# ARTICLES

Boletín de la Asociación de Geógrafos Españoles N.º 58 - 2012, págs. 431-437
I.S.S.N.: 0212-9426

# VARIATIONS OF OXYGEN IN THE AIR AND ITS IMPACT ON HUMAN HEALTH

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## I. INTRODUCTION

Various authors from antiquity have highlighted the importance of climate. There are many examples of the close relationship between climate, weathered and health is obvious physical discomfort caused by certain types of weather, as waves of heat or cold, poor health in people not accustomed to the rigors of those heat or discomfort created by maritime climates influence people with chronic asthma. There are numerous examples of the salutary nature of some wind or unhealthy. Glacken (1996) as the Greeks said, in the theories of the half, gave the weather and, more specifically to temperature, the distinctive character of their civilization. In this context environmental theories based on the physiology evolved from the notion of health and illness as a balance or imbalance humeral (humeral theory) and observations as the advantages of certain cities or purple, the situation in relation to altitude, proximity to water or certain prevailing winds.

Attention on the study of the relationship between health and environmental conditions will focus along the twentieth century, chronic diseases, so-called *diseases of modernity*, that is, those pathologies associated with respiratory and circulatory systems.

This paper analyzes the relationship between the variability of oxygen in the air and the impact that variation in people with diseases related to circulatory and respiratory systems of a particular territory. This is essential to study the general weather conditions at certain times of year on a particular geographical environment.

## II. DENSITY OF OXYGEN IN THE AIR AS A RISK FACTOR FOR HEART, VASCULAR, AND BRAIN DISEASE

Lack of oxygen can lead to serious health consequences of living things, including death. Oxygen, a major component of the atmospheric mass that surrounds us is a basic element for life and, hence, any change in its density in the air can have an impact on our health-hypoxia, especially in people with lung or heart conditions.

Dr. Ovcharova established in 1958, an experiential association between higher nervous activity in laboratory animals and gas exchange thereof with the surrounding environment[1]. In those years, scientists Voronin (1954), Chubukov (1956) had published studies on the relationship between neural activity and changes in environmental conditions. In a joint Voronin, Ovcharova and Spiridonov (1963) argue that: *«…the human body responds to unusual changes in weather and seasonal variations. The human body's response to these changes can be seen mainly through the increase of nerve activity, sudden changes in the thermoregulatory system and the body heat balance and cardiovascular activity»*. In 1963, Ovcharova found that the variation in the density of oxygen in the air conditions produced directly in higher nervous activity of these animals, indicating that this could also happen in humans.

Years later, he established his index Ovcharova density of oxygen in the air as a complex indicator of the effects of weather changes on human health (Ovcharova, 1981)[2]. The composite index of oxygen partial density in the air (DOA) g/m3 measured to calculate the differences in volume of oxygen in air is:

$$\mathbf{DOA = 80.51 \cdot P / (T + 273) \cdot (1 - e/P)}$$

**T**: is the air temperature in degrees Centirade.
**e**: is the partial pressure of water vapor in hPa.
**P**: is the atmospheric pressure in hPa.

In the decade of the eighties of last century, Dr. Ovcharova's ideas were recovered by various researchers in Latin America and Europe. Meanwhile, the International Society of Biometeorology (ISB), through the working group Climate and Human Health began to develop in the nineties of last century to find ways of working impacts on different global environments with the implementation of the methodology discussed and derived from studies Ovcharova. Arise and research groups in different countries working relationship between the density of oxygen and its impact on cardiovascular disease (CVD) and lung.

Today, improved methods of work in these investigations incorporating the effect of voticity and pressure fields by adding new parameters for the index design biometeorological.

## III. TYPES OF WEATHER, OXYGEN IN AIR DENSITY AND IMPACT ON HOSPITAL ADMISSIONS FOR DISEASE RISK. SOME EXAMPLES

In order to verify these assumptions we have analyzed the effects of specific atmospheric conditions and their relationship to a greater or lesser presence of oxygen in the air, the health of residents in the city of Alicante.

It analyzes the relationship between the change in volume of oxygen in atmospheric air resulting contrast of air masses and increased hospital admissions for people in risk groups

1 Ovcharova, V.F. (1958): Changes in the superior nervous activity and the gas exchange during the adaptation process of laboratory animals exposed to different weather conditions [in Russian]. Original Lecture. Library of the Instute of Geography, Academy of Sciences of the former USSR, Moscow [unpublished].

