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COMPARATIVE ANALYSIS OF DIFFERENT HUMAN THERMAL COMFORT INDEXES IN SÃO PAULO CITY AND THEIR RELATIONSHIP WITH RESPIRATORY MORBIDITY .

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1. INTRODUCTION

Many of the thermal comfort studies are carried on in areas were the seasons are marked by a decrease of the temperature. Considering that, the necessity of a better understanding of how do the people living in regions with sub-tropical climate and high temperature variations feel and response about this kind of variation.

The individual thermal comfort or upset perception is related with the metabolic heat production. With the aim of maintain the vital organic functions, this heat is transferred to the surroundings, resulting a psychologic impression and a corporal temperature. This heat transfer is influenced by environmental factors like air temperature, thermal radiation, air speed and humidity, and by individual factors like physical activity and clothing. Those variables, associated with biometeorologic indexes developed for thermal confort classification, contribute to the empiric classification of the human thermal impression. This study makes a comparative analyses of two different biometeorologic indexes (thermal comfort), and assess the potencial relation between those indexes and the respiratory morbidity in children up to 1 year of age in different periods (June to August [winter] and December to February [summer]), to the years 2003 and 2004, in the city of Sao Paulo/SP.

The city of Sao Paulo is located at the Southeast of Brazil (S 23º32'51'' W 46°38'10"). The weather is subtropical or altitude tropical (MARTYN, 1992), with two predominant weathers: the dry weather, from May to September, and the rainy weather, from October to April (SUGAHARA, 1991). The annual temperature average is 19ºC. During the summer the average temperature is about 25ºC, and during the winter the average temperature is 15ºC. The rain pattern is about 1500 mm/ano. Figures 1 and 2 show the annual humidity and temperature distribution for the years 2003 and 2004, measured by the IAG/USP – Atmospherical Sciences, Geophysics and Astronomy Institute Sao Paulo University's meteorological station.

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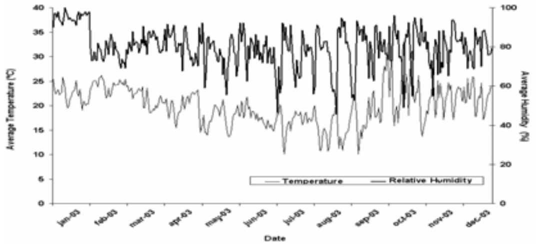

Figure 1: Average temperature and Average Humidity, from year 2003.

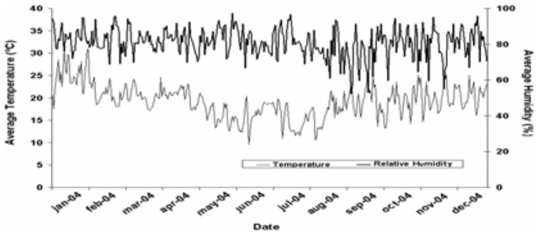

Figure 2: Average temperature and Average Humidity, from year 2004.

2. METODOLOGY

This study was carried on in the city of Sao Paulo/SP from June 2003 to August 2003, and from December 2003 to February 2004. Those periods were studied because they show the biggest thermal contrasts observed in Sao Paulo.

The meteorological data used to the indexes calculation where obtained from the IAG/USP meteorological station, located at the area Água Funda, in the city of Sao Paulo. Representative respiratory disease morbidity data (pneumoniae, asthma, bronquitis), were collected from the Health Information Database – DATASUS (www.datasus.gov.br , table 1).

Two different biometeorological indexes were then applied to characterize the Sao Paulo population's thermal comfort feeling during the two studied periods. Those indexes, linked with the respiratory disease morbidity pattern (hospitalary visits), allowed also the assesment of the upset sensations observed in the population. Despite the fact that the indexes doesn't consider individual human parameters (e.g. physical activity and clothing), they consider the environmental variables temperature, humidity and wind speed, which are the main thermal stress physiologic response starters.

The indexes used were: Efetive Temperature (ET), developed by MISSENARD (1937), which consider meteorological parameters (air temperature [ºC] and relative air humidity [%]); and the (Tev) index, proposed by SUPING (1992), which consider the air temperature, the relative air humidity, and the wind. The indexes were calculated according the following expressions:

TE = T – 0.4(T-10)(1-UR/100);
TEv=37-(37-T)/[0,68-0,0014UR+1/(1,76+1,4v^{0,75})-0,29T(1-UR/100);

where: **TE** is the effective temperature (ºC), **TEv** is the effective temperature related to the wind (ºC); v, is the wind average speed (m/s); T is the dry bulb temperature, and UR is the relative humidity (%).
Different situations were simulated: hot and dry days (QS), hot and wet days (QU), cold and dry days (FS), cold and wet days (FU). The thermal comfort classification criteria was the 22 ºC to 25 ºC range, as sugested by Fanger (1972) as a comfortable zone, which categorizes the thermal comfort in nine class, from very cold to very hot. These criteria was obtained as a result of the physiologic human responses measurements when a person is exposed to a hot or cold environment and is valid for a sedentary person with mild clothing and a low speed wind (0,1 m/s).

3. RESULTS

The thermal comfort indexes results TE and TEv, obtained during the study period and the respiratory disease morbidity (peumoniae, asthma, and bronquitis) are presented in the figures 3, 4 ,5 ,6, and table 1. The figures show too two sinotic simulated situations. Hot and dry days (QS) combine maximun temperature and minimum humidity conditions; hot and wet days (QU) showed maximun temperature and maximun humidity conditions; cold and dry days (FS), the opposite, minimum temperature and minimum humidity conditions; and cold and wet days (FU) showed minimum temperature with maximum humidity conditions.

