THE HEALTH IMPACTS OF DAMP HOUSING CONDITIONS: LESSONS FOR INHABITANTS LIVING IN DAMP TROPICAL BUILDINGS

Agyekum, K.1, Salgin, B2. and Danso, A.K3.

[1, 3]Kwame Nkrumah University of Science and Technology, Kumasi, Ghana
[2]Erciyes University, Faculty of Architecture, Department of Architecture, Kayseri/Turkey
agyekum.kofi1@gmail.com; bsalgin@gmail.com; akdansoh2000@yahoo.com

Abstract

Dampness in buildings is a common problem in Ghana. A nationwide survey has estimated that one out of every ten residential buildings suffers from one form of dampness or the other. The possibility that damp housing conditions may affect the health of occupants, and in particular expose them to respiratory symptoms has been the attention of many cross-sectional epidemiological studies worldwide. Building related mould, fungi, dust mites, etc. associated with dampness have considerable economic consequences in increased healthcare costs because of higher disease prevalence, use of healthcare services and medications. Through literature survey, this study sought to examine the impact of damp housing conditions on the health of occupants, and presents lessons from such studies to those living in tropical buildings (the case of Ghana) with similar conditions. The study was carried out using a two-stage methodology which included identifying the relevant literature material, and reviewing the relevant literature. The key lesson learned from the literature search is the fact that there are many health issues associated with living in damp housing conditions. The review clearly showed that being exposed to damp conditions could trigger a number of upper and lower respiratory tract infections, as well as skin diseases. Among the diseases are asthma, wheeze, allergic rhinitis, atopic dermatitis, headache, eczema, bronchitis, cough at night, etc. Public health researchers and practitioners should be prompted on the adverse health effects of mould, indoor fungi, dust mites (which are accompanied with dampness) to residents, and efforts should be made to enlighten the general public and government bodies on these issues.

Keywords: Damp, Health, Ghana, Tropical buildings

Introduction

Housing characteristics, community and neighbourhood environments have the potential to affect human health through physical, mental and social mechanisms (Udofia et al., 2014; Egan et al., 2010). Adequate housing is expected to provide shelter from climatic conditions, security, environmental nuisances, etc. (Udofia et al., 2014; Lawrence, 2006). Studies worldwide have shown that substandard housing has contributed to indoor air quality problems and has resulted in adverse health conditions like asthma, tuberculosis, and poor mental health (Udofia et al., 2014; Kreiger and Higgins, 2002). According to Maxim (2013), indoor air quality is an important issue for occupational and public health. One of the major building defects which affects the indoor air quality of buildings is the presence of excessive moisture which give rise to dampness.

Moisture is a major problem that affects both olden and modern types of buildings (Sandrolini and

Franzoni, 2006). It affects the hygiene, aesthetics and the structural safety of buildings. Moisture in a building, if not properly controlled, can create serious problems for that building, its occupants and furnishings (Stanke et al., 1998). As the single most important agent of building deterioration, moisture has been an issue of great concern to building professionals (Dacquisto et al., 2004). Moisture from any source may lead to: staining of wall surfaces, damage to paints, corrosion of metal surfaces, increase in the deterioration of building furnishings and structural materials (Stanke et al., 1998); deterioration and disbanding of common building materials like ceiling tiles, wood products, etc. (Rousseau, 2004); and the development of biological agents like moulds and dust mites (Rousseau, 2004).

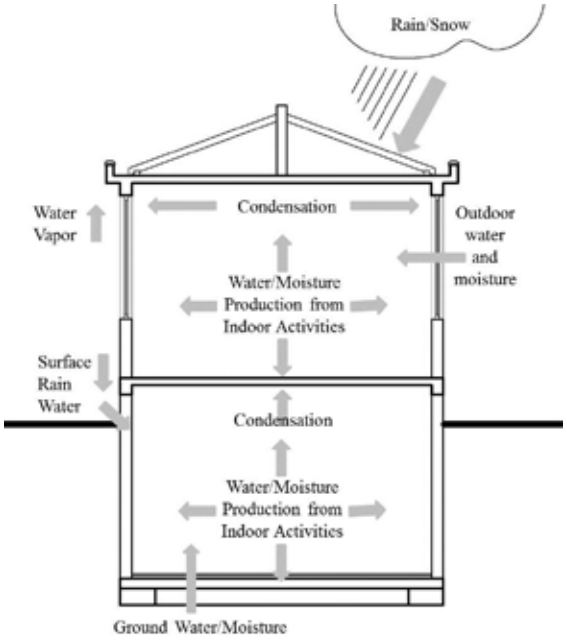

Figure 1. Sources of moisture in buildings
(Source: Authors' own construct)

Moisture that should not be present in a building is known as dampness (Burkinshaw and Parrett, 2004). A building is said to have a dampness problem when the materials in the building become sufficiently damp leading to material damage or visible mould growth (Burkinshaw and Parrett, 2004). According to Straube (2002), biological growth such as fungus associated with moisture can have severe impacts on buildings and the health of occupants. For moisture to be present in buildings, there should be a source of moisture available, a means or route for the moisture to travel and a driving force to enhance the moisture movement (Straube, 2007; Straube and Schumacher, 2007; Straube, 2002). The elimination of any one of these conditions should avoid moisture problems in buildings. However, in reality, it is difficult to manage or remove all the sources of moisture to completely create moisture-free buildings (Straube, 2007; Straube and Schumacher, 2007; Straube, 2002).

