Influence of Climatic Parameters on Incidence of Climate Related Diseases in Children in Abuja Municipal Area Council (AMAC), Nigeria

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Abstract

Climate change is a global phenomenon with consequential health effects on humans especially the children. The relationship between climatic parameters and climate related diseases in children was examined in Abuja Municipal Area Council (AMAC), Nigeria. For the purpose of this study, ten-year data on climatic parameters were obtained from Nigeria Meteorological Agency (NIMET). Hospital records of children under 13 years of age who were diagnosed with climatic related diseases were also collected. Questionnaire was designed to collect information on respondents' socioeconomic characteristics and level of awareness of climate change. Both descriptive and inferential statistics were used in analysing the data collected. Findings revealed that as the pattern of temperature and rainfall increased, the incidences of malaria, respiratory diseases, and typhoid, pneumonia, meningitis and skin diseases decreased. The incidences of diarrhoea and measles however decreased with increase in pattern of temperature and rainfall. Efforts required in mitigating the effects of climate change on children were suggested to be policy formulation and interventions on the part of the relevant government agencies.

Keywords: Climate Change; Climate Parameters; Children's Disease; Children

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1. Introduction

The health implications of climate change are felt by all human populations. Climate change effects on humans of all ages were estimated at 0.3 per cent of global death and 0.4 per cent of the disability-adjusted life year (DALYs) (IPCC, 2007). These statistics expressed actual figures of a global death toll of 150,000 and 5,500,000 DALYs. Meanwhile, children are observed to be the most vulnerable to burden of diseases attributed to climate change (Neira *et al*., 2008; Sheffield and Landrigan, 2011).

In developed and developing countries, statistics indicated that 88 per cent of existing burden of diseases resulting from climate change occurs in children under 5 years of age (Zhang *et al.,* 2007). Such diseases include malaria, diarrhoea, respiratory diseases which were observed to be responsible for more than 50 per cent of childhood death (WHO, 2008a). For instance, out of 655, 000 reported malaria deaths, 86 per cent were children under 5 years of age (Caminade *et al.*, 2014); while 8.7 per cent of children were reported to have asthma in 2001 with the proportion increasing to 9.3 per cent in 2012, but later decreased to 8.3 percent in 2013 (EPA, 2013).

Climate change is therefore observed to likely increase children's exposure to extreme weather temperatures, extreme weather events and infectious diseases, among others (EPA, 2013). High vulnerability to climate sensitive diseases in children is estimated to range between 10 and 20 per cent of the population in countries with least ability to cope with the health implications of climate change (UNICEF, 2007). These countries are mostly located in Africa, Asia and the Pacific that are vulnerable to meteorological and climatological disasters due to natural and anthropological factors (UN/WFP, 2007; WHO, 2008b; Zuma *et al.*, 2012).

Nigeria, being one of the African countries that are vulnerable to climate change impact. Of significance is the health impact of climate change as related in some studies (Oluleye and Akinbobola, 2010; Eke and Onafalujo, 2011). Effort is therefore made in this study to examine the influence of climatic parameters on incidence of climate related diseases among children in Abuja Municipal Area Council (AMAC), Nigeria. This is in an attempt to suggest mitigating measures towards adaptability of children to climate related diseases.

2. Literature review

Many studies have defined climate change from different perspectives (Ayoade, 2004; EPA, 2007; UNEP, 2008; Seal and Vasudevan, 2011; *et al.* 2016). It is a common standpoint that climate change involves the change in global climate resulting from natural variability and man-made activities. The human activities are of high significance because they do result into pollution that produces greenhouse gases which accumulate to cause global warming and other extreme weather effects. These consequential effects are liable on both living and non-living components of the environment at local and global level.

Climate change is measurable through observation and analysis of climatic parameters such as temperature, rainfall and humidity among others. The relationship between climate change and incidence of diseases could therefore be determined by examining the influence of climatic parameters on incidence of climate related diseases. According to WHO (2010), the possibility of using climatic parameters as predictive indicators of climate related diseases has been a focus of interest for many years since geographical and seasonal distributions of many infectious diseases are fundamentally linked to climate. It is observed that any change in climatic parameters such as temperature causes the outbreak of tropical diseases such as malaria, pneumonia, and dengue (WHO, 2003; Oluleye and Akinbobola, 2010; Paul and Tham, 2015).

The incidence of climate related diseases is evident in both developed and developing countries of the world. A review of national health impact assessments of climate change in European countries such as United Kingdom, Netherlands, Portugal, Finland, Germany, Spain, and Switzerland published since 2001 showed the incidence of diverse climate change related diseases (HEAL, 2007). Such diseases include food- and waterborne diseases, malaria, tick-borne encephalitis, leishmaniasis, West Nile fever, Lyme disease, and Mediterranean spotted fever.

The climate change events with most intense public health impact in European countries was the heat-wave of 2003 (Hajat *et al.*, 2006; Robine *et al.*, 2008; Garcia-Herrera *et al.*, 2010); as excessive death by heatwaves could be attributed to diseases such as dementia, renal diseases, respiratory diseases and cerebrovascular diseases (Josseran *et al.*, 2009). In a recent survey of 32 European countries in 2012, intense heat-waves were established as the major risk-factor in these countries with death toll exceeding 70,000 (WHO, 2012), although the impact of other extreme weather events in European countries could not be undermined (Huber and Gulledge, 2011).