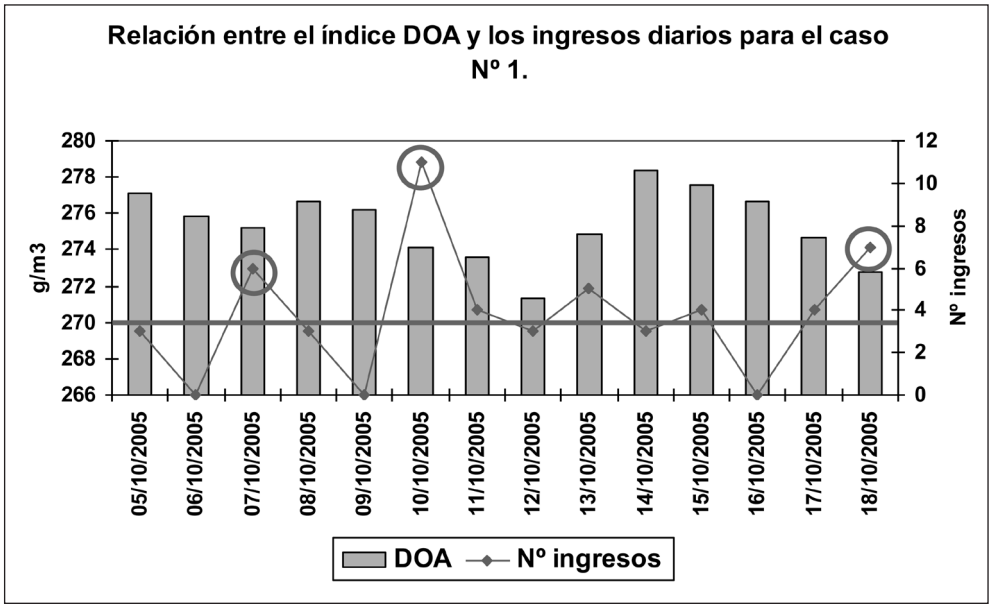
2 Ovcharova, V.F. (1981): Calculation of the oxygen content of the air based upon meteorological parameters (pressure, temperature and humidity) to forecast the effects of hypoxia sensations [in Russian]. *Jour. Questions of Climatotherapy, Physiotherapy and Physical Culture*, Vol. 2; 29-34.

including the Departments of Health[3] of the city of Alicante. We analyze two situations of hypoxia and a hypoxia-hyperoxia contrast to check its influence on increasing hospital admissions for heart disease, lung or stroke. Weather data analyzed are from the Laboratory of Climatology at the University of Alicante, contrasted with those of the two official stations available to the State Meteorological Agency (AEMET) in the territory of the city of Alicante (Garden City and Airport).

### 3.1. Analysis of atmospheric episode with hypoxia and increased revenues in heart disease (CHD)

The first situation takes place from 7 to 10 October 2005. That episode was a significant number of hospital admissions related to heart diseases[4]. So especially the hours of October 10 reported a high number of admissions, significantly exceeding 150% of average daily earnings at the two hospitals analyzed. This value is the threshold that has been used to characterize normal days and extra days depending on the number of reported revenue.

Figure A
*EVOLUTION OF THE DOA INDEX AND HOSPITAL ADMISSIONS IN THE CITY OF ALICANTE (BETWEEN 5TH TO OCTOBER 18TH, 2005)*




Source: Data from the referral hospitals and the Laboratory of Climatology, Interuniversity Institute of Geography.

3 Department of Health. Division of the province of Alicante in areas of hospital care to the Valencian Community under Order of May 12th 2005. In the city of Alicante there are two Departments: Alacant General Hospital and Sant Joan d'Alacant.

