FUDMA Journal of Earth and Environmental Sciences (FUDJEES), Vol. 1, No. 1, 2024

ADAPTATION STRATEGIES TO HUMAN PHYSIOLOGICAL DISCOMFORT AMONG ELDERLY PEOPLE IN KATSINA URBAN, KATSINA STATE, NIGERIA

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https://doi.org/10.33003/jees.2024.0101/05

ABSTRACT

Information on adaptation strategies to human physiological discomfort is very important for individuals, groups of people, planners, and policymakers in the world's tropical regions where thermal stress poses a significant threat to life, especially among elderly people. Based on this, the aim of the study, therefore, is to assess adaptation strategies to human physiological discomfort among elderly people due to temperature and humidity extremes in residential areas and workplaces during the hot and cold seasons in Katsina. A total of 100 copies of a questionnaire were administered to the elderly people to obtain information on their adaptation strategies. A stratified random sampling method was used to select the respondents in the study area. Descriptive statistics were then used to describe their perception of adaptation strategies to human physiological discomfort. Results obtained revealed that in the hot season, the majority of the respondents at residence areas and working places perceived outdoor and indoor with fans "respectively" as their best-adapting strategies to human physiological discomfort due to temperature and humidity extremes. However, in the cold season, the study revealed that the majority of the respondents in residence areas and workplaces perceived thick dress as their best-adapting strategy for human physiological discomfort due to temperature and humidity extremes. Adapting strategies to human physiological discomfort depends primarily not only on environmental conditions but relaxing in natural environments and using customized clothing materials. People are encouraged to continue planting trees in and around their homes, working workplaces and to adequately prepare to adapt to extreme hot and cold seasons.

Keywords: Adaptation, Physiological Discomfort, Humidity, Temperature, Thermal Stress.

INTRODUCTION

The study of human physiologic adaptation to various natural, working, and social conditions is an integrated problem requiring the efforts of experts in different fields for its solution. Humans have an immense capacity to adapt to a broad range of physiologically environmental stresses, although they possess the technological capacity to modify the local environment to support life. It has been critical to the survival and advancement of individuals and their well-being. Humans encounter thermal (heat & cold) stress from climatic conditions, insulation, and body heat production (Kumar *et al*., 2016).

Extremes in weather and climate have become a certainty in today's world, posing challenges for food security, natural ecosystems, freshwater supply, and human health. The Intergovernmental Panel on Climate Change [IPCC] (2023), revealed that the Green House Gas GHG emissions will lead to increasing global warming in the near term, and it is likely this will reach 1.5^0C between 2030 and 2035. This unprecedented increase in temperature is expected to have severe impacts on the global hydrological systems, ecosystems, sea level rise, crop production, human psychosocial comfort, and related processes. Human exposure to extreme weather effects, such as heat stress in the hot season especially in urban areas, and cold stress during Harmattan season in sparsely populated areas is an increasingly important public health problem. For instance, temperature and humidity extremes that exceed the human physiological limit can cause widespread mortality as evidenced by the 2003 heat wave in Europe, which resulted in more than 15000 human fatalities in France alone (WHO, 2003).

Knowledge of adaptation capacity methods is highly required for the advancement of human lives and their well-being. It is believed in addition to some people's habit of working under extreme conditions which is attributed to human physiological discomforts, bodily resistance to extreme weather conditions and modification of their environment was an integral part of the adaptation capacity and strategies to unfavorable weather conditions of an area. It is well established that some locations are hotter than others and some are colder than others. The regions with extremely hotter days have been experiencing serious weather problems due to the hike in temperature and humidity which have a direct effect on human health and their wellbeing. Some climatic elements such as temperature and humidity play a significant role in determining the activities of people for their safety and healthy living. To reduce the effects of weather extremes, people are devising different means to adapt to these extreme weather conditions. Paolo et al, (2021)

Adapting strategies to human physiological discomfort according to Eludoyin (2015) who conducted research on weather and climate extremes in some selected stations which include Kano, Jos, Benin City, Lokoja and Calabar revealed that, the coping strategies often applied by people in those locations have varied. The study revealed that the most used methods to avoid extreme effects of climate health-related problems are the use of certain climate-customized clothing materials and changes in the mode of dressing, especially for outdoor and indoor conveniences. However, people changed from light dresses with their limbs uncovered during the hot weather, to the use of thick dresses (and sometimes with limbs covered) in cold weather times.

