnes were diverted to recycling, 21.7 million tonnes were diverted to composting, and 31.9 million tonnes were combusted with energy recovery. The remaining 137.2 million tonnes were sent to landfills (Thapa *et al.,* 2013). In Nigeria and most other developing countries, municipal solid waste cannot be considered without including human and animal excreta and sharp hospital equipment from patent medicine stores and drug addicts. This may be probably due to indiscipline among other citizens, lack of toilet facilities in several homes as well as unprofessionalism in the handling and management of municipal solid waste. Waste management in developing countries is loose for reasons related to negligence from environmental stakeholders

resulting in poor funding of the sanitary agencies and lack of organization (Burnley, 2007). According to (Ogbonna *et al*., 2012; Fasanella *et al.,* 2013), 20.4kg of solid non-hazardous waste was generated in Port Harcourt by hospitals daily. It was also estimated that between 2007 and 2012, an average of 3.55 million metric tonnes of waste was generated per annum; 3.07 million tonnes of the generated waste were collected while the remaining 478,378 metric tonnes were left uncollected in Lagos (Okonkwo *et al.,* 2010). Records of waste generated in other Nigerian cities in 2009 were 1.88, 1.63, 1.37, 1.01, 0.29, 0.18 and 0.14 million metric tonnes for Kano, Ibadan, Kaduna, Onitsha, Makurdi, Abuja and Nsukka respectively (Ogu, 2000). The challenges of municipal solid waste management in developing countries may include low collection coverage, inconsistency in the collection process, indecency in dumping, uncontrolled environmental pollution, indiscriminate waste picking, scavenging by domesticated animals and breeding of flies and other disease vectors (Bartone, 1995). It has been shown that over 33-66% of municipal solid waste generated in the cities of developing countries is not collected (WHO, 2002). These remnants which are usually mixed with human and animal excreta become dumped along streets and drainages leading to flooding, breeding of insect vectors, rodents and subsequent disease spread. Contamination of the air, water, and land is a result of inadequate municipal solid waste management's effects on public health. This environmental contamination may result in the emergence of air, water and food-borne zoonoses. Injuries from sharp hospital equipment usually dump at these sites also expose children, adult scavengers, and waste workers to diseases such as tetanus, human immune-deficiency virus as well as hepatitis B and C. In the year 2000 alone the World Health Organization estimated that contaminated syringes caused 21 million hepatitis B virus, 2 million hepatitis C virus and 260,000 human immune-deficiency virus infections worldwide (Dziekan *et al.,* 2003; Oresanya, 2011). These risks are particularly higher in developing countries where scavenging at waste disposal sites and manual sorting of hazardous waste from healthcare establishments is common. Another direct effect may include environmental pollution associated with the decaying of long-standing waste. Figure 1 shows waste management hierarchy.

Fig. 1: Waste management hierarchy
Source: (Recycling Industrial Waste, 1996)

2. Waste Management Facilities

2.1 Municipal solid waste – landfills

Living in the vicinity of a landfill can represent a risk to the health of residents because they may be exposed to pollutants from landfill through different pathways: the inhalation of substances emitted by the site, the contact with water or polluted soil, directly or through the consumption of products or contaminated water.

2.2 Exposure assessment

Although some studies have suggested a link between living next to a legal landfill and certain health hazards, overall, this evidence is inconclusive. The weakness of the observations is related, among other factors, to the quality of the exposure assessment. In most of the available studies, the distance from the landfill is used as a proxy of exposure. It has been noted that this measure may reflect and integrate different routes of exposure (not only air but also the contamination of soil or groundwater in the vicinity of the plant). This aspect, in addition to the ease of calculation, makes distance a still widely used metric. However, the distance at best can only provide a first-order approximation of the real exposure to pollutants emitted from this type of plant.

2.3 Effects on health

The potential health implications of living close to landfills have been researched in some studies and compiled in systematic reviews. They mainly concern cancer and birth outcomes; more recently respiratory diseases and annoyance were also investigated. Excess for cancer has been found for different sites (for example, pancreas, larynx, liver, kidney) and non-Hodgkin lymphoma, but the overall evidence is not sufficient for drawing firm conclusions: the most recent reviews (Porta *et al.,* 2009; Mattiello *et al.,* 2013) reached this same conclusion, mainly drawn by a study conducted in England (Jarup *et al.,* 2002).