In developing countries, there have been increasing concerns about emerging and re-emerging challenges of climate change related diseases (Wei *et al.*, 2014). Diseases such as eye infections, respiratory diseases and cardiovascular diseases are found in regions of Asia, and across Mediterranean nations (Mburia, 2012). In Africa, incidence of infectious diseases such as malaria, dengue, lyme, typhoid, measles, and respiratory diseases were evident (Kebede *et al.*, 2010; Jaenisch *et al.*, 2014). Out of these diseases, malaria was prevalent as past statistics indicated that between 300-500 million cases of malaria worldwide, a high proportion of the disease was prevalent in Africa (WGCCD, 2005). Malaria was then estimated to claim between 1-3 million lives per annum (HEAL, 2007).

Another apparent climate related disease in Africa is dengue (Amarasinghe *et al.*, 2011; Were, 2012; Jaenisch *et al.*, 2014). Like malaria, dengue is a disease caused by mosquitoes and several cases have been evident in more than 100 countries in regions of Americas, Asia, Eastern Mediterranean, the Pacific and Africa (WHO, 2015). A total of 22 countries in Africa were reported to experience the disease between 1960-2010 (Amarasinghe *et al.*, 2011). It was reported in later year that dengue has become an endemic in 34 African countries with its primary vector present in 85 per cent of these countries (Were, 2012).

In Nigeria, the health effects of climate change include cerebra-spinal meningitis, cardiovascular respiratory disorder of the elderly, skin cancer, high blood pressure, malaria, pneumonia, cholera (BNRCC, 2008; Oluleye and Akinbobola, 2010). Extreme weather conditions such as high temperature and heavy rainfall are related to be major causes of climate change related diseases in the country (IFRC, 2012; Olawepo and Enu-iyin, 2014). Oluleye and Akinbobola (2010) ascertained a profound influence of climatic parameters such as temperature and rainfall on incidence of malaria and pneumonia. More so, frequent flooding was experienced in most parts of the country due to extreme weather events. The most observable flood event with widespread consequences was in 2012 resulting from excessive rainfall among many other environmental and human factors (Sidi, 2012). While the diseases associated with flooding were observed to be direct waterborne diseases such as malaria, cholera, typhoid, pneumonia and diarrhoea (Eke and Onafalujo, 2011).

3. Study area

Abuja Municipal Area Council (AMAC) is situated in the Federal Capital Territory (FCT), Abuja, Nigeria. AMAC is one of the six area councils in the FCT (see Fig. 1). It was carved out alongside Gwagwalada as Local Government Areas in 1984 and was later re-designated as Area Councils in 1989. The Area Council besides the city caters for the needs of over 49 communities each presided over by a village head. The city, satellite towns and villages are delineated into twelve political wards namely: City Centre Wuse, Gwarinpa, Garki, Kabusa, Gui, Jiwa, Gwagwa, Karshi, Orozo, Karu, and Nyanya constituencies. At present, AMAC comprises twelve political wards which are City Centre, Wuse, Gwarinpa, Garki, Kabusa, Gui, Jiwa, Gwagwa, Karshi, Orozo, Karu, and Nyanya.

Being situated in FCT, AMAC is located approximately within longitude 6º.45' and 7º.39' east of the Greenwich Meridian and latitude 8º.25' and 9º.20' north to the Equator (see Fig. 2). It also possesses the climatic characteristics with respect to FCT. The climate of FCT is a tropical wet and dry climate seasons. The rainy season that begins around March and runs through October and the dry season which begins from October and ends in March. These seasons however comprise a brief Harmattan season that is occasioned by the North East Trade Wind and the attendant dust haze, increased cold and dryness. The condition of weather in the FCT is influenced by its location within the Niger-Benue trough on the windward side of the Jos Plateau and at the climate transition zone which is between the essentially 'humid' South and the 'sub-humid' North of the country.

The climate of the FCT is dictated by the South West to the North West due to the rising elevation from the Gurara valley in the south west, to the Bwari-Aso hills and the Agwa -Karu hills to the north east. The high temperatures and the relative humidity in the Niger -Benue trough is known to provide the FCT a heating effect except for the increasing elevation towards the North East which reduces the heat in areas like on the Gwagwa plains where the FCT is sited than on the Iku-Gurara plains to the West. Rainfall in the FCT likewise reflects the territory's location on the windward side of the Jos Plateau. The monthly rainfall distribution usually increases during the months of July, August and September.

