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Indoor Epidemiological Study: Effects of Pollutant on Respiratory Diseases

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Abstract: In a rural area of southern Italy, the correlation between indoor pollutants and two respiratory diseases (asthma and rhinitis) has been studied. Different environmental factors as altitude, microclimate, biomass burning and exposure to allergens of pets were examined in a sample of 100 asthmatics people. The research included social analysis and environmental analysis, furthermore clinical tests as *Atopy*, *Eosinophilis* and *IgE* were obtained for each patients. Through a cross-epidemiological study was observed that the seasonal rhinitis is higher in people using open fireplace (13% *vs* 8%) and moreover was observed that 62% of all patients examined have rhinitis and 59% of them use biomass burning (wood) in their fireplace. Clinical tests report that people using conventional heating (closed fireplace, wood stoves, pellet stove) have values of *E%*, *Atopy* and *IgE*, greater than patients who use open fireplace.The study remarks that population belongs to areas far from air pollution sources and 11% of the sample is exposed to outdoor allergens such as pollen, instead the remaining percent of simple is not subjects to specific workplace exposure. Finally the study quantified the costs of hospitalization for each patient (DRG 3200€) to highlight the economic damage (direct cost) caused to indoor air quality (IAQ).

Key words: IAQ, IFR, allergens, asthma, rhinitis

1. Introduction

Indoor air pollution can cause side effects ranging from sensory discomfort to serious consequences on the state of people's health.

IAQ is responsible for 2.7% of the global burden of diseases in the world and generally children are the group most affected by indoor air pollution effects [1]. According to WHO, 4.3 million people a year die from the exposure to household air pollution and also etiology diseases not defined as Sarcoidosis, they may be caused by environmental pollution [2].

In Europe IAQ is responsible for 4.6% of death in children aged 0 to 4 years, for acute respiratory infections. Many studies put in evidence that in some European countries 20%-30% of households have moisture problems in home resulting in a 50% increase in the risk of respiratory disorders and 13% of cases of childhood asthma [3].

3%-8% of the European population is affected by asthma while the prevalence in the pediatric population is even greater.

According to the WHO, the increasing incidence of asthma is 50% per decade, and seems almost certainly be related to urbanization, especially when it means an increase in density of people in slums.

So there is a growing tendency to live most of time indoors with little air circulation, more exposed to dust and mites and placed in urban situations by the high rate of pollution.

This study focuses attention on a sample of population that lives in a rural area away from sources of outdoor air pollution, focusing attention on indoor

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Specific relevance has to point out that in Italy the total annual cost attributable to indoor pollution is superior to 152-234 million of euro [4]. Considering, for example, bronchial asthma in children attributable to exposure to indoor allergens, the European Indoor Commission indicates a health impact exceeding 160.000 cases/years with direct costs exceeding 8.000.000 €.

This cross-sectional study (Fig. 1) has its primary purpose to research Indoor Risk Factors (IFR) of two respiratory diseases (Asthma and Rhinitis) in a population living in a rural area; understanding IAQ and its IFR can help the scientific community to reduce the risk of indoor health and the cost of health.

2. Methods and Data

A sample of hundred people with asthma and with an overall mean age of 47 years old were examined.

People included in the study live in a rural areas of southern Italy in the region of Basilicata (40°38’21”N-15°48’19”E) and 93% of them spend 80% of their time in home; they breathe about 22.000 times every 24 hours.

The investigated areas are located far from urban and industrial pollution sources and 40% of the sample lives at an altitude higher than 700 meters above sea level (Fig. 2 shows the localization of investigated

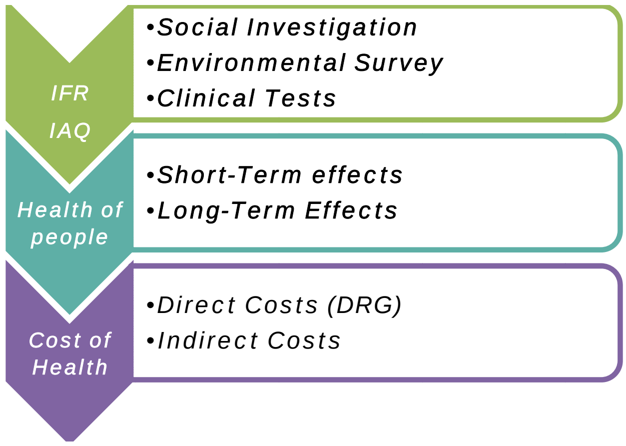


Fig. 1 Cross-sectional study for descriptive epidemiological analysis.

Fig. 2 Localization of investigated areas.

area). 62% of all patients examined have rhinitis, in Italy, the peak incidence of rhinitis is between 20 and 30 years although can affect all ages and it is more common in women and in case of familiarity.

