

Behavioral changes can help prevent indoor air-related illnesses in Ghana

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Received 4 January 2006; received in revised form 31 May 2006; accepted 31 May 2006

Abstract

Research has shown that on the average people in developing countries spend about 54% of their lives in indoor spaces including homes, schools, offices and vehicles. The quality of air in such spaces has tremendous effects on the quality of life. Developing countries like Ghana are not much informed about the impact of indoor air quality on the quality of life. This work intends to make Ghanaians aware of the impact of indoor air quality on the quality of life.

It studies the cultural practices that contribute to indoor air pollution and offers some effective solutions to help the individual address the problem. This work proposes the use of the local culture for the dissemination of pertinent information about the adverse effects of indoor air quality and how they can be prevented. The costs of the solutions offered are inexpensive compared to the cost of health treatments in Ghana. When the solutions are employed, the expenditure on health would be reduced and the government can redirect health treatment subsidies to address other important issues that continue to keep Ghana poor.

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Keywords: Indoor air quality; Pollutants; Respiratory diseases; Residential building types; Cultural norms; Education

1. Introduction

Ghana is a developing country located in West Africa and south of the Sahara desert. Health care is a major problem in Ghana. Among the seven major diseases identified by the Ministry of Health (MOH) are respiratory diseases and the incidence of high infant mortality [1]. The incidence of infant mortality is as high as 60 per 1000 and tuberculosis is also 211 per 100,000 [2]. The causes of high infant mortality and respiratory diseases such as tuberculosis, asthma and acute respiratory infections in children may be traced to indoor air pollutants. However, many individuals in developing countries are not aware of this relationship [3].

Though developing countries like Ghana spend only 54% [4] of their lives indoors as compared to that of 80–90% [5] in developed countries, they still face a unique

problem with regard to indoor air pollution because most people in developing countries use biomass as fuel for cooking and lighting and are constantly exposed to the inhalation of pollutants [6]. In Ghana the main sources of fuel for lighting are kerosene (54.8%) and hydro-electric power (43.7%). The main sources of fuel for cooking are wood (55.8%) and charcoal (30.0%). Other cooking fuels including liquid propane gas (LPG), hydro-electric power and kerosene account for only 9.3% [7]. This problem of biomass usage in Ghana is exacerbated by the land use patterns such as slash-and-burn farming method and the types of residential housing design.

Health treatment is a major problem in Ghana considering the fact that out of its population of 20.2 million only 49.4% are literate [8], and about 40% live below the official poverty line. The average annual take home per capita income is only \$220 [9]. The country itself runs on an annual trade deficit of about \$0.6 billion [10], yet it spends about \$270.6 million annually to treat diseases some of which may be traced to indoor air pollution and therefore preventable [11].

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This work explores the behavioral changes that will help prevent indoor air pollution and thus reduce the occurrence of diseases associated with it. It explores the two main residential housing types in Ghana and the pollutants associated with them. It offers effective solutions to help the individual maintain healthy indoor air. The work also explores cultural norms in Ghana and how they can affect educational programs designed to reduce the adverse effects of indoor air pollution.

The prevention of the concentration of indoor air pollutants and related diseases such as tuberculosis, asthma and acute respiratory infections in children will help improve the health situation. Individuals will be able to spend less of their low per capita income on health treatments and the government can redirect health treatment subsidies to address other important issues that continue to keep Ghana poor.

2. Residential housing types in Ghana

Ghana has two main residential housing types; the traditional huts building type (THBT) and the local residential building type (LRBT). The traditional huts are located in the rural areas where farming activities are concentrated. There is usually neither electricity nor portable water available in these areas. The building materials used to construct these huts are earth-soil, wood and hatch. The occupants of this type of building are mostly poor farmers and fishermen. The THBT accommodate about 40% of the population in Ghana. Fig. 1 is an example of a THBT village located in the middle of farmlands.

The LRBT are mostly located in urban settings, though many are also found in the rural areas. The materials used to construct the LRBT are concrete blocks and mortar. Since heating, ventilation, and air conditioning (HVAC) systems are hardly used in these types of buildings, they rely on natural ventilation especially for cooling. The LRBT accommodate about 60% of the population. Fig. 2 is an example of LRBT environment constructed along an unpaved road network in Accra, the capital of Ghana. The cultural practices that influence indoor air quality differ in these two building type environments.

3. Sources of pollutants within the THBT environment

The main source of outdoor pollutants in the THBT environment is smoke from the slash-and-burn farming



Fig. 1. Traditional huts building type. (Source: <http://www.tanyashaffer.com/Photo%20Galleries/West%20Africa%20Photo%20Gallery/Pages/Image28.html>).