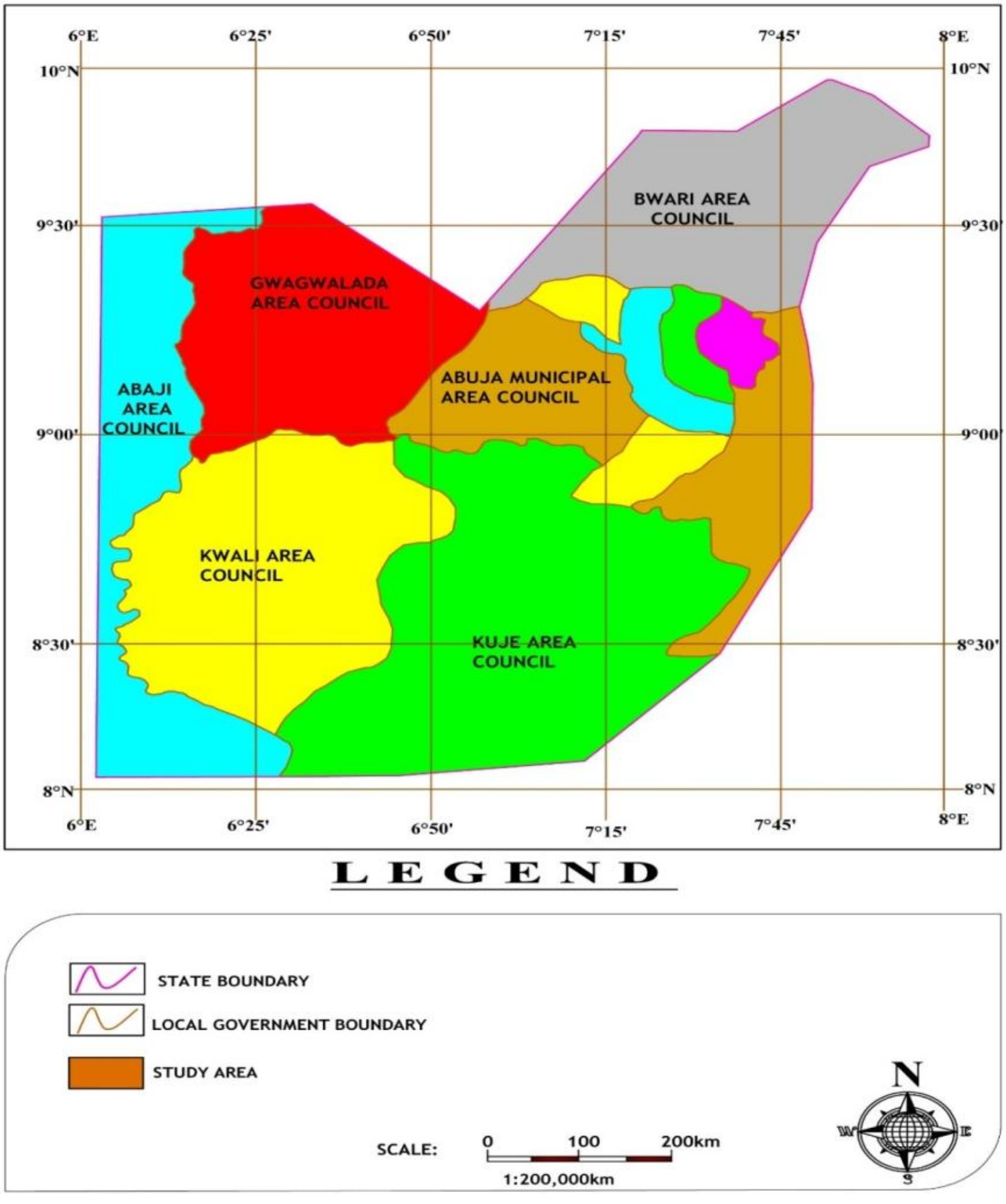

Fig. 1. Map of Abuja Municipal Area Council (AMAC)