For each patient were conducted social investigations, clinical tests and environmental survey.

It is important to consider that each person reacts independently under the same conditions of pollution, therefore is unlikely to evaluate individual risk to exposure.

Additionally, the danger of contaminants derived from time of exposure, concentration, chemical composition and the combination of pollutants.

2.1 Social Investigation

Through the social investigation were collected the following information: age, gender, workplace exposure, time spent in home, smoking history, sport activity.

The sample consisted of 46 women and 54males, the women examined have an average age of 51 years, males have an average age of 46 years.

19% of sample practices sport and this is a possible *triggers* for asthma inasmuch the sportsmen are subjected to hyperventilation. Such as sports, other triggers include cigarette smoking and occupational exposure.

As it is well known, cigarette smoking is a risk factor for asthmatic people.

In cigarette smoke are given off gases such as carbon monoxide, aromatic hydrocarbons, ammonia, formaldehyde and small particles which may penetrate in the upper respiratory tract, they also reach deep into the lungs, into bronchioles and alveolus [5].

Fig. 3 shows the size of PM and its penetration capacity in the airways; $PM_{2.5}$ can penetrate to the alveolar level (deep airways), PM_{10} instead affects the upper airways.

In our sample 14% of people are smokers and 28% had a history of smoking; among the smokers 6% of them smokes 3 cigarettes per day.

Regarding workplace exposure, 11% of the sample works as a farmer and half of this percentage is also smokers.

Farmes are exposed to dust, sensitizing substances (grasses, pollens) and physical agents such as cold air, indeed they cultivate fields during all year in mountainous areas. Fig. 4 shows a summary of social investigation.

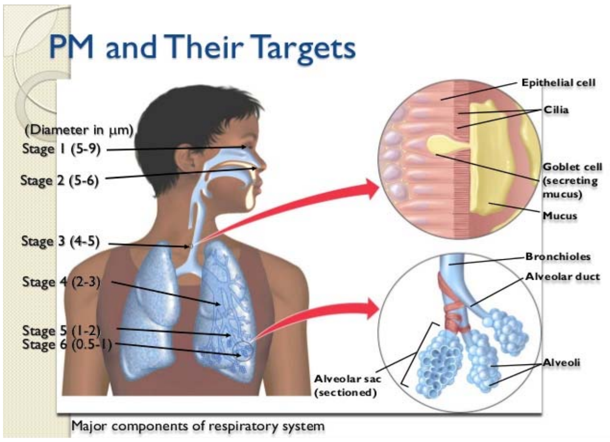


Fig. 3 PM size and penetration into the airways.

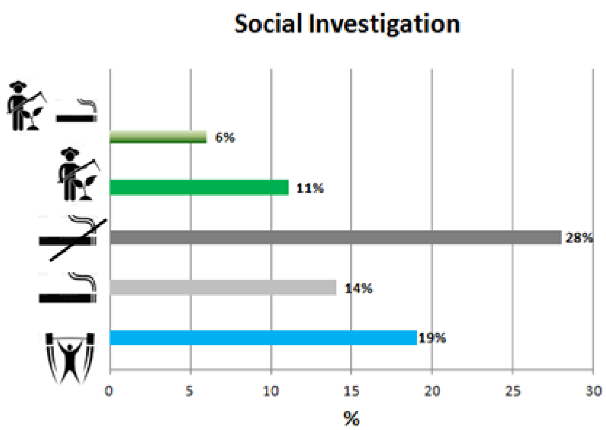


Fig. 4 Social Investigation summary.

2.2 Environmental Survey

The environmental analysis has been focusing on the type of heating used in the home and on the features of population's residence area.

Patients included in this research live in rural areas and in a small not industrialized villages: 40% over 700 meters above sea level, 3% live in plain areas and 57% in a hilly areas.

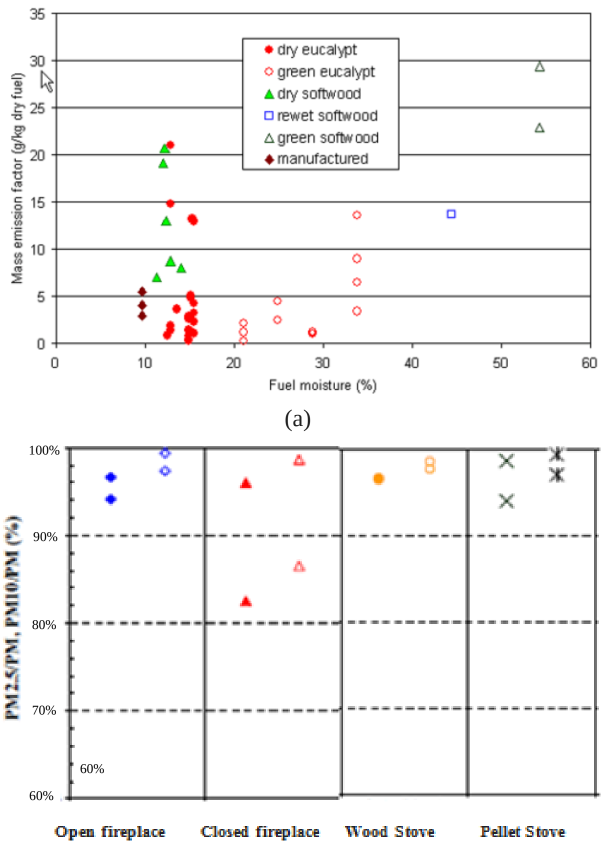
These rural areas are not affected by atmospheric pollution (urban traffic and industrial discharges) and are characterized by a thick forest and pastures. In these rural villages it is very common to use conventional heating such as open fireplace or wood stoves.