Studies have addressed birth outcomes. Adverse effects were observed for toxic waste, as described by both older and more recent papers, but this is less clear when only urban solid wastes are considered. The evaluation of 9,565 landfills in the United Kingdom, in which (Elliott *et al*., 2009) distinguished between non-special and special or unknown waste disposal sites, confirmed an effect of the latter and no evidence of harm from the former. This difference does not hold for congenital malformations and low birth weight, for which limited evidence exists of an increased risk for infants born to mothers living near landfill sites. The most informative results are those of the European EUROHAZCON Study (Dolk *et al.*, 1998) and the United Kingdom investigation by (Elliott *et al.,* 2009). Statistically, significantly elevated risks were found for all congenital malformations, neural tube defects, abdominal wall defects, surgical correction of gastroschisis and exomphalos, and low birth weight for births to people living within 2 km of the sites, both of hazardous and non-hazardous waste. Although several alternative explanations, including ascertainment bias, and residual confounding cannot be excluded, estimates of effects and their level of confidence suggest an increase in the risk of congenital anomalies due to the landfills. In the most recent literature, health outcomes have been examined that are less severe, but of a greater overall impact as more frequent in the exposed population. Several papers reported associations between exposure to odorous disposal facilities such as landfills, and respiratory symptoms and other non-specific symptoms in the population, such as noise and other problems due to annoyance. (Aatamila *et al.,* 2011; Heaney *et al.,* 2011).

2.4 Municipal solid waste – Incinerators

Emissions from incinerators have been improving over the years, as increasingly restrictive regulations came into force, and consequently better techniques for emission abatements were developed. Starting from the late 1970s, a continuous reduction of emissions from incinerators has taken place, with a consequent reduction of expected risks for human health. This aspect makes applying estimates and shreds of evidence from studies related to high levels of emissions (French study on Besançon related to the 1970s and 1980s) to new-generation plants difficult. A review of exposure assessment methods applied in epidemiological studies on incinerators has classified the quality of exposure methods in 41 studies from 1984 to 2013, ranking the papers considering three crucial aspects of this assessment,

namely the proxy measure adopted for the intensity of exposure, the scale at which the spatial distribution of the exposed population was accounted for, and whether temporal variability in exposure was considered or not (Cordioli *et al.,* 2013). Exposure assessment methods were found to have improved, with a reduction in misclassification of exposure when all three aspects were considered with the best approach of analyses. Other studies have addressed the use of human biomonitoring for exposure assessment of pollution due to incinerators. Biomarkers seem to be a less biasing surrogate of real exposure than environmental monitoring (Lin, 2005), for example with levels of polycyclic aromatic hydrocarbon (PAH) in the urine associated with increasing levels of emissions from incinerators (Ranzi *et al.,* 2014).

2.5 Effects on health

Emissions from incinerators have been changing over time. This entails changing health impacts, and it is difficult to formulate overall considerations on the health effects (Alaqarbeh *et al.* 2022)). The available evidence is therefore specific to the period of investigation and the different types of incinerators investigated (old-generation versus new-generation plants). On the other hand, the improvement in exposure assessment methods can help summarize the health risks. Papers examining the health effects of incinerators active in the years 1969–1996 consistently report a detectable risk of some cancers in the populations living nearby, through high-quality studies. Quantitative estimates of excess risks of specific cancers in populations living near solid waste incinerator plants were provided (Elliott *et al.,* 1996) for all cancers, including stomach, colon, liver, and lung cancer. Other studies performed in Italy, France and the United Kingdom indicate some suggestive but not consistent results for non-Hodgkin lymphomas and soft tissue sarcomas (Floret *et al.,* 2004; Ranzi *et al.,* 2011). Most of these studies concerned old-generation incinerators, characterized by high emission levels. The emissions of modern incinerators which have been investigated are different in quantity and composition, because of modern abatement techniques. For this reason, it is impossible to compare the results of all available studies, and consistency between studies is not anticipated. Congenital anomalies were also investigated by several studies. Particular attention has been given to the excess risk for urinary tract defects by a well-designed study in France (Cordier *et al.,* 2010), which confirmed previous observations of an increased risk from exposure to solid waste incinerator emissions in early pregnancy. Results from other studies on the same outcomes are inconsistent. Recent work in Italy found associations between birth outcomes (preterm birth and spontaneous abortion) concerning the increased level of exposure to incinerators (Candela *et al.,* 2013).

