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ABSTRACT

Predicting extreme asthma events in London using quantile regression models

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Objective

This paper describes a framework for creating a time series data set with daily asthma admissions, weather and air quality factors; and then generating suitable lags for predictive multivariate quantile regression models (QRMs). It also demonstrates the use of root mean square error (RMSE) and receiver operating characteristic (ROC) error measures in selecting suitable predictive models.

Introduction

The burden of asthma is a major public health issue, and of a wider interest particularly to public health practitioners, health care providers and policy makers, as well as researchers. The literature on forecasting of adverse respiratory health events like asthma attacks is limited. It is an unclear field; and there is a need for more research on the forecasting of the demand for hospital respiratory services.

Methods

Asthma hospital admissions from the hospital episode statistics (HES) database in the UK, weather and air quality measures obtained via the UK Met Office databases were used in the analysis (2005–2006). The key variables in the data were examined for their distribution and properties. Suitable time series lags were generated and converted into non-time series for bivariate quantile regression analysis. Multivariate QRMs were developed to predict extreme asthma events defined as > the 90th percentile. RMSE and ROC curves were used to compare error measures of each predictive model.

Results

All the potential predictors were independently significant with asthma daily admissions ($P<0.01$), however most proved to be insignificant in multivariate analysis when controlling for the other factors. Three significant predictive models were constructed: Model-I involved an 18-day lag barometric vapour pressure and a 3-day lag Nitrogen dioxide. Model-II included barometric pressure (18-day lag), Nitrogen dioxide (3-day lag) and air temperature (21-day lag), and then Model-III had barometric pressure (18-day lag), Nitrogen dioxide (3-day lag), air temperature (21-day lag), humidity (4-day lag) and formaldehyde (3-day lag). But for humidity and formaldehyde concentrations, all the variables were at least statistically significant at $P<0.01$ (see Table 1). Model-II had better predictive values for both normal and extreme asthma events compared with the other two

Table 1 QRM predictions of extreme (>90th percentile) asthma events in London

Asthma predictive models	*I*		*II*		*III*	
	s.e.	*Coef*$^{\Psi}$	*s.e.*	*Coef*$^{\Psi}$	*s.e.*	*Coef*$^{\Psi}$
Barometric pressure HPa (18-day lag)	−0.18	2.00***	−0.3	1.44***	−0.24	0.85***
Nitrogen dioxide§ (3-day lag)	−7.20e+07	1.8e+08*	−7.50e+07	4.4e+08***	−8.90e+07	2.9e+08**
Air temperature °C (21-day lag)			−0.18	−0.84***	−0.16	−1.11***
Humidity % (4-day lag)					−0.05	−0.04
Formal dehyde§ (3-day lag)					−2.30e+08	3.70e+08
Specification test: (Linktest) *hatsq* *P*-value	0.155		0.922		0.136	

$^{\Psi}$Expected change in log count for a one-unit increase in variable and degree of significance: *$P<0.1$, **$P<0.01$, ***$P<0.001$; §kgm^{-3}; standard error (s.e.).

models, and again had lower error measures compared with Model-I and Model-III.

Conclusions

Asthma daily admissions can be predicted from a combination of weather and air quality indicators including average daily measures of barometric pressure, Nitrogen dioxide, air temperature, humidity, and formaldehyde using QRMs. Barometric pressure, nitrogen dioxide, and air temperature were the best predictors of asthma daily admissions.

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