According to Oke *et al.* (1991), the light colour of many tropical buildings could be decreased by the absorption of heat due to a higher albedo. As highlighted by Norton *et al.*; (2015), increasing the vegetation cover in cities is one of the key approaches to lower both air and radiative temperatures and improve thermal comfort through shading and transpiration.

According to the United States Global Change Research Program [USGCRP] (2016), some groups of people are more vulnerable than others to health risks from climate changes or weather extremes. Three factors contribute to vulnerability. Firstly; sensitivity, refers to the degree to which people or groups are affected by a stressor such as higher temperatures. Secondly; exposure; refers to physical contact between a person and a stressor. Thirdly; adaptive capacity is the ability to adjust to or avoid potential hazards. For example, while older adults are sensitive to extreme heat, an older person living in an air-conditioned apartment won't be exposed as long as that person stays indoors, and as long as that person can afford to pay for the electricity to run the air–conditioner.

The attitude of some people in many developing countries practices illegal cutting down of trees for firewood without replacement and clearing of vegetation for different purposes such as building houses, workplaces, and other town expansion plans which often leads to the loss of microclimates that pave ways to physiologic discomfort. This type of attitude also prevails in the Katsina urban area and has left many inhabitants in the area to become vulnerable to climate-related health problems especially the elderly people who suffer more from extreme weather conditions due to partial loss of their natural immunities as they grow older. Urban Katsina is therefore one of the likely areas that may face the same if not all the kinds of climate-related health problems due to the exposure to temperature and humidity extremes. It is against this background that this paper intends to assess the adaptation strategies to human physiological discomfort due to temperature and humidity extreme among elderly people at their residences and working places during hot and cold seasons in Katsina.

STUDY AREA

Katsina urban area is located between Latitude 12°56.400′N and 13°3.600′N and Longitude 7°36.000′E and 7°39.000′E. The study area is bordered by Kaita Local Government Area (LGA) to the north, Jibia LGA to the west, Batagarawa LGA to the south, and Rimi LGA to the east. Katsina urban area is at the center of the Hausa plains in the extreme northern part of the country, some 30km away from the border of Niger Republic. The climate of Katsina urban is the tropical wet and dry type (Tropical Continental Climate), classified by Koppen as Aw climate. Rainfall is between May and September with very high intensity between July and August (Abaje; *et al*., 2014). The average annual rainfall is about 550mm. The pattern of rainfall is highly variable. As a result, Katsina Urban is subject to frequent floods that can impose serious socio-economic constraints (Abaje; *et al*., 2012a). The Annual mean temperature is about 27°C. The highest air temperature normally occurs in April/May and the lowest in December through February (Nigerian Meteorological Agency, 2012).