3. General Effects of Waste Management on Health

3.1 Contamination of underground water

Water is vital to life and the existence and quality of life of the people living in a region depend on access to good clean water. Groundwater is a crucial link in the hydrologic cycle because it is the source of most of the water in rivers, lakes and wells which are usually municipal sources of water. Contamination of groundwater often results from poor municipal waste management. A study by (Karija *et al*., 2013) showed that drinking water contaminated by municipal solid waste contained faecal coliform counts ranging between 15.25 MPN/100ml of water against the recommended 0 MPN/100ml of water (WHO, 1998, 2001). This may be a confirmation that human and animal excreta are components of municipal solid waste in developing countries as was earlier reported by (Zurbrugg, 2002). Heavy metals including lead, cadmium, mercury, and arsenic from municipal solid waste are also washed into surface and groundwater posing serious public health threats (Karim *et al.,* 2019).

Common sources of these heavy metals in waste may include paint containers and other lead-coated containers, cadmium batteries and cigarette stumps for cadmium, broken mercury thermometers and barometers for mercury and containers of arsenic pesticides and wood preservatives for arsenic. In Nigeria, these materials are not recycled and are commonly disposed of with domestic debris, contaminating both human and animal drinking water sources. Generally, the health effects of heavy metals can be life-threatening and may range from headache, irritability, memory deterioration, diminished intellectual capacity, and kidney damage (Karim *et al.* 2016, Mortada *et al.,* 2001), liver disease (Hyder *et al.,* 2013) and bioaccumulation that leads to cancer (El-Safty, 2014).

3.2 Transmission of food and water-borne endemic zoonoses

One of the public health implications of dumping waste within human settlements is the risk of transmission of food and water-borne endemic zoonoses. These endemic zoonotic pathogens which are usually associated with human and animal excreta on waste dumping sites are usually washed by rains into the surface or groundwater, contaminating these sources of water and resulting in illness. In addition, food animals serving as vertebrate intermediate hosts can feed on human excreta, acquiring infections which are later transmitted to humans causing serious health problems. Common sanitary food and water-borne endemic zoonoses documented in Nigeria include taeniasis/cysticercosis (Karshima *et al.,* 2013a), echinococcosis (Adediran *et al.,* 2014), campylobacteriosis (Karshima *et al.,* 2016), colibacillosis and salmonellosis (Kabiru *et al.,* 2012).

3.3 Possible emergence, re-emergence, and maintenance of diseases

The disposal of dead animals of unknown causes on waste sites especially those within human settlements may pose serious public health threats because 61% of the infectious disease of humans are of animal origin (Jones *et al.,* 2018). These dead animals can pose a health risk to children, adult scavengers and waste workers visiting these sites. If an animal dies with anthrax, there is a chance that the disease could spread to humans and other animals through the disposal of dead animals at waste sites, especially with the fact that anthrax spores can remain viable in the environment for more than a decade (Sweeney *et al.,* 2011). Human outbreaks arising from human contact with animals that died because of anthrax have been documented (Karishma *et al.,* 2016). According to the Independent Monitoring Board of the Global Polio Eradication Initiative report of April 2014, Nigeria was still considered among the countries endemic for poliomyelitis virus; however, the country recorded its last case of poliomyelitis in July 2014 (Karshima *et al.,* 2013b). Because this disease is associated with poor sanitation maintaining this polio-free status requires in addition to strategic vaccination adequate sanitation. Other diseases associated with poor sanitation are cholera, geohelminth infections, typhoid, and cysticercosis among others. Adequate municipal waste management will reduce the incidence of these diseases in Nigeria.

3.4 Breeding sites for disease vectors and rodents

Poor management of municipal solid waste can result in the proliferation of rodents and insect vectors that can spread a variety of diseases. The public health risk becomes higher if these sites are located within human settlements. For instance, municipal solid waste sites either hold water or block drainages resulting in water stagnancy and the breeding of mosquitoes which are capable of transmitting malaria. It is estimated that approximately one million people in Africa die from malaria alone each year and most of these are children under five years (WHO, 2002). Other diseases transmitted by mosquitoes are the dengue virus and yellow fever. Rodents from municipal solid waste sites can also enter

neighbouring houses causing potential risks of diseases like Lassa haemorrhagic fever. House flies from waste sites can find their way into neighbouring homes and in the process transmit several diseases including cholera mechanically from the excreta of infected persons when they come into contact with human food.