For some time now, the home environment has changed considerably worldwide. This is due to altered building technologies, new building components and strong demands for energy conservation (Emenius et al., 2004). In the quest for these changes, there is always the need to control the amount of moisture that enters buildings. Uncontrolled moisture in buildings can lead to a number of issues. According to Harriman et al. (2000), indoor moisture originates from many sources. These sources include vapour diffusion though building envelopes, water rising into walls from the ground, and penetration of precipitation. Oreszczyn and Pretliove (1999) also suggested that indoor activities such as cooking, showering and cleaning can introduce moisture into buildings. Building design and operational issues such as plumbing leakages and uncontrolled airflows may also introduce moisture into buildings (Glass and TenWolde, 2009). All these occurrences may result in structural damages, degradation of materials, health issues, and changes to microbial communities (Dedesko and Siegel, 2015).

Adverse health effects associated with building dampness and other moisture problems have been reported over 2000 years ago. In the days of the Israelites, buildings that were affected by dampness were classified as 'contaminated houses', and such buildings were not fit to be hospitable (Leviticus 14: 33-48). People who dwelled in such buildings were at the risk of developing serious skin diseases. Today, many people are happily living in damp affected buildings without the realization of the health issues they are exposed to (Maxim, 2013). Excessive

moisture which accumulate in building structures through condensation, rain penetration, capillary rise of water, etc. have the potential to promote mould growth (Maxim, 2013). These moulds may release different compounds and particles into the air, which when inhaled, may create health problems.

There are many epidemiological studies that have shown linkages between dampness and adverse health effects. The effects range from irritation of mucous membranes, respiratory symptoms and infections, to chronic diseases like asthma and allergy. Other studies have also reported on general symptoms such as fever, fatigue, headaches and depressions. Despite these findings, it is still unknown how the dampness leads to the appearance of these symptoms (Udofia et al., 2014). Studies that investigate the relationship between housing and health have been conducted in many developed countries. However, in Africa, there are only few of such studies (Udofia et al., 2014; Asamoah et al., 2012; Govender et al., 2011; Arku et al., 2011; Baiden et al., 2010; Ahianba et al., 2008). This study was therefore conducted to review literature on the impact of damp housing on the health of building occupants, as a way of creating awareness for people who are living in damp housing conditions in tropical countries. However, much emphasis was placed on building occupants in Ghana.

The study begins with a brief background on the health impacts of damp buildings, and is followed by a brief description of the methods used to conduct the study. It continues by highlighting on some key issues concerning studies conducted in other countries on the subject matter, and narrows down to damp housing situations in Ghana. It further throws some light on the prevalence of health problems associated with damp housing in Ghana, and draws its conclusion.

Research Methodology

The study was conducted using a two-stage methodology, as follows:

Stage 1: identifying the relevant literature material

In identifying the relevant literature material, journals dedicated to the publishing of issues under discussion were consulted. The top journals reviewed included: Indoor Air; Indoor and Built Environment; Ghana Medical Journal; International Journal of Tuberc Lung Disorders; African Health Sciences; BMC Public Health Journal; Microbiome; European Journal of Allergy and Clinical Immunology; Occup Environ Med; European Respiratory Journal; Pediatrics; Environmental Health; Acta Paediatrics; Environmental Health Perspectives; and Thorax. The articles selected and considered for this study were those which had been cited 50 or more times (excluding the article from Mudarri, 2016) per google scholar citations, and which were relevant to the study.

Stage 2: The review of relevant literature

During the literature review, the major issues covered included the impact of damp housing on the health of occupants, damp housing in Ghana, and the prevalence of health problems associated with damp housing in Ghana. These topics were selected on the basis of previous literature related to the theme under study. More specifically, the works of Norbäck et al. (2000), Bornehag et al. (2001), Kilpeläinen et al. (2001), Maritta et al. (2002), Bhola and Subratty (2003), Park et al. (2004), Emenius et al. (2004), Simoni et al. (2005), Pekkanen et al. (2007), Karvonen et al. (2009), Fisk et al. (2010), Ayanbimpe et al. (2010), Tischer et al. (2011), Han et al. (2013), Agyekum et al. (2013), Agyekum et al. (2014), Agyekum and Ayarkwa (2014) and Mudarri (2016) were reviewed.

Findings and Discussion

Impact of damp housing on the health of occupants: A review of related literature

The house is where most people spend the most parts of their day. It could either be the home or an office. For those who may be employed and are working

on eight hour jobs, this could mean spending a maximum of about sixteen hours (eight in the house and eight in the office) (Udofia et al., 2014). For others like those in pre-schools, homemakers and pregnant women, the time spent could be much longer (Udofia et al., 2014). According to the rule of 1000, a pollutant released indoors is 1000 times more likely to reach people's lungs than a pollutant released outdoors (Udofia et al., 2014; Muruka and Muruka, 2007). It is therefore very important that the home is kept free all forms of contaminants.

Various studies worldwide have identified moisture-related problems in buildings as a health-risk exposure (Han et al., 2013). Such studies have also confirmed the fact that living or working in such building conditions could create respiratory or allergic health effects to occupants (Han et al., 2013). This section reviews and summarizes the findings from various studies conducted on the impact of dampness on the health of people.