Source. LAUTECH GIS Laboratory, 2015

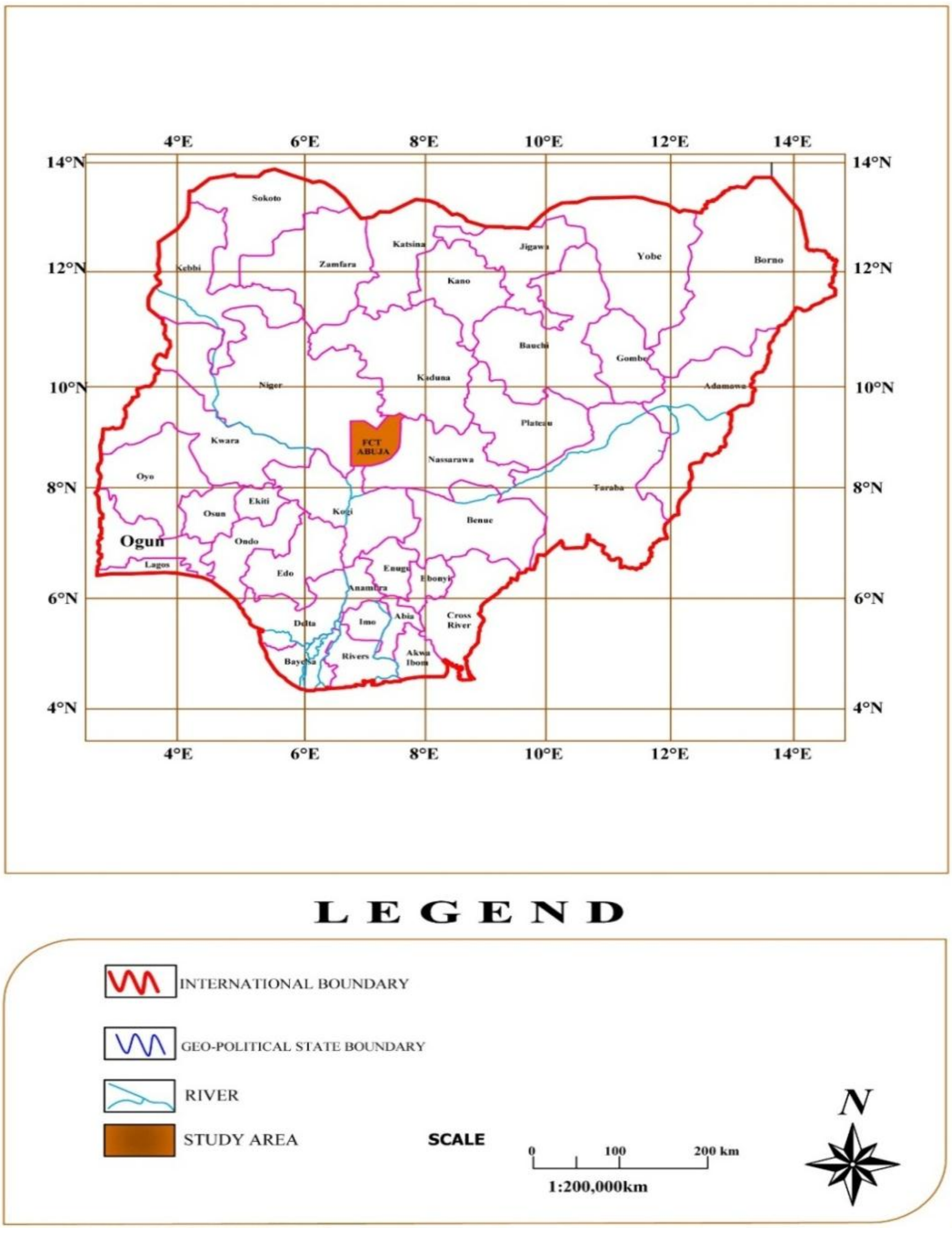

Fig. 2. Map of Federal Capital Territory (FCT), Abuja within National Context
Source. LAUTECH GIS Laboratory, 2015

4. Methodology

In this study, data on from 2005- 2015 climatic parameters covering temperature and rainfall patterns at two-year interval were obtained from Nigeria Meteorological Agency (NIMET). Hospital data records on climate-related diseases connected with children under 13 years of age were obtained from the admission and discharge records unit of the National Hospital, Abuja. It was ensured that the information obtained from the hospital comprised age, gender, residential address of patient, residential density, date of admission and clinically diagnosed diseases with attendant complications.

A social survey was conducted on residents of AMAC. Questionnaire was designed to collect information on each respondent's socioeconomic characteristics, awareness of climate change and climatic parameters. The sampling procedure in the administration of the questionnaire was such that every 30th building on the identified streets in the identified 12 political wards in AMAC was selected until the buildings on each street were exhausted. However, any building that was selected met the criterion that any of the households had children less than 13 years of age were found living in the building. A total of 120 buildings were obtained on which questionnaire was administered an adult in the building.

The data collected from National Hospital, Abuja, NIMET and questionnaire administration were collated and analysed using descriptive and inferential statistics. Descriptive statistics include frequency, percentages, cross-tabulations and the results were appropriately presented in tables, charts and graphs. Inferential statistics such as correlation and regression analysis were employed for further analysis. The Pearson correlation analysis was used to analyse the relationship between climatic parameters and climate related diseases. The multiple regression analysis was used examine to verify the causality of the relationship between changes in climatic parameters and climate related diseases. Under this later analysis, the climate related diseases were the dependent variable while the climatic parameters were independent.

5. Findings and discussion

5.1 Respondents' socioeconomic characteristics

The Socioeconomic characteristic of the respondents was measured using six variables which were considered sufficient to justify both the social and economic status of the population under study. The variables comprised age, gender, educational, marital status, occupational status and income. The summary of the socioeconomic characteristics of respondents in the study area is presented in Table 1.

With regards to gender, the males (29.2%) constituted a lower proportion of the total respondents while the females (70.8%) were the majority. A vast number of the sampled respondents (47.5%) fell within the age range of 31- 40 years, and other age groups that constituted the sample size were: less than 20 years, 21–30 years, 41–50 years and greater than 50 years with 2.5%, 24.2%, 20.8% and 5.0% respectively. In addition to the earlier stated information, 79.2% of the total populations were married parents while the remaining 10.8%, 8.3% and 1.7% were single parents, widowed parents and divorced respectively.

Table 1. Socioeconomic Characteristics of Respondents

Variables	**Frequency**	**Percentage (%)**
Gender		
Male	35	29.2
Female	85	70.8
Total	120	100
Age Structure		
<20 years	03	2.5
21-30 years	29	24.2
31-40years	57	47.5
41-50years	25	20.8
>50years	06	5.0
Total	120	100
Marital Status		
Single Parent	13	10.8
Married	95	79.2
Divorced	02	1.7
Widowed	10	8.3
Total	120	100
Level of Education		
No formal Education	02	1.7
Secondary education	27	22.5
Tertiary Education	91	75.8
Total	120	100
Occupation		
Trading	23	19.2
Civil Servant	47	39.2
Artisans	30	25.0
Students	09	7.5
Unemployed	11	9.2
Total	120	100
Monthly Income		
Below 18,000	13	10.8
18,000 – 30,000	23	19.2
30,001 – 60,000	33	27.5
60,001 – 90,000	30	25.0
Above 90,000	21	17.5
Total	120	100

The reason the sampled population was skewed in favour of the adults was due to the fact that these populations were in the best position to provide the necessary information needed for the research. With regards to educational status, it was observed that about 75.8% of the respondents had tertiary education either from a university, polytechnic or college of education. This high level of education among the respondents increased the reliability of the data obtained from the survey. However, 22.5% of the respondents had only secondary education and a minute portion of the sample population were not educated.

Considering the fact that a vast majority of the respondents were well educated, one would expect most of them should be professionals who engaged in white collar jobs. However, the data obtained through questionnaire administration revealed that only 39.2% of the respondents were professionals such as doctors, lawyers, town planners, architects, engineers, among others. Other occupation common among the sampled population were artisans (25.0%), trading (19.2%) and the remaining 16.7% were unemployed comprising students, housewives and job seekers. It is generally believed that the income of an individual is greatly influenced by his level of education and standard of his job. Sequel to this, Table 1 provided a crystal clear indication that 27.5% of the respondents received a monthly income between ₦30,000 - ₦60,000, 25.0% received between ₦60,001 – ₦90,000, 19.2% received a monthly income between ₦18,000 – ₦30,000, while 17.5% and 10.8% of the respondents received above ₦90,000 and below ₦18,000 as their monthly income respectively.