3.5 Possible intervention strategies

Enactment and enforcement of policies and legislations will serve as useful strategies in improving solid waste management in Nigeria as poor solid waste management was associated with weakness of policy enforcement and implementation (Adebayo, 2000). The legislative arms of Government at the local, state, and federal levels are encouraged to take up their responsibilities by enacting new laws and policies that will govern the management of municipal solid waste in Nigeria to ensure the protection of the public from the hazards associated with this menace. With legislation in place, the public will understand what is required of them by the law and will abide by them. This can be achieved through the formulation of sanitary committees at the local, state, and national legislatures that would sponsor and support all sanitation bills. There is also a need for enforcing the existing legislation such as the harmful waste act of 1988, the national environmental standards and regulations enforcement agency act of 2007, the environmental impact assessment act of 1992 as well as the national environmental sanitation and waste control regulations of 2007 among others. Nigerian laws should also enforce areas such as monitoring and supervision of agencies regulating environmental sanitation and solid waste management, waste recycling and landfill development outside the human settlement. The absence of these landfills leads to indiscriminate disposal of waste in Nigeria. Public education on the principles and effect of waste minimization and recycling is also a critical part of the waste management process. The Nigerian public should be enlightened on the risk of allowing children to scavenge and defecate on refuse dumping sites and the disposal of dead animals on these sites. Waste scavengers and waste management workers should also be encouraged to use protective wear when working to protect themselves against direct injuries from used sharp objects. The public should also be educated on the consequences of indiscriminate defecation and waste disposal within human settlements. Indiscriminate defecation can also be controlled through the provision of toilet facilities in strategic areas for the Nigerian populace, especially those living without toilets. These can be achieved through schools, environmental extension workers and the media. Another major challenge associated with poor waste management in Nigeria is the poor funding of agencies coordinating sanitation. For example, the average fund allocations for sewerage, drainage and refuse services by all the states in Nigeria dropped from 163 million USD between 1981 and 1985 to 17.4 million USD between 1990 and 1992 while local government allocations during the same period dropped from 45 million USD to 5 million USD. The resultant effect of this drastic drop in fund allocations will be poor waste management. So, ensuring a healthy environment in Nigeria requires proper funding for the agencies to be able to carry out this responsibility effectively. Funding can be through government at the local, state and national levels as well as non-governmental organizations. Public-private partnership in environmental sanitation and municipal solid waste management was encouraged (Ogu, 2000). This can be achieved through the complete utilization of fund allocations for sanitation and waste management without misappropriation. Other ways to encourage private sector involvement may be through reasonable taxation and favourable economic policies that will enable businesses to strive positively. Attitudinal change in the area of self-control towards misappropriating public funds allocated for sanitation and waste management will also go a long way in helping in the management of municipal waste and creating a healthy environment that will impact public health positively.

4. Effects of housing on public health

Globally, the issue of insufficient or non-existent housing has become a crisis. According to the United Nations Population Fund, the world population crossed 6.1 billion in 2001 and is projected to reach 7.9-10.9 billion by 2050 (UNPF). This volume alone places a tremendous amount of pressure on improving existing housing and building new homes. Housing affects health in different ways; deficient housing can compromise the most basic needs of water, sanitation, and safe food preparation and storage. The consequences of this are a rapid spread of communicable and food-borne diseases. There is no doubt that shelter is a basic need of mankind, and it is the most important requirement for the physical survival of man. It creates human identity, which greatly influences a person's success in life. It is also viewed as a tool for societal advancement. Housing condition is the totality of the physical, environmental and satisfaction level of a particular dwelling unit measured against some variable of liveability at a particular time. Environmental sanitation is a set of actions geared towards improving the quality of the environment and reducing the number of diseases. Environmental sanitation includes the management of water, solid waste, and industrial waste as well as the reduction of noise and pollution. Health and well-being concerns of inhabitants in developing societies are associated with unplanned urban centres and poor sanitary habits among city dwellers.

The significance of housing offering protection from cold, heat, and extreme weather events is further highlighted by the altering weather patterns brought on by climate change (Pachauri, 2014). People who live in subpar housing face several health hazards. For instance, homes that are structurally unsound because of poor design or upkeep increase the risk of accidents by making it more likely that individuals would trip or fall. Homes with poor accessibility put their elderly and disabled occupants at risk for harm, stress, and loneliness. Unsecure housing can be stressful because of affordability concerns or lax security. High indoor temperatures can increase cardiovascular mortality, while difficult or expensive heat housing can contribute to poor heart and respiratory outcomes. Indoor air pollution harms respiratory health and may trigger allergic and irritant reactions, such as asthma. Indoor air pollution can cause allergic and irritating reactions, including asthma, and is bad for respiratory health. Stress and infectious illness exposure are made more likely by a crowded dwelling. Nutrition and hygienic practices are impacted by an insufficient supply of water and sanitary facilities. Urban planning that inhibits physical activity is linked to obesity, diabetes, and other related diseases, along with poor cardiovascular and mental health. Unsafe building materials or building practices, or building homes in unsafe locations, can expose people to risks, such as injury due to building collapse. Slums and unregulated settlements present significant health hazards. Currently, around 1 billion people live in slum conditions today (UN-Habitat Slum Almanac 2015-2016), which often develop due to exclusion from planning processes. UN-Habitat defines a "slum household" as a group of people living together in an urban area and not meeting at least one of the following four WHO housing and health standards: adequate living space, security of tenure, access to improved water sources, and durable housing. Slum inhabitants are consequently vulnerable to several housing concerns, such as buildings with structural failures, inadequate housing facilities and overcrowding, but also face certain health risks from poor sanitation and unsafe electric connections, toxic building materials, unvented cooking facilities, and unsafe infrastructure, including roads. Furthermore, these communities are occasionally situated in areas where residents are more vulnerable to dangers like collapses, floods, and contaminants from industries. Concerning well-being, the lack of legal title to homes is stressful and can expose slum dwellers to the risk of forced eviction (WHO, 2011). Slums and informal settlements often house migrants, refugees, and internally displaced persons. Prevalence of poor housing conditions large numbers of people live in poor housing conditions.