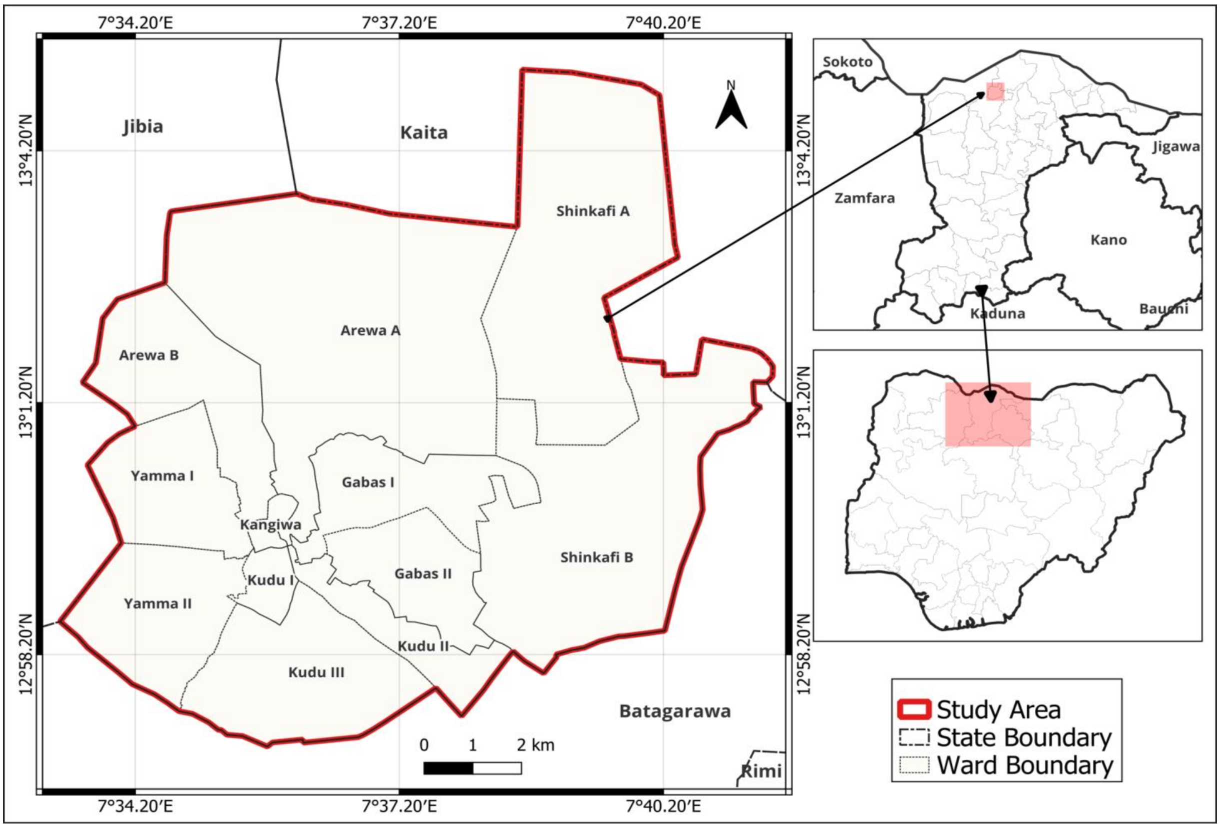

Figure I: Map of the study area

MATERIALS AND METHODS

Taro Yamane's (1967) method of sample size computation was used to determine the sample size from the total population of the study area. Taro Yamane's formula was given as:

$$n = \frac{N}{1 + N(e)^2}$$

Where n = sample size
N= population of study
e = level of significance at 10%
1 = constant value

The sampling procedure for this study is stratified random sampling. In this sampling technique, eleven political wards such as Yamma I, Yamma II, Arewa A, Arewa B, Kudu I, Kudu II, Kudu III, Gabas I, Gabas II, Kangiwa and Shinkafi B. were chosen to serve as a stratum in urban Katsina. By using a proportional sample size allocation scheme of stratified sampling, respondents for the study were determined and selected from each political ward using the following formula:

$$ni = \frac{Ni}{N} \; x \; n$$

Where ni = ward sample size
Ni = Number of individual ward samples
N = Total number of ward sample sizes
n= (%)

The type of data utilized for this study is qualitative. It is the data whose attributes cannot be measured or expressed in numerical terms but its attributes can only be identified (Okpo, 2008). Qualitative data for this study is, therefore, the perception of people's best-adapting strategies to human physiological discomfort due to temperature and humidity extreme at their residences and working places during hot and cold seasons in the Katsina urban area.

