Impact Of Climate Factors Through GLM And GAM Methods

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Abstract:Climate change can directly affect health through extreme temperature, increased floods and droughts and increased frequency of human diseases. Time series modeling are generally used to forecasting the values based on time period. The aim of this study is to assess the association between climate factors and the incidence of childhood pneumonia. The pneumonia incidence morbidity in borns and morbidity out borns children under five year and environmental factors, including monthly rainfall and the monthly average maximum temperatures during the period from January 2014 to Dec 2016 are considered. The data are analyzed with Generalized Linear Model (GLM) and Generalized Additive Model (GAM) to measure the impact of climate factors and both models are compared.

Index Terms:Pneumonia, rainfall, temperature, generalized linear model, generalized additive model.

1 INTRODUCTION

Changes in the earth's climate have been naturally occurring since the creation of the planet. Climate changes in the earth for every month are inevitable A growing body of evidence is attributing some climate changes to human-made environmental pollutants. Climate is how temperature, precipitation, and wind characteristically prevail in a region over many years. Weather, on the state of the atmosphere (temperature, moisture, wind velocity and barometric pressure) at a specific time and place. Climate changes involves statistically significant changes in the mean state of the climate (temperature or amount of precipitation) or in its variability that persist over periods of time on the order of decades or longer in other words, climate change is the long-term change in the average weather condition for a particular area. Annamalai et.al. (2004) investigated the impacts of Indian Ocean SST and heating anomalies on developing El Niño's, focusing on the difference in response before and after the 1976–77 climate shift. Singh et.al. (2012) reviewed the potential impact of climate change on health with a view to identify the scope of formulating steps to address the negative impact in the Indian context. The aim of this study is to assess the association between climate factors and the incidence of childhood pneumonia in Tirunelveli district.

2 MATERIALS

Hospital admission data in Tirunelveli city from January 2014 to December 2016 for Pneumonia disease were obtained from the ~~Mala~~ hospital. Monthly observations of environmental factors data such as maximum temperature (oC) and rainfall (mm) were obtained from www.worldweathearonline.com.

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3 DATA DESCRIPTION

Pneumonia: Inflammation of one or both lugs with dense areas of lung inflammation. Pneumonia is frequently but not always due to inflection. The inflection may be bacterial, viral fungal or parasitic symptoms may include fever, chills, cough with spectrum production, chest pain and shortens of breath.Pneumonia started germs called bacteria, viruses and fungi may cause pneumonia. In adults, bacteria are the most common cause of pneumonia ways you can get pneumonia include you breathe in (inhale) food, liquids, vomit or fluids from the mouth into your lungs. Investigations for bacterial pneumonia: Physical exam where the doctor listens to the patient's chest using a stethoscope for abnormal chest sounds such as roles, wheezing , complete blood picture, pulse oximetry to test the oxygen levels in the blood, chest X-ray, arterial blood gas (ABG), sputum culture, urinalysis. A doctor if we have difficulty for breathing, chest pain, persistent fever of 102^{O} F (39^{O} C) or higher, or persistent cough, especially if we are coughing up pus. It's especially important that people in these high risk groups see doctor adults older than age 65, children younger than age 2 with signs and system, people with an underlying health condition that suppresses the immune system (Merrill (2010)).

4 METHODS

Time series analysis was used in a study that described and compared the associations between certain weather variables and hospitalizations for pneumonia during normal weather periods. Temperature variables and rainfall were analyzed. The Generalized linear Model (GLM)is actually a unifying approach to regression and experimental design models, uniting the usual normal-theory linear regression models and nonlinear models such as logistic and Poisson regression. A key assumption in the GLM is that the response variable distribution is a member of the exponential family of distributions, which includes (among others) the normal, binomial, Poisson, inverse normal, exponential and gamma distributions. The basic idea of a GLM is to develop a linear model for an appropriate function of the expected value of the response variable. Let be the linear predictor defined by $\eta_i = g[E(y)_i] = g(\mu)_i = X'_i \beta$ ---(1) and the expected response is just` $[E(y)_i] = g^{-1}(\eta) = g^{-1}(X'_i \beta)$ ----(2) The Poisson regression model can be written as $y_i = E(y_i) + \varepsilon_{i,}$ i=1,2,….,n ----(3) We assume that the expected value of the observed response can be written as $E(y_i) = \mu_i$ ----(4) and that there is a function g that relates the mean of the response to a linear predictor, say $g(\mu_i) = \eta_i = \beta_0 + \beta_1 x_1 + \ldots + \beta_k x_k = {}_i x' \beta$ ---- *(5)* The relationship between the mean and the linear predictor is $\mu_i = g^{-1}(\eta) = g^{-1}(X'_i \beta)$ ---*(6)* There are several link functions that are commonly used with the Poisson distribution. One of these is the identity link $g(\mu) = \mu_i = X'_i \beta$ ----(7) When this link is used, since another popular link function for the Poisson distribution is the log link $g(\mu_i) = In(\mu_i) = X'_i \beta$ ----(8) For the above log link equation, the relationship between the mean of the response variable and the linear predictor is $\mu_i = g^{-1}(X'_i \beta) = e^{x'\beta}$ ----(8) The log link is particularly attractive for Poisson regression because it ensures that all of the predicted values of the response variable will be nonnegative. The method of maximum likelihood is used to estimate the parameters in Poisson regression. In the development to generalized linear models, we used the link function g to relate the conditional mean μ(x) to the linear predictor η(x). In particular, it all works perfectly well if η is an additive function of x. We form the effective responses zi as before, and the weights wi, but instead of linear regression on xi we needed an additive regression, using back fitting (or whatever). This gives us a generalized additive model (GAM) (Montgomery et.al.,(2003)). The associations between hospital admissions for pneumonia disease and climate variables were estimated using the Relative Risk (RR) and their 95% confidence intervals were using GLM and GAM methods. All statistical analysis were performed using R package.