4.1 Housing as a determinant of health

A growing amount of research has linked low housing quality to deaths from injuries, poor nutrition, chronic illnesses, infectious diseases, and mental problems.

4.1.1 Infectious diseases

Features of substandard housing, including lack of safe drinking water, ineffective waste disposal, intrusion by disease vectors and inadequate food storage have been identified as contributing to the spread of infectious diseases. Crowding facilitates the transmission of tuberculosis and respiratory infections Stein 1950. Lack of housing and overcrowding found in temporary housing for the homeless also contribute to morbidity from respiratory infections and the activation of tuberculosis (Wood *et al.,* 1990; Kermode *et al.,* 1999; Conway *et al.,* 1993).

4.1.2 Chronic diseases

Recent epidemiological research has connected poor housing with a higher risk of developing chronic diseases. Damp, cold, and mouldy housing is associated with asthma and other chronic respiratory symptoms, even after potentially confounding factors such as income, social class, smoking, crowding, and unemployment are controlled (Bornehag *et al.,* 2001). Water ingress is a significant cause of moisture issues. Overcrowding and inadequate ventilation also increase interior moisture. (Markus, 1993), Damp houses provide a nurturing environment for mites, roaches, respiratory viruses, and moulds, all of which play a role in respiratory disease pathogenesis. Cross-sectional epidemiological studies have also established associations between damp housing and recurrent headaches, fever, nausea and vomiting, and sore throats. (Platt *et al.,* 1989), Old, dirty carpeting, often found in substandard housing, is an important reservoir for dust, allergens, and toxic chemicals. (Vaughan *et al.,* 2000) Exposure to these agents can result in allergic, respiratory, neurological, and hematologic illnesses. Asthma, as linked to pest infestation, indicates another factor that relates unhealthy housing to serious illnesses. Cockroaches can cause allergic sensitization and have emerged as an important asthma trigger in inner-city neighbourhoods. Children with asthma who are sensitized and exposed to cockroaches are at elevated risk for hospitalization (Rosenstreich, 1997). Mouse allergen also acts as a clinically important cause of allergy and asthma morbidity (Phipatanakul *et al.,* 2000). Rodents and cockroaches can enter due to structural faults, and they can get water to drink from leaking pipes. Inadequate food storage and disposal facilities provide them with opportunities for obtaining food. Dead spaces in walls harbour pests and permit circulation among apartments in multiunit dwellings (Howard, 1993). Deviation of indoor temperature beyond a relatively narrow range has been associated with an increased risk of cardiovascular disease. Living in cold housing has been associated with lower general health status and increased use of health services (Evans *et al.,* 2000). Exposure to toxic substances found in homes can result in chronic health problems. The association of passive exposure to indoor tobacco smoke with respiratory disease is well documented (Cook *et al.,* 1997). Poor ventilation may increase exposure to smoke. Indoor exposure to nitrogen dioxide (from inadequately vented or poorly functioning combustion appliances has been associated with asthma symptoms (Holgate, 2000). Exposure to volatile organic compounds (emitted by particle boards and floor coverings) may be associated with asthma and sick building syndrome. The relation between lead exposure (from paints) and neurodevelopmental abnormalities is also confirmed, (Rosen, 1995), as an association with hypertension. Asbestos exposure can cause lung cancer (Landrigan, 1998).

4.1.3 Injuries

It is important to design homes to prevent injuries, especially about reducing burns and falls. Exposure to heating sources, unprotected upper-story windows, low sill heights, slippery surfaces, and breakable window glass in areas with a high risk of harm are all characteristics of inadequate housing that increase the risk of damage and poorly designed stairs with inadequate lighting. Building design and materials influence the risk of injury from fires (Conway, 1993).