Norbäck et al. (2000) conducted a study to determine the relationship between the symptoms of asthma (wheeze or attacks of breathlessness) and indoor environment, and dampness in hospitals in Sweden. The authors measured indoor air pollutants, dampness in concrete floors, and allergens in settled dust. The findings from the study revealed that the symptoms of asthma were more common in two buildings with signs of dampness. The asthmatic symptoms were diagnosed to be associated with the higher relative humidity in the upper floor construction, and the presence of ammonia in the floor.

Bornehag et al. (2001) conducted an interdisciplinary review to examine the relationships between the exposure to dampness in buildings and health effects. After the review it was revealed that dampness in buildings increased the risk of health effects in the airways. Several health effects were identified to include cough, wheeze and asthma. The study further identified positive relationships between dampness and other symptoms such as tiredness, headache and airway infections. After the study, it was concluded that the evidence for a causal association between dampness and health effects was strong, however, the mechanisms involved were unknown (Bornehag et al., 2001). This notwithstanding, the researchers iterated through a recommendation that "the limited knowledge about the mechanisms behind the association between dampness and health effects is no excuse for not intervening about dampness problems in buildings". Again, it was further suggested that "it is quite obvious that there is the strong suspicion that dampness causes health effects, with no indication that living in a damp building improves health". This notwithstanding, even though it may be a great challenge to science to explain the associations, the researchers advised that the practical advice is to avoid dampness in buildings.

Kilpeläinen et al. (2001) also conducted a study to examine the relationship between home dampness and current (at that time) physician diagnosed asthma, allergic rhinitis, allergic conjunctivitis, atopic dermatitis, common colds and bacteria respiratory infections among 10, 667 Finnish first year university students. The researchers surveyed several dampness categories to include visible mould, damp stains or water damage during the last year (as at that time). The results from the survey showed that visible mould or damp stains, or water damage was reported by 15% of the respondents. Multivariate models were further developed in the study, and it was revealed that there existed a positive association between home dampness and current asthma, allergic rhinitis, and atopic dermatitis as well as common colds. The researchers confidently concluded that there exist a risk of asthma, allergic rhinitis, and atopic dermatitis in damp homes. Also for respiratory infections, the risk of common colds was very common among the respondents.

Maritta et al. (2002) conducted a study to assess the effects of indoor dampness problems and moulds at work and home on the development of asthma in

adults. In the study, the researchers systematically recruited all new cases of asthma between 1997 and 2000 in the Pirkanmaa Hospital district, South of Finland. The findings from the study revealed that the risk of asthma was related to the presence of visible mould and or mould odour in the working place. The fraction of asthma attributable to workplace mould exposure was estimated to be 35.1% among the exposed. The researchers concluded in their study that indoor mould problems constitute an important occupational health hazard.

A cross-sectional study was conducted by Bhola and Subratty (2003) to investigate the occurrence of respiratory and other symptoms among workers in 25 buildings in Mauritius. From the study it was revealed that the workers complained of health related issues such as headache, excessive mental fatigue, nervousness, unusual tiredness/lethargy, forgetfulness, irritated and tired/strained eyes and sneezing. The study concluded that the cumulative effect of the different dampness characteristics was associated with an increase in health related symptoms. The researchers therefore suggested that measures should be taken to reduce building dampness and microbial growth in dwellings.

Park et al. (2004) used a semi-quantitative mould exposure index to investigate 13 college buildings in USA to examine whether building-related respiratory symptoms among young employees were associated with environmental exposure to mould and dampness in buildings. Data was obtained on upper and lower respiratory symptoms, and their relatedness to time spent in specific rooms affected by dampness using self-administered questionnaires. The findings from the study showed that conditions suggestive of indoor mould exposure at work were associated with building-related respiratory symptoms.

Emenius et al. (2004) explored the relationship between indoor exposures and the home environment, and the development of recurrent wheezing during infancy in Denmark. A birth cohort that comprised of 4,089 children was followed. The study found a trend in the risk of recurrent wheezing in relation to the number of indicators of dampness. It was concluded in the study that indicators of dampness, as well as recently repainted interior surfaces appear to be associated with recurrent infant wheezing, with a strengthened effect of combined indoor exposures.

Simoni et al. (2005) reported on the relationship between home mould and/or dampness exposure and respiratory disorders in children and adolescents in Italy. A total of 20,016 children (mean age 7 years) and 13, 266 adolescents (mean age 13 years) completed questionnaires on indoor exposures and respiratory symptoms/diseases. The findings from the study showed that asthma was more strongly related to early exposure to damp buildings both in children and adolescents. The same result was obtained for eczema, rhino conjunctivitis, among others. In the conclusion, the researchers iterated that respiratory disorders such as asthma and wheeze can often be explained by exposure to home mould/dampness, especially in early life. Such associations seem more evident in children than in adolescents.

Pekkanen et al. (2007) conducted a population-based incident case-control study to examine the association between moisture damage and childhood asthma in Finland. New cases of asthma aged 12-84 months were recruited and matched for year of birth, sex and living area with two randomly selected population controls. The findings revealed that risk of asthma increased with severity of moisture damage and presence of visible mould in the main living quarters. The study concluded that moisture damage and mould growth in the main living quarters were associated with the development of asthma in early childhood.