Fig. 2. The local residential building type in Accra, Ghana.

practices and outdoor cooking. In slash-and-burn method of farming, plant growths are burnt to clear the land for farming. Great amount of carbon monoxide and suspended particulate matter in the form of smoke are thrown into the atmosphere. The smoke carrying these pollutants may enter into indoor spaces through doors, windows and other openings. Outdoor cooking is also a source of pollutant in the THBT environment. Biomass such as wood, charcoal and crop residues use for cooking emits carcinogens which have negative health consequences when inhaled [12].

The main sources of indoor air pollutants in the THBT environment include the burning of kerosene, candles and mosquito coils. Indoor cooking and earth-soil are also indoor sources of pollutants [7,13]. In the rural areas where there is no supply of hydro-electric power, kerosene lamps and candles are used for lighting. Mosquito coils are burnt indoors to keep mosquitoes away. Combustion in enclosed spaces without adequate ventilation leads to higher concentrations of carbon monoxide, nitrogen oxide, and suspended particulate matter. Radon may also be diffused through building materials like earth-soil that are in contact with radioactive material into indoor spaces [14].

Cooking with biomass also takes place in the traditional huts settings especially during the rainy season. The smoke poses problems, considering the fact that the huts are ill-ventilated with average exchange rates between 5 and 20 h^{-1} [15]. Table 1 shows the average rainfall table for Tamale, a town in Ghana. It is a representative of the northern half of the country where farming is the main source of livelihood. Annual wet-days with rainfall above 0.25 mm amount to 93.2 wet-days.

4. Sources of pollutants within the LRBT environment

The outdoor pollutants that have impact on the LRBT environment include dusts and fumes. Sources of indoor pollutants include indoor smoking, overcrowding, building materials and indoor cooking [16,17]. Sources of dusts and fumes within the outdoor setting are unpaved roads, automobiles, mining industries and the dry harmattan winds that blow from the Sahara desert [18,19]. Out of Ghana's total road network of 53,482.4 km only 16% is paved [20]. Vehicles plying the 44,880.5 km unpaved road network and mining industries throw a lot of dusts and fumes into the atmosphere. This dusty situation is compounded during the dry harmattan season. Fig. 3 demonstrates the difference in particulate concentrations in

Table 1
Average climatic conditions: Ghana, Tamale. Source BBC Weather

Ghana-Tamale											
Month	Average sunlight (h)	Temperature				Discomfort from heat and humidity	Relative humidity		Average perception (mm)	Wet days (+0.25 mm)	
		Average		Record			am	Pm			
		Min	Max	Min	Max						
Jan	8	21	36	15	39	Medium	36	20	3	0.6	
Feb	9	23	37	17	40	High	56	33	3	0.4	
March	8	24	37	19	41	High	62	37	53	0.4	
April	8	24	36	20	41	Extreme	80	52	69	6	
May	8	24	33	19	39	High	88	62	104	10	
June	7	22	31	19	36	High	92	69	142	12	
July	5	22	29	18	34	High	94	72	135	14	
Aug	4	22	29	19	33	High	95	74	196	16	
Sep	5	22	30	19	33	High	95	74	226	19	
Oct	8	22	32	19	36	High	94	66	99	13	
Nov	10	22	34	16	37	High	78	42	10	1	
Dec	9	20	35	15	38	Medium	54	27	5	0.8	

Source: http://www.bbc.co.uk/weather/world/city_guides/city.shtml?tt=TT000250.

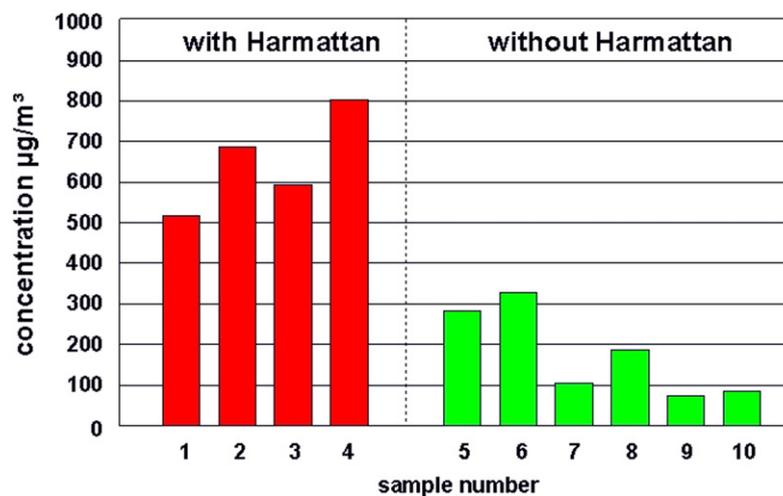


Fig. 3. Particulate matter at Lagos station with and without Harmattan. (Source: <http://www.ivd.uni-stuttgart.de/r/uv1/uv0/Nigeria/NigeriaLang.html>).

