Correlation of Rainfall on Tuberculosis Distribution in South-Southern Nigeria

Efe, S. Ighovie¹, Esososakpo, E. Evelyn² and Awaritefe, O. D.³
Department of Geography and Regional Planning
Delta State University Abraka
E-mail: efesunday@delsu.edu.ng¹, evetehjite@gmail.com²

Abstract
The study examines the problem of rainfall on the prevalence of tuberculosis (TB) in the South-Southern Nigeria. It correlates rainfall with the prevalence of TB in the six states (Cross River, Bayelsa, Rivers, Edo, Akwa Ibom, and Delta) of southern Nigeria. It adopted a survey design of government hospitals and climatic research unit gridded time series (CRU TS), and the National Aeronautics and Space Administration (NASA) from 1991-2021. Statistical diagrams and simple regression techniques were adopted for the study. The results displayed an annual rainfall of 2391mm and a total 695,959 cases of TB in the six states from 1991-2021, with Cross River and Delta states having the highest (546,204) and lowest (1723) cases of TB respectively. It also showed an R value of 0.71 and R square value of 0.50 indicating that rainfall has 50% contribution to the occurrence of TB in South- South states of Nigeria. The regression model revealed 29.326 F-value and 4. 609 t-value with P<0.05. This indicates that rainfall has marked effect on the prevalence of TB in the southern Nigeria. The study therefore recommends that climatic factor should be incorporated into the planning, management, control and prevention of TB programmes in Nigeria.

Keywords: Rainfall, tuberculosis, cases, South-Southern, Nigeria

Introduction
Nigeria ranks third, trailing only India and China in the cases of TB. Every year, over 245,000 die from TB, and approximately 590,000 new cases are diagnosed (of whom approximately 140,000 are also HIV-positive). Over ten percent of the fatalities in Nigeria are caused by tuberculosis. Notwithstanding the availability of modern medicines, about 15 individuals die from TB hourly, equating to around 347 casualties daily, 10,417 each month, and 125,000 annually. (WHO 2019, 2023).

Maharjan et al.(2021) and Kharwadkar et al (2022) observed that the magnitude of current climate change with large shifts in extreme weather like extreme temperatures, torrential downpours and droughts in Nigeria and other countries of the world has some implication on the incidence of diseases. The impact of climate change could boost the prevalence of transmissible diseases like TB. This could affect the interaction of the disease with the individual, societal, and ecological factors. In Nigeria, studies on ecology of disease are limited to malaria, and corona virus and other diseases to the neglect of TB (see Efe and Ojoh 2013, Efe 2023). While the link connecting climate change to TB has emerged in the past few years, it has been overlooked in international discussions. For effective eradication, TB must be recognized to be a climate induced illness (Kharwadkar et al, 2022). Nigeria maintains the largest TB prevalence in Africa as well as one of the eight countries responsible for two-thirds of the world TB incidence. In 2018, the government made agreements during the UN High Level Meeting (UNHLM) against TB to effectively treat 1,109,000 persons having TB between 2018-2022 (Federal Ministry of Health 2019). The ministry opined that fund and environmental factors are the major setback to the control of TB. For instance, just 31
percent of the required $373 million for implementing TB prevention and control in Nigeria in 2020 was accessible to the TB control executioners in Nigeria.

Studies on the influence of climate on Tuberculosis showed divergence viewpoints. For instance while, Beiranvand et al (2016) established rainfall inverse relationship with TB cases, Koh et al (2013) opined that in Birmingham TB correlate inversely with sunlight total hours six months. Similarly, climate change influence on overcrowding and non-communicable diseases: the triple whammy of TB transmission risk in Pacific and other countries was emphasized (McIver et al 2015). They however call for studies in other regions of the world. Upon the above neglects and calls, the study correlates rainfall on tuberculosis distribution in South-Southern Nigeria.

The region is one of the geopolitical zones in Nigeria. South-Southern is located at the intersection of latitudes 4°20'N–7°40'N and longitudes 5°–9°20'E of the Greenwich. The zone stretches from Akwa Ibom, Bayelsa, Cross River, Delta, Edo to Rivers States, and a land mass of 85,303 square kilometers as shown in Fig. 1. Because of its proximity to the coast, lowlands, and enormous water bodies in the area, it often leads to outbreaks of diseases in the region.

The study adopted the schematic model of Hodge (2015) on climate change influence on tuberculosis transmission in the pacific and other countries of the world (see fig 2). It describes the operation of climate change and its effects on the transmission of TB, and socio economic impact of the people. It also shows how the adaptations of weather events influence the prevalence of TB.
The study utilizes temperature data from Climatic Research Unit gridded time series (CRU TS), and the National Aeronautics and Space Administration (NASA) and the tuberculosis data obtained from six states (Cross River, Bayelsa, Rivers, Edo, Akwa Ibom, and Delta) of southern Nigeria ministries of health and government hospitals from 1991-2021. These states were chosen based on data availability and consistence. TB data was obtained from the hospitals' record offices in each state with the agreement of the physician directors, ethics boards, and heads of records. This period was chosen to mark a climate normal met for the description of climate events on man's activities (Efe & Ojoh, 2013; Weli & Efe, 2015). Statistical diagrams and simple regression analysis was used for the study. While the statistical diagrams were used to present the data, the regression analysis was adopted to establish the level of relationship and influence of rainfall on the prevalence of tuberculosis in the South-Southern Nigeria. This technique is in congruent with those of Koh (2013) and Beiranvand et al (2016).