The source of data for this study is primary, and the technique applied in collecting the data is through the use of a structured questionnaire. A closed-ended questionnaire was administered to the literate respondents to answer questions on it and then return to the researcher. The questionnaire for this study therefore covered the socio-economic characteristics of the respondents and their adapting strategies perceived the best for their comfort during heat and cold seasons at residence and working places in the study area. The study area population was estimated at 301,935 according to the Primary Health Care Department, Katsina Local Government. The populations of the eleven wards are determined in Table 1. A stratified random sampling method was adopted and hundred (100) elderly people were randomly selected based on proportional sample sizes of respondents in their respective wards. All these selected respondents were located in their respective wards, and the questionnaire was administered to them.

Table 1: Political Wards and their Sample Sizes

S/N	Political wards	Population	Sample size (Elderly people)
1.	Yamma I	29,339	10
2.	Yamma II	23,016	7
3.	Arewa A	26,309	9
4.	Arewa B	20,285	6
5.	Kudu I	35,279	12
6.	Kudu II	27,033	8
7.	Kudu III	27,256	9
8.	Gabas I	33,452	11
9.	Gabas II	21,696	7
10.	Kangiwa	39,931	14
11.	Shinkafi 'B'	18,339	6
Total		**301,935**	**100**

Source: Data Survey, 2022.

The method for data analysis was descriptive statistics. Thus, people's best-adapting strategies to human physiological discomfort in residence and workplace during hot and cold seasons were described, summarized, and presented in table format.

RESULTS AND DISCUSSION

People`s Adaptation Strategies to Human Physiological Discomfort Due to Temperature and Humidity Extreme at Residence Areas During Hot Season

Results on people's adapting strategies to human physiological discomfort due to temperature and humidity extreme in residence areas during the hot season are presented in Table 2.

Table 2: People's Adapting Strategies to Human Physiological Discomfort in Residence Areas During Hot Season

Political Ward	Adapting strategies				Total
	Outdoor	Indoor with fan	Light dress	Indoor with fan and air conditioner	
Yamma I	1.01%	7.07%	1.01%	1.01%	10.10%
Yamma II	3.03%	1.01%	3.03%	0	7.07%
Arewa A	0	1.01%	2.02%	6.06%	9.09%
Arewa B	1.01%	2.02%	1.01%	2.02%	6.06%
Kudu I	6.06%	5.05%	0	1.01%	12.12%
Kudu II	2.02%	3.03%	1.01%	2.02%	8.08%
Kudu III	2.02%	2.02%	2.02%	4.04%	10%
Gabas I	2.02%	2.02%	4.04%	3.03%	11.11%
Gabas II	3.03%	2.02%	1.01%	1.01%	7.07%
Kangiwa	8.08%	2.02%	3.03%	1.01%	14.14%
Shinkafi B	6.06%	0	0	0	6.06%
Total	**33.33%**	**27.27%**	**18.19%**	**21.21%**	**100%**

Source: Data Survey, 2022.

The results on people's adapting strategies to human physiological discomfort in residence areas during the hot season presented in Table 2 indicated that 33.33% of the total respondents perceived outdoor as their best adapting strategy, 27.27%, indoor with a fan, 18.19%, light dress and 21.21%indoor with fan and air conditioner. These findings indicated that the majority of the respondents (33.33%) are of the view that the outdoors is their best adapting strategy to human physiological discomfort in residence areas during the hot season.

People`s Adaptation Strategies to Human Physiological Discomfort Due to Temperature and Humidity Extreme at Working Places During Hot Season

Results on people's adapting strategies to human physiological discomfort due to temperature and humidity extreme in working places during the hot season are presented in Table 3.

The results on people's adapting strategies to human physiological discomfort due to temperature and humidity extreme in working places during the hot season presented in Table 3 indicated that 12.12% of the total respondents perceived outdoor as their best adapting strategy, 39.40%, indoor with fan, 36.36%, indoor with fan and air conditioner and 12.12% light dress. These findings indicated that the majority of the respondents (39.40%) are of the view that indoors with a fan is their best adapting strategy to human physiological discomfort in working places during the hot season.

