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Comparative Analysis of the Impact of Climate Change on Male and Female Mental Health

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ABSTRACT

The paper examined the impact of temperature and relative humidity escalation on mental health of in-patient and out-patient admitted into Neuropsychiatric Hospital Akure, Ondo State, Nigeria. The main independent variables of interest are temperature and relative humidity covering a period of eight years 2010-2017. Data of in- and out-patients diagnosed with psychiatric cases were sourced from the from the hospital records. The population of the study is 53616 numbers of patients, comprising of 25160 male and 28456 female patients that visited the hospital from the year within the years of study. Data collected were analyzed with used of single regression and multivariate regression analysis using STATA Software. The study found that climate parameters (temperature and relative humidity) as a separate variables and the overlapping effect of the two independent increases the vulnerability of male and female patients to the risk of psychiatric cases and increases the numbers of patient visiting the hospital. There were positive associations between the numbers of male/female patient and the two parameters as well as between the overlapping effects. Male population are more vulnerable to the risks of psychiatric cases as temperature increase while female population were more vulnerable to the risks of psychiatric cases as relative humidity increases. The impact of the overlapping (resultant) effects of the two independent variables is more on the male than the female that were visiting the hospital. Male populations were generally more vulnerable to the risks of psychiatric cases than female as the metabolic rate and brain volume increases with temperature. The vulnerability of male and female population to psychiatric cases was not equally distributed throughout the period of study. Male and female population respond differently to the impact of each parameter throughout those years considered and these are considered to be psychological and physiological factor differences in male and female. Out of a total 53616 numbers patients that visited the hospital between (2010-2017), only 21.28% (11,409) are male patients that were diagnosed with psychiatric cases and all together traceable/attributed to increased temperature, relative humidity and overlapping effect escalation while only 20.02% (10,736) was female that were diagnosed with psychiatric cases and all together traceable/attributed to the increased temperature, relative humidity and overlapping effect escalation. In the overall analysis male population were more vulnerable to the risk of psychiatric cases than female as the two independent variables increases. The effective strength of temperature made the numbers of male/female populations more vulnerable to the risk of psychiatric cases than the effective strength of relative humidity.

KEYWORDS: *Temperature, Relative Humidity, Male and female psychiatric patients*

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1. INRODUCTION

This can be due to the fact that the normal human body temperature differs and that individual body temperature depends upon the age, exertion, infection, sex, and reproduction status (ovulation or pregnancy) of the subject, the time of the day, the place in the body at which the measurement range is made (month, ear, armpit, rectum, forehead, nose, vagina, bladder etc.), and the subject's state of consciousness (awake, sleeping, or sedated), activity level, and emotional state. (Karakitsos et al 2008, Kelly 2007, Mackowiak et al 1992, Sund-Levander

et al 2002, Lingo 2011, Kelly 2006, Susan 2017, Michele 2018, Carissa S 2018). The above shows that we cannot expect the same rate of effects of temperature and relative humidity exacerbation on sex distribution. This is an indication that the temperature variability or increase in temperature can subject everyone to mental health risk. Once there is an increase in body temperature beyond normal temperature relating to sex, negative reactions from their brain could be expected, but not everyone is affected equally. Groups that are especially vulnerable to the mental health impacts of climate change include children, the elderly, and women. Also at risk are disadvantaged groups and those with existing mental illness.

Generally, sweat rate in males are higher than females (Gurung DB et al 2018). The physical parameters associated with lower sweat rate in females are body mass and surface area. The body mass represents the capacity of the body to store heat (Quite different in males and females). The amount of body surface area exposed to the external environment determines the heat exchange between the skins and ambient temperature such as larger body surface area to body mass generally associated with higher skin temperature. In generally females have less body surface area compared to males. Larger surface areas allow more molecules to leave the liquid than smaller one, and therefore sweat occurs more rapidly. Metabolic energy expenditure is proportional to body mass. Lower rate of metabolic heat production elicit a lower sweat rate in females. The physiological parameter associated with lower rate in females is due to less thermal sensitivity of the response because females have less active sweat glands as compared to males.

However, as most of our temperature sensors are located in the skin, women can feel cold even when their internal organs are cosy (or warm). So it's not all in your imagination. It seems that women really are genetically programmed to feel drops in temperature before their male counterparts. The ideal temperature appears to be around 2.5C warmer than men - between 24C and 25C. This is in line with a 2015 study by Dutch scientists, for instance which found that women are comfortable at a temperature 2.5C warmer than men, typically between 24-25^{0}C.

The body's metabolism also plays a role, as this dictates how quickly heat energy is produced and on average, women have a lower metabolic rate than men. In simple terms, higher muscle mass tends to translate to higher resting metabolism, which is linked to burning more calories and higher blood flow, both of which help keep the extremities warm (Hanna KU et al, 2001) According to Daniel G et al (2012) Women differ from men in thermal regulation responses to exogenous heat load and heat loss as well as to endogenous heat load during exercise, because they usually have a large ratio of body surface, a greater subcutaneous fat content, and lower exercise capacity. When males and females exercise at the same percentage of oxygen consumptions, the lower rate of metabolic heat production in females will results in a lower rate of whole body sudomotor (sweating rate). Since it follows that a whole-body sudomotor activity is determine by local sweat production, it follows that a lower rate of metabolic heat production will elicit a lower sweat rate in females. The greater rate of whole-body heat loss is reflected by a greater rate of local sweat production in males compared females. In this situation, the greater rate of local sweat production can be attributed to the different in rate of metabolic production elicit by employing an experimental protocol in which exercise is performed at a given percentage of maximum consumption

Also According to Tikuisis et al (2000) Eleven women (age 24.4 $\pm$ 6.3 $yr, mass$ 65.0 $\pm$ 7.8$kg, height$ 167 $\pm$ 8$cm, body\ fatness$ 22.4 $\pm$ 5.9%, $mean\ \pm SD$) were immersed to neck level in 18^0C water up to 90 min for comparison of their thermal responses with those of men (n=14) in a previous similarly conducted protocol. Metabolic rate increases about three times resting levels in men than women and that the metabolic rate of shivering correlates inversely to the square root of body fatness. The more the body fatness the less is the metabolic rate.

According to Richard L. Burse (1979): Morphologically, women average 20% smaller body mass, 14% more body fat, 33% less lean body mass, but only 18% less surface area than men. Women have greater body insulation when vasoconstricted-reduced in the Blood vessel which tend to increase blood pressure (except hands and feet) and larger peripheral heat sink, but at the cost of:

- Greater Body Fat burden
- Less Muscle Mass and Strength
- Smaller Circulating Blood volumes.

What we can simply derived from the above is that if metabolic rate in males are more than in females due to greater muscles and strength, temperature will increase in males during metabolic process than females (Metabolic rate increases about three times resting levels in men than women), heat can be accumulated in male body more than female if there is no corresponding increase in blood flow. Male will be more vulnerable to the risk of psychiatric cases than female as temperature increases. Also, since increase in relative humidity reduces sweating rate, increase in the relative humidity will affect female more than male (the more the body fatness the less is the metabolic rate), since the female have lower metabolic rate than males, sweating rate is lower in female than male. Increase in the ambient relative humidity will further lower the sweating rate in female than males and without sweating heat will accumulate in the females body than male body as ambient relative humidity increases. The smaller circulating blood volumes in female will not be able to remove enough heat from the female body and this can lead to increase in the female's brain temperature. Females may be found to be more vulnerable to the risk of psychiatric cases than males as the relative humidity increases. We now expect to see that increases of psychiatric cases can be exacerbated among male and female as ambient temperature and relative humidity increases respectively. Differences in their chemical, mechanical and biological responses to environmental factors or external forces are the reason for the differences in the degree of their vulnerability to the risk of mental ill-health as the two parameters increase. According to Prof Paul Thornalley of Warwick Medical School, variation in

average metabolic rate and body heat production between men and women "may explain why there is a difference in environmental temperature required for comfort between males and females". As we can see above, women are more comfortable at a temperature 2.5^{0}C warmer than men, typically, between 24-25^{0}C.

So, Increase in temperature and relative humidity will increase the number of male and female patients with different degrees of effects. Males seem to be more vulnerable to the risk of mental ill-health than the females as temperature increases and Females seem to be more vulnerable to the risk of mental ill-health than the males as relative humidity increases. Their response to change in the climate parameters differs due to the factors stated above. Increase in temperature and humidity increases the number of psychiatric cases and number of patients visiting the hospital. The vulnerabilities of people to the risk of psychiatric cases or mental ill-health such as psychosis, schizophrenia, depression, anxiety, epilepsy, stroke, impairment of memory/cognitive, consciousness and psychoactive substance use/drug abuse differs in term of sex and age distributions as temperature and relative humidity increases. That is the vulnerability of male and female at the risk of psychiatric cases differs as the temperature and relative humidity increases likewise within the age distributions.

