ASSESSMENT OF THE EFFECT OF HARMATTAN ON THE OCCURRENCE OF SOME RESPIRATORY TRACT INFECTIONS IN GWER EAST LOCAL GOVERNMENT AREA OF BENUE STATE, NIGERIA

BY

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A THESIS SUBMITTED TO THE SCHOOL OF POSTGRADUATE STUDIES, AHMADU BELLO UNIVERSITY ZARIA, IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER OF SCIENCE DEGREE IN GEOGRAPHY

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DECLARATION

I declare that the work in this dissertation entitled ASSESSMENT OF THE EFFECT OF HARMATTAN ON THE OCCURRENCE OF SOME RESPIRATORY TRACT INFECTIONS IN GWER EAST LOCAL GOVERNMENT AREA OF BENUE STATE, has been performed by me in the Department of Geography and Environmental Management, Ahmadu Bello University, Zaria. The information derived from the literature has been duly acknowledged in the text and a list of references provided. No part of this dissertation was previously presented for another degree or diploma at this or any other institution.

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CERTIFICATION

This dissertation entitled ASSESSMENT OF THE EFFECT OF HARMATTAN ON THE OCCURRENCE OF SOME RESPIRATORY TRACT INFECTIONS IN GWER EAST LOCAL GOVERNMENT AREA OF BENUE STATE by Abraham, TYOHEMBA meets the regulations governing the award of the degree of Master of Science Degree in Geography of Ahmadu Bello University, and is approved for its contribution to knowledge and literary presentation.

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DEDICATION

This research work is dedicated to Almighty God who makes this work a reality and to my amiable wife Abigail and my kids Avadoo, Avalumun and Selumun for their courage.

`

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ABSTRACT

It has long been observed that the incidence of common respiratory tract symptoms increase in Gwer East Local Government Area during the harmattan months of the year. This study assessed the effect of harmattan dust haze on the occurrence of some respiratory tract infectious diseases in Gwer East Local Government Area of Benue State, Nigeria. Structured questionnaire and hospital records from 2014-2019 were used as the main instrument for data collection in this study. Frequency distribution tables, pie charts, and linear regression were used in analyzing the data using SPSS version 26.0. Results showed that the respondents of the study area faced some respiratory tract symptoms such as coughing, sneezing, nasal congestion among others which occur regularly during harmattan season of the year. The result showed that 93% of the respondents agreed with the view thatharmattan influences breathing.The perception of occurrence of common respiratory tract symptoms indicated that items like harmattan result to unpredicted respiratory tract symptoms, harmattan dust haze reduces solar radiation, harmattan dust haze increase respiratory tract symptoms, there is high body temperature during harmattan season, harmattan season result to decreased day activities and respiratory tract symptoms subside after harmattan season were found to be above the minimum level of decision 3.00 with an average score of 3.77. Findings revealed that there was significant relationship between the respiratory tract symptoms and the respiratory diseases in the study area with catarrh having the strongest relationship with ‘r’ value of 0.821 among all other diseases. Findings confirmed that only 30.30% of respiratory diseases occur in dry season with catarrh having the highest frequency in the study area and 23.83% of cases occur in wet season. About 82.7% of the respondents confirmed that common cold manifests mostly during dry season in the study area. Findings show that 63.1% of the respondents visit hospitals when they are sick during harmattan season and 69% of the respondents agreed that respiratory tract symptoms disappear after

harmattan season. The result revealed that 60.30% of respondents use face masks as the best management strategy against harmattan dust and 80% of the respondents agreed that it is effective. About 37.60% of the respondents suggested the use of face mask as the possible way to mitigate the effect of harmattan dust in the study area.The respiratory tract symptoms faced by the people of the area include coughing, sneezing, nasal congestion among others which occur regularly during harmattan season of the year. The use of management strategies such as the wearing of face mask and adjustment of body outfit/ thick clothing during harmattan season should be practiced in the study area.

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CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND TO THE STUDY

Theglobal wind pattern of each hemisphere are divided into three wind belts namely, polar easterlies, prevailing westerlies and tropical easterlies. The easterly trade winds of both hemispheres converge at an area near the equator called the Inter-tropical Convergence Zone (ITCZ). The atmospheric circulation over the North African dust source regions, predominantly the Sahara and the Sahel, is characterized by three major circulation regimes: the harmattan (trade winds),the Saharan Heat Low(SHL),and the West African monsoon circulation. The strength of the individual regimes controls the Saharan dust outflow by affecting the spatio-temporal distribution of dust emission, transport pathways, and deposition fluxes(Kerstin, Bernd and Ina, 2017).

According to Kerstin et al (2017)the strength of the harmattan, the name used for the trade winds is determined by the pressure gradient between the subtropics and the tropics. Due to the geographic situation, the gradient is strongest over the northern African continent. The northeasterly harmattan winds are deflected by local topography and modulated by variability in pressure distribution to West Africa, the Caribbean and South America.Harmattan is a season in the West African subcontinent, which occurs between the end of November of one calendar year and the middle of March of the next year. It is characterized by the dry and dusty north-easterly trade wind, which blows from the Sahara Desert over West Africa into the Gulf of Guinea.

According to Eappen (2020), harmattan is a dry dusty north-easterly wind on the West Africa and beyond occurring from November of one calendar year to March of the next year. The name is related to the word *haramata*, possibly from Arabic “haram” meaning evil thing in the Twi

language (Onyeakagbu, 2018).The West African region experiences the prevailing north-easterly wind regime known as Harmattan (Falaiye et al, 2013). This dry wind transports and deposits the Saharan dust over the entire region and extends as far as to the Gulf of Guinea. The dust haze predominantly originates from the Bodele depression in the Chad Basin (Xulei et al, 2016; Falaiye and Aweda, 2018; Eappen, 2020).

Beginning in November of every year and ending around March of the following year, fine particulate matter (typically 0.5 – 10 micrometers) emanating from the Sahara desert blow south, obscuring vision and laboring breathing for everyone. In addition, the dry dusty winds cause a variety of domestic inconveniences because of the layers of dust that envelope everything both outdoors and indoors (Oladele, 2007). The dust transport is a seasonal phenomenon due to the existence of the Inter-tropical Discontinuity (ITD) which is the driving mechanism for weather phenomenon and season in Nigeria and West Africa in general. During the dry season, the entire country is usually dominated by the North-easterly trade winds and experiences large quantities of dust that is transported by this prevailing trade wind. This dust accompanied by low temperature is referred to as harmattan dust haze (Ochei and Adenola, 2018).

Eyo, Mankiti, and Udo (2002) added that harmattan period is when cold and dust-laden North-East trade winds from the Sahara desert keeps the atmosphere over the entire West-African sub-region heavily overcast for days, with characteristic hazy and cloud free weather conditions, low relative humidity, reduction in visibility, depletion of solar radiation, attenuation of radio signals, and discomfort to the respiratory system and associated ailments. According to Minka and Ayo (2014), harmattan season occurs from November to early March in the Gulf of Guinea. It is characterized by a very cold–dry (9°C) and dust-laden wind, blowing northeast and west of the Sahara desert into the Gulf of Guinea, towards the Caribbean and South America. It differs from

winter because it is characterized by cold–dry wind, heavy dust-laden particles, and wide fluctuations in day and night ambient temperatures. Mohammed (2013); Achyuta et al (2016) added that the harmattan dust haze carries a large amount of dust haze, mostly quartz, clay, colloids and fine mica. These particles can easily gain access into the respiratory system which may transfer some toxic elements into the blood system. It has been reported by Falaiye and Aweda(2018) that the chemical composition of fine aerosol has a negative impact on human health. The harmattan dust particles affect negatively the health of the people causing the respiratory diseases to adults and children. Health cases such as cough, catarrh, and respiratory diseases are mostly reported in the hospitals during the harmattan season (Sufiyan et al 2020).

Akande et al (2013) stated that concentrated aerosols from substances such as silica, asbestos and diesel particulate generated by harmattan are sometimes found in the workplace and have been shown to result in a number of diseases including respiratory failures, black lung, and ecological stress. Suspended dust particles in the atmosphere affects local and regional air quality and therefore impact on human health.It is common knowledge that the harmattan season, especially in northern Nigeria, is a difficult period for patients with chronic respiratory diseases and that inhalation of cold dusty air has negative effects on the lungs for people with respiratory diseases in particular on asthmatic patients (D'Amato et al, 2018).

Respiratory tract symptoms vary from person to person and might include; runny or stuffy nose, sore throat, cough, nasal congestion, loss of appetite, sneezing, low-grade fever and generally feeling unwell (malaise).Symptoms of lower respiratory tract infections vary and depend on the severity of the infection. Less severe infections can have symptoms similar to the common cold, including; a stuffed up or a runny nose, a dry cough, a low grade fever, sore throat,and a dull headache. In more severe infections, symptoms can includea severe cough that may produce

sputum, fever, and difficulty in breathing, cyanosis, rapid breathing, chest pain and wheezing (Mayo, 2019).Balentine, Siamak and Shiel (2021) enumerated the following as the symptoms of Upper Respiratory Tract Infections (URTI), these include, coughing, sneezing, nasal congestion, nasal discharge and runny nose. Others are slight headache, nasal breathing among many others.Weatherspoon and Certified Registered Nurse Anesthetist (CRNA)(2020), asserted that these symptoms are characterized by inflammation of the mucous membranes in the upper respiratory tract.

The harmattan triggers respiratory diseases, such as asthma, cough, catarrh, tonsillitis, influenza, pneumonia, tuberculosis, and bronchitis etcetera. It worsens conditions like sore throat the dry air that is breathed in irritates the throat as the voice changes and becomes very hoarse (Adesanya and Chioa 2017). Respiratory tract infections are among the most common acute diseases worldwide, leading to considerable morbidity, complications and days lost from work and school (Oladele, 2007).

Common cold, pharyngitis, laryngitis, croup, sinusitis, acute bronchitis, viral exacerbations of chronic bronchitis, bronchiolitis and community acquired pneumonia all occur with peak incidence during harmattan season (Moutzoukou and Falagas, 2007). It has been observed that dysfunction of any part of the upper respiratory tract may change the quality of inhaled air and consequently, may impair function of tracheobronchial tree and the lower respiratory tract (Henna et al 2018).

Harmattan dust haze is considered to be among the most harmful of all air pollutants. When inhaled by particularly those that have antecedents of bronchial asthma, pneumonia and other respiratory diseases, these particles evade natural mucosal defenses of the respiratory system and lodge deep in the lungs causing serious health complications.

Respiratory tract refers to the organs that are involved in breathing. These include the nose, pharynx, larynx, trachea, bronchi and lungs. It is also called respiratory system. The system is divided into the Upper Respiratory Tract (URT) and the Lower Respiratory Tract (LRT) (Micah and Paul, 2018).Respiratory Tract Infections (RTIs) are infectious diseases involving the respiratory tract. An infection of this type usually is further classified as an Upper Respiratory Tract Infection (URTI) or a Lower Respiratory Tract Infection (LRTI),(Micah and Paul, 2018).

Common Respiratory Tract Symptoms (CRTS) are perceived changes in some function, sensation or appearance in a person that indicates a disease or disorder such as fever, coughing, sneezing, sore throat and difficulty in breathing among others, (Crowford, 2019).The residents of Gwer East Local Government Area of Benue state are confronted with these respiratory tract infections on yearly basis with varying symptom characteristics during harmattan season.

1.2 STATEMENT OF THE RESEARCH PROBLEM

Common respiratory tract symptoms emanating from the Upper Respiratory Tract Infections (URTI) to the Lower Respiratory Tract Infections (LRTI) during harmattan period are noticeable generally among households in Gwer East Local Government Area (Eccles and Wilkinson, 2014). There is increased morbidity, hospitalization and mortality during harmattan months. Symptoms of a common cold usually appear one to three days after exposure to cold-causing virus (Oladele, 2007). Signs and symptoms of respiratory tract infections affect the residence of Gwer East Local Government Area on yearly basis (Paul, 2017).

Sufiyan et al (2020) carried out a research on the impacts of the harmattan season on human health in Keffi town, Nasarawa state, Nigeria. The use of correlation and regression analysis was employed to analyse the data. It also involved the collection of data from the Nigerian Meteorological Agency. The field survey also confined about 100 respondents. The results

indicated a positive correlation between the harmattan and its impact on human health, with about 0.64. The climate and anthropogenic factors are mostly the responsible factors influencing the high prevalence of harmattan. Nevertheless, there is the good side of the harmattan season, such as the lowering of environmental temperature and some crops enjoy the cold season

Uduma and Jimoh (2013), investigated high incidence of Asthma, Bronchitis, Pneumonia and Sinusitis in Kano State, North West Nigeria during Saharan dust events. The results showed that apart from the elemental composition; other properties such as pH, organic matter, cat ion exchange capacity(CEC), and texture were elevated in the dust samples. The elemental function (EF) values indicate that the soil is minimally enriched / contaminated with Pb, Cd, Cu, Ni and Mn by the Saharan dust when Fe was used as a background reference element. The result also showed that among the atmospheric aerosols, mineral dust produced from windblown soils and deserts is one of the largest contributors to the global aerosol loading and has strong impacts on human health. Harmattan dust is considered to be among the most harmful of all air pollutants due to the toxic effect of the dust constituents.

Adesanya and Chiao (2017) investigated on the environmental risks associated with symptoms of acute respiratory infections among pre-school children in North- western and South-Southern Nigeria Communities. The study used the 2013 Nigeria Demographic and Health Survey to assess the individual and environmental risks present in the North-Western and South-Southern Nigerian communities and examines their associations with Acute Respiratory Infection (ARI) symptoms. The descriptive findings show that the prevalence of ARI symptoms is significantly higher among preschool children in the North-Western province (5.7%) than in the South-Southern province (1.4%) ($p < 0.001$). In addition to regional differences, multilevel logistic models further indicate that the increased likelihood of a child suffering from ARI symptoms is

significantly associated with the dry season and household poverty even after adjusting for the cooking fuel used and various other characteristics of the children, households, and communities. The findings underscore the importance of taking into account environmental risks when addressing specific regional variations in ARI symptoms, because these determinants differ between communities in Nigeria. As it is imperative to achieve minimum levels of child health, in order to improve economic development across regions, future health policies aiming to promote child health will benefit from taking a region-specific perspective into consideration.

The consulted literature discussed the connection between harmattan and health of humans, particularly the respiratory disorders from different places at different times. However, studies to address these issues at Gwer East Local Government Area of Benue State have remained non-existent. Considering the rate at which households in Gwer East Local Government Area of Benue State recently complain about their respiratory tract symptoms like stuffy nose, coughing, sore throat, sneezing, and malaiseetcetera; during harmattan season, this constitutes the gap in knowledge that the present study intends to bridge. Thus, this study sought to assess the effect of harmattan on the occurrence of some respiratory tract infections in Gwer East Local Government Area of Benue State, Nigeria; with a view to answering the following questions:

1. What are the common respiratory tract symptoms in Gwer East Local Government Area?
2. What are the perceptions of households on occurrence of common respiratory tract symptoms in the study area?
3. What is the relationship between the common respiratory tract symptoms and respiratory diseases in the study area?
4. What is the seasonal variation of occurrence of these common respiratory tract symptoms in the study area?

5. What are the management strategies for common respiratory tract symptoms among households in the study area?

1.3 AIM AND OBJECTIVES OF THE STUDY

The aim of this research is to assess the effect of harmattan on the occurrence of some respiratory tract infections in Gwer East Local Government Area of Benue State, Nigeria. The objectives are to:

i. identify and characterize the common respiratory tract symptoms in the study area;
ii. examine the perception of households on occurrence of common respiratory tract symptoms in the study area;
iii. examine the relationship between the common respiratory tract symptoms and some respiratory diseases in the study area;
iv. examine the seasonal variation in the occurrence of some respiratory tract symptoms in the study area, and
v. examine the management strategies for common respiratory tract symptoms amonghouseholds in the study area.