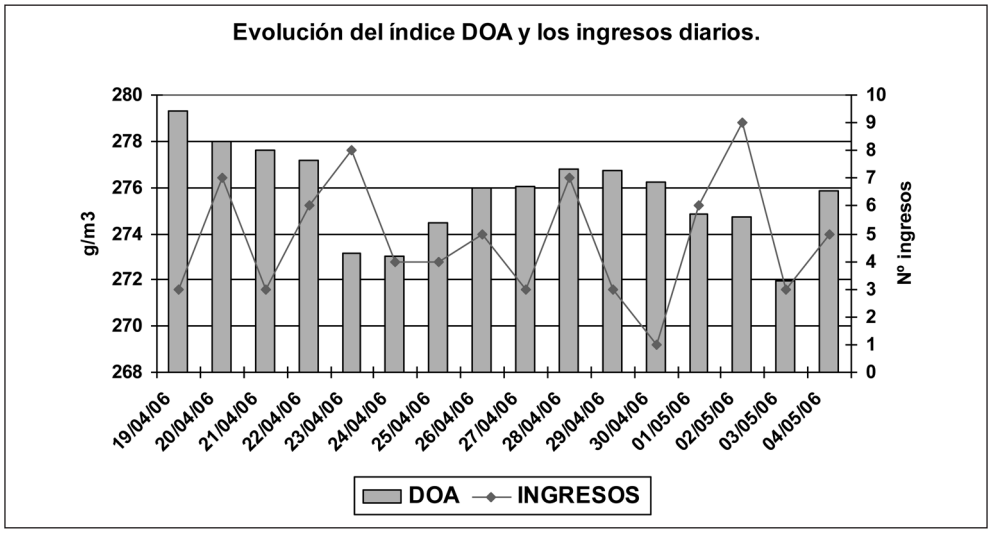
4 According to the International Classification of Diseases ninth review (ICD-9: 410-41).

Atmospheric evolution during this episode can be seen, as noted, the arrival of Saharan air and retention in the atmosphere over the south and east of the Iberian Peninsula along these days. This was manifested in the marked reduction in the amount of oxygen in the air and its relation to the number of hospital admissions for heart disease occurred on October 10. In this episode can be pointed as possible causes to explain the significant increase in hospital admissions for heart disease in the city of Alicante, the combined effect between the contrasts of temperature and humidity combined with the variation in the component of the prevailing winds in those days and the very negative accumulation in the availability of oxygen in air between 7 and October 10 (qv Figure A).

### 3.2. Location of the contrasting situation atmospheric hypoxia and potential increased revenue associated with stroke in late April and early May 2006

Another significant example of the relationship between amount of oxygen in air and in this case, the development of cerebral vascular accident (CVA)[5] is the situation that occurred between late April and early May 2006, which generated a significant number of hospital admissions (in four days, exceeding the threshold of 150% of average daily earnings in the two hospitals in the city of Alicante analyzed).

Figure B
*EVOLUTION OF THE DOA INDEX AND HOSPITAL ADMISSIONS IN THE CITY OF ALICANTE (APRIL 19TH TO MAY 4TH, 2006)*




Source: Data from the referral hospitals and the Laboratory of Climatology, Interuniversity Institute of Geography.

5 CVA: Cerebral Vascular Accidents. According to International Classification of Diseases ninth review (ICD-9: 430-438).

As in the previous case, we are in a time of year equator where changes are constant in time, motivated by the arrival of air masses of different nature to the Iberian peninsula (polar and tropical). These contrasts produce situations of abrupt changes in atmospheric parameters and derived from it, variations in the availability of oxygen in air. Under these conditions, as noted, the need to adapt to the weather conditions may result in individuals with previous risk factors to cause an impact on health that can lead to hospitalization. In the days that make the episode analyzed were recorded revenues of more than three in two referral hospitals, including two days -23 April and May 2, with higher number of admissions to seven. These two days are consistent with a negative variation of oxygen accumulated in air caused by the presence of continental tropical air mass, with several sequences of advection (20-21 April, 23 to 25 April, 28 April and 1 to 3 May). These air advections develop tropical days with normal oxygen levels or slightly above normal, due to the installation of cold air in the space summary Peninsula. Thus, the contrast in the presence of oxygen in the air may predispose certain individuals to suffer an impact sensitive and could be the source of the significant increase in hospital admissions for stroke impact (qv Figure B).

## IV. ESTABLISHMENT OF EARLY WARNING SYSTEMS THAT SIGNIFY THE PRESENCE OF OXYGEN IN THE AIR

One of the issues that currently occupies part of the investigation between the presence of oxygen in the air and possible effects on human health is the establishment of early warning systems to populations. These early warning systems, which already operate in parts of the world, are easily applied by the administrations and they establish the necessary protocols to minimize the impact of weather conditions with a lack or surplus of oxygen.