The brain activity has been known to have connection with temperature, and the relationship between brain metabolic activity and temperature are always interactive, the brain cell metabolism is a major determinant of brain temperature and any minor change in brain temperature can result in significant changes in the neural cell metabolism and therefore in brain functions (Segolene M et al 2012). Male and female with mental illness will be at high risk of death during hot weather i.e. patients with psychosis, dementia and substance misuse (abuse) are at increasing risk of death during high ambient temperature. Apart from metabolic rate, brain volume or brain size, and neuron density have important role to play with temperature in determining mental health in sex distribution as temperature increases. According to Yaguo et al. (2014), Ectothermic animals living in tropic climates should have brain sizes that are several times larger than those of Ectothermic animals living in cold climate. What Yaguo is telling us is that Ectothermic animals living in environments of high temperature (tropic climate) have larger brain sizes than the Ectothermic animals living in environments of low temperature (cold climate). Ectothermic animals; are animals having body temperature that varies with environment. Human beings are such i.e. the brain size increases with increase in temperature.

Also according to James et al (2014), all vertebrates multiple regression analysis indicated relative brain size is related to the mass. He used equation

$$RB_m \propto \frac{BRB_m}{M} \propto M^{-\frac{1}{4}} e^{-\frac{E_a}{KT}} \quad \text{..... 1.1}$$

Where, RB_m-Relative Brain size, B-Metabolic rate, M-Body Mass, $E_a = eV$-characteristic exponential Temperature Dependence, K-Boltzmann Constant, T-Temperature. Natural logarithm of mass-correctedRB_m, decrease with inverse temperature, indicate that relative brain size was shown to increase exponentially with temperature. Here, also brain size increase with temperature.

Number of neurons per unit volume decline with increase in the brain size, as the neuron density declines with increase brain size, so the entropy decline. Here, the brain density declines with increase in brain size, then density decline with increase temperature and entropy decreases with increase in temperature. Entropy is impaired with decrease in neuron density. According to Micheal P (2017) for decades, brain scientists have noticed that on average, male brains tend to have slightly higher total brain volume than female ones, even when corrected for males' larger average body size.

Comparing the volume of their brain, in normal situation the neuron density of male brain and that of the female are approximate the same. Men brain weight $1370g$ and female $1200g$ with volume $1260\ cm^3\ and\ 1130\ cm^3$ respectively. Neuron/brain density of male brain and female brain are $1.07\ g\ cm^{-3} and\ 1.06\ g\ cm^{-3}\ respectively$ approximately $1.1\ g\ cm^{-3}$ equal.

$$S \propto \frac{1}{T}, S \propto \frac{1}{B_s}, T \propto B_s, V \propto T, \rho \propto \frac{1}{V}, \rho \propto \frac{1}{T}, S \propto \rho, S \propto \frac{1}{V},$$

……..1.2

Where
S is the Brain entropy, T is the Brain Temperature, B_s is the Brain size, $V$is the brain volume, and ρ is the neuron density.

If can be permitted to summary the above with this formula

$$S \propto \frac{\rho}{B_s TV} \text{.....1.3}$$

$$S = K\frac{\rho}{B_s TV} \text{.....1.4}$$

The constant K is the Conductivity of the brain tissue.

The brain entropy or brain information entropy is the ability of the brain to process information or signal and transmit the same. The ability to reduce uncertainty contained in any given signal/message. Entropy decreases with increase in temperature. Brain size and brain volume increase with increase in temperature, hence brain entropy decrease with increase in the brain size and brain volume, while neuron density decline with increase in temperature.

Increases in temperature causes:
- Increase in Brain Volume and Brain size
- Decline in neuron density
- Decline in Brain Entropy

It has been mentioned that male brains tend to have slightly higher total brain volume than female ones and that their brain/neuron density are approximately the same.

The brain volume and brain size increases as temperature increases, there is possibility that the male brain volume might increase more than the female as temperature increases because female on the average had thicker cerebral cortices than male. This might further cause neuron density to decrease in male brain than female

brain. If the brain entropy decline with declined of the neuron density as the temperature increases, then there is no doubt that the rate of psychiatric cases will be higher in male than female as temperature increases (brain entropy decline with decline in the neuron density as the brain volume and size increases). Brain entropy or brain Information entropy is inversely proportional to: temperature, brain volume and brain size but proportional to neuron density. All parameters (i.e. Brain- temperature, volume and size) that can cause a decline in the neuron density as they increases can enhance malfunction of the brain entropy- that may result into human mental health impairment. The rate of psychiatric cases increases in numbers among male than female because the brain volume and brain size increase to decline neuron density and decline in brain entropy as temperature increases. Temperature have vital role to play in human mental health as one of the major climate parameters. Since increase in temperature can reduce brain entropy, then temperature at extreme level impair entropy resulting into mental health disorder.

Many literatures have reviewed association between increases in temperature and number of patients diagnosed with psychiatric cases based on sex distributions. According to Phan et al (2016) research on Seasonality of hospital admissions for mental disorders in Hanoi, Vietnam 2008-2012 reported that: In the summer season, hospital admissions for mental disorders among males (RR=1.26, CI=1.12–1.41) were more common than for those among females (RR=1.18, CI=1.03–1.36) compared to the winter season. A peak in cases in both men and women was observed in early summer with RRs of 1.49 (CI=1.22–1.82) among men and 1.37 (CI=1.08–1.74) among women. Men are more vulnerable to mental health effect during temperature increase. While the number of male (17546) and Female (5979) and according to **Ricardo A et al (2018)** Exposure to high temperature should be considered a significant risk for mental disorder: Hospital admissions by mental disorders increase significantly with high temperatures while they tend to decrease with low temperature and that women with mental disorders are more vulnerable than men to high temperatures. The number of hospital admissions for mental disorder during the study period (2008-2014) at Lisbon was 30,139. Hospital admissions increase significantly with high temperatures on the day of exposure. Linear associations between admissions for depressive disorder and ambient temperature show that there were statistically significant relationships in all groups. Moreover, there were relative increases in admissions for higher mean temperature (1°C) for groups of men (Relative Risk (RR)= 1.06, population aged 18-40 (RR=1.06 (1.008 – 1.11) and residents in urban areas (RR=1.08 (1.03 – 1.14). Cases among other groups had slightly higher RRs from RR=1.02 to RR=1.05 **(Trang P. M et al, 2015).** The above as shown association between depressive disorders and ambient temperature while more men visiting hospital for depressive disorder in periods of hot weather. Another study at Hanoi Mental Hospital reviewed that throughout the study period (2008–2012), 23,525 subjects were admitted to the hospital with psychiatric problems, including both inpatients and outpatients (this refers to the first time they were registered at Hanoi Mental Hospital. During this period, the numbers of male and female patients with mental disorder admissions were 17,546 (74.6%) and 5,979 (25.4%), respectively; the numbers of admissions of patients from urban and rural areas were 13,486 (57.3%) and 10,017 (42.6%), respectively, whereas the age distribution in groups 0–17, 18–40, 41–60, and over 60 years was 734 (3.1%), 11,645 (49.5%), 9,380 (39.9%), and 1,766 (7.5%), respectively.

Another means that brain temperature can increase coupled with increase in ambient temperature is during geomagnetic storm most especially the severe/extremes storm. Geomagnetic storm resulted from the interaction of the interplanetary magnetic field (IMF) embedded in the energetic plasma particles flow from the solar arena which perturbed the geomagnetic field (GMF), disorientated this earth magnetic field forced it to move opposite to its emerge direction from the sun side to the night side of the earth. Of course while there is interaction we could expect friction, with friction we could also expect raising temperature or temperature gradient generated due to temperature before and after impacts of the two fields (IMF and GMF). In fact we have been experiencing raise in plasma temperature during geomagnetic storm. The temperature due to frictional force can as well escalate the geomagnetic temperature that can elevate ambient temperature. Of course space activities (Space weather) can alter the earth atmospheric parameters thereby influencing the climate.