Karvonen et al. (2009) evaluated the impact of objectively observed moisture damage and visible mould in the homes on early-life respiratory morbidity and atopic sensitization in a birth cohort. Building Engineers carried out building inspection in the homes of 396 children. Further information was obtained by the researchers on the children from birth to the age of 18 months using questionnaire. The findings from the study revealed that Doctor-diagnosed wheezing was associated with the severity

of moisture damage in the kitchen and with visible mould in the main living area, and especially in the bedroom of the child. The findings from the study further revealed that the risk for parent-reported wheezing apart from cold increased with the severity of moisture damage in the kitchen. Moisture damage in bathrooms or other interior spaces had no significant associations with wheezing. The researchers therefore concluded that the birth-cohort study supports previous observations that moisture mould problems in the kitchen and in the main living area increase the risk for wheezing in early childhood.

Fisk et al. (2010) reported on the results of a quantitative meta-analyses of published studies that examined the association of dampness or mould in homes with respiratory infections and bronchitis. The study found that residential dampness and mould are associated with substantial and statistically significant increases in both respiratory infections and bronchitis.

Ayanbimpe et al. (2010) assessed the level of fungal contamination of indoor air, health related experiences of residents, and the prevalent fungi species in homes in the Jos Metropolis, South Africa. The findings from the study revealed that the indoor air quality of residential dwellings in Jos is poor. The findings further revealed that the residents were displeased with the fungal presence in their homes and their associated health implications.

Tischer et al. (2011) decided to investigate whether reported mould or dampness exposure in early life was associated with the development of allergic disorders in children from eight European birth cohorts. The researchers analysed data from 31, 742 children from eight ongoing European birth cohorts. Exposure to mould and allergic health outcomes were assessed by parental questionnaires at different time points. The findings from the study revealed that exposure to visible mould and/or dampness during the first 2 years of life was associated with an increased risk of developing asthma. The researchers further concluded that a mouldy home environment in early life is associated with an increased risk of asthma, particularly in young children and allergic rhinitis symptoms in school-age children.

Han et al. (2013) conducted a study to assess dampness in dwellings and its associations with asthma and allergies among children in Chongqing, China. A cross sectional questionnaire survey on home characteristics including dampness and symptoms of asthma and allergies in 5,299 children was performed. Data for 4,754 children (aged 3-6 years) and their homes were analyzed. The findings from the study revealed that all the various buildings surveyed exhibited symptoms of one form of dampness or the other. Wheezing, cough at night, rhinitis, eczema, asthma, amongst others were reported amongst the health effects associated with the damp buildings.

At the request of the U.S. Center for Disease Control and Prevention (CDC), the Institute of Medicine (IOM) of the National Academy of Sciences convened a committee of experts to conduct a comprehensive review of scientific literature concerning the relationship between damp or moldy indoor environments and the appearance of adverse health effects in exposed populations. Based on their review, the members of the Committee on Damp Indoor Spaces and Health concluded that the epidemiologic evidence showed an association between exposure to damp indoor environments and adverse health effects, including: Upper respiratory (nasal and throat) symptoms, cough, wheeze, asthma symptoms in sensitized persons with asthma. The committee also determined that there was limited or suggestive evidence of an association between exposure to damp indoor environments and dyspnea (shortness of breath), lower respiratory illness in otherwise healthy children, asthma development, amongst others (EPA, 2013).

Mudarri (2016) currently conducted a study to estimate full disease costs attributable to dampness and mould using available 'cost of illness' and

'willingness to pay' (WTP) estimates to come as close to ideal WTP estimates as possible. The researcher used the framework for hospitalization used by Thayer to highlight the sensitivity of results to alternative assumptions and methods. The dampness related health issues considered in the study included allergic rhinitis, acute bronchitis and asthma. A limited sensitivity analysis of alternative methods and assumptions demonstrated a wide potential range of estimates. In the study, it was finally realized that the total annual cost to society attributable to dampness and mould is estimated to be $3.7 billion for allergic rhinitis, $1.9 billion for acute bronchitis, $15.1 billion for asthma morbidity and $1.7 billion for asthma mortality.

The review has clearly shown that being exposed to damp conditions could trigger a number of diseases. These include upper and lower respiratory tract infections, as well as skin diseases. Among the disease prevalent and found to be associated with dampness are asthma, wheeze, allergic rhinitis, atopic dermatitis, headache, eczema, bronchitis, cough at night, etc.

Table 1 shows a summary of the various studies on major health issues associated with living in damp buildings.

The situation of dampness in Ghanaian residential buildings

Since the year 2012, serious studies have been conducted on the issue of dampness in Ghanaian residential buildings. The views of building occupants and construction professionals had been sought on their level of awareness on dampness in walls of residential buildings (Agyekum and Ayarkwa, 2014; Agyekum et al., 2013). The findings had revealed that generally, the level of awareness of the problem amongst the professionals and the building occupants is very high (Agyekum and Ayarkwa, 2014; Agyekum et al., 2013). It has therefore led to the adoption of various intervention methods like tiling of wall bases, replastering and construction of aprons around wall bases to control the problem.

The findings from the previous studies triggered further studies where a nationwide survey of 5,800 residential buildings with problems of dampness was undertaken to identify the lead source of the dampness (Agyekum et al., 2013). The findings from that study revealed that the most dominant type of dampness in the selected buildings was rising damp which was identified among 5,037 out of the total number of 5,800 buildings surveyed (Agyekum et al., 2013). The buildings identified with the problem of rising dampness showed symptoms such as hygroscopic salts, moist timber skirtings, mould growth, damp in horizontal bands, amongst others (Agyekum et al., 2013).