5.2 Respondents' level of awareness of climate change

Although climate change is a universal phenomenon, the awareness of people about it is not universal. This variation may be due to differing levels of awareness among others. However, the survey of respondents' in the study area revealed that a vast majority (90%) were aware of the incidence of climate change. Among this population, it was observed that 50.8% were very sure the climate is changing, 33.3% were sure, while only 7.5% were slightly sure (see Fig. 3).

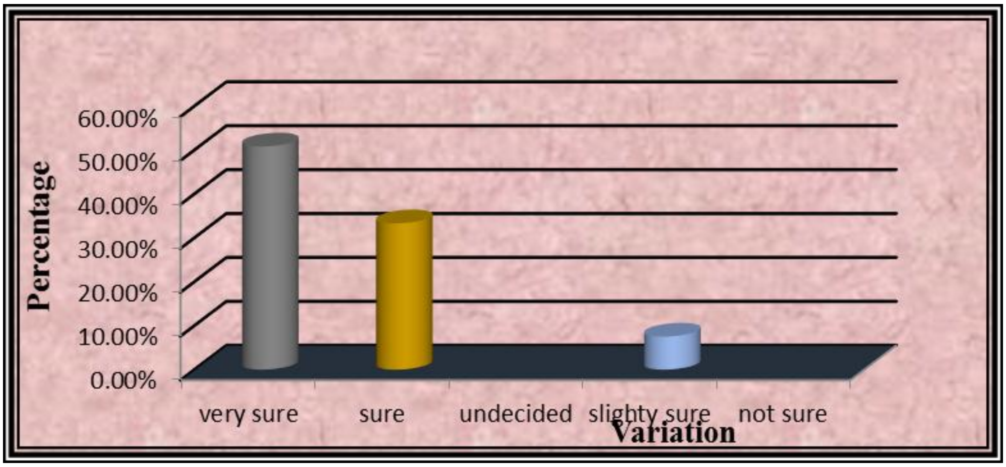

Fig. 3. Variation in Respondents' Level of Awareness to Climate Change

5.3 Relationship between climate parameters and climate related diseases in children

Further examination of the incidence of climate related diseases in relation to changing climate over the years, it was observed that malaria and respiratory diseases were inversely proportional to both temperature and rainfall. In other words, as the pattern of temperature and rainfall increased, the incidences of malaria and respiratory diseases decreased. Hence, a negative correlation existed between these two diseases and both climatic factors. In the case of malaria, the correlation coefficient (r) was 0.911 and it indicated a high correlation. The coefficient of determination (r^2) was 0.831 and it showed that 83.1% of the variation in the incidence of malaria could be attributed to variation in the incidence of the climatic parameters. While in the case of respiratory diseases, the r = 0.415 showed weak correlation with the r^2 = 0.172 showing that 17.2% of the variation in the incidence of respiratory diseases could be attributed to rainfall and temperature (see Fig. 4).

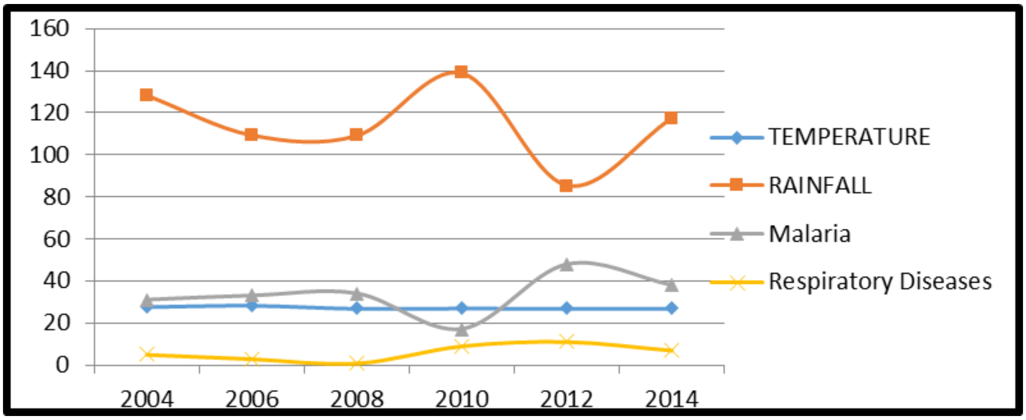

Fig. 4. Relationship between Climate Parameters and Malaria/Respiratory Diseases

A similar relationship existed between typhoid, pneumonia, meningitis, skin diseases (dependent variables) and the two climate factors (temperature and rainfall). It was observed that as the volume of rainfall increased, the incidence of the four diseases also follow suit. The reverse was the case with temperature. In the case of typhoid, the r = 0.476 while the r^2 = 0.227 implying that 22.7% of the variation in the incidence of the diseases could be attributed to rainfall and temperature; with significant values of 0.538 and 0.530 for rainfall and temperature respectively.