According to Mauro Refi et al (2017) in their research on Ultralow Frequency (ULF) Geomagnetic Activity effects on Troposphere Temperature, Specific Humidity and Cover Cloud in Antarctica during 2003 -2010 discovered that there are evidence to prove that geomagnetic activity gives rise to increase in ambient temperature and relative humidity. Using relative variation

$$\Delta X_r = \left(X_{z,d} - X_{z,q}\right)/X_{z,q}$$

To compute the relative variation of zone means temperatureT_z, specific humidity Q_z and Cloud cover CC_z, where d and q indicate “disturbed” and “quiet” geomagnetic activity conditions, respectively.

If ΔX_r is positive, it shows increase in the relative variation during geomagnetic storm in ambient temperature and relative humidity i.e. positive association between increase in temperature/relative humidity and geomagnetic storm. Ambient tropospheric temperature/relative humidity increases with increase in geomagnetic activities and if ΔX_r increases, it is an indication that there are significant variation in tropospheric parameters during geomagnetic disturbances compared with quiet period.

If ΔX_r decreases to functional value less than 1, means there are no significant variation in the tropospheric parameters during geomagnetic activities or disturbances compared with quiet period i.e. the value of $\left(X_{z,d} - X_{z,q}\right)$ is very small and that $X_{z,d}$ is not as much greater than $X_{z,q}$ or the magnitude of the geomagnetic storm (B_z) is small.

According to Maura (2017) a clear relationship was found during the disturbed geomagnetic periods of 26 – 28 July 2004 and that both geomagnetic activities and

atmospheric variation are almost simultaneous, with 6 hours. Also during 28 – 30 October 2003 of the long–lasting geomagnetic activities, the atmospheric parameter response reveals increasingly strong variation in ΔT_r and ΔQ_r i.e. temperature and relative humidity respectively or strong variation in ΔX_r even closed to the ground.

Generally, during the periods characterized by reconnected magnetosphere and strong south-north interplanetary electric field, the atmospheric response is high i.e. high relative variation in ΔX_r (for each atmospheric parameter) and that the two strong geomagnetic storms that occurred on 27 – 29 July 2004 and on 29 – 30 October 2003 both gave evidence of high relative variation of temperature, specific humidity and cloud cover at troposphere which may eventually increase the ambient temperature and relative humidity on the Earth surface.

Even the pressure exerted on the geomagnetic field during interaction with interplanetary magnetic field when geomagnetic field is compressed and this can cause scalp magnetic field compression that may result into increases in the intracranial pressure which may narrow the blood tissue radius, reduces blood flow, reduces the rate of heat removal from the brain, then caused increase in brain temperature that may eventually reduce brain entropy. The pressure on the geomagnetic field at the impact of interplanetary magnetic field may bring about the increase in the ambient humidity at the earth surface that prevent perspiring rate reducing body cooling rate.

The above literature reviewed is an indication that both male and female populations are vulnerable to the risk of psychiatric cases as temperature and relative humidity increases. But in view of metabolic rate, brain volume/size and geomagnetic activities men are more vulnerable to the risk of psychiatric cases as temperature increases while female seem to be more vulnerable as relative humidity increases.

2. Methodology

Data were drawn from two sources being secondary data: Neuropsychiatric Hospital Akure Ondo State where the monthly and the yearly number of in- patient and out-patient admitted with psychiatric cases or mental ill-health from the year 2010 to 2017 were collected and used for the study and Meteorological data on temperature and relative humidity. The meteorological data on temperature and relative humidity Ondo state from 2010-2017 were retrieved from the Modern-Era retrospective analysis for Research Application, Version 2 (MERRA-2) web site. The mean meteorological data over Ondo state was used in assumption that the in-patient and out-patient admitted into Neuropsychiatric Hospital Akure, Ondo State from year 2010-2017 comprises people with psychiatriccases all over the state. The ex-post facto research design was adopted for the study and data collected were analyzed with the use of STATA; single regression analysis and multiple regression analysis. Total number of in-patients and out-patient visiting the hospital with mental ill-health for eight years (2010-2017) was 53616. A total of 25160 (46.93%) were male psychiatric patients and 28456 (53.07%) were female psychiatric patients. Internet facility was employed for this research especially e-library to retrieve text books, journals, research papers etc. for an update information on the topic from others researchers and related studies e.g. Google Alerts and Google Trends to track comprehensive search over lengthy period.

3. Data Presentation and Analysis

3.1. Data Presentation

Month	2010		2011		2012		2013		2014		2015		2016		2017		Total (2010-2017)	Total	
	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F		Male	Female
Jan	147	208	182	248	195	251	275	359	199	231	128	109	308	365	340	392	3937	1774	2163
Feb	155	229	178	196	240	336	283	321	227	224	265	373	322	356	75	121	3901	1745	2156
March	250	150	233	343	320	265	252	271	199	201	309	262	371	398	183	167	4174	2117	2057
April	251	264	164	232	257	269	301	304	322	257	283	405	341	373	246	340	4609	2165	2444
May	204	245	179	221	310	237	314	270	260	288	271	306	321	483	320	369	4598	2179	2419
June	357	545	214	266	250	274	234	351	367	340	267	328	261	322	316	378	5070	2266	2804
July	272	269	243	242	273	336	271	183	130	133	312	356	165	269	308	421	4183	1974	2209
Aug	546	371	259	280	371	340	339	340	137	121	288	335	251	243	336	423	4980	2527	2453
Sept	258	318	263	309	376	244	263	326	223	239	161	174	203	292	272	370	4291	2019	2272
Oct	207	262	228	280	265	361	278	458	232	293	321	367	329	434	315	370	5000	2175	2825
Nov	214	282	308	263	240	349	367	229	281	276	168	135	237	335	324	431	4439	2139	2300
Dec	205	273	240	304	265	234	235	327	218	201	331	414	266	299	320	302	4434	2080	2354
Total	3066	3416	2691	3184	3362	3496	3412	3739	2795	2804	3104	3564	3375	4169	3355	4084	53616	25160	28456
	6482		5875		6858		7151		5599		6668		7544		7439		53616	53616	

Table1: 2010-2017 Numbers of Male and Female Patient (in and out- patient)

Ondo State Monthly and Yearly Temperature (2010-2017)									
Month	2010	2011	2012	2013	2014	2015	2016	2017	Yearly Average Month Temperature (°C)
Jan	25.32	23.84	23.97	24.69	25.04	23.40	24.60	25.13	24.50
Feb	26.31	25.46	25.65	25.49	25.68	26.12	26.58	25.75	25.88
March	26.37	26.22	25.85	26.14	25.86	26.17	27.01	26.39	26.25
April	26.47	25.83	25.71	26.01	25.86	26.13	26.81	26.18	26.13
May	26.10	25.63	25.21	25.34	25.76	25.78	25.94	25.90	25.71
June	25.20	24.93	24.59	24.71	25.19	24.89	24.89	25.26	24.96

July	24.22	24.28	24.02	23.97	24.53	24.71	24.40	24.43	24.32
August	24.30	23.98	23.82	23.78	23.97	24.53	24.37	24.16	24.11
Sept	24.45	24.43	24.31	24.48	24.38	24.70	24.61	24.63	24.50
October	24.93	24.86	24.86	25.13	25.04	25.27	25.44	25.47	25.13
November	25.48	25.15	25.48	25.33	25.42	25.81	26.08	25.51	25.53
December	24.65	23.57	24.29	24.43	24.96	23.03	25.04	25.17	24.39
Mean Year Temperature Value	25.32	24.85	24.81	24.96	25.14	25.05	25.48	25.33	25.12

Table2: 2010-2017 Monthly and yearly Temperature over Ondo State

Ondo State Monthly and Yearly Relative Humidity (2010-2017)									
Month	2010	2011	2012	2013	2014	2015	2016	2017	Average Of Year Monthly Relative Humidity (%)
Jan	80.51	74.45	76.13	78.98	81.85	74	68.29	79.82	76.75
Feb	83.93	85.43	84.67	84.6	83.25	85.02	74.97	81.07	82.87
March	85.35	86.24	86.09	88.09	87.27	86.19	84.24	86.95	86.30
April	88.39	88.67	88.97	88.09	88.62	87.25	86.31	88.72	88.13
May	89.93	90.59	89.43	90.48	89.27	89.75	89.13	89.85	89.80
June	90.56	90.67	90.51	89.96	89.02	90.13	89.37	89.91	90.02
July	89.68	89.93	89.66	89.55	88.58	88.42	89.33	89.76	89.36
August	89.16	89.12	88.27	87.56	88.85	88.01	88.93	89.67	88.70
Sept	89.91	89.75	89.67	89.32	89.02	88.98	89.96	89.63	89.53
October	89.61	89.79	89.85	88.1	89.15	89.23	89.2	88.96	89.24
November	87.39	84.82	87.79	88.56	87.14	84.37	85.15	86.34	86.45
December	78.27	75.84	78.38	82.22	78.72	63.77	80.9	80.9	77.38
Yearly Relative Humidity (%)	86.89	86.28	86.62	87.13	86.73	84.59	84.65	86.80	86.21

Table3: 2010-2017 Monthly and Yearly Relative Humidity over Ondo State.