the atmosphere on days with and without harmattan winds at Lagos (Nigeria) monitoring station. The pollution components detected at the station include NO/NO_x, O₃, SO₂, CO and CO₂ [20]. Both Ghana and Nigeria are located in West Africa and south of the Sahara desert. Both countries experience the harmattan season between November and March.

A study conducted in Ghana between 1995 and 2003 has also revealed that CO, CO₂, HC, NO_x and PM are accumulating in the Accra-Tema Metropolitan area due to automobile emissions. The emission level of the five pollutants for 1995, 1999 and 2003 were 3 million, 7 million and 17 million tonnes, respectively. The study projected that the emission level could rise to 29 million,

63 million and 94 million tonnes in 2005, 2009 and 2011, respectively, if nothing is done to reduce the rate of emissions [21].

About 16% of adults [22] and 16.8 % of youths [23] smoke a kind of tobacco product in Ghana. Though the government of Ghana made some pronouncements in 1989 to ban smoking in public places, there was no legislation to back the pronouncements [24]. About 44.5% of the households in Ghana are considered overcrowded [25]. Overcrowding is a problem especially in the cities and towns. For instance in 1992, an average of 5.5 families lived together in one house in the low-income areas of Accra at the average of about 3.6 persons to a room [26]. Biological pollutants associated with overcrowding include viruses,



Fig. 4. Concrete blocks and mortar as the major building materials for LRBT.



Fig. 5. A kitchen in the LRBT environment in Cape Coast, Ghana.

bacteria and odor. The result of overcrowding is the rise of respiratory diseases such as tuberculosis, asthma and higher infant mortality rates in Ghana [27].

The major building materials used in the construction of the LRBT are concrete blocks and mortar as illustrated in Fig. 4. These materials are good conductors of heat and their use in warm and humid countries like Ghana make indoor environment uncomfortable. Charcoal and wood are the main fuel used for indoor cooking in LRBT environment. The reason for this preference is their lower cost as compared to that of LPG. Fig. 5 illustrates a LRBT kitchen that uses wood and charcoal.

5. Effects of exposure to indoor air pollutants

Research has established a direct relationship between higher concentration levels of indoor air pollutants and health problems. The awareness of this relationship is lacking in many developing countries. Thus, there are inadequate educational policies to help improve indoor air quality. Higher concentrations of indoor air pollutants can be detected by the symptoms that are associated with indoor air pollution. These symptoms include headaches, nausea, dizziness, sore throats, dry or itchy skin, sinus congestion, eye irritation and excessive fatigue. Sickneses that are related to indoor air pollution also include lung cancer, pneumonia, asthma, tuberculosis and infant mortality [28]. Among the illnesses that Ghana continues

to spend about \$270.6 million annually to treat are some of the indoor air related symptoms and sicknesses mentioned above [11].

6. The obligation of individuals towards indoor air quality

Every individual has a right to healthy indoor air [29]. This right also empowers individuals to exercise their obligation in keeping their indoor air healthy. Many Ghanaians are not aware of the relationship between indoor air quality and the quality of life partly because the illiteracy rate is as high as 50.6%. About 143 women (in Kumasi, Ghana) were interviewed to examine their knowledge about acute respiratory infection (ARI) in children. 73.4% of the women had a child or children who had already suffered from cough and/or fever. 21% of the women were incorrectly convinced that worm infestation was the cause of the cough and fever and 25.9% blamed constipation as the cause of the cough. None of the women interviewed reported that good ventilation and the avoidance of overcrowding may prevent cough and fever [30].

The first author of this paper, a Ghanaian, knows that when individual Ghanaians are exposed to indoor air science, they will change many of their behaviors in order to create and maintain a more healthy indoor air at a cheaper cost compared to the higher cost of health treatment. Table 2, for instance, demonstrates a rise in the use of LPG, a result of education programs organized to make Ghanaians aware of the adverse effects of using biomass fuel. Exposure of Ghanaians to the relationship between indoor air quality and health will help improve the health situation and reduce the amount of resources spent on health care by a nation that battles with high annual trade deficits. There are many ways by which individuals can help improve the indoor air quality in Ghana. Discussed below are a few we see applicable at the behavioral level.

