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ENVIRONMENTAL AND SOCIAL CONDITIONS OF ASTHMA AND RHINITIS

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Summary – The frequency of respiratory diseases such as asthma and rhinitis has increased worldwide during the past decades. This increase is parallel to global warming, which creates favourable conditions for these diseases. It has been proved that people fallen ill with allergy can not concentrate on their work, feel unwell and can be on sick leave more often. Causes of respiratory diseases, their climate and weather relations, the role of the biological and chemical air pollutants and the social status are surveyed as potential risk factors.

Key words: respiratory diseases, climate change, biological and chemical air pollutants, social status, pulmonary functions

1. THE SPREAD OF ASTHMA AND RHINITIS IN CONNECTION WITH CLIMATE CHANGE

Asthma- and rhinitis-based allergy has become more frequent worldwide during the past decades. Parallel to this, global warming creates favourable conditions for these diseases Spring in northern Europe begins an average of 15 days earlier now than 30 years ago. This means that pollen-producing plants – such as grass, which triggers attacks in 90% of hay fever sufferers and silver birch trees, which affect a quarter – have a much longer pollen·producing season than in the past (Lundback 1998).

Impact assessment studies clearly suggest that public health largely benefits from better air quality. Even though the air in many cities is much cleaner than in the past, the prevalence of hay fever and asthma has increased worldwide. Recently, 10-25% of the population have symptoms of hay fever or allergic asthma for the whole Earth and the incidence has more than doubled since the 1970s (Traidl-Hoffmann et al. 2003). Today, in the U.S. 11.7% of the population have seasonal hay-fever allergies and about 6.7% suffer from asthma (in 2004: 6%, in 1980: 3% (U.S. Center for Disease Control and Prevention, Atlanta)). Rimpela et al. (1995) describes a three-fold increase of physician-diagnosed asthma and allergic rhinitis among Finnish adolescents in the period 1977-1991. Studies indicate that asthma and allergic conditions are most prevalent in the UK, Australia and New Zealand. High rates have also been reported for Chile. Concerning Europe, intermediate prevalence rates are seen in Southern Europe (Lundback 1998). Lundback (1998) gives an account of the lowest rates of asthmatic diseases from Central Europe (Lundback 1998); however, in the Carpathian Basin it is not the case (Makra et al. 2004, 2005). In Hungary, about 30% of the population has some type of allergy, 65% of them

have pollen sensitivity and at least 60% of this pollen-sensitivity is caused by ragweed. It is a shocking fact that by the late 1990s the number of patients with registered allergic illnesses has doubled and the number of cases of allergic asthma has become four times higher in Southern Hungary in 40 years. However, it is important to remember that the diagnosis of asthma has also developed significantly during this period (Rimpela et al. 1995, Makra et al. 2004).

The increase in asthma incidence, prevalence and morbidity over recent decades presents a significant challenge to public health. Pollen is an important trigger of some types of asthma and both pollen quantity and season depend on climatic and meteorological variables. Global warming, due to considerable increase in atmospheric carbon dioxide level, is presumably a plausible contributor to the rise in asthma. Greater concentrations of carbon dioxide and higher temperatures may increase pollen quantity and induce longer pollen seasons (Beggs and Bambrick 2005). In environmentally controlled greenhouses a doubling of the atmospheric CO_2 concentration stimulated ragweed-pollen production by 61% (Wayne et al. 2002). Ziska et al. (2003) demonstrated that average daily values of CO_2 concentration and air temperature within an urban environment were 30-31% and 1.8-2.0°C higher than those at a rural site. This result is consistent with most global change scenarios. Ragweed grows faster, flowers earlier and produces significantly greater above-ground biomass at urban locations than at rural ones. In this way, global climatic change together with urbanization might already have public health consequences.

2. CAUSES OF RESPIRATORY DISEASES

The sites throughout the world where the frequency asthma has increased, share no common changes that could be identified, suggesting that this "epidemic" phenomenon is likely due to multiple factors. The following have been most discussed: exposure to indoor and outdoor allergens, modification of the patterns of respiratory infections, decreasing trends of physical activity, evolution in the compounds of environmental irritants, including tobacco smoke and urban air toxicants (Just et al. 2006). The rapid increase in the frequencies of burden or atopic diseases has undeniably occurred in parallel with rapid industrialization and urbanization in many parts of the world. Consequently, more people are exposed to air pollutants than at any point in human history (Riedl and Diaz-Sanchez 2005). The studies are selective underestimates as they are strongly driven by mortality, but do not include full quantification of the impact on morbidity and their consequences on quality of life among the diseased people (Kunzli 2002).