3.2. Data Analysis

3.2.1. Regression Analysis: Individual Parameters

Table 4: Regression Analysis: STATA

Year		Male		Female	
		Temperature	Relative Humidity	Temperature	Relative Humidity
2010	Coefficient	-56.55688	12.18437	-30.34831	10.81611
	P	0.152	0.131	0.414	0.146
	T	-1.55	-1.64	-0.85	1.58
	R^2	0.1942	0.2127	0.0678	0.1989
	CI	[-137.7209, 24.60716]	[-4.330294, 28.69902]	[-109.6276, 48.93095]	[-4.479025 26.11125]
	% of Determination	595.4172	652.1382	231.6048	679.4424
	Number of Patients	3066	3066	3416	3416
2011	Coefficient	-15.43935	0.5359174	-6.82206	-0.7262229
	P	0.336	0.829	0.664	0.761
	T	-1.01	0.22	-0.45	-0.31
	R^2	0.0928	0.0049	0.0196	0.0097
	CI	[-49.45732, 18.57862]	[-4.862338, 5.934173]	[-40.822, 27.17788]	[-5.903804, 4.451359]
	% of Determination	249.7248	13.1859	62.4064	30.8848
	Number of Patients	2691	2691	3184	3184
2012	Coefficient	-12.32395	5.385082	2.97791	3.75146
	P	0.599	0.126	0.888	0.247
	T	-0.54	1.67	0.14	1.22
	R^2	0.0286	0.2184	0.0021	0.1312
	CI	[-62.95035, 38.30245]	[-1.71275, 12.56291]	[-42.14476, 79.10058]	[-3.050832, 10.55375]
	% of Determination	96.1532	734.2608	7.3416	458.6752
	Number of Patients	3362	3362	3496	3496
2013	Coefficient	3.211506	2.428572	-2.671236	-6.094341
	P	0.854	0.514	0.93	0.339
	T	0.19	0.68	-0.09	-1.01
	R^2	0.0035	0.0438	0.0008	0.0009
	CI	[-34.7181, 41.1411]	[-5.567358, 10.4245]	[-68.52194, 63.17947]	[-19.60527, 7.416585]
	% of Determination	11.942	149.4456	2.9912	3.3651
	Number of Patients	3412	3412	3739	3739

2014	Coefficient	62.1356	3.207958	54.87876	3.443995
	P	0.055	0.61	0.079	0.558
	T	2.17	0.53	1.96	0.61
	R^2	0.3211	0.027	0.3768	0.0354
	CI	[-1.547274, 127.4585]	[-10.36352, 10.77944]	[-7.607459, 117.245]	[-9.227552, 16.11554]
	% of Determination	897.4745	75.465	1056.5472	99.2616
	Number of Patients	2795	2795	2804	2804
2015	Coefficient	9.301657	0.4714492	10.75672	0.3140107
	P	0.658	0.867	0.739	0.942
	T	0.46	0.17	0.34	0.007
	R2	0.0204	0.003	0.0116	0.0006
	CI	[-36.06391, 54.66722]	[-5.624187, 6.567085]	[-59.0958, 80.60925]	[-9.091193, 9.669214]
	% of Determination	63.3216	9.312	41.3424	2.1366
	Number of Patients	3104	3104	3564	3561
2016	Coefficient	45.70969	-2.987721	42.64029	-0.785056
	P	0.007	0.29	0.04	0.812
	T	3.34	-1.12	2.36	-0.24
	R^2	0.528	0.111	0.3573	0.0062
	CI	[15.25816, 76.16122]	[-8.945014, 2.969572]	[2.344899, 82.93588]	[-7.928657, 6.358545]
	% of Determination	1782	374.625	1489.5837	25.8478
	Number of Patients	3375	3375	4169	4169
2017	Coefficient	-56.08966	5.625314	-84.89325	11.11421
	P	0.107	0.377	0.045	0.151
	t	-1.77	0.92	-2.29	1.55
	R2	0.2383	0.0788	0.3434	0.1945
	CI	[-126.7375, 14.55817]	[-7.925608, 19.17624]	[-167.6085, -2.178028]	[-4.834002, 27.12243]
	% of Determination	799.4965	264.374	1402.4456	794.338
	Number of Patients	3355	3355	4084	4084

From the table 4

- In 2010, the coefficient for temperature shows that an increase in temperature resulted in 56.56 and 30.35 decreases in number of male and female patients respectively. While an increase in the relative humidity resulted in 12.18 and 10.82 increase in the number of male and female patients respectively. The rate at which the male population is at risk of psychiatric cases is more than female population as relative humidity increases and statistically not significant from confidence interval and P-values. The t-value and coefficient carried the same corresponding sign. The percentage of determination shows that number of male patients and female diagnosed with psychiatric cases and traceable to the temperature decreased by 595 and 232 respectively and that of relative humidity increased by 652 and 679 respectively. The number of females vulnerable to the risk of psychiatric cases as the relative humidity increases was more than the male.
- In 2011, the coefficient for temperature shows that an increase in temperature resulted in 15.44 and 6.82 decreases in number of male and female patients respectively. While an increase in the relative humidity resulted in 0.54 increase and 0.73 decrease in the number of male and female respectively. The rate at which the male population is at risk of psychiatric cases is more than female population as relative humidity increases and statistically not significant from confidence interval and P-values. The percentage of determination shows that number of male and female patients diagnosed with psychiatric cases and traceable to the temperature decreased by 250 and 62 respectively and that of relative humidity increased the number of male and female patients by 13 and decreased by 31 respectively. The numbers of male vulnerable to the risk of psychiatric cases as the relative humidity increases were more than the female.
- In 2012, the coefficient for temperature shows that an increase in temperature resulted in 12.32 decreases and 2.98 increases in number of male and female patient respectively. While an increase in the relative humidity resulted in 5.39 and 3.75 increases in the number of male and female respectively. The rate at which the female population is at risk of psychiatric cases is more than male population as temperature increases and the rate at which the male population is at risk of psychiatric cases is more than female population as relative humidity increases and statistically not significant from confidence interval and P-values. The percentage of determination shows that number of male and female patients diagnosed with psychiatric cases and traceable to the temperature decreased by 96 and increased by 7 respectively and that of relative humidity increased the number of male and female patients by 734 and 459 respectively. The numbers of female vulnerable to the risk of psychiatric cases as the temperature increases were more than the male and the numbers of male vulnerable to the risk of psychiatric cases as the relative humidity increases were more than the female.
- In 2013, the coefficient for temperature shows that an increase in temperature resulted in 3.21 increases and 2.67 decreases in numbers of male and female patients respectively. While an increase in the relative humidity resulted in 2.43 increase and 6.09 decrease in the number of male and female patients respectively. The rate at which the male population is at risk of psychiatric cases is more than female population as the independent variables (i.e. temperature and relative humidity) increases and statistically not significant from confidence interval and P-values. The percentage of determination shows that numbers of male patient and female diagnosed with psychiatric cases and traceable to the temperature increases with 12 and decreases with 3 numbers of patients respectively and that of relative humidity increases with 149 and decrease with 3 numbers of patients respectively. The numbers of male vulnerable to the risk

of psychiatric cases as the two independent variables (i.e. temperature and relative humidity) increases were more than the female.