4.1.4 Childhood development and nutrition

The analyses of longitudinal cohorts of children have examined the influence of childhood housing conditions on the subsequent development of chronic diseases. A study conducted in Britain demonstrated modest associations of inadequate ventilation with overall mortality and type of water supply with coronary heart disease mortality, independent of other measures of deprivation (Dedman *et al.,* 2001). Lack of affordable housing has been linked to inadequate nutrition, especially among children. Expensive housing may force low-income tenants to use more of their resources on shelter, with less for food and other needs (Ellaway *et al.,* 2000). Homeless children often lack cooking facilities, leading to poor nutrition.

4.1.5 Mental health

Substandard housing may impact mental health negatively, although the evidence is more tentative. Excessive indoor temperature has been linked with irritability and social intolerance (Collins, 1993). Damp, mouldy, and cold indoor conditions may be associated with anxiety and depression (Hyndman, 1990). Because residents are hesitant to extend invitations to visitors, poor housing conditions may cause residents to become socially isolated. The lack of common areas in high-rise buildings may make social interaction more difficult. Also, concerns about substandard housing and fear of homelessness are psychosocial stressors that can lead to mental health problems. According to a preliminary study, people's opinions about their homes (such as pleasure and pride in their residences as well as worries about indoor air quality) may be related to their self-rated health status (Dunn *et al.,* 2000).

4.1.6 Neighbourhood effects

Beyond the state of the actual housing unit, the location of the house may be a factor in determining health. Neighbourhood-level effects on health include elevated rates of intentional injury, (Cubbin *et al*., 2000), poor birth outcomes, cardiovascular disease, (Diez *et al.,* 2001), gonorrhoea, tuberculosis, depression, (Schulz, 2000), physical inactivity and all-cause mortality in neighbourhoods of low socioeconomic status, independent of individual-level risk factors. Several features of these neighbourhoods may contribute to poor health. Air quality may be poor because of their proximity to sources of vehicle exhaust emissions such as major roads, bus depots, and trucking routes. These sources also create substantial noise exposure, which may be associated with a range of adverse health effects (Stanfield *et al.,* 2000). Sites of improper waste disposal can harbour pests, which can then infest homes. Also, physical insecurity and violence can constrain people to their homes, thus limiting physical activity.

4.2 Burden of disease associated with poor housing.

Health conditions related to housing present a critical health burden. Some of this can be attributed to inadequate water access and poor indoor air quality. Water, sanitation, and hygiene were responsible for 829,000 deaths from the diarrhoeal disease worldwide in 2016. This constitutes 1.9% of the global

burden of disease measured as disability-adjusted life years (DALYs) (WHO, 2018). In 2016, 3.8 million deaths globally were attributable to household air pollution from the use of solid fuels for cooking, almost all of which occurred in low- and middle-income countries (WHO, 2018; Air pollution and control). About 15% of new childhood asthma in Europe can be attributed to indoor dampness, representing over 69000 potentially avoidable DALYs and 103 potentially avoidable deaths every year (Braubach *et al.,* 2018). Housing also contributes to the burden of disease by exposing people to dangerous substances or hazards, or infectious diseases. For example, almost 110 000 people die every year in Europe because of injuries at home or during leisure activities, and a further 32 million require hospital admission because of such injuries (Angerman *et al.,* 2007). In Europe, it has been estimated that 7500 deaths and 200,000 DALYs are attributable to a lack of window guards and smoke detectors (WHO, 2018). Approximately 10% of hospital admissions per year in New Zealand are attributable to household crowding (Baker *et al.,* 2013). In 2012, India recorded over 2600 deaths and 850 of various injuries resulting from the collapse of over 2700 buildings (Chalabi, 2013). In Kyrgyzstan, household crowding causes 18.13 deaths per 100,000 from tuberculosis per year (WHO, 2018). Exposure to lead is estimated to have caused 853,000 deaths in 2013 (Forouzanfar, 2013). While everyone can be exposed to the risks associated with unhealthy housing, people with low incomes and vulnerable groups are more likely to live in unsuitable or insecure housing or to be denied housing altogether (Jacobs, 2011).