The two main sources of pollutants identified in the THBT outdoor environment are the slash-and-burn farming method and outdoor cooking. Individual farmers in Ghana can take the initiative to learn more about the

Table 2
Energy consumption growth in Ghana 1990–2000

Fule type	% growth per year
Gasoline	1.5–4.0
Kerosine	0.2
Diesel	1.2–1.3
RFO	0.6
LPG	14.0
Electricity	10
Woodfuel	2.5–3.0
Charcoal	3.0–5.0

Source: Quaye—foli EA. Liquified petroleum gas (LPG) promotion: the ghana experience. Presentation at UNDP/World Bank-Energy and Poverty Workshop, Addis Ababa, Ethiopia 2002.

benefits of practicing crop rotation method of farming which outweighs the benefits of the slash-and-burn method. Individual farmers can also pull their resources together to purchase mechanized farming tools to prepare the land as practiced in Zimbabwe. Both crop rotation and mechanized farming methods do little damage to the environment compared to slash-and-burn method that throws dusts and particulate matter into the atmosphere. Research conducted about farming technologies in Ghana has recommended the increase use of mechanized farming and crop rotation. They help improve soil nutrient content, increase fertility and ease weed control [31].

The use of low cost chimney and locally produced LPG stoves outdoors can reduce the amount of smoke inhaled. These devices are able to reduce air pollution caused by cooking with biomass by 80%. The awareness creation programs organized by the United Nations Development Program (UNDP) and the Ministry of Energy (MOE) in Ghana about the use of LPG are having substantial impact in Accra. The sales of LPG cylinders increased from 80,000 to 600,000 between 1989 and 1997 [32]. Similar awareness programs need to be organized in the rural areas of the country. There will also be a significant difference in health if cooking activities are moved farther away from the huts and placed at the leeward side of the wind to prevent smoke from entering indoor spaces.

The sources of indoor air pollutants in the THBT include the burning of kerosene, candles and mosquito coil and indoor cooking. Individuals must be educated to change their habits and use more LPG by taking advantage of LPG promotion and price control programs offered by the UNDP and the MOE in the rural areas. The LPG stoves and low cost chimneys proposed above can be used to reduce indoor air pollution due to cooking with biomass by 80% [32]. Table 2 confirms the rise in the use of LPG in Ghana. The annual growth of LPG between 1990 and 2000 in Ghana was 14% as compared to 2.5–3% of wood fuel and 3–5% of charcoal [33]. Door and window screens can be used to prevent mosquitoes from entering indoor spaces. The proposed chimneys can easily be built into the existing huts. Small windows can be cut into the huts to facilitate the effectiveness of the chimneys.

Outdoor pollutants of LRBT include dusts and fumes that are blown into the atmosphere by automobiles, mining industries and the dry harmattan winds. Research conducted in Ghana has proposed three ways of reducing automobile emissions. These include the use of emission control devices (ECD), mass transportation and the use of less pollutant emission means of transportation. Installing ECD such as catalytic converters and fuel injection systems in all vehicles would reduce emission by 50%. Replacing half of the private cars with mass transportation can also reduce emission by 50%. The use of less pollutant emission forms of transportation such as cycling and walking is also plausible. For instance, about 40% and 75% of trips in Accra are less than 5 and 10 km, respectively. Individual

must be encouraged to consider using these three methods to reduce automobile emissions [34].

Individuals must also opt for building designs that takes into consideration the local issues including the climate. Residential buildings must be designed to be able to prevent fumes and dust from entering indoors during rash hours and the harmattan season and also be able to open to facilitate natural ventilation when needed.

The sources of indoor pollutants in the LRBT environment include smoking, overcrowding, the building materials used and indoor cooking. Though only 16% of adults and 16.8% of youths smoke in Ghana, the individual Ghanaian must not only be educated about the impact of smoking on their health, they must also be persuaded not to sell or buy cigarettes [24]. Individual Ghanaians can help improve the health situation in the country by quitting smoking. A quit smoking campaign was conducted in Ghana in 2004 to increase public awareness of the dangers of smoking and promote smoke free lifestyle and environment. There were 1648 participants in the program. A follow up study was conducted on 664 of the participants the following year. It was found that as many as 43.3% of the 664 stopped smoking. Most of them sited awareness of the adverse effects of smoking on their health as reason for quitting [35].

Overcrowding is a big issue for the government of Ghana especially in the cities. The overcrowding issue has contributed to the high incidence of tuberculosis (211 per 10,000) and other respiratory diseases. The individual Ghanaian can choose to move from the slums and the overcrowded areas in the cities to the less populated areas closer to the cities where the cost of living is cheaper. This will reduce the overcrowding situation in the cities and consequently the high incidence in respiratory diseases.