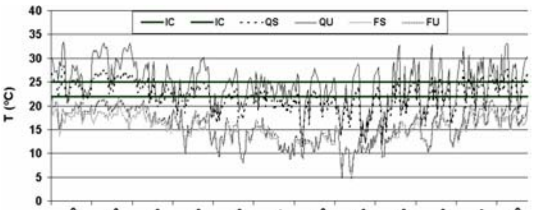

Figure 3: Efetive Temperature Index distribution from year 2003.

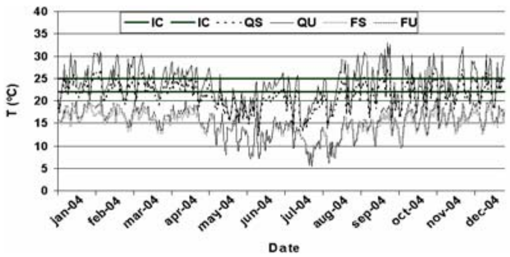

Figure 4: Efetive Temperature Index distribution from year 2004.

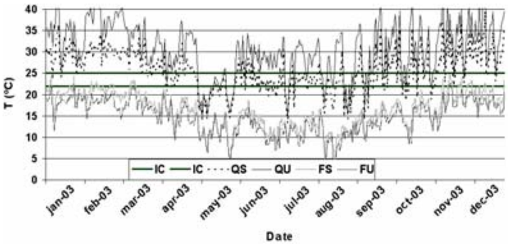

Figure 5: Efetive Temperature Index distribution as function of the wind, from year 2003.

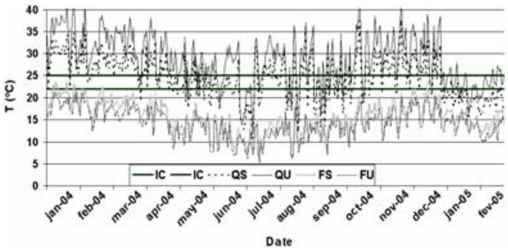

Figure 6: Efetive Temperature Index distribution as function of the wind, from year 2004.

Table 1 – Respiratory disease hospitalary visits, children up to 1 year of age, city of Sao Paulo, winter 2003 and 2004.

ILLNESSES OF THE RESPIRATORY SYSTEM (CID 10)	Number of Internations
2003 WINTER (period: 2003,Jun-Aug)	
Pneumonia	2509
Acute bronchitis and acute bronquiolitis	556
Asthma	529
Total	**3594**
2004 WINTER (period: 2004,Jun-Aug)	
Pneumonia	2474
Acute bronchitis and acute bronquiolitis	623
Asthma	481
Total	**3578**
2003 SUMMER (period: 2003 Dec - 2004 Feb)	
Pneumonia	1237
Acute bronchitis and acute bronquiolitis	225
Asthma	227
Total	**1689**
2004 SUMMER (period: 2004 Dec – 2005 Fev)	
Pneumonia	1008
Acute bronchitis and acute bronquiolitis	234
Asthma	346
Total	**1588**

Figures 4 and 5 present the effective temperature index variation (TE) in the June to August, and December to February periods in the years 2003 and 2004. This index shows clearly the thermal stress generated by high temperatures in Sao Paulo population, mainly during the summer months afternoons (rainy weather, QU), both in 2003 and 2004. By the other hand, with the winter getting closer (dry weather), it's observed that the population feels the thermal stress during the cold mornings. The year 2003 showed the more severe winter months (figures 1 and 2), when compared to the year 2004, resulting a bigger thermal stress related to cold temperatures. The same analisys is performed to the summer months, which have the highest temperatures in the year 2003.

Concerning the the respiratory disease morbidity in children up to 1 year of age, is observed that in the winter of 2003 it has more expressive values, although the number of hospitalary visits due to bronquitis and bronquiolitis were highest for the winter of 2004. The number of hospitalary visits during the summer time of 2003 is also higher than the summer of 2004, however, the number of asthma cases was higher in 2004.

Figures 5 and 6 show the index that consider the average wind speed in addition to the temperature and the relative humidity. It's observed that due to the wind influence, the cold upset feeling rises, mainly during the winter months mornings (dry weather), no matter the air humidity characteristics (FS or FU). During the afternoons the temperatures become more gently, closer to the comfort zone. Parallely, the wind increases the thermal stress due to high temperatures, mainly in the summer afternoons (rainy weather, QU). The mornings, in general, are characterized as comfortable in this weather.

4. CONCLUSION

This study showed the application of two different biometeorological indexes (thermal comfort) and aimed at characterizes the upset feelings observed by the population of the city of Sao. The respiratory disease morbidity (hospitalary visits) pattern was also evaluated for each period of interest (June to August and December to February) of the winter and summer in the years 2003 and 2004.

The summer months afternoons (D,J,F), -rainy weather- are related to high temperature stress, and the winter mornings are related to low temperature stress, either with high or low relative humidity. By the other hand, the summer mornings and mainly the winter afternoons showed a comfortable situation, with mild temperatures (FU, QU).

Concerning the morbidity values, they follow the sinotic pattern observed in the winter and summer of 2003 and 2004, with an increase of the hospitalary visits in the winter and summer of 2003, when the lowest and the highest temperatures were observed, respectively.

The wind influence when applied to the TE index contributed to the upset increase, both related to lower temperatures during the winter mornings (FS, FU) and related to higher temperatures during the summer afternoons (QU,QS). Is important remark that those upset feelings related to the wind influence were calculated using the daily average wind. This situation could be modified in case of considering the daily maximum wind.

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