1.4 SCOPE OF THE STUDY

This study focused on the effect of harmattan on the occurrence of some respiratory tract infections in Gwer East Local Government Area of Benue State. The content scope for the study was limited to seven (7) wards in the study area which are Aliade / Mbalav, Ikwe, Mbaiase, Mbasombo, Mbakyaan, Mbabur, and Ugee council wards because of high population of people in these areas. The study considered the time frame of six years (2014 – 2019), because of the availability of hospital records on the prevalence of some respiratory tract symptoms during harmattan season in the study area within the time period.

1.5 JUSTIFICATION OF THE STUDY

Gwer East Local Government Area of Benue State is deeply covered by dust haze during harmattan season that households are always complaining of respiratory tract symptoms such as sneezing,stuffed up or a runny nose, dry cough, low grade fever, mild sore throat, dull headache among other symptoms. Infections of the upper respiratory tract is caused by the direct invasion of the inner lining (mucusa) of the upper airway by the culprit virus or bacteria causing respiratory tract infection symptoms and diseases for the people of the study area (Micah and Paul, 2018).

Respiratory disorders are typically caused by allergic reaction, infection, or inhalation of dusts or chemicals, and may be influenced by weather and climate, either directly via sudden drops in temperature or indirectly via an increase in pollutant levels. The external organisms (microbes) crossing the body's natural barriers and invading into the healthy body, such organisms can cause havoc if the immune system doesn't handle it right away(Crowford, 2018). Thus, the need to take precautionary measures to alleviate the spread of windblown pollutants in the environment is paramount. This study provides information to the general public on the dangers of harmattan dust haze to human health particularly the incidence of respiratory tract symptoms among households in the study area. This is because healthy living can improve the development, peace and progress of human beings and the study area in particular.

Furthermore, this study is significant to the health sector in discharging their duties particularly in the months of harmattan season in the study area. Respiratory tract symptoms in the study area is alarming during the harmattan dust haze period, therefore health workers in the study area ought to be responsive in carrying out their duties and ensure that there is adequate medication for patients during the harmattan dust events in the study area.

CHAPTER TWO

CONCEPTUAL, THEORETICAL FRAMEWORK AND LITERATURE REVIEW

2.1 INTRODUCTION

This chapter reviewed the concepts of harmattan dust haze, some diseases associated with respiratory tract infection symptoms and theoretical framework for the study. It also reviewed related literature on harmattan dust haze history and its occurrence on common respiratory tract symptoms and human health in general.

2.2 CONCEPTUAL FRAMEWORK

2.2.1 Harmattan

Harmattan derived its name from the trade winds that blow during the dry season in West Africa, it is designed to suit the needs of languages using the Arabic script in West Africa, related to the word “haramata” meaning evil thing in Twi language (Onyeakagbu, 2018). The West African region experiences the prevailing north-easterly wind regime known as Harmattan (Falaiye et al, 2013). According to Okwumbu (2020), harmattan season, in Nigeria, is a period between early November and mid-March when the people experience cold, dry and dusty wind that blows from the northeast or east in the Western Sahara. It is generally associated with large amounts of dust, which usually impedes airways.

During the months of November to March, the climate of the West African region is dominated by northeasterly trade winds, these winds, commonly referred to as the harmattan, arise due to synoptic-scale pressure gradients that align north–south across the Saharan desert (Burton et al 2013). The harmattan wind is considered a natural hazard because during its passage over the

desert it picks up fine dust particles and can push large quantities of sand and dust, facilitating the spread of wind-borne diseases for thousands of kilometers (Minka and Ayo, 2014).

According to Paul (2017), Dr. Omojowolo, former President, Association of Resident Doctors, Lagos University Teaching Hospital (LUTH), said harmattan is a cold, dry and dusty wind that blows over West Africa. It has very far-reaching medical implication, as it consists of fine dust particles between 0.5 and 10 micrometers. Raymond (2019) stressed that harmattan is a cold, dry wind that sweeps across the West African sub region. The season is harsh to the skin; skin dries up, lips crack, the dust get into throat and eyes, People develop coughs and other breathing issues. Aweda, Falaiye and Babatunde (2017) reported that on the average, it takes about twenty-four hours for the harmattan to reach the Northern part of Nigeria from Bodele depression (the area of origin).

2.2.2 Harmattandust

Harmattan dust (fine particle dust, typically 0.5 μm–10 μm) is known to rise in the Sahara desert and is carried south by winds from that area (Mohammed, 2013). These dust particles are small discrete mass of solid earth matter which are very fine and can remain suspended in the air for a long period of time, Falaiye, Aweda and Yakubu (2017). The harmattan dust invasions are sustained by the northeast trade winds, which blow across the Sahara desert towards the Gulf of Guinea and beyond, in northeasterly direction during this period(Holali, 2016).

Shahram et al (2016) opined that harmattan dust storms can cause certain environmental impacts such as reducing solar radiations, geochemical and biogeochemical effects, affecting marine primary producers or autotrophs, (thus reducing the disposal of carbon dioxide and global warming), affecting snow's Albedo. Uduma and Jimoh (2013) added that enormous amounts of

dust are carried, deposited, resuspended and redeposited along the transport path, as the Inter-tropical Convergence Zone (ITCZ) in December to February is located in the Atlantic Ocean but close to the Coast of the Gulf of Guinea, the harmattan wind stops there and most of the dust settles over the land.

Ochei and Adenola (2018) stressed that dust has become the most abundant aerosol type in the atmospheric column worldwide. It is the most significant source of atmospheric aerosol in the western Sahel (including Nigeria). This is due to the location of Nigeria in Sub-Saharan West Africa. Aerosols are transported regularly from dust sources across Nigeria towards the Atlantic Ocean (Mohammed, 2013). Ochei and Adenola(2018) also reported that the intensity of dust transport is a seasonal phenomenon due to the existence of the Inter-tropical Discontinuity (ITD) which is the driving mechanism for weather phenomenon and season in West Africa and Nigeria.

Mohammed (2013) reported that during dry season, the entire country is usually dominated by the northeasterly trade winds and experiences large quantities of dust and smoke from biomass burning that is transported by the prevailing north-east trade winds. During this period, dust emission, circulation and distribution in the atmosphere are significantly influenced by favorable weather conditions. Nigeria is described as one of the heavily aerosol-laden regions of West Africa, where aerosol studies are of great interest and the period of dust transport (harmattan period) over Nigeria is characterized by lower than normal temperatures in the early morning and night time, and hotter temperature during the day time (Falaiye and Aweda, 2018).

2.2.3 Sources of harmattan dust haze

According to Kerstin, Bernd and Ina (2017), harmattan is the name for the northeasterly trade winds over West Africa that result from the continental-scale pressure gradient between the Sub-Tropical Subsidence Zone (STSZ) and the Inter-Tropical Convergence Zone (ITCZ). With

regard to dust entrainment, winds are of particular interest as they are involved in the development of the nocturnal low - level jets, which are the dominant and frequent drivers for dust source activation over West Africa. Kerstin, Bernd and Ina (2017) also reported that the outflow of dust from the northern African continent towards the North Atlantic is stimulated by the atmospheric circulation over West Africa, which modulates the spatio-temporal distribution of dust source activation and consequently the entrainment of mineral dust into the boundary layer, as well as the transport of dust out of the source regions.

Falaiye et al (2013) identified two sources of dust plumes and these include the dust originating from the region around Mauritania, Algeria and Morocco which accounts for most dust observed over the Atlantic extending as far west as the Barbados Island and dust originating from the Chad Basin which accounts for the dust observed over countries around the Gulf of Guinea and as far as South America. Mohammed (2013) stated that Sahara desert is a key source of dust storms, particularly the Bodele depression. The Bodele depression is the lowest point in Lake Chad located at the southern edge of the Sahara desert in north central Africa. Adetunji(2016) also identified two sources of the Saharan dust; the Bodele depression in north-eastern Chad, which is part of the now dried up lake mega Chad, the most intense and dust source of the world and Tibesti mountain region in northern Chad.

The source of north east prevailing wind predominantly originates from the Bodele depression in the Chad Basin (Wolfgang and Brigitta, 2007, Chineke and Chiemeka, 2009, Rashki, 2012, Xulei, et al, 2016 and Falaiye and Aweda, 2018). This is the source of the prevailing harmattan dust haze that is causing incidences of respiratory tract infection symptoms in Gwer East Local Government Area of Benue State, Nigeria.

2.2.4 Atmospheric harmattan dust haze distribution

The atmospheric dust load is often used to assess the different elements of the atmospheric dust life cycle consisting of dust emission, dust transport, and dust deposition (Kerstin et al, 2017). Dust emission is determined by source characteristics “that is Sediment supply and availability” and wind strength, and thus dust emission fluxes are representative of the connection of these factors (Kerstin et al,2017) stated.

According to Sophie and Martine (2017) mineral dust emissions occur by the wind erosion of bare surfaces. Three different mechanisms have been highlighted for these emissions, depending on the particle size and soil composition: creeping of the largest particles, saltation for the middle size particles (diameter between 70 and 500 μm and suspension of fine particles. He added that creeping occurs for particles that cannot be uplifted (too heavy and/or low wind); they are rolled over the surface and may induce emission of smaller particles upon impact.

Saltation is considered the most efficient emission mechanism (50 to 90%)(Sophie and Martine, 2017) and consists of subsequent short jumps along the surface which induce disaggregation in smaller particles or emission of other particles, a process called sandblasting. The study also revealed that suspension occurs when fine particles are directly uplifted by strong winds. However, this mechanism is reported to account for only about 1% of the total dust emissions, (Sophie and Martine, 2017). Kerstin, et al (2017) added that dust transport results from prevailing wind regimes, but also particle buoyancy, which is influenced by atmospheric stability respective turbulence. According to Mage, Agber and Nwoye, (2017) wind movement is caused by pressure differences which generates a pressure gradient force that propels air in motion.

2.2.5 Mineralogical constituents of harmattan dust haze

Mineral soil particles eroded from bare soils by wind and subsequently mixed into the atmosphere contribute significantly to the global atmospheric aerosol burden (Kerstin, et al

2017). Mineral aerosols impact the Earth's energy balance along the whole solar (short-wave) and terrestrial (long-wave) spectral ranges, due to the large particle size and the existence of significant absorption features in both visible and Thermal Infrared ranges (Sophie and Martine, 2017).

Mineral dust is a crucial factor in the earth's climate system and impact on nutrient dynamics and biogeochemical cycling of ocean and terrestrial ecosystems (Wolfgang and Brigitta, 2007).Depending on its mineralogical composition, which is determined by the source region, harmattan dust transported to remote places may deliver micronutrients and thus fertilize terrestrial and marine ecosystems, (Kerstin, et al 2017).

The composition of the harmattan dust is complex, consisting of both inorganic and organic compounds, as well as microbial entities (Mohammed, 2013). The chemical composition of harmattan dust was estimated to have about 29 different elements through neutron instrumental activation analysis. The mean concentrations are (in μg/g) (Sufiyan et al, 2020). Theelementsand their concentrations are shown in Table 2.1

Traces of minerals in the clay fraction of the harmattan dust haze may have their origin in the Bodele depression or other saline environments (Gry,Awadzi and Madson, 2011).Burton et al, (2013) opined that a significant quantity of mineral dust is advected southwards across the region by harmattan wind, leading to a major impact on local visibility, agriculture, and health. According to Basil(2016) harmattan dust haze is the main global source of atmospheric mineral dust, with particulate matter (PM) levels significantly exceeding limit values, silicon makes up the bulk of the elemental content of the harmattan dust.

Table 2.1: Composition of Harmattan Dust Haze

Elements	Symbols	Concentrations(μg/g)
Aluminium	Al	61100
Arsenic	As	6.95
Gold	Au	0.16
Barium	Ba	695
Bronium	Br	195
Cerium	Ce	122
Chlorine	Cl	6200
Cobalt	Co	20.9
Chrome	Cr	119
Cesium	Cs	2.72
Europium	Eu	1.31
Iron	Fe	431000
Galium	Ga	21.9
Hafnum	Hf	8.05
Potasium	K	15700
Lathanium	La	53.9
Magnesium	Mg	8700
Manganese	Mn	825
Sodium	Na	6400
Ribidium	Rb	82.4
Bismuth	Sb	32.7
Scandium	Sc	10.3
Selenium	Se	6.61
Samarium	Sm	6.5
Thalium	Th	14
Titanium	Ti	4900
Uranium	U	6.28
Vanadium	V	81.6
Zinc	Zn	2200

Source: Adopted from Dept. of Chemistry ABU, Zaria (2021).

Furthermore, Mohammed(2013) and Achyuta,Prashant, James, Anant and Richard (2016) added that the harmattan dust haze constitutes mostly quartz, clay, colloids and fine mica. These particles can easily penetrate into the respiratory system which may transfer some toxic elements into the blood system. Akande et al (2013) stated that concentrated aerosols from substances such as silica, asbestos and diesel particulate generated by harmattan are sometimes found in the

workplace and have been shown to result in a number of diseases including respiratory failures, black lung and ecological stress.

Falaiye et al (2013) carried out a mineralogical study on harmattan dust, samples were collected over Ilorin sub-Sahara region of West Africa. Minerals such as quartz, gibbsite, rutile, goethite, halloysite and kaolinite were detected. Quartz, halloysite, microcline and mica were similarly identified in harmattan dust sampled at Ile-Ife. However, gibbsite, rutile, goethite which were identified at Ilorin were not detected at Ile-Ife, while microcline and mica detected in Ile-Ife were not observed at Ilorin. The mineralogical composition of the harmattan dust at a locality is most probably determined by the source and the distance from the source of the harmattan dust.

2.2.6 Effects of harmattan dust haze on respiratory tract

A number of medical conditions can be traced to the impact of harmattan dust, and the effects of fine wind-borne particles on human health have recently been the subject of considerable interest (Rashki, 2012). Mineral dust is a known hazard for human health, causing respiratory, cardiovascular disorders and infectious diseases, the latter due to the presence of micro-organisms on dust particles, (Sophie and Martine, 2017). Inhalation of the dust aerosols has been shown to cause adverse effects on human respiratory systems. The straightforward inhalation of fine particles can cause and or aggravate diseases such as bronchitis, emphysema and silicosis, (Rashki, 2012).

Minka and Ayo (2014) enumerated some of the signs and symptoms of respiratory tract affected by the harmattan dust haze which include; runny or stuffy nose, sore throat, cough, nasal congestion, slight body aches or a mild headache, sneezing, low-grade fever and generally feeling unwell (malaise). Uduma and Jimoh (2013) stressed that harmattan dust is considered to be among the most harmful of all air pollutants. When inhaled, particularly those that have

antecedents of bronchial asthma, pneumonia and other respiratory diseases, these particles evade natural defenses of the respiratory system and lodge deep in the lungs causing serious health complications.

Respiratory disorders are typically caused by allergic reaction, infection, or inhalation of dusts or chemicals, and may be influenced by weather and climate, either directly via sudden drops in temperature or indirectly via an increase in pollutant levels, (Akinyemi, Olusegun, Andreas and Olabinjo, 2011). As a result of the intense heating over the Sahara desert, sand and dust particles are uplifted into the atmosphere by convective forces to great heights estimated to reach 6.0km above the surface (Chineke and Chiemeka, 2009).

Among the atmospheric aerosols, mineral dust produced from windblown soils and deserts are one of the largest contributors to the global aerosol loading and has strong impacts on human health (Uduma and Jimoh, 2013). One possible connection between reaction products and health effects is that oxygenated organic compounds reduce the release of an epithelium-derived relaxing factor, which can lead to a damaged and thus more susceptible epithelium (Mohammed, 2013). The increased aerosol concentrations cause irritation of respiratory tracts (Wolfgang and Brigitta, 2007). Sources of aerosols include soil dust during the harmattan season (Anjorin,Utah and Buba, 2015). Falaiye,Aweda,Yakubu (2017) reported that the aerosol optical thickness (AOT) which is a measure of the amount and size of dust particles present in the atmosphere during the harmattan months can be extremely high and ranges from 1.0 to 4.0m.