5 RESULT AND DISCUSSIONS

The descriptive statistics for during the 3 years of the study, there were 36 pneumonia cases in hospital in born admissions and 36 pneumonia cases in hospital out-born admissions and corresponding climate factors data are shown in Table 1.

Table 1: *Descriptive analysis of Pneumonia Cases and Climate Factors.*

Characteristics	**Min**	**1st Quartile**	**Median**	**Mean**	**3rd Quartile**	**Max**
Max. Temp.	30.0	33.0	35.0	34.6	36.50	41.00
Rainfall	0.0	9.8	43.2	60.6	76.30	366.06

5.1 Association of Climate Factors and Pneumonia Cases Using Generalized Linear Model

GLM indicated that the concentrations of maximum temperature and rainfall were significantly associated with monthly hospital admissions due to pneumonia cases shown in Table 2.

Table 2: *Association of hospital admissions in Climate Factors using GLM*

Variables	**RR**	**LCL**	**UCL**	**P – Value**
In-Born Cases in Poisson Regression				
Maximum Temperature	0.986	0.968	1.0050	0.1416
Rainfall	1.001	1.000	1.0017	0.0117
In-Born Cases in Gaussian Regression				
Maximum Temperature	0.644	0.311	0.1657	0.5292
Rainfall	1.030	0.966	1.0997	0.3630
Out-Born Cases in Poisson Regression				
Maximum Temperature	1.0236	0.9972	1.0521	0.0878
Rainfall	1.0019	1.0010	1.0029	0.0000
Out-Born Cases in Gaussian Regression				
Maximum Temperature	1.5171	0.0610	3.7751	0.3768
Rainfall	1.0388	1.0010	1.0779	0.0519

The risks of weather variables for pneumonia disease after stratification by patient's age showed by Table 2. Effect modification was found for patient's age and pneumonia disease as shown by the significant P value for interaction terms. The effect on hospital admissions for In- Born Cases in Poisson regression on maximum temperature RR value is 0.9860 and 95% CI value is 0.9680 to 1.0050 and rainfall RR value is 1.0010 and 95% CI value is 1.0002 to 1.0017. The effect on hospital admissions for Out-Born cases in Poisson regression on maximum temperature RR value is 1.0236 and 95% CI value is 0.9972 to 1.0521 and rainfall RR value is 1.0019 and 95% CI value is 1.0010 to 1.0029.The effect on hospital admissions for In-Born Cases in Gaussian regression on maximum temperature RR value is 0.6442 and 95% CI value is 0.3110 to 0.1657 and rainfall RR value is 1.0309 and 95% CI value is 0.9664 to 1.0997.The effect on hospital admissions for Out-Born Cases in Gaussian regression on maximum temperature RR value is 1.5171 and 95% CI value is 0.0610 to 3.7751 and rainfall RR value is 1.0388 and 95% CI value is 1.0010 to 1.0779.

5.2 Association of Climate Factors and Pneumonia Cases using Generalized Additive Model

GAM indicated that the concentrations of maximum temperature and rainfall were significantly associated with monthly hospital admissions due to pneumonia cases shown in Table 3.

Table 2: *Association of hospital admissions in Climate Factors using GAM*

Variables	**RR**	**LCL**	**UCL**	**P – Value**
In-Born Cases in Poisson Regression				
Maximum Temperature	0.9860	0.979	1.105	0.141
Rainfall	1.0010	0.980	1.102	0.011
In-Born Cases in Gaussian Regression				
Maximum Temperature	0.0644	0.0532	0.0857	0.592
Rainfall	1.0309	0.9869	1.0197	0.363

Out-Born Cases in Poisson Regression				
Maximum Temperature	1.0236	0.9982	1.0621	0.087
Rainfall	1.0020	0.9890	1.1329	0.001
Out-Born Cases in Gaussian Regression				
Maximum Temperature	1.5170	1.4986	1.7151	0.376
Rainfall	1.0388	1.0098	1.1781	0.051

The risks of weather variables for pneumonia disease after stratification by patient's age showed by Table 3. Effect modification was found for patient's age and pneumonia disease as shown by the significant P value for interaction terms. The effect on hospital admissions for In- Born Cases in Poisson regression on maximum temperature RR value is 0.9860 and 95% CI value is 0.9790 to 1.1050 and rainfall RR value is 1.0010 and 95% CI value is 0.9802 to 1.1017. The effect on hospital admissions for Out-Born cases in Poisson regression on maximum temperature RR value is 1.0236 and 95% CI value is 0.9982 to 1.0621 and rainfall RR value is 1.0020 and 95% CI value is 0.9890 to 1.1329. The effect on hospital admissions for In-Born Cases in Gaussian regression on maximum temperature RR value is 0.0642 and 95% CI value is 0.0532 to 0.0857 and rainfall RR value is 1.0309 and 95% CI value is 0.9869 to 1.0197. The effect on hospital admissions for Out-Born Cases in Gaussian regression on maximum temperature RR value is 1.5170 and 95% CI value is 1.4986 to 1.7151 and rainfall RR value is 1.0388 and 95% CI value is 1.0098 to 1.1781.

6 Conclusions

The results of this study showed that among the climate factors, the associations between pneumonia cases were statistically significant was found. The effect of climate factors on childhood pneumonia in varied depending on the region. The childhood pneumonia risk generally showed a positive association with maximum temperature and rainfall. In comparison GLM and GAM, a positive association between rainfalls, in-born and out-born childhood pneumonia cases increase in the rainfall season.

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