Table 3: People's Adapting Strategies to Human Physiological Discomfort in Working Places during the Hot Season

Political Ward	Adapting Strategies				Total
	Outdoor	Indoor with fan	Indoor with fan and air conditioner	Light dress	
Yamma I	1.01%	7.07%	2.02%	0	10.10%
Yamma II	0	7.07%	0	0	7.07%
Arewa A	0	2.02%	6.06%	1.01%	9.09%
Arewa B	1.01%	0	0	5.05%	6.06%
Kudu I	2.02%	4.04%	6.06%	0	12.12%
Kudu II	3.03%	2.02%	2.02%	1.01%	8.08%
Kudu III	1%	3.03%	6.06%	0	10%
Gabas I	1.01%	3.03%	4.04%	3.03%	11.11%
Gabas II	0	1.01%	4.04%	2.02%	7.07%
Kangiwa	2.02%	8.08%	4.04%	0	14.14%
Shinkafi B	2.02%	2.02%	2.02%	0	6.06%
Total	**12.12%**	**39.40%**	**36.36%**	**12.12%**	**100%**

Source: Data Survey, 2022.

People's Adapting Strategies to Human Physiological Discomfort Due to Temperature and Humidity Extremes in Residence during Cold Season.

Results on people's adapting strategies to human physiological discomfort due to temperature and humidity extreme in residence areas during the cold season are presented in Table 4.

Table 4: People's adapting strategies to human physiological discomfort in residence area during the cold season

Political Ward	Adapting Strategies				Total
	Indoor	Thick dress	Outdoor	Indoor with room heater	
Yamma I	3.03%	7.07%	0	0	10.10%
Yamma II	1.01%	5.05%	1.01%	0	7.07%
Arewa A	2.02%	6.06%	0	1.01%	9.09%
Arewa B	2.02%	3.03%	1.01%	0	6.06%
Kudu I	4.04%	7.07%	0	1.01%	12.12%
Kudu II	2.02%	3.03%	3.03%	0	8.08%
Kudu III	2.02%	8.08%	0	0	10%
Gabas I	1.01%	9.09%	1.01%	0	11.11%
Gabas II	1.01%	6.06%	0	0	7.07%
Kangiwa	4.04%	7.07%	1.01%	2.02%	14.14%
Shinkafi B	2.02%	2.02%	0	2.02%	6.06%
Total	**23.23%**	**63.63%**	**7.08%**	**6.06%**	**100%**

Source: Data Survey, 2022.

The results on people's adapting strategies to human physiological discomfort due to temperature and humidity extreme in residence areas during the cold season presented in Table 4 indicated that 23.23% of the total respondents perceived indoor as their best adapting strategy, 63.63%, thick dress, 7.08%, outdoor and 6.06%indoor with a room heater. These findings indicated that the majority of the respondents (63.63%) are of the view that thick dress is their best adapting strategy to human physiological discomfort in residence areas during the cold season.

Adapting Strategies to Human Physiological Discomfort due to Temperature and Humidity Extremes in working Place During Cold Season.

Results on people's adapting strategies to human physiological discomfort due to temperature and humidity extreme in working places during the cold season are presented in Table 5.

Table 5: People's adapting strategies to human physiological discomfort in working places during the cold season

Political Ward	Adapting strategies				Total
	Indoor	Thick dress	Outdoor	Indoor with room heater	
Yamma I	2.02%	8.08%	0	0	10.10%
Yamma II	1.01%	5.05%	1.01%	0	7.07%
Arewa A	2.02%	2.02%	1.01%	4.04%	9.09%
Arewa B	1.01%	5.05%	0	0	6.06%
Kudu I	9.09%	1.01%	0	2.02%	12.12%
Kudu II	2.02%	3.03%	3.03%	0	8.08%
Kudu III	1%	9.09%	0	0	10%
Gabas I	4.04%	7.07%	0	0	11.11%
Gabas II	1.01%	6.06%	0	0	7.07%
Kangiwa	5.05%	5.05%	2.02%	2.02%	14.14%
Shinkafi B	1.01%	3.03%	0	2.02%	6.06%
Total	**28.29%**	**54.54%**	**7.07%**	**10.10%**	**100%**

Source: Data Survey, 2022.