In relation to pneumonia, the r = 0.659 while the r^2 = 0.434 implied that 43.2% of the variation in pneumonia was attributed to climatic parameters with significance of 0.416 for rainfall and 0.288 for temperature respectively. The correlation coefficient for skin diseases was r = 0.773 and r^2 = 0.598 was the coefficient of determination which indicated that 59.8% of the variation in pneumonia was attributed to climatic parameters with significance of 0.155 and 0.335 for rainfall and temperature respectively. Finally, meningitis had r = 0.239 with r^2 = 0.057 which implied that 5.7 % of the variation in meningitis was due to climatic factors, with significant value of 0.764 and 0.778 for rainfall and temperature respectively (see Fig. 5).

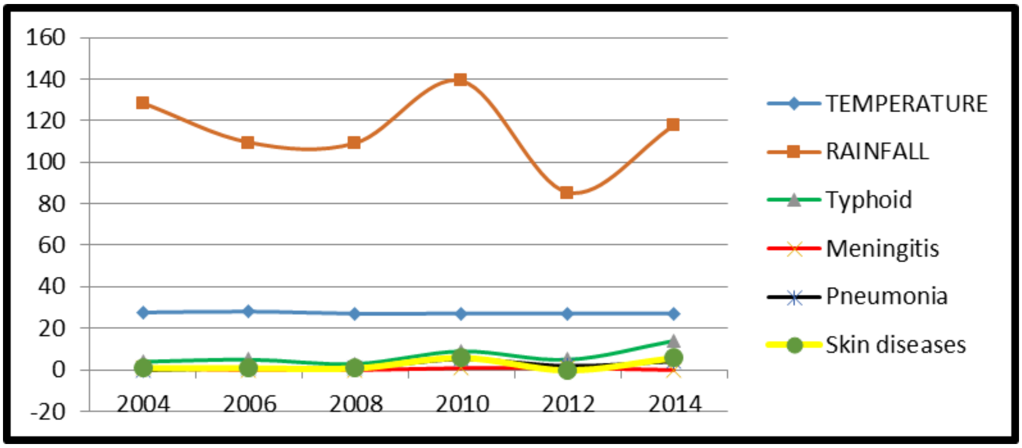

Fig. 5. Climate Parameters against Typhoid, Pneumonia, Meningitis and Skin Diseases

Unlike the just examined cases of typhoid, pneumonia, meningitis and skin diseases, the relationship between asthma, and temperature and rainfall took a different dimension. From the regression analysis, it was observed that a negative relationship existed between asthma and rainfall, while a positive relationship existed between the same and temperature. However, since r= 0.649 with r^2 = 0.422, it is implied that 42.2% of the variation in the incidence of asthma in the study area could be attributed to variation in temperature and rainfall (see Fig. 6).

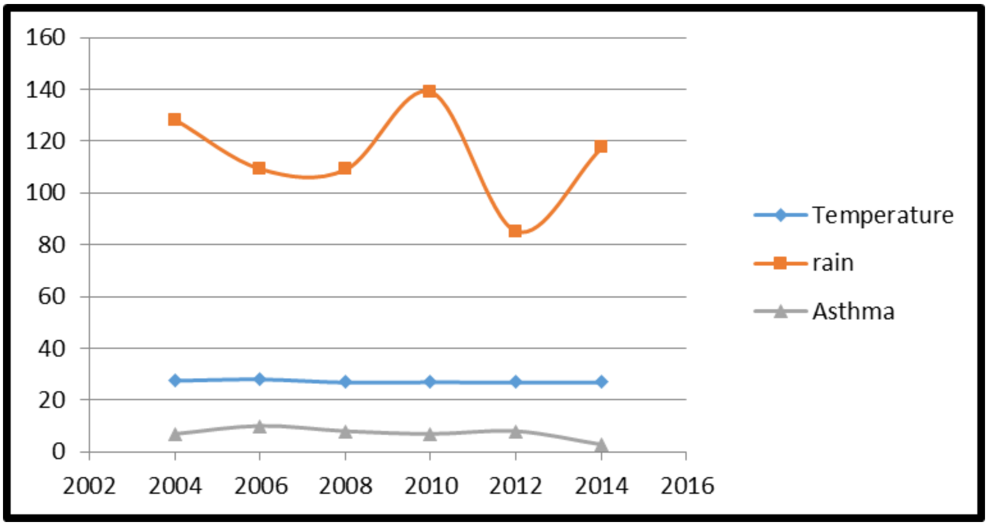

Fig. 6. Climate Parameters against Asthma

Only diarrhea and measles had a positive relationship with the two climate parameters considered. In the case of diarrhoea, r = 0.840 showed a high correlation while r^2 = 0.705 implied that 70.5% of the incidence of diarrhea in the study area could be attributed to variation in the rainfall and temperature while the remaining 25.5% could be explained by other unknown variables. In the case of measles, where r = 0.443 and r^2 = 0.196, it could be inferred that a small percentage of 19.6% of the incidence of measles in the area could be attributed to the variation in rainfall and temperature (see Fig. 7).