The availability of oxygen in air to develop vital functions is shaped by the changing weather conditions. If they have abrupt changes, as is normal in middle latitudes in the months of transition to summer and winter, ie, spring and autumn, the presence of an early warning system can help minimize risks. These systems establish different degrees of notice, enabling health professionals, the establishment of protocols for action (eg the use of medical oxygen) in order to try to reduce the potential crises in patients with previous pathologies. Can serve as a reference the adaptation process to be carried out by the climbers ascend high altitude relief and, if not carried out a program of adaptation to altitude may have pulmonary or cerebral vascular diseases due to severe lack of oxygen at high altitude (at 8,000 m altitude there is only a percentage of oxygen in the air for 37% of the existing sea level), hence it is necessary to use oxygen bottles to avoid the risk often fatal, the one known as «altitude sickness».

Existed for years warning systems to extraordinary range of weather events, which include those generated by maximum or minimum extreme temperatures. Thus, in the U.S., the Federal Emergency Management Agency and NOAA also have a warning system to predict heat waves and cold, with protocols for action by citizens. In Spain both the State Meteorological Agency (AEMET) and meteorological agencies from different Autonomous Communities have a warning system that produces daily maps of alert extreme temperatures. With them advised of the likelihood of developing dangerous situation and establish working protocols to be developed by civil protection. This mechanism is part of the notice of Europe

«Meteoalarm» which includes thirty European countries in a networked system of information on extreme weather events.

They have joined biometeorological warning systems, which incorporate indicators of climatic comfort in relation to atmospheric conditions. This is the case of the «PronBiomet» early warning protocol, developed in Cuba and that part of the mapping of large-scale biometeorological forecast, indicating settings of hypoxia and hyperoxia. These maps also include the distribution of surface pressure fields. So the reading and interpretation of these maps forecast allows for a catalog of synoptic situations (weather types) more or less likely to develop hypoxia and hyperoxia, look back prior to the establishment of warnings to the population. In Germany, meanwhile, has developed a forecasting service biometeorological (MedizinID™-System) which includes a new index values of universal thermal environment[6] for the different regions.

So the traditional weather alert systems that warn of the possible occurrence of extreme weather events range, have added new warning systems. Some aim to warn of consequences for human health from atmospheric conditions in relation to the greater or lesser presence of oxygen in the air. Others are based on complex biometeorological rates, which aims to establish stages or degrees of warning the population in relation to the surrounding atmospheric environment at that time and the days to come.

## V. CLIMATE CHANGE, THE PRESENCE OF OXYGEN IN THE AIR AND FUTURE INCREASE IN CARDIOVASCULAR AND PULMONARY DISEASES

Climate change models from the IPCC (2007) and regional adaptation has taken place in Spain Meteorological Agency (AEMET) indicate the likely change in the weather conditions in the Spanish Mediterranean region which would increase average temperatures and maximum, declining rainfall and increased atmospheric irregularity, that is, the likelihood of increased frequency of extreme events in the development of this territory. Increase the danger to projected climate for the coming decades, joins the increased social vulnerability in this territory since the Spanish Mediterranean coast is one focus of attraction for people from different areas of Spain and countries in Central and northern Europe. In addition to the seasonal population increase that occurs in the summer months, related to tourism, from the nineties of the twentieth century are witnessing the arrival of European residents who have found in the southeast peninsular territory conducive to developing their final period of life. The majority population group in this process has been, therefore, people over 65 years. This, combined with a structure of the Spanish population, increasingly aging and less generational replacement has caused a significant increase in the population group of older people. This is a non-exclusive territory Alicante has affected much of the Spanish Mediterranean coast and the Canary Islands, and which has built a significant percentage of residential real-estate activity has been the engine of economic development these territories until the recent economic crisis.

6 Universal Termal Climate Index (UTCI). It is a composite index that incorporates various atmospheric parameters (effective temperature, radiation, humidity and wind). The index is standardizing on a global level the results of previous indexes. Available at www.utci.org

Regarding health issues, the presence of this important population group of older people has helped in the past two decades, increased social vulnerability to trafficking in good health generally more delicate and very sensitive to sudden changes in weather. If we add the forecast indicated significant increase in extreme weather events, identified in the climate change models (IPCC, 2007), the Spanish Mediterranean coast and the Canary Islands can become alert to areas of human health and therefore given priority in the design of preventive health systems.