4.3 Components of housing quality

Components of housing quality are the measures used to assess housing schemes based on quality rather than cost. Quality housing should provide adequate protection from cold, dampness, heat, rain, wind, structural hazards, disease 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, and the internal environment coupled with an assessment of the neighbourhood and environmental sustainability. The external structure is described by the structural integrity of the building, weather tightness, 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, and tightened windows explain the internal structure of the building. The internal environment is characterized by ventilation, illumination, indoor air quality, and moisture. A broader assessment of the quality and safety of the neighbourhood in terms of community facilities, quality of paths/streets and services coupled with environmental sustainability forms an integral component of housing quality.

5. Profile of Nigeria in a Brief

Nigeria is the most populous nation in Africa with over 200 million people (UN, 2009). Based on the 2010 Gross National Income (GNI) per capita, the World Bank classified Nigeria as a “Lower Middle-Income Economy, with 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 km2. With a coastline of at least 853 kilometres, it borders Benin (773 km), Niger (1497 km), Chad (87 km), and Cameroon (1690 km) on a 4047 km border. Nigeria is between latitudes 4° and 14°N, and longitudes 2° and 15°E. The country has more than 500 ethnic groups. Nigeria is the eighth-largest exporter, the world's 12th-largest producer of crude oil, and it has the 10th-largest known reserves. Petroleum plays a large role in the economy of Nigeria, accounting for 40% of the GDP and 80% of Government earnings.

5.1 Housing conditions in Nigeria

At the national scale, (Abumere, 1987) studied 40 cities cutting across various Nigerian city typologies. He noted that because of low building technology and the 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 a few other hinterland cities that formed contact points for colonial trade and administration.

A study carried out by (Udoh *et al.,* 2013) examined the association between housing conditions and health status among households in Nigeria's deserted rural areas, with a focus on rural Akwa Ibom State. They revealed that rural households in Akwa Ibom State had a 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 extinguishers in their homes, 73% had no first aid box and 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 (Udoh *et al.,* 2013). The study also revealed that 60% of the households live in houses with a leaking roof, cracked wall (56%) and broken windows (54%) while 75% of the household lived in houses with broken floor conditions (Udoh *et al.,* 2013).

5.2 Indicators for evaluating housing quality.

Qualitative research has identified a few standards as useful indicators for quality evaluation in residential development when determining the calibre or suitability of housing. Among such are (Ebong, 1983) aesthetics, ornamentation, sanitation, drainage, age of the building, access to basic housing facilities, burglary, spatial adequacy, noise level within neighbourhoods, sewage and waste disposal and air quality as associated factors affecting home quality. However, (Hanmer *et al.,* 2000) 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, (Neilson *et al.*, 2007) stipulates five basic criteria which include compliance with a tolerable standard, free from serious disrepair, energy efficiency, being provided with modern facilities and services, and that it must be healthy, and safe.

However, these various studies provide some evidence that a single variable might not be sufficient to evaluate the quality of residential housing; as a result, housing acceptability and qualitative assessment should also consider the nature of structures, materials used, services, spatial configuration and amenities within dwellings, purpose, and aesthetics, among other factors (Jiboye, 2004).

5.3 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 Nations Habitat in 2006 found that 90% of slum residents are in developing countries with struggling economies. In addition, most urban settings were not designed to handle millions of people which directly impacts the availability and affordability of housing, forcing millions to live in substandard dwellings with poor housing quality (Amao, 2012).

5.4 Indoor air and housing quality

Indoor air is defined as the air within an indoor environment. 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 (Krieger *et al.,* 2002), which are important agents that impair the air quality in an indoor environment. Several 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 pollutants, considering the amount of time stayed indoor (Anyanwu, 2011). 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 (Ana *et al.*, 2015). A study conducted by (Rim-Rukeh, 2015) in a slum squatter inundated area of Warri, Nigeria, reported the measured levels of nitrogen dioxide (NO2), carbon monoxide (CO) and suspended particulate matter (SPM10) to be over WHO air quality standard levels in all assessed homes. His report suggests that the 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 diseases such as asthma, as it is usually associated with poor air quality. This therefore further suggests that impairing air quality in a housing setting has an inverse relationship with the housing quality, and thus a negative impact on the health and wellness of its occupant.

5.5 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. Acute respiratory infections (ARIs) are a group of heterogeneous diseases caused by a diverse group of organisms in which the anatomical sites involved consist of the airways from the nostrils and pharynx down to the alveoli (Akanbi *et al.,* 2009). In most developing countries including Nigeria, the burden of respiratory disease is largely unknown; however, on 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 (Acharya, 2003). Data from the national demographic health survey 2013 reported the prevalence of ARIs in Nigeria to be about 2% (NPC, 2014).