Basil (2016) asserted that the bulk of elemental content of the dust is silicon and the size of the fine dust particles 0.5–10 μm diameter puts them in the PM10 particulate matter air pollutant group, which has already been shown by WHO to lead to multiple adverse health effects.

Harmathan dust is considered to be among the most harmful of all air pollutants due to the toxic effect of the dust constituents (Uduma and Jimoh, 2013).

Okwumbu (2020) observed that harmattan dust haze is characterized with some dreadful diseases. For instance, it is not the best of time for asthma patients. It aggravates cold as well as causes catarrh. As the throat gets sore; sneezing is frequent while sometimes the eyes become wet or ruddy. The harmattan also comes with frequent headaches, dull faces, sputum in the saliva because of catarrh and over time, cough. The dry, cold and dusty wind associated with harmattan also triggers sickle cell anemia in affected individuals.

The Nigerian Meteorological Agency (NiMet), has announced that the severity of harmattan period would be higher and longer over the Northern states due to its proximity to the Sahara desert compared to the South in 2018/2019 dry season. The Director General of NiMet, Prof. Sani Mashi, who gave the warning in an interview with the News Agency of Nigeria (NAN), on Thursday explained that dust haze could lead to deterioration of air quality with adverse effects on human health as it could trigger asthma and bronchitis attacks as well as cause cold, cough, catarrh, and meningitis,(NAN,16/11/2018).

Emeka and Lilian (2015) reported that the President of the Association of Resident Doctors at the University of Benin Teaching Hospital, Dr Kingsley Okafor, in an interview with The Guardian highlighted some of the medical implications of harmattan. His words: “Harmattan has very far reaching medical implications because it is a dry and dusty wind blowing northeast and west of the Sahara into the Gulf of Guinea especially between November and March of the following year. It consists of fine dust particles between 0.5 and 10 micrometers. It is a natural hazard that affects all exposed surfaces of humans like skin, the eyes, nose, mouth and the

respiratory tract which directly communicate with the atmosphere. “Infants, children and the elderly are more vulnerable to hypothermia (core body temperature below 35 degrees centigrade) due to sub optimal temperature regulating mechanism. The eyes are exposed to the dust particles carried by the dry, cold and dusty wind leading to itching, redness, and foreign body sensation. Harmattan, he continued, also has harmful effects on the respiratory system. This, he added, is because this system communicates directly with the atmosphere. “The dust particles may overwhelm the system and predispose it to infection. It is common place to experience excessive sneezing, cough, catarrh and nasal bleeding.

2.2.7 Some respiratory diseases associated with common respiratory tract infections.

2.2.7.1Chronic obstructive pulmonary disease(COPD)

A functional disorder of the lung characterized by progressive and persistent airflow obstruction and actual destruction of lung tissue, (FirstNations and Inuit Health Branch, 2010). Chronic Obstructive Pulmonary Disease (COPD) is an umbrella term that encompasses several respiratory illnesses that cause breathlessness, or the inability to exhale normally. Symptoms, include shortness of breath, and normally cough up sputum (mucus from the lungs), especially in the morning (Meyer et al, 2018).

Yabluchansky et al (2013) buttressed that Chronic Obstructive Pulmonary Disease (COPD) is characterized by airflow limitation that is not fully reversible, the symptoms include shortness of breath (in early stages occurs only with exertion), tightness in chest and cough (dry or production of white or colored sputum). Others are flare-up (an exacerbation), often worse in winter with wheezing, depression and anxiety, weight loss, tiredness and fatigue, swollen ankles and limitations in activity and lifestyle.

2.2.7.2Community-acquired pneumonia (CAP)

The more common organisms to cause pneumonia are the bacteria Streptococcus pneumoniae, staphylococci, Haemophilus influenzae, Pseudomonas aeruginosa, and coliform rods (Roy, 2019). Pneumonia is a common lung disease caused by an infection in the air sacs in the lungs, the infections can be bacterial, viral or fungal. Symptoms, which include cough, fever, shaking chills and shortness of breath, can range from mild to severe (Meyer et al 2018).There is considerable overlap in the symptoms of the various types of pneumonias. Fever, chills, cough and sputum may be yellow, green, and blood-tinged. Also chest pain, sharp and localized pleuritic chest pain is seen in acute lobar type only, shortness of breath may be present, (FNIHB, 2010). It can be caused by many kinds of both bacteria and viruses.

A common factor amongst a wide range of respiratory diseases such as common cold, flu like illness, and pneumonia is a correlation between the incidence of the disease and air temperature, with the incidence of respiratory disease increasing as the air temperature falls (Eccles and Wilkinson, 2014). Roy (2019) added that when the infection is widely disseminated within the parenchyma as multiple foci, the disease is termed bronchopneumonia. When the infection diffusely involves an entire lobe it is referred to as lobar pneumonia.

2.2.7.3Asthma

Asthma is a disorder of the airways characterized by paroxysmal or persistent symptoms (including dyspnea, chest tightness, wheeze and cough) with variable airflow limitation, airway inflammation and airway hyper responsiveness to a variety of stimuli (FNIHB, 2010). Asthma is a complex disease that is divided into two major subtypes: extrinsic and intrinsic, in both forms, the condition usually evolves in early childhood (Roy, 2019).

Meyer et al (2018) opined that asthma is a common, chronic respiratory condition that causes difficulty in breathing due to inflammation of the airways. Asthma symptoms include dry cough, wheezing, chest tightness and shortness of breath. Meyer et al (2018) says there is a major connection between environmental allergies and asthma. Allergic reactions, infections and pollution can all trigger an asthma attack. Harmattan dust haze which serve as a major atmospheric pollutant could be responsive to triggering these respiratory tract diseases. In asthma the bronchial tubes (airways) are hyper responsive and usually triggered by breathing in things in the air such as dust, pollen among others, with recurring episodes of wheezing, breathlessness, chest tightness, and coughing, particularly at night or in the early morning(Yabluchansky, et al 2013).

2.2.7.4 Emphysema

Emphysema is a serious respiratory disease, which is another form of COPD (Meyer et al 2018). The most common cause is smoking and dust inhalation. Those who suffer from emphysema have trouble exhaling air from their lungs (Meyer et al 2018). Roy (2019) added that emphysema is characterized by dyspnea, as the terminal airway loses septal surface area for gaseous exchange, expirations must be forced. David and John (1768) reported that **e**mphysema destroys the walls of the alveoli of the lungs, resulting in a loss of surface area available for the exchange of oxygen and carbon dioxide during breathing.

Roy(2019)contributed that affected patients are slender and barrel chested and in most cases, bronchitis, bronchiolitis, and emphysema occur together. FNIHB (2010) considered some of the symptoms of emphysema aschronic shortness of breath, initially with exercise.They added that cough is only a minor problem and sputum production is limited, also shortness of breath gradually becomes worse until the person is short of breath even at rest.

2.2.7.5Chronic Bronchitis

Chronic bronchitis refers to the abnormal, irreversible dilatation of the bronchi caused by destructive and inflammatory changes in the airway walls, (Yabluchansky et al, 2013).Chronic bronchitis is a form of COPD emphasized by a chronic cough. Usually people cough up sputum (mucus from the lungs), especially in the morning. According to Meyer et al (2018), this happens because mucus glands in the airways increase output, and patients have to cough that extra secretion out.

FNIHB, (2010) buttressed that chronic productive cough that is present for at least 3 months each year, for 2 years in a row. Initially, cough and sputum are present only in the morning (especially in the winter). Eventually the symptoms are present throughout the day and throughout the year. There are frequent episodes of acute chest infections superimposed on the chronic condition (FNIHB 2010). In chronic bronchitis the air passages become clogged with mucus, and this leads to a persistent cough (Disabled World, 2020). In addition to the major factor of cigarette smoking, environmental pollution may contribute to the development of chronic bronchitis (Meyer et al 2018). Roy (2019) added that bronchitis is characterized by chronic productive cough as smoke and dust irritants stimulate inflammation and mucus secretion in the bronchi and bronchioles (bronchiolitis).

2.2.7.6 Tuberculosis (TB)

Tuberculosis (TB) is the infectious disease caused by the bacterium Mycobacterium tuberculosis, spread by coughing and primarily enters the body by inhaled air. Tuberculosis spread to the oral cavity from the primary infection in the lung (Meyer et al 2018). The bacteria that cause tuberculosis are spread from one person to another through tiny droplets released into the air via

coughs and sneezes (Mayo, 2019). The organisms gain access to the oral regions by hematogenous spread, and when they adhere to oral tissues, a site of granulomatous inflammation develops (Roy, 2019).Mayo (2019) added that the signs and symptoms of active TB include, coughing that lasts three or more weeks, coughing up blood, chest pain, or pain with breathing or coughing, unintentional weight loss and fatigue. Others are fever, night sweats, chills and loss of appetite. Tuberculosis can also affect other parts of your body, including your kidneys, spine or brain. When TB occurs outside your lungs, signs and symptoms vary according to the organs involved. For example, tuberculosis of the spine may give you back pain, and tuberculosis in your kidneys might cause blood in your urine (Mayo, 2019).

2.2.7.7Catarrh

Catarrh is caused by a build-up of mucus in an airway or a cavity of the body. It usually affects the back of the nose, throat or sinuses, which are air-filled cavities in the bones of the face. It is often temporary, though some people experience it for months or years. Catarrh is usually caused when the immune system reacts to an infection or irritation, causing the lining of your nose and throat to become swollen and produce mucus. This can be triggered by hay fever or other types of allergic rhinitis, non-allergic rhinitis, nasal polyps or a cold and other infections, (Yvette, 2019).

There are a number of relatively common symptoms which are associated with catarrh. These include, a constant need to clear your throat, persistent cough, feeling that your throat may be blocked, headache or facial pain. Others are, crackling sensation in your ear and some temporary hearing loss, blocked or stuffy nose that you can’t clear, runny nose and reduced sense of smell and taste (Mayo, 2019).

2.2.7.8Influenza

Influenza or flu, is a respiratory illness that results from a viral infection. Flu is highly contagious and spreads through respiratory droplets. A person can pass it on while talking or through physical contact, such as shaking hands, (Yvette, 2019). The symptoms of influenza typically come on suddenly. These include high body temperature, stuffy or runny nose, and dry cough. Others are, cold sweats and shivers, aches that may be severe, headache, low appetite, fatigue and feeling of being unwell (malaise), (Mayo,2019).

2.3 THEORETICAL FRAMEWORK (The Brownian Motion Theory)

Brownian motion is the random movement of particles in a fluid due to their collisions with other atoms or molecules. Brownian motion is also known as *pedesis*, which comes from the Greek word for“leaping." Even though a particle may be large compared to the size of atoms and molecules in the surrounding medium, it can be moved by the impact of molecules of the surrounding medium with many tiny, fast-moving masses. Brownian motion may be considered a macroscopic (visible) picture of a particle influenced by many microscopic random effects (Anne, 2019).

Brownian motion takes its name from the Scottish botanist Robert Brown, who observed pollen grains moving randomly in water. He described the motion in 1827 but was unable to explain it. While pedesis takes its name from Brown, he was not the first person to describe it. The Roman poet Lucretius describes the motion of dust particles around the year 60 B.C., which he used as evidence of atoms (Anne, 2019). The emission, transportation and deposition of harmattan dust particulates from Sahara desert down south is supported here by this theory.

Holali(2016) observed Brownian motion as the irregular wiggling motion of an aerosol particle in still air caused by random variations in the relentless bombardment of gas molecules against the particle. Diffusion of aerosol particles is the net transport of these particles in a concentration

gradient. Filtration by Brownian diffusion occurs when small particles collide with the air molecules and move in an erratic path (Brownian movement).

The initial importance of defining and describing Brownian motion was that it supported the modern atomic theory. Today, the mathematical models that describe Brownian motion are used in math, economics, engineering, physics, biology, chemistry, and a host of other disciplines (Anne, 2019).

2.4 LITERATURE REVIEW

2.4.1 Harmattan dust daze and respiratory tract infections

A considerable amount of research have been conducted and published on various topics related to harmattan dust events and respiratory tract ailments. Uduma and Jimoh (2013) carried out a research on High Incidence of Asthma, Bronchitis, Pneumonia and Sinusitis in Kano State, North West Nigeria during Saharan Dust Events, The study aimed to evaluate particulate concentrations and associated chemical species in Saharan dust and top soil during Saharan dust events and their impact on human health. The results showed that apart from the elemental composition; other properties such as pH, organic matter, cat ion exchange capacity(CEC), and texture were elevated in the dust samples. The elemental function (EF) values indicate that the soil is minimally enriched / contaminated with Pb, Cd, Cu, Ni and Mn by the Saharan dust when Fe was used as a background reference element. The geo – accumulation index values show that the soil was moderately polluted with Pb, Cd, Cu, Fe, Ni and Mn by the Saharan dust. Based on hospitalization data on respiratory diseases collected, the study concludes that the prevalence of respiratory diseases in Kano State is consistent with the Saharan dust events.

Shahram et al (2016) investigated on the origins and sources of dust particles, their effects on environment and health, and control strategies.The result showed that dust storms can cause

certain environmental impacts such as reducing solar radiations, geochemical and biogeochemical effects, affecting marine primary producers or autotrophs, (thus reducing the disposal of carbon dioxide and global warming), affecting snow's Albedo. One reason why dust causes such global effects is its transferability range up to 20,000 km. Dust can also negatively affect the respiratory, cardiovascular, cerebral-vascular systems; cause or intensify meningitis, fever, pain, allergies, and viral infections; damage the DNA of skin and lung cells. The most important methods of dust storm prevention and controlling it can be biological, sprays (water), mechanical, chemical, and engineering. Biological methods are the best-known ways of preventing dust storms and desertification. This can be achieved by creating vegetation and ecological barriers, such as forest belts. Considering the increasing number and periods of dust storms and dust effects on the environment and human health, the review article aimed to determine appropriate strategies to prevent dust occurrence and explain the effects of dust on health and the environment.

Holali (2016) carried out a research on design, manufacturing and Test a nose/mouthfilter for use during the harmattan. The result showed that inhalation of the dust aerosols has been shown to cause adverse effects on human respiratory systems. Even though there are a lot of importedrespirators in the local market which are used for various purposes, there is nonedesigned specifically for the harmattan dust. The purpose of this study is todesign, manufacture and test a mouth/nose filter (mechanical respirator) for use during the harmattan period. To achieve this objective of filtering the dustaerosols, four (4) different locally made filters were tested using an experimentaltest rig set up to simulate the inhalation of the harmattan dust. The test wascarried out at a constant flow rate of min 22.8 l where the salient filter designparameters such as pressure drop, penetration, efficiency and quality factor wereobserved. The results suggest that the tri-ply of calico, felt and twill is appropriateto be used as mouth/nose

filter for the harmattan dust particles owing to the factthat it had the highest efficiency of 80%, the lowest aerosol penetration of 20%, apressure drop of 47.67 Pa and a filter quality of 0.0337.

Mohammed (2013) carried out a research on indoor and outdoor dust in Damaturu and the surrounding communities. People attributed various types of ailments ranging from conjunctivitis, gastro-intestinal disorders and respiratory tract infections to the dusty weather conditions (Harmattan and Dust storm) observed in the area. During the dust events people spend much of their time indoors. The method provided a relatively quick way of collecting chemical emissions from dusts that are readily available for release. The sampled tubes were analyzed by TD/GC/MS. The conventional solvent extraction of the dusts was also carried out and the extracts were analyzed by liquid injection-GC/MS and results of the two methods compared. The results of the investigation of the dust composition, combined with information on exposure to dust and pollutants, showed that dusts are a risk to the health of people in the Damataru community.

Sufiyan et al (2020) carried out a research on the impacts of the harmattan season on human health in Keffi town, Nasarawa state, Nigeria. The use of correlation and regression analysis was employed to analyse the data. It also involved the collection of data from the Nigerian Meteorological Agency. The field survey also confined about 100 respondents. The results indicated a positive correlation between the harmattan and its impact on human health, with about 0.64. The climate and anthropogenic factors are mostly the responsible factors influencing the high prevalence of harmattan. Nevertheless, there is the good side of the harmattan season, such as the lowering of environmental temperature and some crops enjoy the cold season.