With this information on the dominant source of dampness in residential buildings, further studies were conducted on three residential buildings that were severely affected by the problem of rising dampness (Agyekum et al., 2014). The study had two key objectives, that is to determine the types of soluble salts and their concentrations in the soils within the vicinities of the buildings, and their accumulated percentages in the walls over time. The study also sought to determine whether there existed any linkages between salts present in the walls affected by the rising damp and those in the ground (Agyekum et al., 2014). Several salt groups were identified in the walls, with the most damaging and dangerous being magnesium sulphate, magnesium chloride, and sodium sulphate salts. The same salts were further identified in the soils located within the vicinities of the buildings (Agyekum et al., 2014). The researchers however did not look at the issue of mould (though prevalent) growth in the previous studies because it was not the focus at that time. The issue of mould growth and its impact on the health of occupants who come in contact with them has however been debated on for many years. Some of its related health impacts is what has been discussed in section 3.1 of this paper.

The prevalence of health problems associated with damp housing in Ghana

Unlike the advanced countries such as UK, USA, Finland, Sweden, Italy and Germany, not much is known about the health issues associated with living or working in damp buildings in Africa and in Ghana. Few studies have been conducted on some respiratory health issues but there are no clear evidences of their linkages to the affected living in damp and mouldy buildings (Udofia et al., 2014; Asamoah et al., 2012).

Udofia et al. (2014) conducted a study on residential characteristics as correlates of occupants' health in the greater Accra region of Ghana. The researchers conducted a cross sectional survey among 500 informed adults aged 18 years and above using a semi-structured questionnaire to investigate residential characteristics associated with self-rated occupants' health. Among the health issues identified were malaria, typhoid, skin infections, respiratory tract infections, gastroenteritis and measles (Udofia et al., 2014). However, the study did not indicate whether any of these health issues like the respiratory tract infections, skin infections, etc. identified was/were directly related to the occupants living in damp buildings. The results from their study provided further evidence of housing as a determinant of occupants' health, and identified housing characteristics and living conditions as issues for public health action in Ghana (Udofia et al., 2014).

Asamoah et al. (2012) explored literature on epidemiological studies on asthma carried out in Ghana and how these findings fit into the wider context of observations from other countries. The review of literature revealed that asthma research in Ghana has focused mainly on children between the ages of 5-16 years with one published study that included adults. Different markers for the disease have been used such as clinician-diagnosed asthma, exercise-induced bronchospasm as well as questionnaire-derived symptoms of asthma (Asamoah et al., 2012). Factors found to be associated with asthma in Ghana include atopic sensitization to environmental allergens, inner-city residence and socioeconomic differences. Other implicated factors were family history of asthma, sib-ship position, breast-feeding duration and helminth infections (Asamoah et al., 2012). The study recommended that there is the need to examine the role of environmental air pollutants on the disease's pathogenesis (Asamoah et al., 2012).

Moisture-Related Possible Health Problem		Study that Mentioned the Health Problem																
		Norbäck et al. (2000)	Bornehag et al. (2001)	Kilpeläinen et al. (2001)	Mariëtte et al. (2002)	Bhola and Subratty (2003)	Park et al. (2004)	Emenius et al. (2004)	Simoni et al. (2005)	Pekkanen et al. (2007)	Karvonen et al. (2009)	Fisk et al. (2010)	Ayanbimpe et al. (2010)	Tischer et al. (2011)	Han et al. (2013)	EPA (2013)	Mudarri (2016)
Respiratory Symptoms	Asthma	x	x	x	x				x	x				x	x	x	x
	Bronchitis											x					x
	Cough		x												x	x	
	Wheeze		x					x	x		x				x	x	
	Sneeze					x	x										
	Common colds			x													
	Airway infections		x														
	Bacteria respiratory inf.			x								x					
Aller. Symp.	Allergic rhinitis			x					x					x	x		x
	Allergic conjunctivitis			x					x								
	Irritated eyes					x											
Derma.sym p.	Atopic dermatitis			x													
	Eczema								x						x		
	Fungal presence												x				
Mental Symptoms	Headache		x			x											
	Mental fatigue					x											
	Nervousness					x											
	Forgetfulness					x											
	Tiredness		x			x											

Table 1. Summary of health issues associated with living in damp buildings

The way forward for Ghana with regards to the health impact of damp housing conditions

A large number of studies in various geographical regions have identified moisture-related problems in buildings. Comparing the findings from the international reviews conducted with that of Ghana, it is very evident that researchers worldwide have paid serious attention to the health impacts associated with living in damp buildings. However, in Ghana that is not the case. In the international studies, it has been proven that the evidence between dampness and health effects (such as cough, wheeze, asthma and other respiratory tract infections) is very strong. The few studies conducted in Ghana and reviewed showed no detailed evidences as such. The

problem may be as a result of the fact that not much awareness has been created on the dangers posed by dampness to the health of occupants living in damp buildings.

In 2013 for instance, a report submitted by World Health Organization (WHO) indicated that acute respiratory infections were third in terms of the distribution and causes of deaths in children under five years old in Ghana (Figure 2).