Different studies reveal a negative impact on health ($PM_{2.5}$ emission, black carbon, etc.) [6] due to the combustion of biomass burning for home heating. $PM_{2.5}$, as well as being a substance with important climate-altering effects can lead to substantial direct health effects [7]. High level of indoor $PM_{2.5}$ can be due to several factors: outdoor concentration of $PM_{2.5}$ (15.9%), wind speed and direction (5.2%), the use of gas cookers (1.4%), outdoor temperature (1.4%) and cigarette smoke (17.7%) [8]. As it found in literature values of PM emission due to the indoor biomass burning are presented in the following figures.

Fig. 5(a) shows the variation of PM emission based on the fuel humidity [9] and Fig. 3(b) exposures values of $PM_{2.5}$/PM, PM_{10}/PMobtained with different types of heating [10] in developing countries.

One of the first studies about the domestic use of biomass, was carried out in a village of Nepal, where the main fuel was wood, charcoal and agricultural waste. The study showed, inside homes, concentrations of respirable dusts comprised between 1 and 14 mg/m^3 and indoor medium concentrations of CO (21 ppm) and C_6H_6 (280 ppb) from ten to hundred times higher than the external values simultaneously measured [11].

In recent years, have been conducted some studies on exposure to biomass burning of rural population in developing countries, although it has shifted attention to the air quality inside the home in developed



(a)

(b)

◊ Open fireplace-PM10/PTS ◆ Open fireplace-PM2.5/PTS

▲ Closed fireplace-PM2.5/PTS △ Closed fireplace-PM10/PTS

● Wood Stoves -PM2.5/PTS○ Wood Stoves-PM10/PTS

× Pellet Stove -PM2.5/PTS ＊Pellet Stove -PM10/PTS.

Fig. 5 (a) PM emission related to fuel humidity; (b)$PM_{2.5}$/PM, PM_{10}/PM for different types of heating.

Countries [12]. G. Gilli et al. (Benzene, Toluene and Xylene in air, geographical distribution in the Piemonte region (Italy) and personal exposure; 1994) focus attention on population exposure to indoor pollutants in the metropolis of Turin; highlighting the internal sources of BTX. S. Galante et al. (2013) focus on pollutants arising from biomass burning.

The Environmental investigation focuses the interest on internal heating, in our rural sample, 62.4% use the open fireplace and burning wood as fuel, the remaining percentage use other types of heating.

In relation to the type of heating used by sample, two groups have been formed: UC1 (open fire) and UC2 (closed fireplace, wood stoves, pellet stove).

2.3 Clinical Tests

Clinical tests performed at Hospital are: Prick test, Blood Test, Calculation of IgE_{tot}, Simple Spirometry; Tests of Bronchial hyper-reactivity to methacholine.

Through clinical investigation the following informations were collected: Severity of rhinitis and its Seasonality, Nasal septum deviation, Symptoms. Clinical analysis has focused on the presence of allergens deriving by pets.

Besides animal allergens, inside homes, there are other biological pollutants; indeed the majority of people with asthma is allergic to dust mites and also other allergic form, as the so-called “fever of dehumidifier”, it seems that involve cell-mediated immunity. Other indoor biological species, such as molds (some mycotoxine derived from molds are carcinogenic to the lungs) and some fungal species (sources of SOV) are irritating to respiratory mucous membranes and it would seem linked to sick building syndrome.

Depending animal allergens, patients subjected to clinical analysis were divided into two groups: WP1 (patients living with pets) and WP2 (people who do not have pets) and for which there is no daily exposure to allergens: FelD1, CanF1, CanF2.

3. Results

Clinical analysis has shown that patients living with pets (WP1) are more rhinitis than WP2 group (71.4% vs 57%) and they have higher values of Atopy (60% vs 55.2%).

The Table 1 shows comparison between the values of *IgE*, Rhinitis, and Atopy in the two groups of patients.