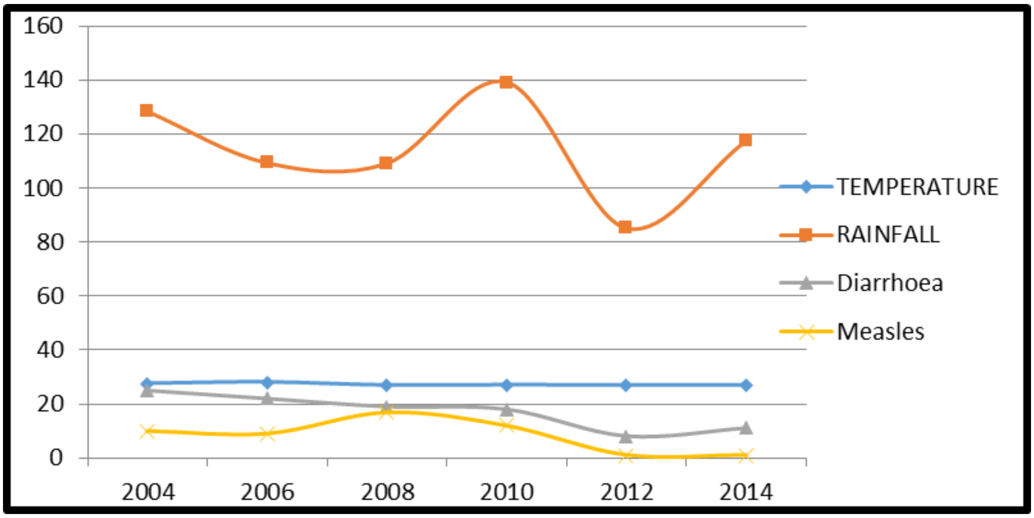

Fig. 7. Climate Parameters against Diarrhea and Measles

6. Conclusion

In synopsis, the female gender constituted a larger proportion of the respondents with most of the respondents being within the age range of 31 – 40 years. A large proportion of these respondents were highly aware of climate change and variation in climatic parameters. moreover, it was observed that as the pattern of temperature and rainfall increased, the incidences of malaria, respiratory diseases, and typhoid, pneumonia, meningitis and skin diseases decreased. The incidences of diarrhoea and measles however decreased with increase in pattern of temperature and rainfall.

Since climate change is a global phenomenon that also affects the local climate, the Government and all stakeholders involved in managing the phenomenon should increase public awareness, promote research and establish a commission or an agency that will handle issues related to climate change. Governmental policies to promote mitigation activities against notable causes of climate change should be formulated. Likewise, health programmes should be implemented to carter for children's health and their other biological and developmental needs.

References

Amarasinghe, A, Kuritsk, J. N., Letson, G. W., and Margolis, H. S. , 2011. Dengue virus infection in Africa. *Emergency Infectious Diseases.* Vol. 17, No. 8, pp. 1349-1354. Accessed March 13, 2016. doi:10.3201/eid1708.101515

Ayoade, J. O. (2004). *Introduction to climatology for tropics*. Second Edition, Spectrum, Ibadan, Nigeria.

Building National Response to Climate Change [BNRCC], 2008. Accessed March 12, 2016, from www.nigeriaclimateclimatechange.org.

Caminade, C., Kovat, S., Rocklov, J., Tompkins, A. M., Morse, A. P., *et al.* (2014). Impact of climate change on global malaria distribution. *Proceedings of the National Academy of Science*. USA. Vol. 111, No. 9, pp.3286-3291 Accessed March 21, 2016 from Doi:10.1073/pnas.1302089111.

Eke, P. O., and Onafalujo, A. K. (2011). Effects of climate change on health risks in Nigeria. *Asian Journal of Business and Management Sciences*. Vol. 1, No. 1, pp.204-215. Accessed March 13, 2016 from www.ajbms.org.

Environmental Protection Agency [EPA]. (2007). A decade of children's environmental health research: highlights from EPA's science to achieve result program Global warming. Accessed March 9, 2016 from http://www.epagov/climatechange/glossary.html.

EPA. (2013). Environments and contaminants In: American's children and the environment. Third Edition. pp. 105-107.

Garcia-Herrera, R., Diaz, J., Trigo, R. M., Lutherbacher, J., and Fitcher, E. M. (2010). A review of the European summer heatwave of 2003. *Critical Reviews in Environmental Science and Technology*. Vol. 40, Issue 4, pp. 267-306. Accessed March 12, 2016, from doi:10.1080/10/10643380802238137

Hajat, S., Armstrong, B., Baccini, M, Biggeri, A., Bisanti L., Russo, A., Paldy, A. Menne, B., and Kosatsky, T. (2006). Impact of high temperatures on mortality: is there an added heat wave effect? Epidemiology. Vol. 17, pp. 632-638. Accessed March 12, 2016, from doi:10.1097/01.ede.0000239688.70829.63

Health and Environment Alliance [HEAL] (2007). Climate change and health: Protecting the most vulnerable. Accessed March 14, 20014 at http://www.env-health.org/a/2637

Huber, D., and Gulledge, J. (2011). Extreme weather and climate change: understanding the link and managing the risk. Science and Impacts Program. Center for Climate and Energy Solutions. Arlington, VA. Accessed March 21, 2016 from http://www.c2es.org/publications/extreme-weather-and-climate-change.

Intergovernmental Panel on Climate Change [IPCC]. (2007). Global burden of disease study. In Climate Change 2007: Working Group II: Impacts, Adaptation and Vulnerability. IPCC Fourth Assessment Report.

International Federation of Red Cross and Red Crescent Societies [IFRC], 2012. Floods international federation of red cross and red crescent societies. Emergency Appeal Nigeria: Emergency Appeal.

Jaenisch, T., Junghanss, T., Wills, B., Brady, J. O., Eckerle, I. *et al*., 2014. Dengue expansion in Africa-not recognized or not happening? *Emergency Infectious Diseases.* Vol. 20, No. 10, pp. 1349-1354. Accessed March 13, 2016 from http://dx.doi.org/10.3201/eid2010.140487

Josseran, L., Caillere, N., Brun-Ney, D., Rottner, J., Filleul, L., *et al*., 2009. Syndromic surveillance and heat wave morbidity: a pilot study based on emergency departments in France. BMC Medical Informatics and Decision Making. Vol. 9, 14 doi:1186/1472-6947-9-14.