- In 2014, the coefficient for temperature shows that an increase in temperature resulted in 62.14 and 54.88 increases in the number of male and female patients respectively. While an increase in the relative humidity resulted in 3.21 and 3.44 increases in the number of male and female patients respectively. The rate at which the male population is at risk of psychiatric cases is more than female population as temperature increases and the rate at which the female population is at risk of psychiatric cases is more than male population as relative humidity increases and statistically not significant from confidence interval and P-values. The percentage of determination shows that numbers of male and female patients diagnosed with psychiatric cases and traceable to the temperature increases by 897 and 1057 respectively and that of relative humidity increases the number of male and female patients by 75 and 99 respectively. The numbers of female vulnerable to the risk of psychiatric cases as the two independent variables (i.e. temperature and relative humidity) increases were more than the male.
- In 2015, the coefficient for temperature shows that an increase in temperature resulted in 9.30 and 10.76 increases in the number of male and female patient respectively. While an increase in the relative humidity resulted in 0.47 and 0.32 increases in the numbers of male and female respectively. The rate at which the female population is at risk of psychiatric cases is more than male population as temperature increases and the rate at which the male population is at risk of psychiatric cases is more than female population as relative humidity increases and statistically not significant from confidence interval and P-values. The percentage of determination shows that number of male and female patients diagnosed with psychiatric cases and traceable to the temperature increases by 63 and 41 respectively and that of relative humidity increases the number of male and female patients by 9 and 2 respectively. The numbers of male vulnerable to the risk of psychiatric cases as the two independent variables (i.e. temperature and relative humidity) increases were more than the female.
- In 2016, the coefficient for temperature shows that an increase in temperature resulted in 45.70 and 42.64 increases in numbers of male and female patient respectively and statistically significant from confidence interval and P-values. While an increase in the relative humidity resulted in 2.99 and 0.79 decrease in the numbers of male and female respectively and statistically not significant from confidence interval and P-values. The rate at which the male population is at risk of psychiatric cases is more than female population as temperature increases. The percentage of determination shows that numbers of male patient and female diagnosed with psychiatric cases and traceable to the temperature increases by 1782 and 1490 respectively and that of relative humidity decreases the number of male and female patients by 375 and 26 respectively. The numbers of male vulnerable to the risk of psychiatric cases as the temperature increases were more than the female.
- In 2017, the coefficient for temperature shows that an increase in temperature resulted in 56.09 and 84.90 decrease in the number of male and female patients respectively and statistically not significant from confidence interval and P-values. While an increase in the relative humidity resulted in 5.63 and 11.11 increase in the number of male and female respectively and statistically not significant from confidence interval and P-values. The rate at which the female population is at risk of psychiatric cases is more than male population as temperature increases. The percentage of determination shows that numbers of male patient and female diagnosed with psychiatric cases and traceable to the temperature decreases by 800 and 1403 respectively and that of relative humidity increases the number of male and female patients by 264 and 794 respectively. The numbers of female vulnerable to the risk of psychiatric cases as the relative humidity increases were more than the male.

3.2.1. Table 5: Summary of Regression Analysis

	% Coefficient of Determination					% Coefficient of Determination				
	Temperature			t-value		Relative Humidity			t-value	
Year	Male	Female	Total	Male	Female	Male	Female	Total	Male	Female
2010	(-)595	(-)232	0	-1.55	-0.85	652	679	1331	1.64	1.26
2011	(-)250	(-)62	0	-1.10	-0.45	13	(-)31	13	0.22	-0.31
2012	(-)96	7	7	-0.54	0.14	734	459	1193	1.67	1.22
2013	12	(-)3	12	0.19	-0.09	149	(-)3	149	0.68	-1.01
2014	897	776	1673	2.17	1.96	75	99	174	0.53	0.61
2015	63	41	104	0.46	0.34	9	2	11	0.17	0.07
2016	1782	1490	3272	3.34	2.36	(-)375	(-)26	0	-1.12	-0.24
2017	(-)800	(-)1403	0	-1.77	-2.29	264	794	1058	0.92	1.55
TOTAL	2754	2314	5068			1896	2033	3929		

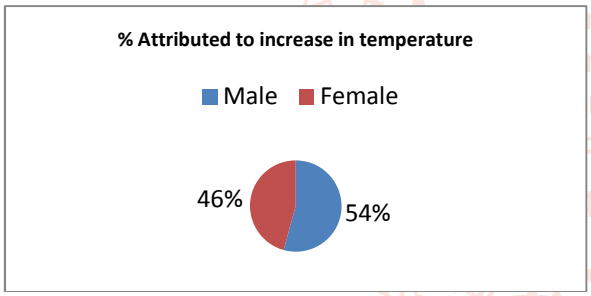
From the table (5) above: t-values have the same direction with coefficient. But if we consider the magnitude of t-values and the magnitude % coefficient of determination only, the t-values shows the fluctuations in the number of male and female patient traceable to temperature and relative humidity down the table. In each year the sex with greater numbers of patient correspond to higher t-value. The sum of t-values from 2010 -2017 for male and female are 11.12 and 8.48 corresponds to 2754 and 5068 total number of male and female patients respectively as the temperature increases. The sum of t-values from 2010 -2017 for male and female are 6.95 and 4.25 corresponds to 1896 and 2033 total number of male and female patients respectively as the relative humidity increases. The higher the t-value, the greater the number of patients we have not minding the direction.

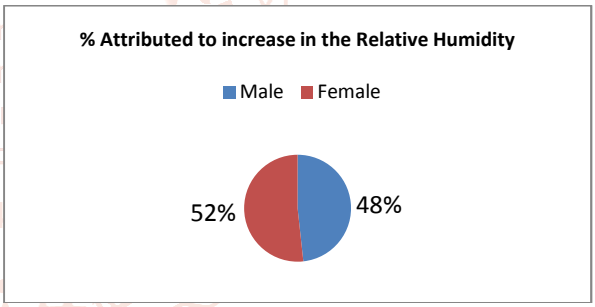
Temperature

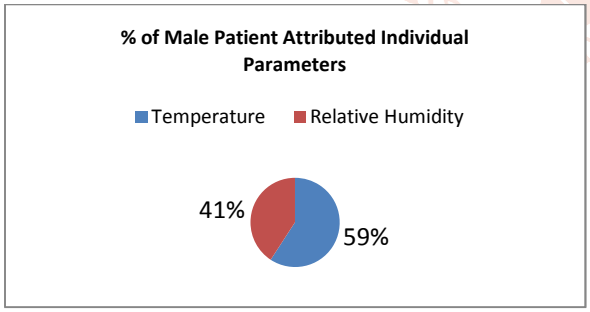
None of the number of male and female diagnosed with psychiatric cases in the year 2010, 2011 and 2017 was traceable to increase in temperature. Certain numbers of male and female diagnosed with psychiatric cases in the year 2014 -2016 were traceable to increase in temperature and that in each of the year (2014 -2016) increase in the temperature contributed more to the numbers of male patient than the number of female patients i.e. the increases in temperature made male population more vulnerable to the risk of psychiatric cases than female population positively in the years 2014 – 2016 while increase in temperature contributed nothing to number of male and female patient in the years 2010, 2011 and 2017. For year 2012 increase in temperature contributed to the numbers of female patient but none to the male patient and in the year 2013 increase temperature contributed to number of male patients while none to the female patient i.e. in the year 2012 increases in temperature made female population to be more vulnerable to the risk of psychiatric than the male population and made male population to be more vulnerable to the risk psychiatric cases than the female in the year 2013 as temperature increases. The total numbers of patient diagnosed with psychiatric cases and traceable to the increase in temperature for the 8-years (2010 – 2017) were 5068 and the total numbers of male patient out of 5068 were 2754 (54%) and the numbers of female patient were 2314 (46%).

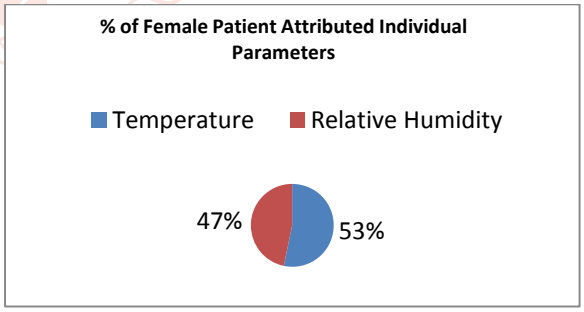
Relative Humidity

None of the number of male and female patients diagnosed with psychiatric cases in the year 2016 was traceable to increase in the relative humidity. Certain numbers of male and female patient diagnosed with psychiatric cases in 2010, 2012, 2014, 2015 and 2017 were traceable to increase in relative humidity and that in each of the year (2012 and 2015) increase in the relative humidity contributed more to the number of male patients than the of female i.e. the increases in temperature made male population more vulnerable to the risk of psychiatric cases than female population in 2012 and 2015 and that in 2010, 2014 and 2017 female population were made to be vulnerable to the risk of psychiatric cases than male population as relative humidity increases. The increase in relative humidity contributed nothing to number of male and female patients in 2016. While 2011 and 2013, increase in relative humidity contributed to the numbers of male patient but none to the number female patient i.e. in 2011and 2013 increase in the relative humidity made male population to be more vulnerable to the risk of psychiatric than the female population. The total numbers of patient diagnosed with psychiatric cases and traceable to the increase in relative humidity for the 8-years (2010 – 2017) were 3929 and the total numbers of male patient out of 3929 were 1896 (48.26%) and the numbers of female patient were 2033 (51.74%).