Achyuta et al, (2016) carried out a research on dust and death: evidence from the West African Harmattan, The result showed thatdust pollution in West Africa increases infant and child

mortality. Employing differences in differences, we make three contributions. First, using data from 12 poor countries, we highlighted the vulnerability of people with few resources, fragile health, and limited capacity to adopt avoidance behavior. Second, we examine prenatal and post-natal parental investment responses, and show evidence consistent with compensating behaviors. However, despite these efforts, the health of surviving children is still adversely affected. Third, we investigate differential impacts over time and across countries. We find declining effects over time, implying in the absence of reductions in dust itself that societies are adapting in some way. Using national-level measures of macroeconomic conditions and public health resources, we find suggestive evidence that both economic development and public health improvements have contributed to this adaptation, with health improvements seemingly playing a stronger role.

Akinyemi et al (2011) investigated on a study of weather related respiratory diseases in Eco-climatic zones, the study posited that temporal pattern of selected respiratory diseases and the influence of specific weather parameters on their morbidity in two eco-climatic zones in Nigeria for the period 1996- 2006. Out of 2,056 and 2,647 cases of respiratory diseases (bronchial asthma, bronchopneumonia, lobar pneumonia, bronchiolitis, cardiac asthma, pulmonary tuberculosis, sinusitis, tonsillitis and upper respiratory tract infection) reported in Humid-forest (Ile-Ife) and Derived-savanna (Ilorin), respectively, 60% and 48% for each region respectively occurred in subjects of age less than ten years. Whereas, for patients aged 80 years and above it accounted for 1.2% and 1.7% in respective zones. There is a significant ($p<0.01$) variation in the morbidity pattern of respiratory diseases among age groups at each location. Males in humid forest and derived savanna reported respectively about 56.7% and 59.0% of the specific respiratory diseases. Out of all the respiratory diseases considered, bronchial asthma, lobar pneumonia, sinusitis and tonsillitis are statistically significant with weather variables in humid forest (Ile-Ife) while bronchial asthma, bronchopneumonia, cardiac asthma and lobar pneumonia

are statistically significant with maximum air temperature ($p < 0.05$) in derived savanna (Ilorin). Further analysis showed that maximum air temperature accounted for 46.6% ($r=0.68$) and 43.3% ($r=0.66$) of bronchial asthma ($p< 0.05$) at humid forest and derived savanna, respectively. Similarly, air temperature explained 39.1%, 39.8% and 43.8% of bronchopneumonia, cardiac asthma and lobar pneumonia occurrence in derived savanna respectively. Relative humidity accounted for 36.3% of tonsillitis morbidity and in combination with wind speed, explained 82.1% of lobar pneumonia in humid forest. Maximum temperature and wind speed accounted for 69.3% of the occurrence of sinusitis at humid forest. The study advocates the importance of inclusion of thermal environment into monitoring and surveillance of respiratory diseases transmission.

Aweda, Falaiye and Babatunde (2017) investigated on elemental concentration of harmattan dust sample in Iwo and Oyo towns south west Nigeria, It was observed that the sample of dust particle collected by the means of distilled water in Iwo town contains Ca (22.278ppm), Mg (8.904ppm), and Fe (2.133ppm), and the sample of dust particle collected by the means of the first rain water of the year under consideration contains Ca (5.494ppm), Mg (6.417ppm), and Fe (0.741ppm). For Oyo location, it was observed that the sample of dust particle which was collected by the means of distilled water contains Ca (17.701ppm), Mg (11.751ppm), and Fe (3.729ppm).More so, the sample of dust particle collected by the means of rain water for Oyo contains Ca (4.138ppm), Mg (4.074ppm), and Fe (0.412ppm). The results showed that there was less effect of harmattan dust on human health due to zero or no lead (Pb) content present in the same collected during the period.

Chineke and Chiemeka (2009) studied harmattan particulate concentration and health impacts in sub-Saharan Africa. In their investigation, the determination of aerosol concentration and the

elemental composition of air obtained during the harmattan season at Uturu Abia state, Nigeria, were carried out using Atomic Absorption Spectroscopy (AAS) after digestion of the collected dust samples by wet ash method. The mass concentrations of aerosols in air for the two harmattan seasons are 1.20 mg/cm2 and 3.67 mg/cm2, respectively. The mean sizes of the collected harmattan dust samples determined for the two seasons are 2.7 µ m and 4.4 µ m, respectively. The mean values of the elemental concentrations obtained for the two periods of the harmattan seasons are 16.470 mg/kg for potassium (K), 9.098 mg/kg for magnesium, (Mg), 331.995 mg/kg for calcium (Ca), 47.673 mg/kg for Iron (Fe), 81.598 mg/kg for Zinc (Zn), 12.791 mg/kg for manganese (Mn), and 1.161 mg/kg for lead (Pb) for the first period of the Harmattan season. The harmattan particulates affected negatively the health of the people causing respiratory diseases to adults and children.

De Logueville et al (2012) carried out a research on desert dust impact on human health, the paper aimed to learn more about the relationship between desert dust and human health in the world and to analyse the place of West Africa as a study area of interest. Papers focusing on the potential relationship between dust and health and showing quantitative analyses, published between January 1999 and September 2011, were identified using the ISI Web of Knowledge database (N050). A number of adverse health effects, including respiratory, cardiovascular and cardiopulmonary diseases, are associated with dust. This survey highlights obvious dust impacts on human health independently of the study area, health outcomes and method. Moreover, it reveals an imbalance between the areas most exposed to dust and the areas most studied in terms of health effects.

Xuelei et al (2016) examined a systematic review of global desert dust and associated human health effects, the result showed that dust storms and sandy dust events originating in arid and

semi-arid areas can transport particulate material, pollutants, and potential transport long distances from their sources and exposure to desert dust particles is generally acknowledged to endanger human health. The review revealed an imbalance between the areas most exposed to dust and the areas most studied in terms of health effects. Among the human health effects of dust storms are mortality and morbidity, arising from respiratory system, circulatory system, and other diseases.

Adesanya and Chiao(2017) investigated on the environmental risks associated with symptoms of acute respiratory infections among pre-school children in North- western and South-Southern Nigeria Communities. The study used the 2013 Nigeria Demographic and Health Survey to assess the individual and environmental risks present in the North-Western and South-Southern Nigerian communities and examines their associations with Acute Respiratory Infection (ARI) symptoms. The descriptive findings show that the prevalence of ARI symptoms is significantly higher among preschool children in the North-Western province (5.7%) than in the South-Southern province (1.4%) ($p < 0.001$). In addition to regional differences, multilevel logistic models further indicate that the increased likelihood of a child suffering from ARI symptomsissignificantlyassociatedwiththedryseason andhousehold poverty even after adjusting for the cooking fuel used and various other characteristics of the children, households, and communities. The findings underscore the importance of taking into account environmental risks when addressing specific regional variations in ARI symptoms, because these determinants differ between communities in Nigeria. As it is imperative to achieve minimum levels of child health, in order to improve economic development across regions, future health policies aiming to promote child health will benefit from taking a region-specific perspective into consideration.

Kotsyfakis, Zarogiannis and Patelarou, (2019) investigated on the health impact of Saharan dust exposure, the results showed that air pollution is a high priority global health concern. The health damaging effects of ambient particulate matter (PM), a component of air pollution, are extensively documented, with 1.4% of deaths worldwide resulting from exposure to PM. A growing body of evidence suggests that mineral dust, found in PM, may contribute to some of these deleterious health impacts. Approximately half of atmospheric mineral dust originates from the Sahara Desert. This systematic but concise review summarizes the findings from recent literature exploring the adverse health effects of Saharan dust particles worldwide. The respiratory system includes the nasal and oral cavities, the sinuses and larynx as the upper airway, and the trachea, bronchi, bronchioles, and alveoli as the lower airway, (Roy,2019). It is justified to note that respiratory tract symptoms (RTS) and respiratory tract disease (RTD) relate to some extent, the emergence of the respiratory tract symptoms can result to a severe occurrence of respiratory diseases. The upper respiratory tract infections (URTI) are generally caused by the direct invasion of the inner lining (mucosa or mucus membrane) of the upper airway by the culprit virus or bacteria (Lisa, 2019). The upper respiratory tract includes the sinuses, nasal passages, pharynx and larynx. These structures direct the air taken in from the outside to the trachea and eventually to the lungs for respiration to take place.

Balentine, Nabili, and Shiel,(2021) opined that if the symptoms of upper respiratory tract symptoms such as runny nose, sore throat, nasal congestion coughing, sneezing, low grade fever, slight headache malaise among other symptoms prolong for more than 14 days, alternative diagnosis should be considered. Degeneration to severe cases like sinusitis, allergy, pneumonia or bronchitis and other symptoms of lower respiratory tract infections is disease condition. Lower respiratory system is include the trachea, which separates into a path of bronchial tubes that lead down into either lungs (Crowford, 2018).

Within the lungs, the bronchial tubes are divided into multiple smaller branches called bronchioles. Stemming from these narrowing branches are small air sacs called alveoli. Tiny blood vessels called capillaries surround the alveoli and once the foreign substance such as pollutants (dust, toxin, smoke) invades the entire system, the system is destabilized (Lisa, 2019). Henna et al (2018) observed that the dysfunction of any part of the upper respiratory tract may change the quality of the inhaled air and consequently may impair function of tracheobronchial tree and the lower respiratory tract. Respiratory disease such as chronic obstructive pulmonary disease (COPD), emphysema, bronchitis asthma pneumonia, tuberculosis all have different signs and symptoms of respiration. It is in view of this that the researcher decided to looked at their relationship using some selected respiratory diseases in Gwer East L.G.A of Benue state.

CHAPTER THREE

THE STUDY AREA AND METHODOLOGY

3.1 THE STUDY AREA

3.1.1 Location of the study area

Gwer East Local Government Area is situated between latitudes 7.05^{o} to 7.45^{o}North of the Equator and between longitudes 8.10^{o} to 8.40^{o} East of the Greenwich meridian. It is bounded to the north by Makurdi and Guma Local Government Areas, to the East by Gboko and Tarka Local Government Areas and to the West by Gwer West Local Government Area. It is also bounded by Otukpo, Obi and Oju Local Government Areas to the South and Konshisha Local Government Area to the South East as shown in the Figure 3.1.

3.1.2 Climate

Gwer East Local Government Area falls within the Aw climate (Tropical humid wet and dry) according to Koppen's classification scheme. Rainy season lasts for seven (7) months from April to October, with average rainfall of 1,200mm, andwith double maxima in August and September (Tyubee and Adokwe, 2014). While the dry season starts in November and ends in March.

Temperature of Gwer East Local Government Area is low during the peak of harmattan from the month of December to January. The average monthly minimum temperature of the area ranges between 21.3^{o}C and 21.5^{o}C, the maximum temperature ranges between 25.7^{o}C and 27.0^{o}C. The temperature of Gwer East Local Government Area is relatively high from March to October and decreases in November to February as a result of the cold harmattan winds (Tyubee and Adokwe, 2014).

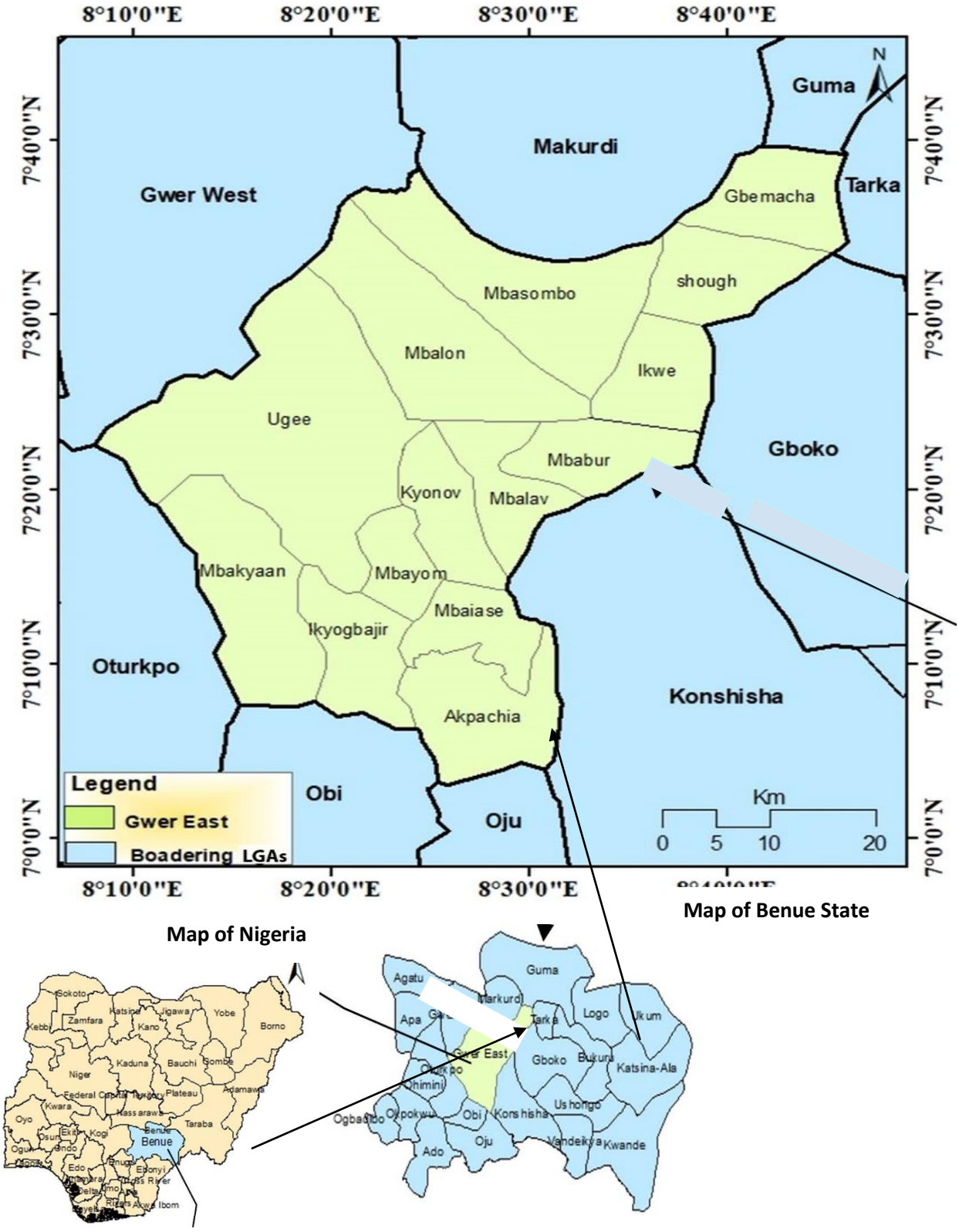


Figure 3. 1: Map of the Study Area

Source: Adapted from Administrative Map of Benue State, 2019.

3.1.3 Relief and drainage

The land of Gwer East Local Government Area is generally low lying averaging from 100-250m above sea level and gently undulating with occasional inselberges locally referred to as hills such as Ikwe Hill, knolls and low ridges. The Local Government is drained by the river Gwer from where the Local Government Area derived its name and other rivers which include Gbaya and Mu. Streams like Awum, Mchihi, Awana and Uwule are the tributaries of river Mu. Streams like Fete, Agum, Baar and Ikyende are the tributaries of river Gwer and Shishan, Bele, Uhur and Abelekete are the tributaries of river Gbaya respectively. Most of these streams are seasonal and are only left with some ponds during dry season. When the rainfall reaches its peak in August and September, the rivers and streams overflow their banks and cause floods in the study area (Tyubee and Adokwe, 2014).

3.1.4 Soils and vegetation

As a result of its location in the savanna region, Gwer East Local Government Area is dominated by tropical ferruginous soils which are rich in the oxides and hydro oxides of iron and aluminums. These soils are sub- divided on the basis of texture and type of parent materials into sandy – loam, clay and more soil intrusions like sandy and stony areas (Tyubee, and Adokwe, 2014).