The results on people's adapting strategies to human physiological discomfort due to temperature and humidity extreme in working places during the cold season presented in Table 5 indicated that 28.29% of the total respondents perceived indoor as their best adapting strategy, 54.54%, thick dress, 7.07%, outdoor and 10.10% indoor with a room heater.

These findings indicated that the majority of the respondents (54.54%) are of the view that thick dress is their best adapting strategy to human physiological discomfort in working places during the cold season.

DISCUSSION

Discussing the results of adaptation strategies to human physiological discomfort in urban Katsina involved an analysis of various approaches taken to mitigate discomfort caused by factors such as heat, humidity, and air pollution. It includes examining urban planning initiatives, the use of green spaces, building design techniques, and public health interventions aimed at improving residents' well-being. Additionally, understanding the effectiveness of these strategies and their implications for future urban development in Katsina is essential.

The result of the study showed that the adaptation strategies during the hot season in both residence areas and working places exhibited variations. These variations depend on people's choices to seasonal adaptations which range from changing clothing materials, spending time indoors, use of fans or air conditioners for the few that can afford; indoors, or mostly staying outdoors under shades for those who live in the very small housing units. While existing studies on thermal adaptation make up for both indoor and outdoor temperatures. The variations that depend on seasonal periods were however not highlighted in most previous studies of the diurnal aspect of thermal discomfort and adaptations in hot and cold environments (Eludoyin, 2014; Sawka *et al*., 2002) who pay more attention on day to day thermal stresses which centered more on heat acclimation mediated adaptations.

The results of the respondents in residence areas for example in Table 2, showed (33.33%) stayed out-door because of a very small housing unit they occupied without enough ventilation. This is followed by respondents who stayed indoors but with fans blowing air which constituted 27.27% of the total respondents. Only 18.19% of respondents wear light dress and this category is broadly more preferred to any of the residence or workplace situations during the hot season. However, 21.21% of the total respondents preferred staying indoors with a fan and air conditioner during their stay at residences whereas their financial status determined their ability to afford to use a fan and air conditioner to adapt to human physiological discomfort. These findings indicated that the majority of the respondents (33.33%) adapt outdoors as their best adaptation strategies to human physiological discomfort in the residence areas during the hot season.

However, results on people's adapting strategies to human physiological discomfort due to temperature and humidity extreme in working places during the hot season presented in Table 3 showed that 12.12% of the total respondents perceived outdoors as their best adapting strategy and this has to do with the nature of their working conditions. Although 39.40% of the respondents prefer indoors with fans as their adapting strategies. These categories spend most of their time in offices as most of their employers ensure a relatively adequate supply of electricity to avert heat stress during working hours. Additionally, 36.36% of the respondents preferred indoors with fans and air conditioners such that this category worked in higher-paid organizations. The working conditions are improved and well taken care of. Only 12.12% of the respondents adopted light dress in addition to the condition of their working places as their adapting strategies to human physiological discomfort in the hot season. These findings indicated that the majority of the respondents (39.40%) adapt indoors with fans as their best adapting strategy to human physiological discomfort in working places during the hot season. A related study revealed that housing construction materials are crucial factors in the heat resistance capacity of residential buildings (Akande, 2010; Hatvani Kovacs *et al*., 2016).