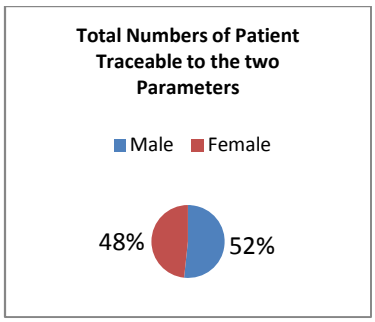


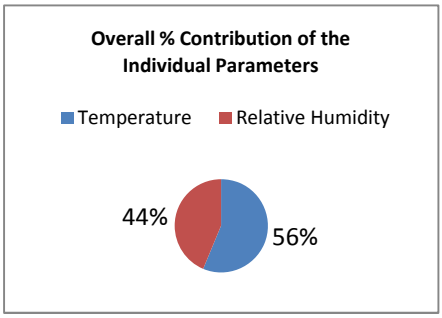






The total numbers of Male Patient diagnosed with psychiatric cases and traceable to increase in the temperature and relative humidity is 4650 and that of female is 4347





3.2.2. Multivariate Analysis: Overlapping effect

Table 6: Multiple Regression Analysis: STATA

Overlapping Effect					
Year		Male		Female	
		Temperature	Relative Humidity	Temperature	Relative Humidity
2010	Coefficient	-50.63983	11.03361	-42.49467	9.850444
	P	0.173	0.152	0.222	0.174
	Overall (F)	2.604195	2.604195	2.190399	2.190399
	R^2 (Overall)	0.3666	0.3666	0.3274	0.3274
	Overall (P)	0.1281	0.1281	0.1679	0.1679
	CI	[-128.1272, 26.84755]	[-4.917226, 26.98444]	[-115.8036, 30.81425]	[-5.240251, 24.94114]
	% of Determination	1123.9956	1123.9956	1118.3984	1118.3984
	Number of Patients	3066	3066	3416	3416
2011	Coefficient	-22.0051	2.108799	-5.866548	-3.068933
	P	0.244	0.451	0.755	0.914
	Overall (F)	0.8027956	0.8027956	0.0962398	0.962398
	R^2	0.1514	0.1514	0.0209	0.0209
	Overall (P)	0.4777	0.4777	0.9092	0.9092
	CI	[-61.93768, 17.92749]	[3.941674, 8.159273]	[-47.10503, 35.37194]	[-6.535234, 5.941447
	% of Determination	407.4174	407.4174	66.5456	66.5456
	Number of Patients	2691	2691	3184	3184
2012	Coefficient	-21.06847	6.135307	-2.495627	2.840327
	P	0.34	0.096	0.907	0.274
	Overall (F)	1.907421	1.907421	0.6877179	0.6877179
	R^2 (Overall)	6.2977	0.2977	0.1326	0.1326
	Overall (P)	0.2039	0.2039	0.5273	0.1326
	CI	[-68.35173, 26.21479]	[-1.338412, 13.00903]	[-49.72923, 44.73797]	[-3.625543, 11.3062]
	% of Determination	21172.8674	1000.8674	463.5696	463.5696
	Number of Patients	3362	3362	3496	3496
2013	Coefficient	2.07667	2.382769	0.2337595	-6.099497
	P	0.909	0.546	0.194	0.367
	Overall (F)	0.2133249	0.2133249	0.4545824	0.454824
	R^2	0.0453	0.0453	0.0917	0.0917
	Overall (P)	0.8119	0.8119	0.6485	0.6485
	CI	[-37.86671, 42.02005]	[-6.213064, 10.9786]	[-67.31119, 67.77871]	[-20.6352, 8.436207]
	% of Determination	154.5636	154.5636	342.8663	342.8663
	Number of Patients	3412	3412	3739	3739
2014	Coefficient	64.94273	4.165016	56.86169	4.281963
	P	0.056	0.444	0.077	0.415
	Overall (F)	2.600671	2.600671	2.227938	2.227938
	R^2	0.3663	0.3663	0.3311	0.3311
	Overall (P)	0.1284	0.1284	0.1637	0.1637
	CI	[-1.986806, 131.8723]	[-7.597945, 15.92798]	[-7.615861, 121.3392]	[-7.050058, 15.61398]
	% of Determination	1023.8085	1023.8085	958.2034	958.2034
	Number of Patients	2795	2795	2894	2894
2015	Coefficient	13.50649	-0.7952687	18.04406	-1.378267
	P	0.665	0.847	0.706	0.829
	Overall (F)	0.1139278	0.1139278	0.0781261	0.0781261
	R2	0.0247	0.0247	0.0171	0.0171
	Overall (P)	0.8936	0.8936	0.9255	0.9255
	CI	[-54.72315, 81.73613]	[-9.882344, 8.291807]	[-86.9525, 123.0409]	[-15.36214, 12.6056]
	% of Determination	76.6688	76.6688	60.9444	60.9444
	Number of Patients	3104	3104	3564	3564
2016	Coefficient	43.92738	-2.294296	42.55235	-0.1133393
	P	0.01	0.263	0.054	0.968
	Overall (F)	6.547091	6.547091	2.502986	2.502986
	R^2	0.5927	0.5927	0.3574	0.3574
	Overall (P)	0.0176	0.0176	0.1367	0.1367
	CI	[13.4655, 74.38925]	[-6.636613, 2.04802]	[-0.8340547, 85.92875]	[-6.298035, 6.071361]
	% of Determination	2000.3625	2000.3625	1490.0006	1490.0006
	Number of Patients	3375	3375	4169	4169
2017	Coefficient	-52.36417	4.218635	-76.87548	9.079077
	P	0.145	0.48	0.059	0.179
	Overall (F)	1.76409	1.76409	3.981404	3.981404
	R^2	0.2816	0.2816	0.4694	0.4694
	Overall (P)	0.2257	0.2257	0.0577	0.0577
	CI	[-126.6781, 21.94977]	[-8.742546, 17.17982]	-157.4084	3.657432
	% of Determination	944.768	944.768	1917.0296	1917.0296
	Number of Patients	3355	3355	4084	4084

This is the combination of the impact (or resultant effect) of the two independent variables (i.e. the two climate parameters-temperature and relative humidity) on the number of male and female patients with mental ill-health. From table 6:

- During the overlapping process in 2010, the coefficient for temperature shows that an increase in temperature resulted in 50.64 and 42.59 decreases in the number of male and female patients respectively. While an increase in the relative humidity resulted in 11.03 and 9.90 increases in the numbers of male and female respectively. The rate at which the male population is at risk of psychiatric cases is more than female population as relative humidity increases and statistically not significant from confidence interval and P-values. The F-value been a positive value is an indication that the numbers of male and female patient increases as the overlapping effect of the two independent variables increases. The percentage of determination shows that number of male and female patients diagnosed with psychiatric cases and traceable to the overlapping effect were 1134 and 1127 respectively. The number of male vulnerable to the risk of psychiatric cases as the overlapping effect increases was more than the female.
- During the overlapping process in 2011, the coefficient for temperature shows that an increase in temperature resulted in 22.01 and 5.87 decreases in the number of male and female patients respectively. While an increase in the relative humidity resulted in 2.11 increase and 3.07 decrease in the number of male and female patients respectively. The rate at which the male population is at risk of psychiatric cases is more than female population as relative humidity increases and statistically not significant from confidence interval and P-values. The F-value been a positive value is an indication that the number of male and female patients increases as the overlapping effect of the two independent variables increases. The percentage of determination shows that number of male and female patients diagnosed with psychiatric cases and traceable to the overlapping effect were 404 and 64 numbers respectively. The numbers of male vulnerable to the risk of psychiatric cases as the overlapping effect increases were more than the female.
- During the overlapping process in 2012, the coefficient for temperature shows that an increase in temperature resulted in 21.07 and 2.50 decreases in number of male and female patients respectively. While an increase in the relative humidity resulted in 6.12 and 2.84 increase in the number of male and female patients respectively. The rate at which the male population is at risk of psychiatric cases is more than female population as relative humidity increases and statistically, not significant in view of confidence interval and P-values. The F-value been a positive value is an indication that the numbers of male and female patient increases as the overlapping effect of the two independent variables increases. The percentage of determination shows that numbers of male patient and female diagnosed with psychiatric cases and traceable to the overlapping effect were 1009 and 455 respectively. The numbers of male vulnerable to the risk of psychiatric cases as the overlapping effect increases were more than the female.
- During the overlapping process in the year 2013, the coefficient for temperature shows that an increase in temperature resulted in 2.08 and 0.23 increases in number of male and female patients respectively. While an increase in the relative humidity resulted in 2.38 increase and 6.10 decrease in the numbers of male and female respectively. The rate at which the male population is at risk of psychiatric cases is more than female population as relative humidity and temperature increases and statistically not significant from confidence interval and P-values. The F-value been a positive value is an indication that the number of male and female patients increases as the overlapping effect of the two independent variables increases. The percentage of determination shows that number of male patient and female diagnosed with psychiatric cases and traceable to the overlapping effect were 171 and 337 respectively. The number of female vulnerable to the risk of psychiatric cases as the overlapping effect increases was more than the male.
- During the overlapping process in the year 2014, the coefficient for temperature shows that an increase in temperature resulted in 64.94 and 56.86 increases in the numbers of male and female patient respectively. While an increase in the relative humidity resulted in 4.17 and 4.28 increase in the numbers of male and female respectively. The rate at which the male population is at risk of psychiatric cases is more than female population as temperature increases while the rate at which the female population is at risk of psychiatric cases is more than male population as relative humidity increases and statistically not significant from confidence interval and P-values. The F-value been a positive value is an indication that the number of male and female patient increases as the overlapping effect of the two independent variables increases. The percentage of determination shows that number of male patient and female patients diagnosed with psychiatric cases and traceable to the overlapping effect were 1034 and 925 respectively. The number of male vulnerable to the risk of psychiatric cases as the overlapping effect increases was more than the female.
- During the overlapping process in the year 2015 coefficient for temperature shows that an increase in temperature resulted in 13.51 and 18.04 increases in the numbers of male and female patient respectively. While an increase in the relative humidity resulted in 0.80 and 1.38 decreases in the numbers of male and female respectively. The rate at which the female population is at risk of psychiatric cases is more than male population as temperature increases and statistically not significant from confidence interval and P-values. The F-value been a positive value is an indication that the number of male and female patient increases as the overlapping effect of the two independent variables increases. The percentage of determination shows that number of male patient and female diagnosed with psychiatric cases and traceable to the overlapping effect were 62 and 71 numbers of patients respectively. The numbers of female vulnerable to the risk of psychiatric cases as the overlapping effect increases were more than the male.
- During the overlapping process in the year 2016, the coefficient for temperature shows that an increase in temperature resulted in 43.93 (statistically significant) and 42.55 (not statistically significant) increases in number of male and female patient respectively. While an increase in the relative humidity resulted in 2.29 and 0.11 decrease in

the numbers of male and female patient respectively. The rate at which the male population is at risk of psychiatric cases is more than female population as temperature increases and statistically not significant from confidence interval and P-values. The F-value been a positive value is an indication that the number of male and female patient increases as the overlapping effect of the two independent variables increases. The percentage of determination shows that numbers of male patient and female diagnosed with psychiatric cases and traceable to the overlapping effect were 1991 and 1501 number of patients respectively. The number of male vulnerable to the risk of psychiatric cases as the overlapping effect increases was more than the female.

- During the overlapping process in the year 2017 coefficient for temperature shows that an increase in temperature resulted in 52.36 and 76.88 decreases in numbers of male and female patient respectively. While an increase in the relative humidity resulted in 4.22 and 9.08 increase in the numbers of male and female patient respectively. The rate at which the female population is at risk of psychiatric cases is more than male population as relative humidity increases and statistically not significant from confidence interval and P-values. The F-value been a positive value is an indication that the number of male and female patient increases as the overlapping effect of the two independent variables increases. The percentage of determination shows that number of male and female patients diagnosed with psychiatric cases and traceable to the overlapping effect were 939 and 1919 number of patients respectively. The numbers of female vulnerable to the risk of psychiatric cases as the overlapping effect increases were more than the male.

3.31. Summary: Multivariate Analysis

Table 7: Summary of the Multivariate Table

	% Coefficient of Determination			F-Value	
Year	Male	Female	Total	Male	Female
2010	1134	1127	2262	2.60	2.19
2011	404	64	467	0.89	0.10
2012	1009	454	1463	1.91	0.69
2013	171	337	507	0.21	0.45
2014	1034	925	1959	2.60	2.23
2015	77	61	138	0.11	0.08
2016	1991	1501	3492	6.55	2.50
2017	939	1919	2859	1.76	3.98
TOTAL	6759	6389	13148	17	12

The F-value defines the fluctuation of the independent variables and their effective strength on the dependent variable. As the F-value goes up and down its shows that there is rising and falling in the impact of the overlapping effect of the two independent variables on the number of male and female patients diagnosed with psychiatric cases. As we follow the trend of F-value from 2010-2017 where there is rise in the F-values shows that the number of patients increases more than previous year and where there falling in the F-values shows that the numbers of patient decrease below the previous year. Where the F-value is low is an indication that the capability/strength of the overlapping effect to make population sex based vulnerable to the risk of psychiatric cases is weak and this does not signify negative association between the numbers of patient and the overlapping effect. It is positive association because the F-values are all positive.

From the year 2010 – 2017 in each year the number of male patient diagnosed and traceable to the increase in the overlapping effect were more than the numbers of female patient with exemption of 2013 and 2017 were female patients are more than male patients This is evidence when we compare each year F-values for male and female. The F-value for male is higher than F-value for the female (e.g. 2010, 2011, 2012, 2014, 2015 and 2016) while the F-value for female is higher than F-value for the male (e.g. 2013 and 2017). We can then say that the strength of the overlapping effect of the two independent variables is more positive on the male patients that the female. The overlapping effect made male population to be more vulnerable to the risk of psychiatric cases than the female. Total numbers of male and female patient are 6759 and 6389 respectively corresponds to F-values of 17 and 12 male and female patients respectively.

Now the total number of patients diagnosed with psychiatric cases and who visited the Neuropsychiatric hospital from the year 2010 – 2017 were 53616. Out of this number, 25160 (46.93%) were male patients and 28456 (53.07%) were female patients. One would expects that the number of female patients diagnosed with psychiatric cases 2010 -2017 being more than male should be vulnerable to risk of psychiatric cases than the male as the overlapping effect increases. But numbers of male is more than female due to overlapping effect. Out of 53616 total number of psychiatric diagnosed in the hospital between 2010- 2017, 13148 (24.52%) total number of male and female patients were traceable to the overlapping (or resultant) effect of the two independent variables (i.e. temperature and relative humidity) and that the remaining explaining 40468 (75.48%) can be traceable to others factors such as socio-economy factors or other climate parameters rather than temperature and relative humidity. The overall total numbers of psychiatric cases from 2010 -2017 due to overlapping effect of the two independent variables is 13148. Here, we have number of male patients to be 6759 (51.41%) and the female is 6389 (48.59%).

Consider the total 53616 number of patients that visited the hospital between 2010- 2017, we will have 12.60% numbers of male patient and 11.91% numbers of female patient diagnosed and traceable to overlapping effect. The remaining and unexplained percentage can be traceable to others factors.

4. Discussion of Findings

It is discovered from single regression analysis:

- The male populations were found to be more vulnerable to the risk of psychiatric cases than the female as the temperature increases.
- The female populations were found to be more vulnerable to the risk of psychiatric cases than the male as the relative humidity increases.
- Increase in temperature made populations of male and female to be more vulnerable to risk of psychiatric cases than the increase in relative humidity i.e. The total number of male and female patients diagnosed and traceable/attributed to increase in temperature was 5068 in 2010-2017 while the total numbers of male and female patient diagnosed and traceable/attributed to increase in relative humidity was 3929 in 2010-2017.
- The increase in the overlapping effect made male population to be more vulnerable to risk of psychiatric cases than female population
- This is also an indication that various factors that resulted to psychiatric cases may have different degree of effect on mental health even with the sex distribution.

The response of both sexes to the increase in temperature, relative humidity and overlapping effect of the two parameters is an indication that male and female response differently to environmental changes. From single regression analysis the total number of patient diagnosed with psychiatric cases and traceable or attributed to increase in temperature was 2754- male and 2314-female and the total number of patients diagnosed with psychiatric cases and traceable or attributed to the increase in temperature was 1896-male and 2033-female. We have total numbers of Male- 4650 and female- 4374. The total number of patients diagnosed with psychiatric cases as the overlapping increases was 6759-male and 6389-female. The increases in overlapping effect escalated psychiatric cases in both sexes than the increase in the two parameters as a separate entity.