Gwer East Local Government Area is located in the Guinea savanna zone. The vegetation here is characterized by open woodlands with a diminishing density of trees towards the Local Government Headquarters due to human activities such as grazing, farming, building and road construction. The original wood savanna here in most places has been replaced with man- made vegetation of oranges (*citrus spp),* mangoes (*magniferaindica),* and banana (*musaspp).* Natural vegetation is usually found in interior villages and it is characterized by locust bean

(*parkiabiglobosa),* Mahogany (*Khaya senegalensis)* and Iron tree *(prosopis Africana*), soft timber (*daniella olivera)* and (*isoberlina spp)*(Hula, 2010).

These woody trees have an average height not extending 20 meters. Grasses like spear grass (*imperitacylindrical),* elephant grass (*pannisetumpurpureu),* guinea grass (*pannicummaximum)* and *cida acuta* are also found in the area. Climbers include lianas and many epiphytes including ferns and orchids are also present in Gwer East LGA, (Hula, 2010).

3.1.5 People and population

The indigenous people of Gwer East Local Government Area are Tiv and Igede people. The non-indigenous people here include Igbos, Yorubas, Idomas, and the Hausa people. Gwer East Local Government Area has population of 163,647 according to 2006 Census. Gwer East Local Government Area has a large number of communities such as Ikpayongo, Taraku, Igbor, Howe, Ullam and Aliade as its head quarter. The languages spoken are Tiv, Igede, Hausa,Igbo, Yoruba, Idoma and English language as the conventional means of communication. Religiously, the people of the area are majorly Christians and few Muslims in the study area.

3.1.6 Occupation

Farming is the basic occupation of the people of the area. The people engage themselves in the practice of agriculture mainly to get money for themselves as well as the provision of food for consumption purposes.

Initially, the early people of the area cultivated crops to feed the family only (subsistence agriculture), but as time goes on, majority of farmers had picked interest in the cultivation of very large farms so as to get food and also a source of income. Some of the crops produced for commercial purposes include yams, groundnuts, soybeans maize and sorghum among others.

Apart from farming, many people are civil servants with a good number of people exchanging their occupation from farming to petty business activities in Gwer East LGA, (Tyohemba, 2016).

3.2 METHODOLOGY

3.2.1 Reconnaissance survey

A reconnaissance survey was carried out by the researcher between 6th- 17th May, 2019, visiting the Local Government Area, the Gwer East Local Government Area Ministry of Health, government and privately owned hospitals like General Hospital Aliade, Saint Vincent Hospital Aliade, Gwer City Clinic Taraku, Hosana Hospital Aliade andSaint Gregory's Hospital Ikpayongo. Others include NKST Hospital Taraku, Comprehensive Clinic Igbor and Blessed hospital Aliade. The hospitals in the study area with proper medical records of respiratory tract symptoms ailment include General Hospital Aliade, St Vincent Hospital Aliade, St Gregory's Hospital Ikpayongo and NKST Hospital Taraku.

3.2.2 Data used for the study

The following are the types of data used for the study**:**

i. Data on the characteristics of the some respiratory tract diseases which helped to know the various characteristics of common respiratory tract symptoms households are facing in the study area.

ii. The perception of households on occurrence of some respiratory tract symptoms which were used to assess the impact and conscious understanding of respiratory tract symptoms among households in the study area.

iii. The occurrence of some respiratory tract symptoms and some respiratory diseases from 2014-2019.

iv. Data on the seasonal variation in the occurrence of the some respiratory tract symptoms in the study area were used to determine the seasonal variation of occurrence of respiratory tract symptoms in the study area, and

v. Data on the management strategies of some respiratory tract symptoms, preventive strategies were identified of households in the study area.

3.2.3 Sources of data

Two sources of data were used for this work, namely, primary source of data and secondary source of data.

3.2.3.1 Primary source

Field survey was conducted using structured questionnaire to solicit information on the knowledge of households on the occurrence of some respiratory tract symptoms in the study area, how often it occurs during and after harmattan season.

3.2.3.2 Secondary source

The secondary sources of data were obtained from hospitals such as General hospital, Aliade,NKST hospital ,Taraku, Saint Vincent hospital, Aliade, and Saint Gregory's hospital, Ikpayongo that treat respiratory tract related ailments from (2014-2019) as well as literature, text books, journals, internet, among others.

3.2.4 Instrument for data collection

Survey, secondary data review and personal observations were the methods used for data collection in this work. Structured questionnaire were administered to household heads because of their knowledge on the effect of harmattan on the occurrence of respiratory tract infections in the study area for primary data collection in this study. The questionnaire consisted of four sections (A, B, C and D). Each section contained questions in line with study objectives.

i. Section A: This section consisted of questions designed to collect some relevant data on demographic and socioeconomic characteristics of the respondents such as age, level of literacy, occupation of respondents. Each of the questions have multiple choice answers and a space for answer other than mentioned.

ii. Sections B and C consisted of questions designed to collect relevant data on the characteristics of common respiratory tract symptoms and the perception of households on common respiratory tract symptoms in the study area. Each of the questions have multiple choice answers and a space for answer other than mentioned in the multiple choices.

iii. Section D was used to seek information from the respondents on the management strategies for common respiratory tract symptoms among households in the study area.

Secondary data were collected from the hospital records from 2014-2019 because of the available record of data for the time, these hospitals are 1.General hospital, Aliade, 2. St. Vincent hospital, Aliade, 3. St. Gregory's hospital, Ikpayongo, and 4. NKST hospital, Taraku. The data was restricted for respiratory tract patients admitted to these hospitals.

3.2.5 Sample size and sampling technique

3.2.5.1Sample size

According to the 1991 census, the population of Gwer East (LGA) was 117,630 people with a growth rate of 3.01% (NPC, 1991). These figures were used to project the population to 2019 using Newman's (2001) method of population projection, given as:

$$Pn = Po + (1 + R/100 * Po)\ n$$

Where: Pn = Population projected

Po = Population in the base year

R = annual growth rate

n = number of intermediary years.

Therefore, using the above formula, the projected population of Gwer East LGA in 2019 is 216,467 people. Gwer East Local Government Area has fourteen (14) council wards, namely Akpachai, Aliade/Mbalav, Gbemacha, Ikwe, Ikyogbajir, Kyonov, Mbabur Mbaiase/Mbakine, Mbakyaan, Mbalom, Mbasombo, Mbayom, Shough and Ugee council wards. However, for the purpose of this research, seven (7) out of the fourteen wards werepurposively sampled because of the high population of people in the seven sampled council wards. Base on the projected population at ward level using the 1991 ward population figure of the seven (7) council wards sampled, two communities out of the selected wards were purposively chosen due to their high population in the study area, and they had a total population of 61,921. Using the formula of Yamane (1967), number of respondents as follows:

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

Where: SS = sample size

N = finite population of the study area

e = level of significance (0.05)

$$SS = \frac{61{,}921}{1+ 61{,}921\ (0.05)^2}$$

= 397

The sample size for this study therefore was 397 respondents.

To get the number of respondents for each ward, Yamane, (1967) formula was used.

$$\frac{n\ x\ SS}{N}$$

Where; n = Ward population

SS = Sample Size

N = Total population

3.2.5.2Sampling technique

Multi-stage sampling technique was adopted in this study. In the first stage, purposive sampling was used in selecting seven out of the fourteen council wards in the study area based on the high population of people in these council wards in 1991 population census exercise. The sampled council wards are; Aliade /Mbalav, Ikwe, Mbabur, Mbakyaan, Mbasombo, Mbaiase/Mbakine and Ugee wards as shown in Table 3.1.

The second stage adopted simple random sampling technique to select fourteen communities with two communities from each ward, the communities were randomly selected by the cast of a dice, and these communities are Aliade north, Aliade south, Mase, Igbor, Abenga, Ahumbe, Akpaegher and Taraku. Others are Howe, Tomatar, Ullam, Kyon, Ikpayongo and Abiem because of high population of people in those communities as shown in Table 3.1 Convenience sampling was used to administer questionnaire to the households' head as the sampling point and whenever the head was not available, eldest person was selected to represent the household to ensure that only respondents with adequate knowledge on occurrence of respiratory tract symptoms in the study area were administered the questionnaire.

3.2.5.3 Questionnaire Administration

Questionnaire administration in the study area was carried out in a smooth way such that some respondents were given the questionnaire to fill over time by themselves and collected the

following day. The respondents with inability to write were assisted by the researcherhence the reliability of the data acquired from them.

Table 3. 1: Population and Sample Size of Selected Wards/Communities in Gwer East L.G.A

	Wards	Selected Communities	1991 population	2019 projected population	Sample size
1	Aliade/Mbalav				
		Aliade North	2590	4794	31
		Aliade South	2779	5142	32
2	Ikwe				
		Igbor	2827	5230	29
		Mase	2119	3927	24
3	Mbabur				
		Abenga	2394	4433	28
		Ahumbe	1982	3675	26
4	Mbaiase/Mbakine				
		Ullam	2293	4247	29
		Kyon	1994	3897	27
5	Mbakyaan				
		Akpaegher	2191	4059	28
		Taraku	2748	5084	31
6	Mbasombo				
		Abiem	2413	4468	30
		Ikpayongo	2999	5546	32
7	Ugee				
		Howe	1996	3901	26
		Tomatar	1897	3518	24
	Total		**33,222**	**61,921**	**397**

Source: (NPC, 1991) and Author's Compilation (2019).

3.2.6 Data analysis

Statistical package for Social Sciences (SPSS) Version 26.0 was used for the data analysis. Frequency distributions such as tables, pie charts and inferential statistics such as linear regression were specifically explained by the objectives below.

Objective 1: To identify and characterize the common respiratory tract symptoms in the study area. Frequency distribution tables and pie charts were used to present data in percentages on common respiratory tract symptoms of the study area.

Objective 2: To examine the perceptions of households on occurrence of common respiratory tract symptoms in the study area. Information from the questionnaire were analyzed and presentedin Likert scale.

Objective 3: To examine the relationship between common respiratory tract symptoms and some respiratory diseases in the study area.The data on the relationship between common respiratory tract symptoms and some respiratory diseases were subjected to Linear Regression analysis.

Objective 4: To examine seasonal variation in the occurrence of the common respiratory tract symptoms in the study area. The year was divided into seasons and each season, the occurrences of respiratory tract symptoms was analyzed by frequency and percentages.

Objective 5: To examine the management strategies for common respiratory tract symptoms among households in the study area. Information from questionnaire were presented infrequency distribution tablesand pie charts.

CHAPTER FOUR

RESULTSAND DISCUSSION

4.1 INTRODUCTION

This chapter presents and discusses the results of this study.

4.2 QUESTIONNAIRE RETURN RATE

The survey response rate for this study showed that out of 397questionnaire administered in this study 388 were returned, therefore, the questionnaire return rate for this study was 97.0%.

4.3 SOCIO-DEMOGRAPHIC CHARACTERISTICS OF THE RESPONDENTS

Seven items were used to present the respondents' demographic and socio-economic characteristics. The items are sex, age, marital status, educational qualification, and occupation. Others are duration of residency in the study area and experience of asthma.

4.3.1 Sex of respondents

Figure 4.1presents the sex distribution of respondents in the study area. In this study both males and females participated in answering the questionnaire.

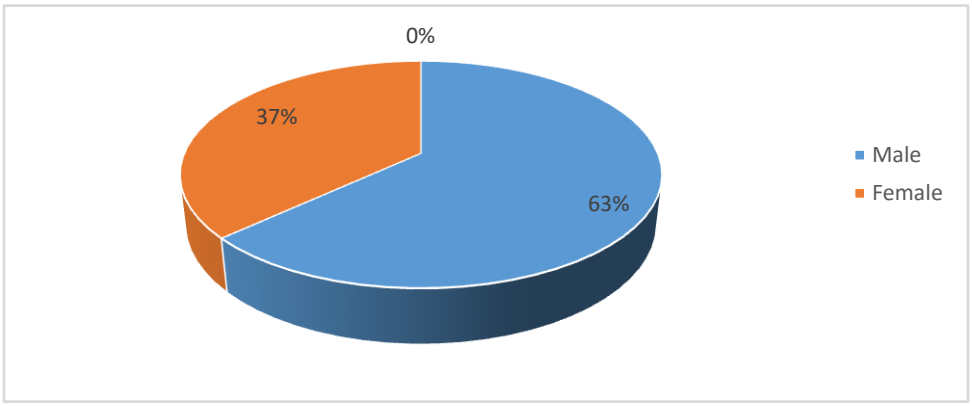


Figure 4.1:Sex of Respondent
Source: Author's Field work, 2021

The result from Figure 4.1 showed that 63% of respondents were males while 37% were females. Most of the respondents were males because they are the head of many households and are in a better position to answer the questionnaire. Being the head oftheir families, the males go outside in search of food, shelter and work for their families even during harmattan period. This is in agreement with Eccles and Wilkinson (2014) who noted thatacute Upper Respiratory Tract Infections (URTI) are commonly associated with cold exposure and this may be the origin of the term 'common cold' which implies exposure to cold or a feeling of chilliness and coldness of the harmattan season.

4.3.2 Age of respondents

Table 4.1 presents the ages of the respondents in the study area.

Table 4.1: Age of Respondents

Age Range (Years)	Frequency	Percentage
18-27	185	45.7
28-37	73	18.8
38-47	85	21.9
48 and above	45	11.6
Total	388	100

Source: Author's Field work, 2021

Table4.1 shows that the respondents who were withinthe age bracket 18 and 27 years accounted 45.7%, while the respondents who were within the age bracket 28-37 years accounted 18.8%. The respondents whose age bracket were between 38 and 47 yearsaccounted 21.9% and thosewithin 48 years and above accounted 11.6%. Majority(45.7%) of the respondents are between 18 and 27 years. With these age distributions the respondents can be considered as youthful given validation to the assumption that youths are the pillars and active in most family affairs.This finding agrees with Adesanya and Chiao, (2017)who noted that the exposure-disease-stress model places young children in their physical and social

contextsandconsiderstheextentandintensityofassociationallinkstosymptomsofacuterespiratory infection (ARI), taking in to account a range of biological, social, and environment components.

4.3.3 Marital status of respondents

Figure 4.2 shows the classification of respondents by their marital status. Respondents have been classified into those that were single, married and divorced.

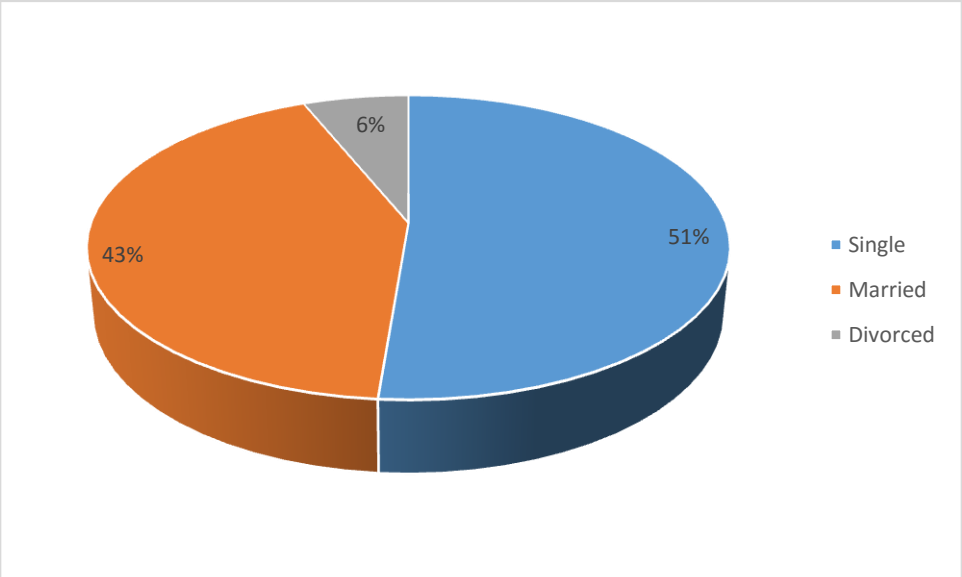


Figure 4.2: Marital status of Respondents

Source: Field Survey, 2021

Figure4.2 indicates that51% of the respondents were single, 43% were married, while 6% were divorced. This implies that majority (51%) of the respondents were single. This study is in contrast with the work of Shahram et al (2016) who noted that married people usually face the dangers of dust storms which can cause certain environmental impactsmostly to children.