5.6 Meteorological conditions of houses and respiratory conditions

The term "meteorological conditions" refers to the current environmental circumstances as they affect weather forecasting. In Ibadan, a case-control study comparing young children with and without ARI found that a higher percentage of the homes visited reported a relative humidity (RH) value above the comfort level (30–60%) (Fakunle *et al.,* 2015). This high RH observed among a large proportion of house cases could be 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 dust (Choa *et al.,* 2004). High relative humidity above 70% also tends to favour the survival of viruses that infect the membrane of the respiratory tract.

5.7 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 (Makene, 2007). Exposure to biological, chemical, and physical hazards like lead, carbon monoxide, and volatile organic compounds may rise in substandard housing hazards leading to a wide range of adverse health outcomes, especially respiratory diseases. Adequate housing, therefore, remains essential to people's comfort, health, and overall well-being. Thus, understanding the link between housing and respiratory health condition is important in

designing effective strategies to improve quality of life. Crowding, poor air quality within homes due to inadequate ventilation, and the presence of smoke contribute to poor respiratory health in general and have been implicated in the spread and/or outcome of tuberculosis.

5.8 Covid-19 Pandemic and Housing

Evidence has shown that Covid-19 is transmitted primarily between people via respiratory droplets and contact routes. Droplet transmission occurs when a person is in close contact with an infected person or exposed to the potentially infective transmission which can be because of coughing, sneezing or very close contact with infected persons resulting in absorption or inoculation by nose, mouth, eyes of such infected droplets by the next individual. Such transmission can also occur directly or indirectly with surfaces or objects an infected person might have made contact with. Social distancing and isolation have been enforced by various governments across the nations of the world to reduce the spread of the deadly virus. This has helped in 'flattening the curve' of the pandemic. Housing is one of the major factors affecting the spread of COVID- 19 (Garber, 2020). Maintaining social distancing within the home is very difficult. Restricting people in their homes serves as a way of saving people from exposure to the virus. For people experiencing homelessness or those who sleep arbitrarily in open spaces, or slums, the idea of isolation, and quarantining is unrealistic because of the absence of private dwellings. And such can lead to greater exposure to COVID-19.

5.8.1 The Challenge of Covid-19 And Residential Housing

The Nigerian government has adopted several strategies to prevent the spread of Covid-19, but housing remains a perennial problem. With a population estimate of 206,139,589 people in midyear 2020 according to United Nations data (World Metre Live, 2020) and a projected population of 263 million by 2038, the housing situation in Nigeria requires an urgent response. Many residents of Lagos are poor and are accommodated in slums, squatter settlements and degraded environments, their lives are not safe. Housing conditions are poor and overcrowded, leading to multiple vulnerabilities. Research conducted by (Oluwafemi, 2020) found that about 80% of the residents of the Sari-Iganmu area of Lagos live in one room with an average of seven people. With no running water, an average of seven households share toilet and bathroom facilities. The fact that Lagos has the highest number of COVID-19 cases in the country to date could be explained by these factors. The densely populated mainland areas have the highest number of infections. Alimosho, Osodi, Mushin, Ikeja, Kosofe and Isolo areas have the highest cases reported. The population density in these areas is high with more than five persons living in a room. The residents suffer an unacceptable level of hygiene and health, residents make use of overcrowded and stressed facilities with inadequate water supply and electricity. They also lack good proper garbage disposal facilities, good drainages, and poor personal hygiene. Open defecation is widely practised. A triggered rise in COVID-19 infections increases the vulnerable population daily. The inadequate shelter which results in overcrowding and lack of clean water for hand washing are among the major factors in the transmission of COVID-19 infections in these communities.

Conclusion

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 a decent and good standard of living. In Nigeria, the prevalence of respiratory disorders and morbidity, particularly in young children under the age of five, have been

linked to overcrowding, poor ventilation, the use of biomass fuel, mould growth in homes, dampness, and poor quality. Therefore, measures such as health policy changes regarding the construction of homes, better ventilation of kitchens and homes, and use of environmentally friendly, low-emission and energy-efficient cooking stoves must 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 programs, raising housing awareness, encouraging good self-help environmental sanitation among households, and developing of good and effective master/development plan for physical planning.

Health hazards associated with poor municipal solid waste management are real and pose serious public health threats ranging from the transmission of endemic zoonoses to the emergence and re-emergence of new zoonoses arising either from direct or indirect effects of poor waste management. These health hazards can be reduced to minimal levels through public education, enactment and re-enforcement of policies and legislations, improvement of funding, monitoring and supervision, recycling waste and development of landfills among others. It is pertinent that all human settlements regardless of their sizes and locations develop landfill for proper waste management which will preserve the environment and promote the well-being of the people.

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