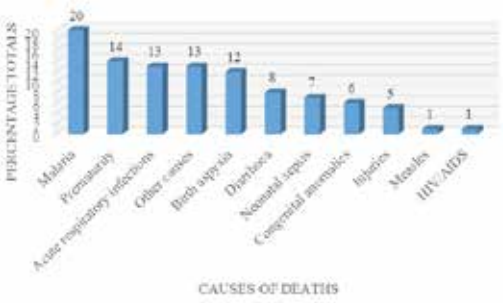

Figure 2. *Distribution of causes of deaths in children under 5years old in Ghana*
(Source: World Health Organization, 2013)

Also in 2012, among the top 10 causes of deaths in Ghana, lower respiratory infections were the leading cause, killing 22.4 thousand people (Figure 3). Looking at these trends, it becomes very evident that respiratory infections are very popular amongst the diseases which cause deaths in both the young and the old in Ghana.

These problems are worldwide and need urgent attention. In a Global Health Observatory Data submitted by WHO in 2015, it was reported that Ischaemic heart disease, stroke, chronic obstructive lung disease, and lower respiratory infections have remained the top killers during the last decade. Lung cancers (along with trachea and bronchus cancers) went up to become the 5th leading cause of death in 2012. It killed 1.1 million men and 0.5 million women worldwide. Though these reports did not categorically state that such diseases were as a result of people exposed to damp conditions, the findings from other studies revealing that living in damp houses may cause such respiratory diseases should not be overlooked.

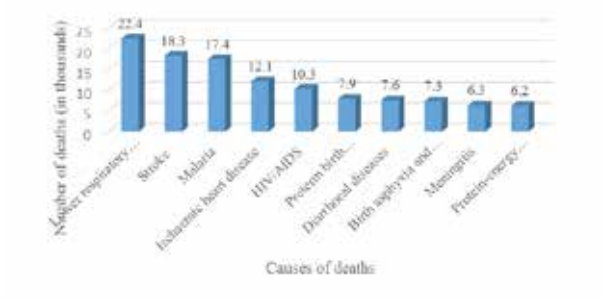

Figure 3. *Overall causes of deaths in Ghana*
(Source: World Health Organization, 2012)

The details presented by WHO was not very specific on the examples of such respiratory infections. However, it is very evident in literature that asthma is one of such respiratory infections that affect young children exposed to damp conditions in buildings. According to Simoni et al. (2005), respiratory disorders such as asthma and wheeze can often be explained by exposure to home mould/dampness, especially in early life. Such associations seem more evident in children than in adolescents (Simoni et al., 2005). In a similar study by Tischer et al. (2011), it was revealed that exposure to visible mould and/or dampness during the first 2 years of life was associated with an increased risk of developing asthma. The researchers further concluded that a mouldy home environment in early life is associated with an increased risk of asthma, particularly in young children and allergic rhinitis symptoms in school-age children (Tischer et al., 2011).

From these reports together with studies conducted worldwide on the health effects of dampness on building occupants, it has become very evident that dampness in one way or the other may pose serious health risks to occupants, and that serious attention should be paid to this issue. It has not yet been confirmed in Ghana that such respiratory tract infections are as a result of damp conditions in buildings. However, it is very important if the various stakeholders come together to ensure that, in as much as other causes of the problems are being investigated, the issue of being exposed to mould, fungi, house dust mites, etc. as a result of damp conditions in buildings are also investigated.

This will enable the stakeholders concerned to have enough evidences as to whether being exposed to dampness in buildings could increase the risks of building occupants to these health effects.

Conclusion

Adverse health effects associated with moisture and mould problems worldwide have been well documented. In most underdeveloped and developing countries not much studies have been conducted in this area. Studies have revealed that the effects of indoor mould on the health of occupants are greater on the poor and low-income people with substandard housing. Building related mould has considerable economic consequences in increased healthcare costs because of higher disease prevalence, use of healthcare services and medications. Through literature survey, this study sought to examine the impact of damp housing conditions on the health of occupants, and presents lessons from such studies to those living in tropical buildings (the case of Ghana) with similar housing conditions. The key lesson learned from the literature search is the fact that there are many health issues associated with living in damp housing conditions. The review clearly showed that being exposed to damp conditions could trigger a number of upper and lower respiratory tract infections, as well as skin diseases. Among the diseases are asthma, wheeze, allergic rhinitis, atopic dermatitis, headache, eczema, bronchitis, cough at night, etc. In conclusion, the researchers would like to quote Bornehag et al. (2001, pp.83) by saying that "though there may not be adequate scientific evidence to support the fact that dampness affects the health of occupants, there is also no indication that living in a damp building improves health. Hence, even if it is a great challenge to science to explain the associations, it is practically advised that occupants should avoid damp buildings". Public health researchers and practitioners should be prompted on the adverse health effects of mould, indoor fungi, dust mites (which are accompanied with dampness) to residents and efforts should be made to enlighten the general public and government bodies on these issues. Moreover; there should be some precautions in the design stage of buildings to avoid dampness problems. Designers and Architects should be made aware of the problem. Taking extra measures in design stage, such as; use of climate-appropriate vapor retarders and ventilation systems, careful installation of insulation, control of air leakage, appropriate planning of duct supplies and returns, correct sizing of air conditioning equipment, and provision of comprehensive setup materials and instructions can minimise the risks. These measures may relatively add to the cost of buildings, but they may also help to extend the healthy life time of buildings.