Table 1 Values of *IgE*, *Rhinitis*, *Atopy* in WP1 and WP2 group.

	WP1	WP2
IgE	302 UI/mL	230.5 UI/mL
Rhinitis	71.4%	57%
Atopy	60%	55.2%

Therefore the prolonged exposure to pets allergens may cause a growing number of rhinitis and Atopy which are reflected in higher levels of the peripheral level of *IgE*. Crossing the environmental data and clinical test, were calculated the values of Percentages *Eosinophils* (E%), IgE_{tot}, Absolute *Eosinophils* (UI/mL).

In according to the type of heating used by UC1 (open fireplace) and by UC2 (closed fireplace, wood stoves, pellet stove), the values of E% and IgE_{tot} were compared.

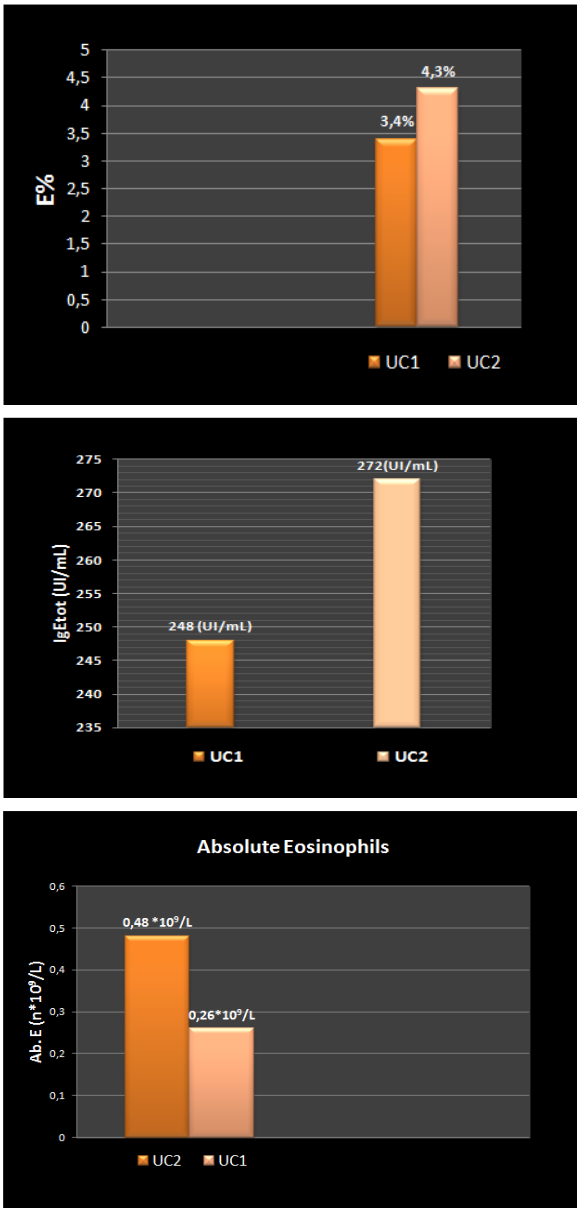


Fig. 6 Values of *E%*, *$IgE_{tot.}$* *and Ab.Eosinophils* in UC1 and UC2 group.

Fig. 6 shows the clinical results obtained for the two groups of patients: E% (3.4% vs4.3%) and IgE_{tot} (272 UI/mL vs 248 UI/mL). E%, IgE_{tot} and Absolute *Eosinophils* (0.26·109/lvs0.48·109/l) are lower in UC1 group.

The group of patients who don't have open fireplace has higher levels of *IgE* and *Eosinophils*. The biomass burning in uncertified wood and pellet stoves could cause the same dispersion of particulate in the home of our patients and it appears to affect rhinitis phenomena at the level of the upper airways.

4. Discussion and Final Remarks

From the all informations collected can be observe that the seasonal rhinitis is higher in people using open fireplace (13% *vs* 8%); recalling that 62% of all patients examined have rhinitis, we observe that 59% of them use wood burning in open fireplace. Furthermore, conventional and not certified heating (wood stoves, pellet stove and closed fireplace), it would seem to affect productivity of peripheral *IgE* and *Eosinophilia* in the group UC2.

The biomass combustion could be an internal risk factor for seasonal rhinitis [13]. The observations on the Rhinitis Severity Index show that cases of severe rhinitis (intermittent and persistent) are indistinctly present in all groups, with a positive but not relevant percentage in WP1 and UC1 group.

Finally, the study has estimated for each patient an average direct cost of hospitalization (DRG) amounted to 3200€(average cost of hospitalization and treatment). Moreover IAQ implies also indirect costs because the hospitalization causes the absence in the workplace therefore resulting additional indirect costs related to the lack of productivity.

Reducing IFR (Indoor Risk Factors) it would benefit for the health of population, health care-costs and social costs.

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