Moreover, results presented in Table 4 and Table 5 on people's adapting strategies to human physiological discomfort during the cold season in both residence and working places in the study area nearly showed similarity. These similarities depend on the unique nature of the cold season and its popular defense mechanism to the extreme effect of cold weather. People majorly adapt to wearing thick clothing materials as their adapting strategy. Other strategies were staying indoors, outdoors, or indoors with a room heater. For example, Table 4 shows that most of the respondents (63.63%) in the residence area adopt thick dress materials because of their availability, affordability, and the most used protection materials against cold weather.

Another 23.23% of the respondents shown in Table 4, prefer to stay indoors with most of the doors and windows closed and covered which prevents "the cold wind and dust" from getting access. This adapting strategy was rated the 2nd to human physiological discomfort in residence during the cold season. Then 7.08% of the respondents who stayed outdoors for most hours in residence aligned with their daily hustle for bedeviling with family responsibilities, non-completion of their homes or demolished due to flooding, and other reasons at the time of conducting this research are some reasons that led them stayed outdoor during cold season. The last group of respondents 6.06% stayed indoors with room heaters during the cold season and this is because of their capacity to afford the means to adapt this strategy to human physiological discomfort in residence during the cold season. These findings indicated that the majority of the respondents (63.63%) adapt thick dresses as their adapting strategies to human physiological discomfort during the cold season in the residence area.

Similarly, Table 5 showed that 54.54% of the respondents in their workplaces during the cold season adopted thick dress as their adapting strategy, because of its availability, affordability, and the most used protection materials against cold weather. While 28.29% of the respondents prefer to stay indoors as revealed in Table 5 and this is because their working environment provides them with a defense mechanism against the cold season. However, Table 5 also showed that 10.10% of the respondents stayed indoors with an air room heater which provides a warm environment in offices and other places of work. The last category is people who stayed outdoors which constituted 7.07% as their adapting strategies to human physiological discomfort during the cold season in working places aligned with assigned duty at work mostly in open spaces, their daily hustle for bedeviling with family responsibilities, non-completion of their working place and for other reasons at the time of conducting this research were some reasons that led them stayed outdoor during the cold season in their working places. These findings indicated that the majority of the respondents (54.54%) adapt thick dresses as their adapting strategies to human physiological discomfort during the cold season in workplaces.

Nonetheless, Guardian online newspaper (2022) in a report on what Nigerians should do to protect themselves, Osibogun who is the immediate past Chief Medical director (CMD) of LUTH, said: "We should reduce our exposure to the sun. It depends on the kind of work you do, but reduce the number of hours you stay under the sun, or rather outside, although some people, like bricklayers, cannot help but stay in the sun all day. The negative effect could also be reduced by drinking enough water to replace the lost fluid from excessive sweating. Hezekiah, et al., (2019) identified behaviors that occupants within a student housing in Abeokuta, Nigeria adopt in response to heat. Opening windows and taking cold drinks were the top two behavioral responses to heat. Going to the building's atrium, taking a bath, changing clothes, and switching on the air conditioner were other behavioral responses identified. Hezekiah, *et al*., (2019) also found that switching on fans and/or air conditioner are the top response in their study in Ibadan, Nigeria. Opening windows and doors as well as sleeping outside till late at night are the least practiced responses. Similar studies were conducted in the context of residential buildings outside Nigeria – in Australia (Soebarto and Bennetts, 2014; Hatvani-Kovacs *et al*., 2016 as cited by Hezekiah, *et al.,* 2019).

CONCLUSION AND RECOMMENDATIONS

Adaptation strategies to human physiological discomfort against temperature and humidity extremes among elderly people showed a remarkable variation in the hot season and nearly similar in the cold season. This is attributed to the people's choice of adaptation methods to the extreme weather conditions at their disposal, such as staying outdoors in residential areas and indoors with fans at working places during the hot season. It could also be noted that wearing thick dresses at residence and working places in the cold season in the study area was the best.

Based on the findings of this research, the following recommendations are made:

i. Planting of trees in and around homes and working places should be encouraged.
ii. Houses should be well-designed for proper ventilation.
iii. Electricity distribution companies should make a constant supply of electricity affordable to the subscribers.

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