References

Agyekum, K. & Ayarkwa, J. (2014), Dampness in walls of residential buildings: The views of building construction professionals, Africa Development and Resources Research Institute Journal, Vol. 7 No 7(2), pp. 1-17.

Agyekum, K., Ayarkwa, J. & Koranteng, C. (2014), Holistic diagnosis of rising damp and salt attack in two residential buildings in Kumasi, Ghana, Journal of Construction Engineering, 2014, pp 1-13.

Agyekum, K., Ayarkwa, J., Koranteng, C. & Adinyira, E. (2013), Level of knowledge of building occupants on dampness in walls of residential buildings in Ghana, Modern Management Science and Engineering, Vol. 1 No. 1, pp. 171-184.

Agyekum, K., Ayarkwa, J., Koranteng, C. & Adinyira, E. (2013), Preliminary assessment of dampness in walls of residential buildings in four climatic zones in Ghana, Journal of Sustainable Development, Vol. 6 No. 9, pp. 51-61.

Ahianba, J.E., Dimuna, K.O. & Okogun, G.R.A. (2008), Built environment decay and urban

health in Nigeria, Journal of Human Ecology, Vol. 23 No. 3, pp. 259-265.

Asamoah, A.S., Forson, A.G. & Boakye, D.A. (2012), A Review of epidemiological studies of asthma in Ghana, Ghana Medical Journal, Vol. 46 No. 2, pp. 23-28.

Arku, G., Luginaah, I., Mkandawire, P., Baiden, P. & Asiedu, A.B. (2011), Housing and Health in three contrasting neighbourhoods in Accra, Ghana, Soc Sci Med, Vo. 72 No. 11, pp. 1864-1872.

Ayanbimpe, G.M., Wapwera, S.D. & Kuchin, D. (2010), Indoor air mycoflora of residential dwellings in Jos Metropolis, African Health Sciences, Vol. 10 No. 2, pp. 172-176.

Baiden, P., Arku, G., Luginaah, I. & Asiedu, A.B. (2010), An assessment of residents' housing satisfaction and coping in Accra, Ghana, Journal of Public Health, Vol. 19 No. 1, pp. 29-37.

Bholah, R. & Subratty, A.H. (2003), Humid building problems in Mauritius, Indoor and Built Environment, Vol. 12, pp. 221-225.

Bornehag, C.-G., Blomquist, G., Gyntelberg, F., Järvholm, B., Malmberg, P., Nordvall, L., Nielsen, A., Pershagen, G. & Sundell, J. (2001), Dampness in buildings and health. Nordic Interdisciplinary Review of the Scientific Evidence on Associations between Exposure to "Dampness" in Buildings and Healh Effects (NORDDAMP), Indoor Air, Vol. 11, pp. 72-86.

Burkinshaw, R. & Parrett, M. (2004). Diagnosing damp. Coventry: RICS BOOK, ISBN-13: 978-1842190975.

Dacquisto, D.J., Crandell, J.H. & Lyons, J. (2004), Building, moisture and durability: Past, present and future work. US Department of Housing and Urban Development, Office of Policy Development and Research, Washington, D.C.

Dadesko, S. & Siegel, J.A. (2015), Moisture parameters and fungal communities associated with gypsum drywall in buildings, Microbiome, Vol. 3, pp. 71.

Egan, M., Keams, A., Mason, P., Tannahil, C. , Bond, L., Coyle, J., Beck, S., Crawford, F., Hanlon, P., Lawson, L., Maclean, J., Petticrew, M., Sautkina, E., Thompson, H. & Walsh, D. (2010), GoWell Team: Protocol for a mixed methods study investigating the impact of investment in housing, regeneration and neighbourhood renewal on the health and wellbeing of residents: the GoWell programme. BMC Med Res Methodol 2010, 10:41.

Emenius, G., Svartengren, M., Korsgaard, L., Nordvall, G. & Wickman, M. (2004), Indoor exposures and recurrent wheezing in infants: A study in the BAMSE cohort, Acta Paediatr, Vol. 93, pp. 899-905.

Fisk, W.J., Eliseeva, E.A. & Mendell, M. (2010), Association of residential dampness and mould with respiratory tract infections and bronchitis: A meta-analysis, Environmental Health, Vol.9, pp. 72.

Glass, S.V. & TenWolde, A. (2009), A review of moisture balance models for residential indoor humidity. Montreal, Quebec: Proceedings from the 12th Canadian Conference on Building Science and Technology.

Govender, T., Barnes, J.M. & Pieper, C.H. (2011), The impact of densification by means of informal shacks in the backyards of low-cost houses on the environment and service delivery in Cape Town South Africa, Environ Health Insights, Vol 5, pp. 23- 52.

Han, W., BaiZhan, L., Qin, Y., Wei, Y., Juan, W., YiLong, L., YangJin, O. & Jan, S. (2013), Dampness in dwellings and its associations with asthma and allergies among children in Chongqing: A cross-sectional study, Chinese Science Bulletin, Vol. 58 No. 34, pp. 4259-4266.

Harriman, L.G., Lstiburek, J. & Kittler, R. (2000), Improving humidity control for commercial buildings, ASHRAE Journal, Vol 42 No 63, pp. 24-30.

Karvonen, A.M., Hyvärinen, A., Roponen, M., Hoffman, M., Korppi, M., Remes, S., von Mutus, E., Nevalainen, A. & Pekkanen, J. (2009), Confirmed moisture damage at home, respiratory symptoms and atopy in early life: A birth-cohort study, Padiatrics, Vol.124 No. 2, pp. 329-338.

