Influence of Weather and Air Quality Conditions on the Physiological response to cold weather stress: Impact on Asthma exacerbation in Miami Dade, Florida

D. Quesada, A. Perez, Y. Davila, M. Generani, and L. Perez- Cernuda
School of Science, Technology and Engineering Management, St. Thomas University, 16401 NW 37 Ave. Miami Gardens FL 33054

Abstract

Human Health is affected by a complex and coordinated action of many factors: Atmospheric, physiological, and behavioral; placing humans into different scenarios of sensible stress, that immediately impact the response of human beings to these external forcing. Asthma, a respiratory disorder characterized by airways inflammation and shortness of breath is an example of a human response to adverse environmental conditions modulated by the genetic predisposition of each individual. Florida Asthma Consortium (FAC) provided the asthma database for Miami and Broward from January 2005 to December 2011, showing the number of visits to Emergency Rooms. Additionally, a comprehensive weather database obtained from WeatherBug (Earth-network) including outdoor temperature (T), humidity (H), barometric pressure (P), wind direction (θ), and speed (v) as well as the values of maximum and minimum and the range of all these variables has been created. Environmental Protection Agency stations in Miami Dade provided information about Ozone and Particulate Matter over the same time frame. As a result, a seasonal pattern emerged, with a maximum appearing around the middle of December and a minimum around the middle of March every year for five years of analysis. The inclusion of weather indexes facilitates the understanding of the obtained correlations and helps to predict possible outbreaks of asthma.

Weather and Air Quality Data

Correlations between the number of cases and the given set of variables

The Acclimatization Thermal Strain Index – ATSI

Q = C + E = Respiratory Heat Exchange, Forced Convection
C = Dry heat flux through the skin (W/m²)
E = Humid heat exchange (W/m²)

Q = M x \( \text{ΔT}_{\text{ATSI}} \)

\( \text{ΔT}_{\text{ATSI}} \) = Body core temperature (°C) – Ambient air temperature (°C)

M = Metabolic heat rate (W/m²)

\( \text{ΔT}_{\text{ATSI}} < 0 \) cold strain

Why negative thermal loading is so relevant?
- Keytones in the etiology of acute respiratory diseases.
- Respiratory heat losses above the norm (15 W) – effective heat loss lead to high frequency of respiratory diseases in children.
- High heat losses from respiratory organs make it easier for pathogens to enter the lungs and may be the reason for increased mortality.

Miami Dade Data

The information about the number of Emergency Room (ER) visits due to Asthma was provided by the Florida Asthma Consortium (FAC) and covers years from 2005 through 2011 on daily basis. A breakdown by zip codes is also included in order to determine possible geographical spots.

Health Data

Features of Circled Areas
- Very close to highly transited roads and air
- Expressways
- High motor load, due to connecting bridges
- Low income population
- Predominantly ethnicity
- African – American

Areas of major incidence within Miami Dade County

Time series of Asthma ER visits in Miami Dade County from January 2005 to December 2011. It is noteworthy the maxima happening between December and January every year.

Health Laboratory

Broward
Miami Dade

WeatherBug Stations

Ozone Measuring Stations