Kebede, S., Duale, S., Yokouide, A., Alemu, W., 2010. Trends of major disease outbreaks in the African Region, 2003-2007. East African Journal of Public Health. Vol. 7, No. 1, pp. 20-29.

Mburia, R., 2012. Climate change and disease prevalence in Africa. Climate emergency institute. The health and human rights approach to climate change. Accessed March 13, 2016 from www.climateemergencyinstitute.com/disease_africa_mburia.html

Niera, M., Gore, F., Brune, M., Hudson, T., Garbino, J. P., 2008. Environmental threats to children's health: a global problem. *International Journal of Environment and Health.* Vol. 2 (2/4), pp. 211-233.

Olawepo, A. O., Enu-iyin, O., 2014. Comparative study of climate variability over two climatic zones of Nigeria. *Ilorin Journal of Science*. Vol. 1., No. 1, pp. 142-153.

Oluleye, A., Akinbobola, A., 2010. Malaria and pneumonia occurrence in Lagos, Nigeria: role of temperature and rainfall. *African Journal of Environmental Science and Technology*. Vol. 4, No. 8, pp. 504-516.

Paul B., Tham W. L., 2015. Interrelation between climate and dengue in Malaysia. *Health*. Vol. 7, pp.672-678. Accessed March 24, 2016 from http://dx.doi.org/10.4236/health.2015.76080

Robine, J. M., Cheung, S. L., Le Roy, S., Van Oyen, H., Griffiths, C. *et al.*, 2008. Death toll exceeded 70,000 in Europe during summer of 2003. *Competes Rendus Biologies*. Vol. 331, No. 2, pp.171-178. Accessed March 12, 2016, from doi:10.1016/j.crv.2007.12.001.

Seal, A., Vasudevan, C., 2011. Climate change and child health. *Archive of Disease in Childhood*. Vol. 96, pp. 1162-1166. Accessed March 23, 2016 from doi:10.1136/adc.2010.186213.

Sheffield, P. E., Landrigan, P. J., 2011. Global Climate Change and Children's Health: Threats and Strategies for Prevention. *Environmental Health Perspectives, 119*, 291-298. http://dx.doi.org/10.1289/ehp.1002233

Sidi M. S., 2012. The impact of the 2012 floods on agriculture and food security in Nigeria using GIS. *A paper delivered at the United Nations international conference on space-based technologies for disaster management - "Risk Assessment in the Context of Global Climate Change", Beijing, China*. pp. 3.

United Nations Children's Emergency Fund [UNICEF], 2007. Climate change and children's health. UNICEF, New York, NY, USA.

United Nations Environment Programme [UNEP], 2008. Scoping paper for expert group meeting on climate change adaptation, African Minister Conference on the Environment, 12th meeting of the expert group TBC. Accessed July, 25, 2015 http;://www.unep.org/roa/about-AMEN/default.asp.

United Nations World Food Programme [UN/WFP], 2007. Floods across sub-Saharan Africa hit 1.5 million people. Retrieved from m.wfp.org/stories/floods-across-sub-saharan-africa-hit-15million-people

Wei J., Hansen, A., Zhang, Y., Li, H., Liu, Q., *et al.*, 2014. The impact of climate change on infectious diseases transmission: perceptions of CDC health professionals in Shanxi Province, China. PLoS One. Vol. 9, No. 10, pp. Accessed March 24, 2016, from doi:10.1371/journal.pone.0109475.

Were, F., 2012. The dengue situation in Africa. *Paediatrics and International Child Health.* Vol. 32, Suppl. 1, pp. 18-21. Accessed March 13, 2016. doi:10.1179/2046904712Z.00000000048

World Health Organization [WHO], 2003. Climate change and human health- risks and responses. Summary. Pp.1-37. Accessed March 24, 2016 from htpp://www.who.int/globalchange/summary/en/

WHO, 2008a. Global burden of diseases. 2004 update. Accessed March 21, 2016 from http://www.who.int/che/indicators/en/.

WHO, 2008b. Protecting health from climate change - World Health Day. Geneva: World Bank.

WHO, 2010. Using climate to predict infectious disease epidemics / Communicable Diseases Surveillance and Response, Protection of the Human Environment, Roll Back Malaria. WHO Document Production Services, Geneva, Switzerland.

WHO European Region, 2012. Implementing the European regional framework for action to protect health from climate change: a status report. Accessed March 12, 2016, from www.euro.who.int/en/publications/abstracts/implementing-the-european-regional-framework-for-action-to-protect-health-from-climate-change-a-status-report

WHO, 2015. Dengue and severe dengue. Word Bank Fact Sheet. Geneva: World Bank.

Working Group on Climate Change and Development [WGCCD], 2005. Africa up in smoke? The second report from the Working Group on Climate Change and Development.

Wu, X., Lu, Y., Zhou., S., Chen, L., Xu, B., 2016. Impact of climate change on human infectious diseases: empirical evidence and human adaptation. *Environmental International.* Vol. 86, pp. 14-23. Accessed March 24, 2016, from doi.q0.1016/j.envint.2015.09.007

Zhang, Y., Bi, P., Hiller, J. E., 2007). Climate change and disability-adjusted life years. *Journal of Environmental Health.* Vol. 70, pp. 32-36.

Zuma, B., Luyt, C., Chirenda, T., Tandlich, R., 2012. *Flood disaster management in South Africa: Legislative framework and current challenges*. Paper presented at International Conference on Applied Life Sciences, Turkey.