4.3.4 Educational statusof respondents

Figure 4.3 reveals the distribution of respondents by their level of education. The categories of the level of education of the respondents were informal education, primary school, secondary school and tertiary institution as shown on Figure 4.3.

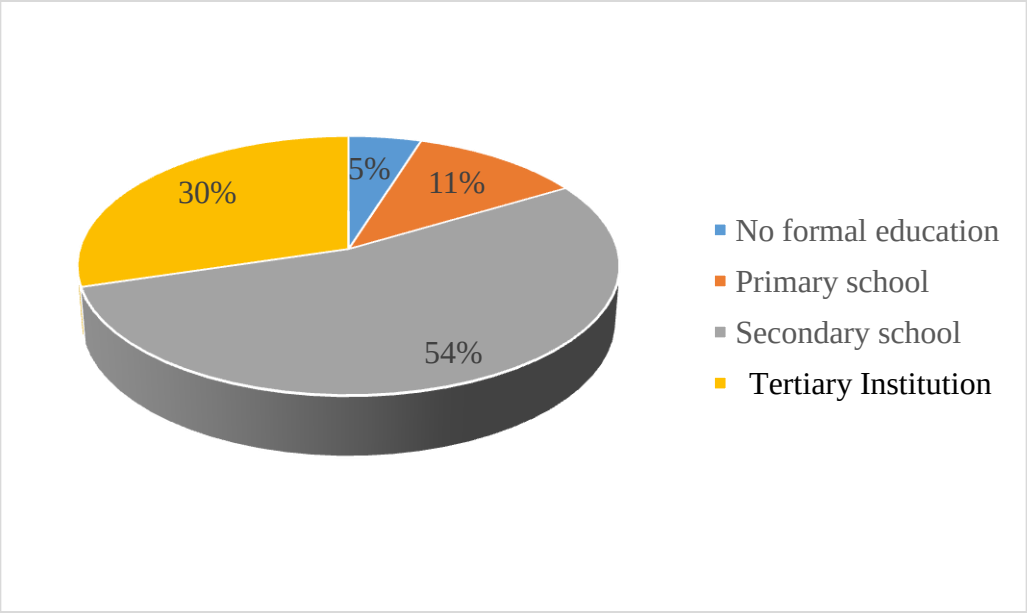


Figure 4.3: Educational Status of Respondents
Source: Field Survey, 2021

The highest level of education showed 54% of the respondents as secondary school leavers, followed by 30% with tertiary institution. Primary school leavers were 11% of the respondentswhile 5% had non-formal education. It implies that majority (95%)of the respondents had formal education with secondary school being the highest level of education attained. This statement is in agreement withBasil (2016) who noted that there may be a need for public health education to discourage seasonal lifestyles that are adverse to good health and to encourage adoption of favorable lifestyles, including modification of indoor climate.

4.3.5 Occupation of the respondents

The occupation of the respondents which was classified into farming, trading, civil service and other occupations are given in Table 4.2.

Table 4.2: Occupation of the Respondents

Occupation	Frequency	Percentage
Farming	212	54.6
Trading	87	22.9
Civil service	77	19.8
Other occupations	10	2.7
Total	388	100

Source: Field Survey, 2021

Table4.2shows that 54.6% of respondents were farmers, 22.9% were traders, 19.8% were civil servants and 2.7% of respondents fall under other occupations respectively. Majority(54.6%) of the respondents were farmers who usually expose themselves to the dreaded harmattan winds. This is in consonance with the work of Eccles and Wilkinson (2014)who asserted that exposure to cold and acute upper respiratory tract viral infections (URTI) are commonly associated with common cold.

4.3.6 Duration of residency in Gwer East L.G.A

Table 4.3 illustrates the duration of residency of the respondents in the study area.

Table 4.3: Duration of Residency in Gwer East L .G. A

Duration	**Frequency**	**Percentage**
6-10years	57	14.7
11-15 years	79	20.4
16-20 years	76	19.5
21-25 years	98	25.3
26 years and above	78	20.1
Total	388	100.0

Source: Author's Field work, 2021

On how long the respondents have been in Gwer East L.G.A, 14.7% indicated they have resided from6-10 years, while 20.4% have stayed there between11-15 years, 19.5% said they have resided for16-20 years. Also, 25.3% of the respondents have stayed from21-25 years and 20.1% have resided for 26 years and above. This indicates that majority(25.3%)of the respondents have been in Gwer East L.G.A for, 21-25years as such the incidences of common respiratory tract symptoms that are confronting themyearly are not new to them.

4.4 SOME RESPIRATORY TRACT SYMPTOMS IN THE STUDY AREA

4.4.1 Perception of harmattan dust haze influencing breathing

Figure 4.5 shows the respondents' views concerning the influence of harmattandust on breathing in their localities**.**

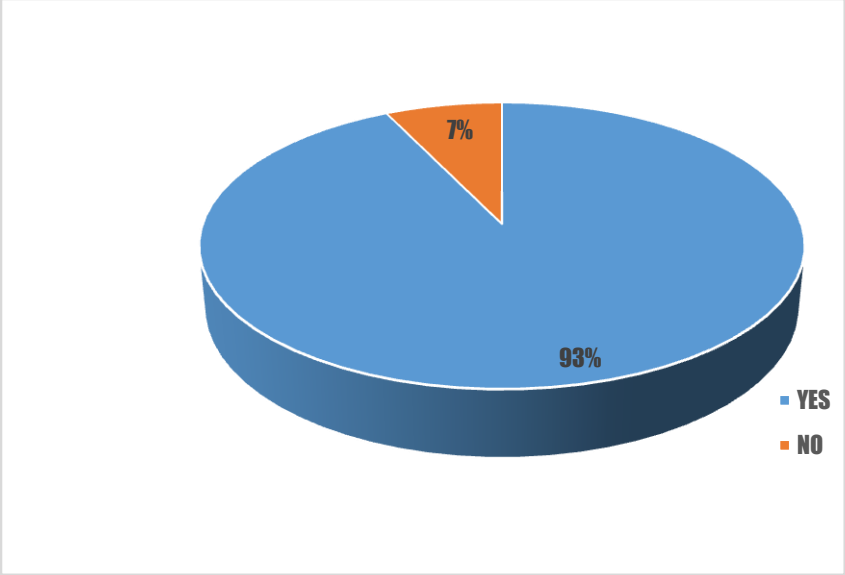


Figure 4.5:Perception of Influence of Harmattan Dust Haze on Breathing
Source: Author's Field work, 2021

From Figure 4.5, it could be seen that 93% of the respondents agreed that harmattan dust has effect on their breathing and 7% disagreed. This implies that most of the respondents perceive that harmattan dust haze has effect on how they breathe. The respiratory tract symptoms such as runny nose, slight headache, coughing among other symptoms experienced in Gwer East L.G.A

yearly affects breathing as a result of different substances that are blown by wind.This is in consonance withXuelei et al (2013) who noted that harmattan dust carries certain amounts of bio-particulates and microorganisms such as pollen, fungi, bacteria, and viruses, as well as related protein and lipid components that endangers respiration.

4.4.2 Some respiratory tract symptoms experienced during harmattan season

Table 4.4 shows the respiratory tract symptoms experienced by the residents of Gwer East L.G.A. The following respiratory tract symptoms were identified by the respondents as being experienced during the harmattan season in Gwer East LGA.

Table 4.4:Some Respiratory Tract Symptoms Experienced during Harmattan Season in Gwer East LGA

Symptom	Frequency	Percentage
Sneezing	69	17.8
Coughing	137	35.3
Sore throat	68	17.5
Nasal congestion	87	22.4
Slight headache	27	7.0
Total	388	100.0

Source: Author's Field Work, 2021

Table 4.4 shows that 17.8% of the respondents listed sneezing, and 35.3% said coughing, while 17.5% indicated sore throat. Also, 22.4% of the respondents said nasal congestion is the major symptom and 7.0% said it is slight headache. This shows that majority of the respondents often cough during harmattan season**.**The effects of the upper respiratory tract symptoms canresult to respiratory diseases if not well handled on time. This is in consonance with Crowford (2018) who asserted that the external organisms crossing the body's natural barriers and invading into the healthy body can cause havoc if the immune system does not handle it right away. Furthermore, Sufiyan, et al (2020) noted that health issues such as cough, catarrh, and

respiratory disease are mostly reported in the hospitals during the harmattan season. This is applicable to Gwer East L.G.A. of Benue State.

4.4.3 Other effects of harmattan

Table 4.5 presents other effects of harmattan dust in the study area during harmattan season.

Table 4.5:Other Effects of Harmattan in the Study Area

Effects	Frequency	Percentage
Sick	133	34.3
Weak	154	39.7
Normal	89	22.9
Other effects	12	3.1
Total	388	100.0

Source: Author's Field work, 2021

Table 4.5 shows that other effects of harmattan faced by the residents of the study area include sickness(34.3%)and weakness(39.7%), while 22.9% of the respondents admitted that they felt normal and 3.1% other effects. Most of the respondents felt weak during harmattan as a result of the respiratory tract symptoms that residents of the area encountered during harmattan season.This is in consonancewith Mohammed(2013) and Chineke and Chiemeka, (2019) who noted thatexposure to the various pollutants in the environment has been associated with numerous adverse health effects including allergenic and immune system effects, respiratory effects, cardiovascular and nervous system effects, irritating effects of the skin and mucous membranes, cancer, and reproductive effects.

4.4.4 Diseases that manifest during harmattan season

Table 4.6 presents some of the respiratory diseases that manifest and are triggered by harmattan season in the study area.

Table 4.6: Diseases that Manifest during Harmattan Season in the Study Area

Sickness	Frequency	Percentage
Asthma	27	7.0
Pneumonia	27	7.0
Common cold	321	82.7
Rhinitis	5	1.3
Others	8	2.1
Total	388	100.0

Source: Author's Field work, 2021

Table 4.6 indicated that 7.0% of the respondents observed the occurrence of asthma, and 7.0% pneumonia, while 82.7% noted common cold, and 1.3% identified rhinitis. The remaining 2.1% of the respondents said others. This implies that common cold is the disease that manifests most with (82.7%) response in the study area. The manifestation of the disease is as a result of the mineral substances that the cold northeasterly wind blow south.This is in consonance with the work ofUduma and Jimoh (2013) who noted that harmattan dust is considered to be among the most harmful of all air pollutants. When inhaled, particularly those that have antecedents of bronchial asthma, pneumonia and other respiratory diseases, these particles evade natural defenses of the respiratory system and lodge deep in the lungs causing serious health complications.

4.4.5 Increase in frequency of sickness during harmattan season

Figure 4.6 presents the increase in sickness during harmattan season in the study area.

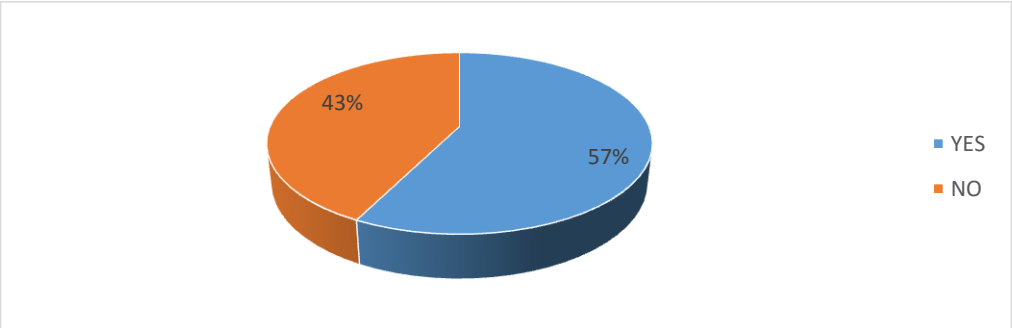


Figure 4.6: Increase in Frequency of Sickness during Harmattan Season in the Study Area
Source: Author's Field work, 2021

Figure4.6 indicates that 57% of the respondents agreed that harmattan dust increases the frequency of sickness during harmattan season, while 43% of the respondents did not agree. The people of Gwer East L.G.A of Benue State always complain of respiratory tract symptoms during the Saharan dust events. This could be because the dust increases the rate of these symptoms that trigger their sicknesses. This is in consonance with Ochei and Adenola (2018) who noted that some people used to experience nasal congestion, cough, muscular aches and pains, painful watery eyes (Apollo), and unusually high body temperature during the more dusty Harmattan periods.

4.4.6 Various means of mitigating the respiratory diseases during harmattan season

Table 4.7 gives the various means by which the residents of Gwer East L.G.A of Benue State use to cure their diseases during harmattan season. The places that the residents of the study area usually visit while they are sick include hospital, herbal house, prayer house and any other places as shown in Table 4.7

Table 4.7: Various Means of Mitigating the Respiratory Diseases during Harmattan Season in the Study Area

Mode of Treatment	Frequency	Percentage
Go to hospital	245	63.1
Visit a herbalist	26	6.7
Pray over it	45	11.6
Do nothing	72	18.6
Total	**388**	**100.0**

Source: Author's Field work, 2021

From Table 4.7 it could be seen that 63.1% of the respondents admitted that they go to hospital when they are sick, and6.7% indicated they visit a herbalist, while 11.6%said they pray over it

and 18.6% do nothing. This implies that majority (63.1%) of the respondents visit the hospital for medical attention when they are sick during harmattan season in the study area. This is in consonance with Uduma and Jimoh (2013) who investigatedthe content of the harmattan dust and associated top soils from Bayero University demonstration farm and hospitalization data from Aminu Kano Teaching Hospital on respiration related diseases for three years.

Figure 4.7 indicates that 31% of the respondents agreed that they still experience the respiratory tract symptoms after harmattan season while 69% disagreed. This implies that after harmattan season, incidences of respiratory tract symptoms subsides, as majority (69%) of the respondents said that theydo not experience the respiratory tract symptoms after harmattan season. This statement is in agreement with Mourtzoukou and Falagas (2007) who noted that there is usually a decrease in the respiratory infections around places that cold weather reduce every season of the year.

4.4.7 Awareness on the effects of exposure to harmattan dust

Awareness on the effect of harmattan dust on breathing when exposed to it, is presented in Figure 4.8

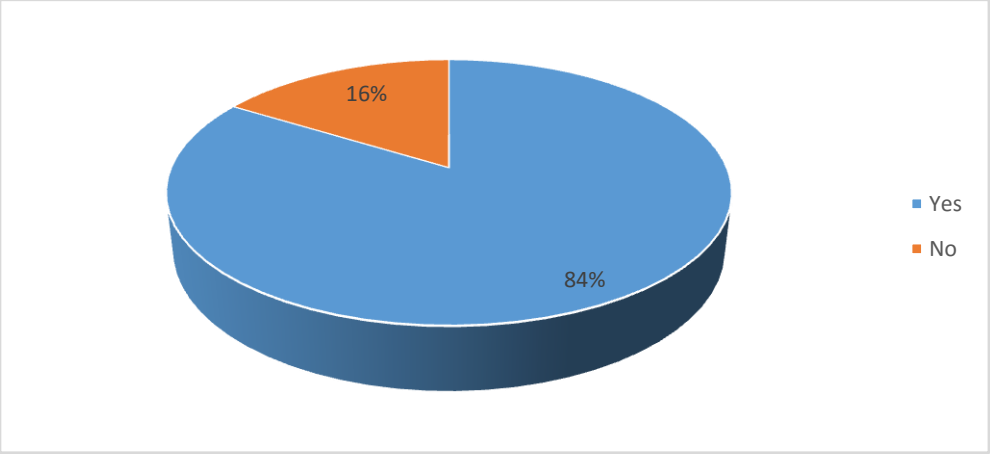


Figure 4.8:Awareness on Effects of Exposure to Harmattan Dust in the Study Area
Source: Author's Field work, 2021

On if the respondents know that exposure to harmattan dust affects their breathing and can lead to death, 84% of the respondents from Figure 4.8 agreed that exposure to harmattan dust affect breathing while 16% disagreed with the view. A common factor about harmattan affecting breathing and the upper respiratory tract which degeneratesto respiratory diseases such as common cold, flu like illness, and pneumonia among other respiratory diseases is by exposing one's self to the harmattan pollutants. This is in agreement with Mourtzoukou and Falagas, (2007) who researched on exposure to cold and respiratory tract infections and noted that, there is a constant increase in hospitalizations and mortality during winter months; cardiovascular diseases as well as respiratory infections are responsible for a large proportion of this added morbidity and mortality. Exposure to harmattan has often been associated with increased incidence and severity of respiratory tract infections.