The positive association we found in both numbers of males and females psychiatric patients and the increase in the temperatures and relative humidity can be seen as real-life scenarios and differences in their responses can be due to the fact that workers are exposed to a variety of ambient temperature and relative humidity. This exposition to variety of ambient temperatures and relative humidity is found to be severe on males and females during the periods of the eight years. The visiting of male psychiatric patients had higher risks than those females and these might be due to those facts that males spent more time outside for occupational activities compared to women. The fact that men spent more time outside for occupational activities and the metabolic rate is higher in male than female are evidence that men are at more risk of mental ill-health as we experiencing hot weather compared to those females. Men respond to stress from increase in the temperature with more intensely negative effects (impacts) than females while females respond to stress from the increase in the relative humidity with more intensely negative effects (impacts) than males. Differences in their chemical, mechanical and biological (generally physiological and psychological factors) responses to environmental factors or external forces are the reason for the differences in the degree of their vulnerability to the risk of mental ill-health as the two parameters increases.

Increases in the relative humidity prevent body cooling process because sweating will be impaired. This impairment of cooling process (sweating) will generate heat that might not be tolerant to the body. Since women are less heat tolerant than men we expect the effects of the increase in relative humidity to be more intensely negatively impacts the females than the males and also since the metabolic rate in women is less than men the rate of sweating in women will be at fewer rates than men. This lack of sweating rate in women can be escalated during elevation in the ambient relative humidity making women to be prone to the risk of mental ill-health than men. According to the NIOSH (2013): The National Institute for Occupational Safety and Health (NIOSH) reports that several studies comparing the heat tolerances of men and women have concluded that women are less heat tolerant than men. While this difference seems to diminish when such comparisons take into account cardiovascular fitness, body size, and acclimatization, women tend to have a lower sweat rate than men of equal fitness, size and acclimatization. This lower sweat rate means that there can be an increase in body heat and we could expect extreme heat to have worse effects on mental health when relative humidity is high. According to Phan M T (2017) the numbers female patients with psychiatric cases increases significantly during longer heat waves.

Women are less heat tolerant than men and also have lower sweat rate than men. Hypothermic effects will be more in women than men during elevations in the relative humidity. When heat increase in the body brain temperature increases, the fact that women have less heat tolerant than men, brain entropy information will be impaired at a faster rate than men.

We all know that females spent more time inside kitchen activities compared to males. Since fan or air conditioning may not be easily incorporated into the kitchen, ambient air will be hot due to heat generation during cooking. The body cooling process might be difficult and this can lead to the raising in the body humidity which can affects them mentally. If the difference in the partial pressure of water vapor between the skin and ambient air decrease with increasing ambient relative humidity, driving for evaporation will also reduce. This situation can aggravate mental ill-health among females with symptoms of mental disorders or already in the mental world ill-health, so, staying long times in the kitchen expose to extensively to heat from the kitchen fires.

If women were to be considered more comfortable at temperature of 2.5^0C warmer than men typically between temperature ranges of $24 - 25^0C$. It could be expected from this study that at an average annual temperature of $24 - 25^0C$ and above, male population should be more vulnerable at the risk of psychiatric/mental ill-health cases than female population.

From table 2 and 5: where we have average annual temperature and contributions of temperature to male and female patient diagnosed with psychiatric cases. We discovered that at temperature range of $24 - 25.48^0C$ from 2013 – 2016 the number of male patients diagnosed with psychiatric cases is more than female.

Year	Average Annual Temperature (^0C)	Male	Female
2013	24.96	12	(-)3
2014	25.14	897	776
2015	25.05	63	41
2016	25.48	1782	1490
Total Numbers of Patient		2754	2307

In each of the years in the table above: Female are less vulnerable to the risk of psychiatric cases than male at this temperature range. Female are then more comfortable than male. Male are more vulnerable to the risk of psychiatric cases with this range of temperature in each year than female. The immunities of female population are stronger against psychiatric influence with this range of temperature than males. This could make male less comfortable than female, so male were more vulnerable to the risk of psychiatric cases than female with this range temperature. The total numbers of male patient are more than that of numbers of female patient between at this range of temperature (2013 -2016).

The men brain being larger in size and volume than women brain with approximately the same neuron density, increase in volume/size reduces the brain/neuron density and the decline in the brain density can have adverse effect on the brain functionality in turns decline in the brain entropy and brain entropy information processing capacity. Since male brain is larger in size/volume than female and the brain size/volume increases with increase in temperature, then neuron density will decline with increase in temperature. The male neuron density will decline more than the female as temperature increases. The decline in the male neuron density declined the brain entropy will make male population to be more vulnerable to the risks of psychiatric cases than female population as the temperature increases.

The fact that male are more vulnerable to the risk of psychiatric cases as temperature increases while female are more vulnerable to the risk of psychiatric cases as relative humidity increase. But there are some years (e.g. 2011, 2012, 2013 and 2015) where male population were more vulnerable to the risk of psychiatric cases than female as relative humidity increases. Even in the year 2012, the numbers of female vulnerable to the risk of psychiatric cases are more than male as temperature increases and according to **Ricardo A et al (2018)** Expose to high temperature should be considered a significant risk for mental disorder: Hospital admissions by mental disorders increase significantly with high temperatures while tend to decrease with low temperature and that women with mental disorders are more vulnerable than men to high temperatures.

It can be said that increases in temperature and relative humidity (when considered separately) and the increases in the overlapping effect are positively associated with increases in the numbers of male and female psychiatric patients and that male population were more vulnerable to the risk of psychiatric cases than female in the overall event.

5. Summary of the Findings

Generally the number of psychiatric cases (or mental ill-health) and the rate of hospital visits among male and female increased with increase in both parameters. There are positive association between the number of male patients/number of female patients and increase in temperature. There are positive association between the number of male patients/number of female patients and increase in relative humidity. The variability of the climate parameters (temperature and humidity) impact is not uniformly distributed among sexes. Male population were more vulnerable to the risks of psychiatric/mental ill-health cases than female population as temperature increases i.e. the increase in the temperature as a separate independent variable exacerbated the number of the male psychiatric patients than the female psychiatric patients.

Female population were more vulnerable to the risks of psychiatric/mental ill-health cases than male population as relative humidity increases i.e. the increase in the relative humidity as a separate independent variable exacerbated the numbers of the female psychiatric patients than the male psychiatric patients.

According to the data collected for the study, female population are more comfortable than male between temperature range 24-25.5^{0}C and that male are more vulnerable to the risks of psychiatric cases than female between the same temperature range. Male populations are more vulnerable to the risk of psychiatric cases than female population as the overlapping (resultant) effect of the two parameters increases.

Male populations are more vulnerable to the risk of psychiatric cases than female population as the male brain/neuron density decline as temperature increases because increase in brain/ambient temperature increases the volume of the brain and brain/neuron density is inversely proportional to the brain volume. The male brain volume been larger than the female brain size/volume further increases in the temperature will further increase the male brain size/volume in turns further decline the men brain/neuron density and brain entropy more than the female brain/neuron density and brain entropy making male to be at the risks of psychiatric cases than female as temperature increases.

6. Conclusion

Increase in the temperature exacerbates psychiatric cases among male and female populations more than relative humidity. Finally, male and female respond differently to their environmental challenges e.g. variability in their environmental climate parameters such as temperature, relative humidity and overlapping effect of the two parameters. The differences in their responses to environmental variability can be due to the fact male and female are psychologically and physiologically different. Male and female population respond differently to the impact of each parameter throughout those years

considered and these are considered to be psychological and physiological factors differences in male and female. Out of 53616 patients that visited the hospital between (2010-2017), only 11,409 (21.28% of 53616) male were diagnosed with psychiatric cases and all together traceable/attributed temperature, relative humidity and overlapping effect escalation while only 10,736 (20.02% of 53616) female were diagnosed with psychiatric cases and all together traceable/attributed temperature, relative humidity and overlapping effect escalation. In the overall analysis male population were more vulnerable to the risk of psychiatric cases than female as the two independent variables increases. The effective strength of temperature made the numbers of male/female populations more vulnerable to the risk of psychiatric cases than the effective strength of relative humidity. There exist positive associations between the rate of admission and increase temperature (relative humidity) for both numbers male and female, only that the number of patients differs from sex to sex in the distributions.

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