Results and discussion

Fig. 3 shows that South-Southern Nigeria has an annual rainfall of 2391mm and a total 695,959 cases of TB from 1991-2021 periods. The year 2000 has the lowest rainfall of 2278mm and the highest rainfall value of 2625mm was observed in 2012. Other years rainfalls span 2291mm - 2587mm. This is in tandem with Efe 2005); Efe & Ojoh (2013) and Weli & Efe (2015). However, 2014 had the lowest value (2778 cases) of TB and 2019 recorded the highest value (58994 cases) of TB in this region. The rest years had 3331-51248 cases of TB during this period.

Fig. 4 showed the TB cases in the South-Southern states. These are 546204 cases (Cross River), Bayelsa (112305 cases), Rivers (31500 cases), Edo (2375 cases), Akwa Ibom (18351 cases) and Delta (1723 cases).
Fig. 3: Annual Distribution of Rainfall and Tuberculosis in South-Southern Nigeria

Fig. 4. Total Cases of TB in the States of the South-Southern Nigeria (1991-2021)

The details year by year are displayed in Fig, 5. The yearly cases of TB are: Cross River has 896 in 2014 and 35110 in 2019. Bayelsa recorded 11im 1992 and 23444 in 2013. While Rivers cases span 232 to 1819 in 2013 and 2016 respectively, Akwa Ibom has 3 cases in 1993,1996, 1998 and 2001 to 290 cases in 2014 .Delta state had the least cases of 3-305 cases in 2015, 2016 to 305 cases in 2011.
Table 1 Model Summary Explaining the Relationship Between Rainfall and TB

<table>
<thead>
<tr>
<th>Model</th>
<th>R</th>
<th>R Square</th>
<th>Adjusted R Square</th>
<th>Std. Error of the Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>.709a</td>
<td>.503</td>
<td>.486</td>
<td>11857.40528</td>
</tr>
</tbody>
</table>

a. Predictors: (Constant), Rainfall

Table 1 established 0.709 R-value, indicating that rainfall distribution has a strong relationship with the occurrence of TB, and this demonstrated R square value of 0.503 showing that rainfall has 50% contribution to the occurrence of TB in South-Southern states of Nigeria. Tables 2 and 3 showed 29.326 F-value and 4.609 t-values respectively. The 29.326 F-value and 4.609 t-value are P<0.05, indicating that rainfall has marked effect on the occurrence of TB in the southern Nigeria. This is however incongruent with Beiranvand et al (2016) that established inverse relationship.

Table 2: ANOVAa

<table>
<thead>
<tr>
<th>Model</th>
<th>Sum of Squares</th>
<th>Df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Regression</td>
<td>4123154726.203</td>
<td>1</td>
<td>4123154726.203</td>
<td>29.326</td>
</tr>
<tr>
<td></td>
<td>Residual</td>
<td>4077343740.562</td>
<td>29</td>
<td>140598060.019</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>8200498466.765</td>
<td>30</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

a. Dependent Variable: TB
b. Predictors: (Constant), Rainfall

Table 3: Coefficientsa

<table>
<thead>
<tr>
<th>Model</th>
<th>Unstandardized Coefficients</th>
<th>Standardized Coefficients</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B</td>
<td>Std. Error</td>
</tr>
<tr>
<td>1</td>
<td>(Constant)</td>
<td>11405.645</td>
</tr>
<tr>
<td></td>
<td>Rainfall</td>
<td>.861</td>
</tr>
</tbody>
</table>

a. Dependent Variable: TB
Conclusion
The study established South-Southern Nigeria has a rainfall of 2391mm and a total of 695959 cases of TB from 1991-2021 with Cross River and Delta states having the highest (546, 204) and lowest (1723) cases of TB respectively. It also showed an R value of 0.71 and R square value of 0.50 which shows that rainfall has 50% contribution to the prevalence of TB in South-Southern Nigeria. Rainfall during this period correlated positively with occurrence of TB. Thus, rainfall established a marked effect on the occurrence of TB in the southern Nigeria. Arising from the above the study recommends that Nigeria ministry of health should incorporate weather vagaries into the TB prevention and control programmes on drug and vaccines preservation so as to minimize the cases of TB in Nigeria

References
Efe S. I. (2023) Spatial Distribution of Corona virus in Nigeria, a paper presented at ANG National conference on Climate Change, Disease Pandemic and Insecurity: The Geographical Perspective at University of Nigeria, Nsukka, Enugu State, Nigeria.
Weli, V.E. and Efe, S.I. (2015) Climate and
Efe, S. Ighovie, Esosuakpo, E. Evelyn and Awaritefe, O. D.: Correlation of Rainfall on Tuberculosis Distribution in South-Southern Nigeria

Epidemiology of Malaria in Port Harcourt Region, Nigeria. America Journal of Climate Change, 4, 40-47. http://dx.doi.org/10.4236/ajcc.2015.41004.