4.4.8 Frequency of occurrence of respiratory tract symptoms during harmattan season

Table 4.8 presents the frequency of experience of respiratory tract symptoms during harmattan season in Gwer East L.G.A. The periods were categorized into regularly, very regularly, occasionally and don't know.

Table 4.8: Frequency of Occurrence of Respiratory tract symptoms during Harmattan in the Study Area

Duration of Occurrence	Frequency	Percentage
Regularly	116	29.9
Very regularly	60	15.5
Occasionally	113	29.1
Don't know	99	25.5
Total	**388**	**100.0**

Source: Author's Field work, 2021

Table 4.8 shows that the frequency of experience of respiratory tract symptoms during harmattan dust events is regular (29.9%) while 15.5% indicated very regularly, 29.1%said occasionally and 25.5% of the respondents said they don't know. This implies that most (29.9%) of the

respondents experience the respiratory tract symptoms regularly during harmattan dust events. Harmattan season aggravates respiratory tract symptoms in the study area and especially among those who have some underlying respiratory diseases. Respiratory tract symptoms such as coughing, sneezing, nasal discharge, nasal congestion, slight headache among others occur regularly during the harmattan months of the year. This is in agreement with D'Amato et al (2018) whose work on the impact of cold on the respiratory tract and its consequences to respiratory health; contributed that, it is common knowledge that the winter season, (Harmattan season) especially in the higher latitudes, is the difficult part of the year for patientswith chronic respiratory diseases and that inhalation of cold/dust air has negative effects on the lungs for people with respiratory diseases in particular on asthma patients.

4.5 PERCEPTION OF OCCURRENCE OF SOME RESPIRATORY TRACT SYMPTOMS

Table 4.10 illustrates the respondents' perception on the occurrence of respiratory tract symptoms in the study area. The items include some statements concerning harmattan dust and respiratory tract symptoms whereas the response category has SA for strongly agreed, A for agreed, UD for undecided, D for disagreed and SD for strongly disagreed

Table 4.10: Perception of Occurrence of Some Respiratory Tract Symptoms in the Study Area.

Items	Response category					Mean
	SA	A	UD	D	SD	
Harmattan result to unpredicted symptoms	156	171	30	13	18	4.12
Harmattan dust haze reduces solar radiation	108	121	22	66	71	3.33
Harmattan increase respiratory tract symptoms	146	160	41	26	15	4.02
There is high body temperature during harmattan	131	127	24	62	44	3.62
Harmattan results to decreased day activities	144	144	40	40	20	3.91

Respiratory tract symptoms subside after harmattan	112	143	64	23	46	3.65
Cumulative mean		**3.77**				

Decision mean=3.00
Source: Author's Computation (2021)

Table 4.10 indicates that, the respondents had high perception that there is serious occurrence of common respiratory tract symptoms in the study area as the cumulative or overall mean of 3.77 is greater than the decision or standard mean of 3.000. Specifically, the respondents perceive that harmattan dust haze results to unpredicted respiratory tract symptoms as this view was characterized by the mean score of 4.12, with details showing that 40.2% of the respondents strongly agreed, 44.1% agreed and 7.7% undecided, while 3.4% disagreed and 4.6% of the respondents strongly disagreed with the item.

The respondents also agreed that harmattan dust increases respiratory tract symptoms, having the second highest mean score of 4.02, with 42.3% of the respondents strongly agreed, 41.2% agreed and 10.6% undecided, while 6.7% disagreed and 3.9% of the respondents strongly disagreed with the view. Harmattan season results to decreased day activities came third with the mean score of 3.91, and 37.1% of the respondents strongly agreed, 37.7% agreed and 10.3% undecided, while 10.3% disagreed and 5.2% of the respondents strongly disagreed with the item.

Similarly, respiratory tract symptom subside after harmattan season had fourth position with the mean score of 3.65, 28.9% of the respondents strongly agreed, 36.9% agreed and 16.5% undecided, while 5.9% disagreed and 11.9% of the respondents strongly disagreed. There is high body temperature during harmattan season had fifth position with the mean score of 3.62, 33.8% of the respondents strongly agreed, 32.7% agreed and 6.2% undecided, while 15.9% disagreed and 11.3% of the respondents strongly disagreed with the item. Lastly, harmattan dust haze reduces solar radiation is the least with the mean score 3.33, 27.8% of the respondents

strongly agreed, 31.2% agreed and 5.7% undecided, while 17.0% disagreed and 18.3% of the respondents strongly disagreed with the view.

In summary, the respondents highly perceive that there is serious occurrence of common respiratory tract symptoms in the study area due to harmattan. This is in harmony with Sufiyan et al, (2020) whose work on impact of harmattan season on human health in Nasarawa state, noted that the harmattan dust particles affect negatively the health of the people causing the respiratory disease to adults and children. Health cases such as cough, catarrh, and respiratory disease are mostly reported in the hospitals during the harmattan season.

4.6 Relationshipbetween Some Respiratory Tract Symptoms and Respiratory Diseases

Table 4.9 shows the relationship between the common respiratory tract symptoms and some selected respiratory diseases in Gwer East L.G.A. These diseases include asthma, pneumonia, catarrh, bronchitis and tuberculosis.

Table 4.9: Relationship between Common Respiratory Tract Symptoms and some Selected Respiratory Diseases

Diseases	R	R-Square	Adjusted R	F computed	p	Remarks
Catarrh	0.907	0.822	0.821	1319.727	0.000	Significant. Relationship
Pneumonia	0.877[a]	0.769	0.768	949.906	0.000	Significant. Relationship
Asthma	0.783[a]	0.613	0.611	452.218	0.000	Significant. Relationship
Bronchitis	0.636[a]	0.405	0.402	194.279	0.000	Significant. Relationship
Tuberculosis	0.784[a]	0.614	0.613	455.030	0.000	Significant. Relationship

R > 0.400, F computed > 3.000, p < 0.05 at df 1
Source: Author's Computation (2021)

Results from the Linear Regression analysis in Table 4.9 revealed that allcommon respiratory tract symptoms in Gwer East L.G.A were significantly related to each of the five selected respiratory diseases (Catarrh, Pneumonia, Asthma, Bronchitis, andTuberculosis). This is because

in each of the tested linear regression, the computed R, R Square and the adjusted r values are greater than the 0.4 R critical and their computed F values were each higher than the Critical F value of 3.000 at df 1. In each case the calculated p value was lower than the 0.05 alpha level of significance. Therefore, the relationship between the respiratory tract symptoms and the respiratory diseases in the study area is significant. This finding agrees with Henna et al (2018) who investigatedthe potential relations between cold temperature and reported functional disability and exacerbation of health problems among subjects with pre-existing respiratory diseases, such as asthma and allergic rhinitis. They hypothesized that subjects with asthma and/or allergic rhinitis experience more cold weather-related functional disabilities than subjects without such underlying respiratory diseases, and found out that cold weather exacerbates their health problems.

4.7 Seasonal Variation in the Occurrence of Some Respiratory Tract Symptoms

The climate of Nigeria is usually characterized into two seasons, the wet season and dry season. The wet season (summer) is normally from April to October while the dry season (winter) is from November to March (Kabir, 2018). The harmattan months of the dry season in Nigeria are (November to March) where the north easterly wind invades the country with cold dusty harmattan wind which is known to cause the incidence of respiratory tract infections in Gwer East L.G.A of Benue State.

4.7.1 Frequency of occurrences of respiratory diseases during wet and dry seasons

Table 4.11 illustrates the frequency of occurrences of respiratory diseases during the Wet and Dry seasons in Gwer East L.G.A of Benue state. The respiratory diseases consideredin the study area include catarrh, pneumonia, asthma, bronchitis and tuberculosis.Table 4.11 shows that during the wet season,catarrh has the highest frequency of 23.83% of cases of respiratory disease

occurrence in the area, followed by tuberculosis with 22.62% of cases and the least was bronchitis with 15.24%. In dry season, catarrh again has the highest frequency of 30.30% of cases of respiratory diseases occurrence in the study area, followed by pneumonia with 21.04 % of cases and the least was bronchitis with 12.07% of cases of respiratory diseases in dry season.

Table 4.11: Frequency of Occurrences of Respiratory Diseases between Wet and Dry Seasons in the Study Area

Diseases	Seasons			
	Wet		Dry	
	Frequency	%	Frequency	%
Catarrh	316	23.83	566	30.30
Pneumonia	259	19.53	393	21.04
Asthma	249	18.78	308	16.49
Bronchitis	202	15.24	226	12.10
Tuberculosis	300	22.62	375	20.07
TOTAL	**1326**	**100**	**1868**	**100**

Source: Hospital Records in Gwer East LGA, (2021)

In Summary, each of the disease occurrence in dry season is significantly higher than in the Wet season. This shows that respiratory disease in the study area are associated more with dry season than wet season. This is because of the harmattan dust haze distribution that prevails in some months of the season that led to the high occurrence of respiratory diseases during dry season in the study area.

This is in agreement with Akinyemi et al (2011) whose work on a study of weather related respiratory diseases in Eco- climatic zones, noted thatrespiratory disorders are typically caused by allergic reaction, infection, or inhalation of dusts or chemicals, and may be influenced by weather and climate, either directly via sudden drops in temperature or indirectly via an increase in pollutant levels.They further lamented thatabrupt changes in weather, such as those associated with the passage of a weather fronts, have been implicated in human discomfort with symptoms such as headache. Moreover, there is evidence that weather changes may be related to the onset

of some diseases, such as common colds and upper respiratory tract infections especially during dry season as these diseases are accompanied with the respiratory tract symptoms.

4.8 Management Strategies Against Harmattan InducedRespiratory Tract Symptoms

Some of the coping strategies to be adopted during harmattan season are discussed in this section.

4.8.1 Awareness ofpreventive measures against effects of harmattan dust in the study area

Figure 4.10illustrates whether there was preventive measures against harmattan dust in Gwer East LGA, or not.

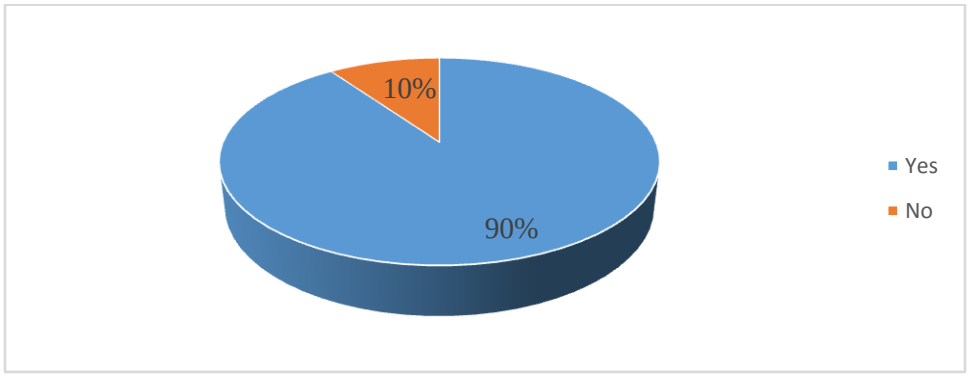


Figure 4.10: Awareness of Preventive Measures against Harmattan in the Study Area

Source: Author's Field work, 2021

From Figure4.10 90% of the respondents admitted that there are preventive measures against hamattan dust while 10% disagreed. This implies that majority of the respondents often take steps to prevent harmattan dust haze from affecting their health using diverse means like heating up, sealing windows, avoiding cold drinks/foods among others. This is in consonancewith Sufiyan et al (2020) who again noted that harmattan season is perhaps the best period to explore the cultural advantage of wearing *Babban Riga* and suits as it pleases one to keep warm.

4.8.2 Management strategies against harmattan

Table 4.12 presents the management strategies against harmattan in Gwer East L.G.A. Some of the strategies adapted by the inhabitants of the area include, use of face mask/scuff, adjusting body outfit, moisturizing the nostrils and other strategies not mentioned here.

Table 4.12: Management Strategies against Harmattan in the Study Area

Strategies	Frequency	Percentage
Use of face mask	234	60.3
Adjusting body outfit	126	32.4
Moisturizing the nostrils	27	6.9
Other strategies	1	0.4
Total	388	100.0

Source: Author's Field work, 2021

Table 4.12 indicates that60.3% of the respondents make use of face mask, 32.5% said adjusting body outfit, while 6.9% indicated moisturizing nostrils and only 0.4% said other strategies. This implies that most of the respondents use face mask in order to prevent the harmattan dust haze from affecting their health. Probably because of the compulsion to use face mask toprevent the spread of Covid-19 pandemic that many of the respondents are making use of face masks. The people of Gwer East L.G.A of Benue State are deeply covered by harmattan which is affecting their respiratory tract.

4.8.3 Effectiveness of the management strategies

Figure 4.11 illustrates the perception of respondents on the effectiveness of the management strategies during harmattan season.

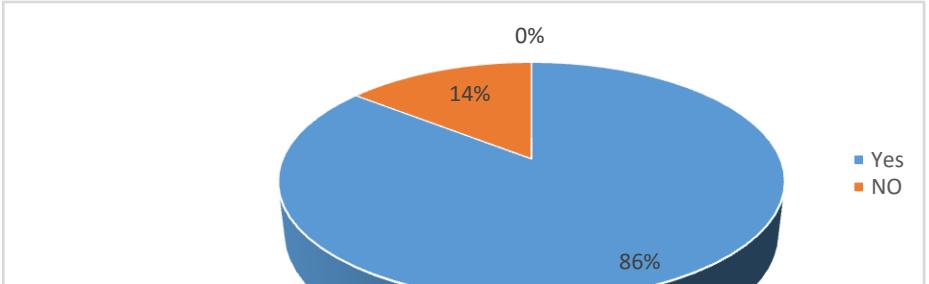


Figure 4.11 Effectiveness of the Management Strategies during Harmattan Season in the Study Area
Source: Author's Field work, 2021

Considering whether the preventive measures were often effective, 86% of the respondents agreed that the management strategies are effective during harmattan season and 14% disagreed. This implies that most of the respondents in the study area have perceived these preventive measures as very effective. The constant use of these preventive materials would minimize the cases of respiratory tract symptoms in the study area that harmattan dust usually brings yearly. This is in concurrence with the work of Onyeakagbu (2018) who researched on how to survive harmattan in Nigeria, noted that to be on safer side during harmattan season, put on warm clothing when going to bed at night or when going out in the morning.

4.8.4 Suggestedpossible ways of mitigating the effect of harmattan

Table 4.13 suggests possible ways to mitigate the effects of harmattan dust in the study area.