Kilpeläinen, M., Terho, E.O., Helenius, H. & Koskenvuo, M. (2001), Home dampness, current allergic diseases, and respiratory infections among young adults, Thorax, Vol. 56, pp. 462-467.

Kreiger, J. & Higgins, D.L. (2002), Housing and Health: Time again for public health Action, Am Journal of Public Health, Vol. 92(5), pp. 758-768.

Lawrence, R.J. (2006), Housing and Health: Beyond disciplinary confinement, Journal of Urban Health, Vol 83 No. 3, pp. 540-549.

Maritta, S. J., Nordman, H., Piipari, R., Uitti, J., Laitinen, J., Karjalainen, A., Hahtola, P.& Jaakkola, J.J.K. (2002), Indoor dampness and molds and development of adult- onset asthma: A population-based incident case-control study, Environmental Health Perspectives, Vol. 110 No. 5, pp. 543-547.

Maxim, D. (2013), Health effcts of exposure to indoor fungi: Case Study-The Restorers of Mural Paintings, European Journal of Science and Theology, Vol. 9, No. 3, pp. 149-157.

Mudarri, D.H. (2016), Valuing the economic costs of allergic rhinitis, acute bronchitis and asthma from exposure to indoor dampness and mould in the US, Journal of Environmental and Public Health, pp. 1-12.

Muruka, C. & Muruka, A. (2007), Guidelines for environmental health management in childrens' homes in Sub-Sahara Africa, Int. Journal Environ Res Public Health, Vol. 4 No. 4, pp. 319-331.

Norbäck, D., Wieslander, G., Nordström, K. & W–linder, R. (2000), Asthma symptoms in relation to measured building dampness in upper concrete floor construction, and 2-ethyl-1-hexanol in indoor air, Int Journal Tuberc Lung Dis, Vol 4 No. 11, pp. 1016-1025.

Oreszczyn, T. & Pretlove, S.E.C. (1999), Condensation targeter ii. Modelling surface relative humidity to predict mould growth in dwellings, CIBSE A Build Serv Eng Res Technol., Vol. 20 No. 3, pp. 143-153.

Park, J.H., Schleiff, P.L., Attfield, M.D., Cox-Ganser, J.M. & Kreiss, K. (2004), Building-related respiratory symptoms can be predicted with semi-quantitative indices of exposure to dampness and mould, Indoor Air, Vol.14, pp. 425-435.

Pekkanen, J., Hyvärinen, A., Haverinen-Shaughnessy, U., Korppi, M., Putus, T. & Nevalainen, A. (2007), Moisture damage and childhood asthma: a population-based incident case-control study, European Respiratory Journal, Vol. 29, pp. 509-515.

Rousseau, D. (2004), Adapting to climate change: some observations, Building Research & Information, Vol. 32 No. 1, pp. 58-60.

Sandrolini, F. & Franzoni, E. (2006), An operative protocol for reliable measurements of moisture in porous materials of ancient buildings, Build Environ, Vol. 41, pp.1372–80.

Simoni, M., Lombardi, E., Berti, G., Rusconi, F., La Grutta, S., Piffer, S., Petronio, M.G., Galassi, C., Forastiere, F., Viegel, G. & The SIDRIA-2

Collaborative Group (2005), Mould/dampness exposure at home is associated with respiratory disorders in Italian children and adolescents: the SIDRIA-2 Study, Occup Environ Med, Vol. 62, pp. 616-622.

Stanke, D. Bradway, B. & Hallstrom, A. (1998), Managing building moisture, Trane. American Standard, Inc. La Crosse, Wisconsin. Sys-AM-15.

Straube, J. (2007), Review and hygrothermal simulations of planned insulation retrofit to Hitchcock Hall, Dartmouth College.

Straube, J. & Schumacher, C. (2007), Interior insulation retrofits of load-bearing masonry walls in cold climates. Building Science Digest 114. Available buildingscience.com, accessed 16/08/2014.

Straube, J.F. (2002), Moisture in Buildings, ASHRAE, Vol. 44, No. 1, pp. 15-19.

Tischer, C.G., Hohmann, C., Thiering, E., Herbarth, O., Müller, A., Henderson, J., Granell, M.P., Fantini, M.P., Luciano, L., Bergström, A., Kull, I., Link, E., von Berg, A., Kuehni, C.E., Strippoli, M.P.F., Gehring, U., Wijga, A., Eller, E., Bindslev-Jensen, C., Keil, T., Heinrich, J. & as part of the ENRIECO consortium (2011), Meta-analysis of mould and dampness exposure on asthma and allergy in eight European birth cohorts: an ENRIECO initiative, European Journal of Allergy and Clinical Immunology, Vol. 66, pp. 1570-1579.

Udofia, E.A., Yawson, A.E., Aduful, K.A. & Bwambale, F.M. (2014), Residential characterisitics as correlates of occupants' health in the Greater Accra Region, Ghana, BMC Public Health Journal, Vol. 14, pp. 244.

World Health Organization (2013), Ghana: WHO statistical profile, Available http://www.who.int/gho/en/. Accessed 4/09/2016.

World Health Organization (2012), Ghana: WHO statistical profile. Available http://www.who.int/gho/en/. Accessed 4/09/2016.