The issue of comfort associated with the high tropical temperatures which is compounded by the use of concrete blocks materials for LRBT can be addressed by opting for building designs which incorporate larger operable fenestrations that can be opened to facilitate natural ventilation and closed to prevent dust and fumes from entering indoors. The use of LPG stoves and the chimney proposed above can be used to effectively reduce the emission of pollutants as much as 80%.

The individual is given a lot of power to control the quality of indoor air when exposed to the concept of indoor air science. Education and training are important to enable the individual Ghanaian understand and work towards achieving healthy indoor air. Every individual must be educated about the effects of indoor air quality [36]. When individuals are educated, the health situation will improve. The individual will spend less on health treatment and the government will be able to redirect health subsidies to address other issues that continue to keep the country poor. However, for success, any educational program designed to disseminate information about the relationship between indoor air pollutants and health

must take the Ghanaian socio-cultural norms into consideration.

7. Cultural norms that facilitate mass education in Ghana

The failure of many socio-economic development programs in developing countries like Ghana can be traced to their lack of organic relationship with the local cultural norms. Every country has certain socio-cultural values that make it unique. Ghana holds important many such cultural values [37]. The socio-cultural values of Ghana that have major influence on education and training can be summarized in the words of Hofstede [38] as collectivism, femininity, low uncertainty avoidance and high power distance.

The Ghanaian society is rooted and organized in its collectiveness. The traditional institutions such the extended family and kinship systems are the connectors between individuals and the society [39]. The extended family system plays an active role in the preservation of integrity and vitality of the lineage, especially in the organization of marriages, households, traditional education and training [40].

Femininity is closely related to collectivity. Femininity is a term used to describe a culture in which the dominant values are caring and ensuring quality of life of members. Such cultures place more emphasis on cooperation, friendliness and job security [41]. The traditional training system in Ghana is designed mainly to teach social adaptation. It places great emphasis on active participation in community life [42].

The Ghanaian culture is characterized by weak uncertainty avoidance. Many activities and organizations are less structured. There are less written rules to guide social behavior. Social behavior is regulated by unwritten rules that are usually orally transmitted from one generation to another. Agreements are based on trust and often sealed with just hand shakes [41].

The socio-cultural norms of Ghana are also said to be high power distance because there is a recognition and acknowledgment of inequality of power between elders and subordinates or family heads and family members. The cultural values of Ghana attribute great respect for those who wield traditional authority such as traditional chiefs, queen mothers, community leaders, family heads and the elderly. Family heads are expected to assume paternalistic responsibility for the welfare of the family members. Family members also reciprocate with the feelings of respect, loyalty, obedience and dependency. The society members are usually unwilling or afraid to disagree with their leaders [43].

8. Cultural norms and educational programs

Indoor air educational programs that put more emphasis on the socio-cultural norms and behavioral changes can go a long way to improve the quality of life in Ghana, a

country characterized with high trade deficits and low per capita income. Educational programs designed to expose Ghanaians to the effects of indoor air quality on health must take into consideration that the society is more collective and that members are subject to the authority of the traditional leaders. The programs must concentrate on educating the traditional authorities such as traditional chiefs, community leaders, family heads and elders as the transmitters of information to their respective members. These leaders are considered to be the symbols and guardians of social values [39]. Moreover, most socio-economic activities including farming are controlled by the families or households leaders [44]. It will be more effective to entrust the dissemination of the knowledge about indoor air quality to these traditional leaders. They are more trusted by their subjects as paternal and maternal leaders.

The design of educational programs must also take into consideration the literacy level in Ghana and the fact that many of the leaders and their subjects can neither read nor write. Traditional education and the transmission of knowledge to the masses must rely more on oral transmission than on written documents. In Ghana, educators are more successful when they assume the trusting, friendly, caring and the paternal or maternal characteristics of the traditional Ghanaian leader.

9. Conclusion

Though this research concentrates on the Ghanaian situation, it is also applicable to many developing countries in the world with similar cultural practices. Individuals in other developing countries must also be exposed to similar kind of research to encourage them work towards the improvement of indoor air quality. Though characterized by high trade deficit and low per capita income, many developing countries spend considerable amount of their resources for the treatment of illnesses that can otherwise be prevented by behavioral changes that cost much less compared with the high cost of health treatment. When the individual is educated to help improve indoor air quality, the health of many will improve. Individuals in developing countries will spend less of their low per capita income on health treatments and governments can redirect health treatment subsidies to address other important issues that continue to keep their countries poor.

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