Table 4. 13 Suggested Possible Ways to Mitigate Effect of Harmattan Dust in the Study Area

Solutions	Frequency	Percentage
No response	11	2.80
Wearing of thick clothes	125	32.20
Wearing of face masks	146	37.60
Avoidance of cold water	66	17.00
Other means	40	10.30
Total	**388**	**100.00**

Source: Author's Field work, 2021

Table 4.13indicates possible ways suggested to mitigate the effects of respiratory tract symptoms in the study area, 2.8% of respondents had no response, while 32.2% use thick clothes, 37.6% use face masks, while 17.0% avoid using cold water and cold food, and 10.3% of the respondents make use of other means. Most 37.6% of the respondents suggested wearing of face mask as a possible way to help the households on the effect of respiratory tract symptoms during harmattan season in the study area. This is in agreement with the study of Holali, (2016) who researched on design, manufacture and test a nose/mouth filter for use during the harmattan noted that respiratory equipment like filters and masks are used throughout the world to provide personal protection from a variety of noxious gases, vapours and aerosol hazards which could cause harm and even death to humans.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 INTRODUCTION

This concluding chapter presents the summary, conclusion and recommendations as well as suggestion for further studies.

5.2 SUMMARY OF FINDINGS

This study assessed the effects of harmattan dust on the occurrence of some respiratory tract infections in Gwer East Local Government Area of Benue state. Analysis of the respondents' demographic characteristics revealed that majority (53%) are male and majority (45.70%) were between the ages of 18- 27 years. Also majority (51%) of the respondents were single and 54% of them had secondary education. On the occupation of the respondents, 52.10% were farmers and majority(25.30%) resided in the area for a period of 15- 20 years.

Findings also revealed thatmost (93%) of the respondents perceive that harmattan dust haze has effect on how they breathewhile 7% disagreed. The study also revealed that 35.3% of the respondents experience the respiratory tract symptoms regularly during harmattan dust events. On the other effects of harmattan dust in the study area, weakness of the body was the major felt effect.

Furthermore, findings of the study showed that 82.7% indicated that common cold was the common symptom among the diseases during harmattan season in the study area and the least frequent disease that manifests was rhinitis. On whether there was an increase in sickness during harmattan season, 57% of the respondents agreed while 43% disagreed. Findings from the study further showed that 63.1% of the respondents visit hospital when they felt sick whereas 6.7% of the respondents visit herbalists when they are sick. On experience of breathing difficulty after

harmattan season, majority 69% of the respondents disagreed while 31%agreed. Findings from the study also revealed that 84% of the respondents agreed being aware of effects of exposure to harmattan dust and 16% disagreed. Also, most 29.9% of the respondents notice the occurrence of respiratory tract symptoms regularly while 15.5% notice it very regularly.

On the respiratory tract symptom experience in the study area, 17.8% of the respondents listed sneezing as the highest symptom while slight headache was the least with 7.0%. The perception of occurrence of common respiratory tract symptoms, all the items were found to be above the decision level of 3.00 with an overall value of 3.77. Findings on the relationship between common respiratory tract symptoms and respiratory diseases revealed a significant relationship between all the common respiratory tract symptoms and the respiratory diseases (p values= 0.00).

Findings from the seasonal variation of the respiratory diseases in the study area showed that 30.30% of respiratory diseases occur mostly in dry season than in wet season with catarrh being the most noticeable disease and 23.83% of the respondents indicated its occurrence in wet season while 12.10% indicated the occurrence of bronchitis in dry season and 15.10% indicated during the wet season in the study area.

Finally, findings on the management strategies against harmattan dust induced respiratory tract symptoms revealed that 90% of the respondents agreed that they are aware of the preventive measures against the effect of harmattan while 10% disagreed. Also, 60.30% of the respondents make use of face mask as their management strategy. On the effectiveness of the management strategies, 86% of the respondents agreed that the management strategies are effective while 14% of the respondents disagreed.

5.3 CONCLUSION

Based on the findings from this study in Gwer East LGA of Benue State, it can be concluded that the respiratory tract symptoms faced by the respondents of the study area include coughing, sneezing, nasal congestion among others which occurs regularly during the harmattan season of the year.

The residents of the study area perceive that respiratory tract symptoms are triggered by harmattan dust haze with rapid and unpredicted increase in its occurrence during harmattan season. These respiratory tract symptoms are significantly related to respiratory diseases such as catarrh, pneumonia, asthma, bronchitis, and tuberculosis in the study area.

The occurrence of respiratory diseases is significantly higher in dry season than in wet season. The management strategies for coping with harmattan season arethe usage of face mask, thick clothes, and avoidance of exposing one's self to harmattan dust.

5.4 RECOMMENDATIONS

Based on the findings, the following recommendations are put forward, these are:

The use of management strategies such as wearing of face mask and adjustment of body outfit/thick clothing during the harmattan season should be practiced by the people in the study area.The Gwer East Local Government authorityshould ensure that there are availabledrugs for use during harmattan season.

There should be wide publicity and enlightenment of health extension workers by the local government authority on the dangers and prevalence of health issues associated with harmattan

using local languages in radio stations, Television stations and through religious and traditional meetings in the study area.

The relevant authorities concerned in the LGA should use both stick and carrot approach in enforcing compliances with the preventive measures and offenders should be prosecuted while those who obey the rules should be intrinsically and extrinsically motivated.

5.5 SUGGESTIONS FOR FURTHER STUDIES

The study Assessment of the Effect of Harmattan on the Occurrence of Some Respiratory Tract Infections in Gwer East LGA, of Benue State can further be studied under the following topics.

1. Assessment of the effect of seasonal weather conditions and its prevalence and management in Gwer East LGA, of Benue State.
2. Issues of respiratory tract diseases in Gwer East LGA, of Benue State.
3. Analysis of weather Related Issues on Respiratory Tract Infections (RTIs) in Gwer East LGA, of Benue State.

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APPENDICES

Appendix I

DEPARTMENT OF GEOGRAPHY AND ENVIRONMENTAL MANAGEMENT

FACULTY OF PHYSICAL SCIENCES

AHMADU BELLO UNIVERSITY, ZARIA, KADUNA STATE

Dear Respondent,

I am a postgraduate student of Geography Department, Ahmadu Bello University, Zaria, conducting a research on Assessment of the Effect of Harmattan on the Occurrence of Respiratory Tract Symptoms in Gwer East L. G. A, Benue State. I solicit for your cooperation in completing this questionnaire. All information supplied would be treated confidentially, and used strictly for academic purpose.

Thank you.

Please tick appropriately the column that suits your conception.

SECTION A: SOCIO ECONOMIC CHARACTERISTICS OF RESPONDENTS

Name of ward……

1. Sex: Male [ ] Female [ ]
2. Age: 18 - 27 [ ] 28 – 37 [ ] 38 -47 [ ] 48 – 57 and above [ ]

3. Marital status: Single [ ] Married [ ] Divorced [ ]

4. Level of education: No formal education [ ] Primary school [ ] Secondary school [ ] Tertiary institution [ ]

5. Occupation: Farming [ ] Trading [ ] Civil service [ ]

Others ……..

6. How long have you been in Gwer East L. G.A? 0 – 5 years [ ] 5 – 10 years [ ] 10 – 15 years [ ] 15 – 20 years [ ] 20 years above [ ]

SECTION B: COMMON RESPIRATORY TRACT SYMPTOMS AND THEIR CHARACTERISTICS

8. Do you think that harmattan dust haze has effect on how you breathe? Yes [ ] No [ ]

9. If yes, what signs do you often notice during harmattan season?

Sneezing [ ] Coughing [ ] Sore throat [ ] Nasal congestion [ ] Slight headache [ ] Others……..

10. Apart from the above mentioned signs, what else happens to you during harmattan season?

Sick [ ] Weak [ ] Normal [ ] Others ……..

11. If sick, what type of sickness occurs to you during harmattan season?

Asthma [ ] Pneumonia [ ] Common cold [ ] Rhinitis [ ] Others ……..

12. Does your sickness increases during harmattan months? Yes [ ] No [ ]

13. If yes, what do you do next to curb the disease?

Go to hospital [ ] visit a herbalist [ ] pray over it [ ] do nothing [ ]

14. Do you experience these respiratory symptoms after harmattan season? Yes [ ] No [ ]

15. Do you know that exposure to harmattan dust affect your respiratory tract and can led to death?

Yes [ ] No [ ]

16. How often do you experience these respiratory tract symptoms during harmattan dust events?

Regularly [ ] Very regularly [ ] occasionally [ ] don't know [ ]

SECTION C: PERCEPTION OF HOUSEHOLDS ON OCCURRENCE OF COMMON RESPIRATORY TRACT SYMPTOMS

18. For each of the following statements, please tick the appropriate box which you agree with using the following scale- Strongly Agree (SA), Agree (A), Undecided (UND), Disagree (D), and strongly disagree (SD).

S/N	**Variables**	**Responses**				
		SA	**A**	**UND**	**D**	**SD**
1	Harmattan dust haze result to unpredicted respiratory tract symptoms					
2	Harmattan dust haze reduces solar radiation					
3	Harmattan dust haze increase respiratory tract symptoms					
4	There is high body temperature during harmattan season					
5	Harmattan season results to decreased day activities					
6	Respiratory tract symptoms subside after harmattan season					

SECTION D: MANAGEMENT STRATEGIES FOR COMMON RESPIRATORY TRACT SYMPTOMS

19. Are there steps you often take to prevent harmattan dust haze from affecting your health?

Yes [ ] No [ ]

20. What are these steps?

Use of face mask [ ] Adjusting body outfit [ ] Moisturizing the nostrils [ ] Others……..

21.Are these preventive measures often effective? Yes [ ] No [ ]

22. Suggest possible ways to help the households on the effect of respiratory tract symptoms during
harmattan.……

.....
.....
.....

Appendix II: Raw output/results from the computer

Frequency Table

Sex

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	245	63.1	63.1	63.1
	Female	143	36.9	36.9	100.0
	Total	388	100.0	100.0	

Age

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	18-27	185	47.7	47.7	47.7
	28-37	73	18.8	18.8	66.5
	38-47	85	21.9	21.9	88.4
	48-57 and above	45	11.6	11.6	100.0
	Total	388	100.0	100.0	

marital status

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Single	199	51.3	51.3	51.3
	married	165	42.5	42.5	93.8
	divorced	24	6.2	6.2	100.0
	Total	388	100.0	100.0	

level of education

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	no formal education	19	4.9	4.9	4.9
	primary school	45	11.6	11.6	16.5
	secondary school	209	53.9	53.9	70.4
	tertiary institution	115	29.6	29.6	100.0
	Total	388	100.0	100.0	

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	farming	212	54.6	54.6	54.6
	trading	89	22.9	22.9	77.6
	civil service	77	19.8	19.8	97.4
	others	10	2.6	2.6	100.0
	Total	388	100.0	100.0	

how long have you been in Gwer East L.G.A?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	6-10years	57	14.7	14.7	14.7
	11-15 years	79	20.4	20.4	35.1
	16-20 years	76	19.6	19.6	54.6
	21-25 years	98	25.3	25.3	79.9
	26 years and above	78	20.1	20.1	100.0
	Total	388	100.0	100.0	

are you asthmatic

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	yes	51	13.1	13.1	13.1
	no	337	86.9	86.9	100.0
	Total	388	100.0	100.0	

do you think that harmattan dust haze has effect on how you breathe

	Frequency	Percent	Valid Percent	Cumulative Percent

Valid	yes	360	92.8	92.8	92.8
	no	28	7.2	7.2	100.0
	Total	388	100.0	100.0	

Frequency Table

CATARRH

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	.00	18	10.7	10.7	10.7
	1.00	34	20.2	20.2	31.0
	2.00	70	41.7	41.7	72.6
	3.00	42	25.0	25.0	97.6
	4.00	4	2.4	2.4	100.0
	Total	168	100.0	100.0	

PNEUMONIA

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	.00	14	8.3	8.3	8.3
	1.00	66	39.3	39.3	47.6
	2.00	72	42.9	42.9	90.5
	3.00	15	8.9	8.9	99.4
	4.00	1	.6	.6	100.0
	Total	168	100.0	100.0	

ASTHMA

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	.00	18	10.7	10.7	10.7
	1.00	69	41.1	41.1	51.8
	2.00	64	38.1	38.1	89.9

	3.00	16	9.5	9.5	99.4
	4.00	1	.6	.6	100.0
	Total	168	100.0	100.0	

BRONCHITIS

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	.00	36	21.4	21.4	21.4
	1.00	71	42.3	42.3	63.7
	2.00	53	31.5	31.5	95.2
	3.00	7	4.2	4.2	99.4
	4.00	1	.6	.6	100.0
	Total	168	100.0	100.0	

TUBERCULOSIS

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	.00	13	7.7	7.7	7.7
	1.00	50	29.8	29.8	37.5
	2.00	74	44.0	44.0	81.5
	3.00	25	14.9	14.9	96.4
	4.00	4	2.4	2.4	98.8
	5.00	1	.6	.6	99.4
	6.00	1	.6	.6	100.0
	Total	168	100.0	100.0	

```
USE ALL.
COMPUTE filter_$=(Season=2).
VARIABLE LABELS filter_$ 'Season=2 (FILTER)'.
VALUE LABELS filter_$ 0 'Not Selected' 1 'Selected'.
FORMATS filter_$ (f1.0).
FILTER BY filter_$.
EXECUTE.
FREQUENCIES VARIABLES=ASTHSMA PNEUMONIA CATTARH BROCHYTIS TUBERCULOSIS
  /ORDER=ANALYSIS.

95).
```

T-Test

Group Statistics

	Season	N	Mean	Std. Deviation	Std. Error Mean
CATARRH	Wet season (Apr - Oct)	168	1.8810	.98376	.07590
	Dry season (Nov - Mar)	120	4.7167	1.82044	.16618
PNEUMONIA	Wet season (Apr - Oct)	168	1.5417	.79560	.06138
	Dry season (Nov - Mar)	120	3.2750	1.46076	.13335
ASTHMA	Wet season (Apr - Oct)	168	1.4821	.83324	.06429
	Dry season (Nov - Mar)	120	2.5667	1.26845	.11579
BRONCHITIS	Wet season (Apr - Oct)	168	1.2024	.84456	.06516
	Dry season (Nov - Mar)	120	1.8833	1.08607	.09914
TUBERCULOSIS	Wet season (Apr - Oct)	168	1.7857	.97969	.07558
	Dry season (Nov - Mar)	120	3.1250	1.35698	.12387

Post Hoc Tests

Multiple Comparisons

Dependent Variable: frequencies of occurrence

Scheffe

		Mean Difference			95% Confidence Interval	
(I) Diseases	(J) Diseases	(I-J)	Std. Error	Sig.	Lower Bound	Upper Bound
Catarrh	Pneumonia	.79861*	.12412	.000	.4157	1.1816
	Asthma	1.12847*	.12412	.000	.7455	1.5114
	Bronchitis	1.18250*	.31056	.006	.2244	2.1406
	Tuberculosis	.71875*	.12412	.000	.3358	1.1017
Pneumonia	Catarrh	-.79861*	.12412	.000	-1.1816	-.4157
	Asthma	.32986	.12412	.133	-.0531	.7128
	Bronchitis	.38389	.31056	.822	-.5742	1.3420
	Tuberculosis	-.07986	.12412	.981	-.4628	.3031
Asthma	Catarrh	-1.12847*	.12412	.000	-1.5114	-.7455
	Pneumonia	-.32986	.12412	.133	-.7128	.0531
	Bronchitis	.05403	.31056	1.000	-.9041	1.0121
	Tuberculosis	-.40972*	.12412	.028	-.7927	-.0268
Bronchitis	Catarrh	-1.18250*	.31056	.006	-2.1406	-.2244
	Pneumonia	-.38389	.31056	.822	-1.3420	.5742
	Asthma	-.05403	.31056	1.000	-1.0121	.9041
	Tuberculosis	-.46375	.31056	.694	-1.4219	.4944
Tuberculosis	Catarrh	-.71875*	.12412	.000	-1.1017	-.3358
	Pneumonia	.07986	.12412	.981	-.3031	.4628
	Asthma	.40972*	.12412	.028	.0268	.7927
	Bronchitis	.46375	.31056	.694	-.4944	1.4219

*. The mean difference is significant at the 0.05 level.