It is well accepted that people with asthma are more sensitive than people without asthma to air pollutants such as cigarette smoke, traffic emissions and photochemical smog components. It has also been demonstrated that exposure to a mix of allergens and irritants can at times promote the development of the disease. It also seems that climate change is increasing the abundance of aeroallergens, such as pollen, which may result in greater incidence or severity of allergic diseases (Gilmour et al. 2006, Frei 2002). Ambient tobacco smoke, outdoor air pollution and climate change may also act as environmental risk factors for the development of asthma (Gilmour et al. 2006).

The pathogenesis of allergy depends on the interaction between the time and amount of allergen exposure and the presence of non-specific "adjuvant" factors in genetically susceptible individuals. There seems to be a period in early life during which the individual

is particularly susceptible to sensitization and there are variations in susceptibility over time. Allergens are almost ubiquitous but the relative importance of the individual allergens varies between regions. In many temperate regions house-dust mites used to be absent but are now more common. This may be due to modern methods of building houses. Differences in the prevalence of a particular allergy cannot explain variations in the prevalence of allergy in general. Various environmental factors that may enhance sensitization include tobacco smoke, NO_2, SO_2, ozone and diesel particles. Passive smoking is by far the best established risk factor, particularly in early childhood. The indoor environment probably plays a larger role than outdoor air pollution in the development of allergic diseases. The mother is not only a source of genetic information but also an "environmental factor", as there is a close immunologic interaction between the mother and her offspring, mediated through the placenta and the breast milk, which may affect the likelihood of allergic disease. The concepts of "lifestyle" and "environment" should be expanded to include for example dietary changes, the microbial environment and extensive travelling, as all the currently suspected risk factors taken together can only explain a small proportion of the geographic differences in and increasing prevalence of allergy. The future search for significant environmental factors should be interdisciplinary and be directed toward areas that have not yet been explored (Bjorksten 1999).

The incidence of allergic rhinitis and asthma is increasing. There are many theories to explain, including better diagnosis, urban living, and higher exposure to dust mites, atmospheric pollution, nutrition, lifestyle changes, maternal smoking, diesel fumes, geography, the "hygiene hypothesis" and several others. It has been known that atopic diseases run in families and a family history is the strongest risk factor for the development of allergies/asthma. Molecular studies have also identified some specific atopic entities that are determined genetically (eosinophils, interleukin-5, etc.) (Kaiser 2004). Environmental issues and lifestyle changes are becoming increasingly more important as significant risk factors but the evidence can be confusing, controversial and even contradictory. There is overwhelming evidence that sensitization to indoor allergens is a major risk factor for the development of clinical atopic diseases in genetically susceptible individuals. Not everyone agrees and there are newer data to suggest that early exposure to endotoxin and/or living on a farm and even early exposure to cats and dogs protects against sensitization by driving the immune system to a TH1 lymphocyte response (Kaiser 2004). The "hygiene hypothesis" suggests that lack of exposure to a childhood infection, endotoxin and bacterial products is an important determinant regarding development of atopic diseases. It is clear that a family history (genetics) is the strongest risk factor for the development of clinic atopic diseases but it is also clear that environmental issues play a significant role.

The issue of asthma is most acute in urban areas and racial/ethnic minority populations. Hospitalization and morbidity rates are significantly higher for non-whites than for whites. Asthma is characterized by recurrent wheezing, breathlessness, chest tightness, and coughing. Research has revealed the importance of inflammation of the airways in asthma and clinical treatment to reduce chronic inflammation. Asthma is associated with the production of IgE to common environmental allergens including house dust mite, animal dander, cockroach, fungal spores and pollens. Some interventions to reduce symptoms through control of dust mite and animal dander have had positive results. Increases in asthma prevalence have occurred at the same time as general improvements in air quality. However, air quality appears to exacerbate symptoms in the child who already has the disease. Decreased pulmonary function has been associated with exposure to

particulates and bronchial hyper-responsiveness to smoke, SO_2 and NO_2. The control of asthma in children will entail the collaborative efforts of patients, family, clinical professionals and school personnel, as well as community-wide environmental control measures and conducive national and local policies based on sound research (Clark et al. 1999).

Data from epidemiological studies have shown that allergic conditions have increased over the last 30-40 years. Other epidemiological studies suggest an interaction between allergic diseases and traffic pollution and laboratory findings indicate that diesel exhaust particles enhance sensitivity to allergens. In an in vitro study, Davies et al. (1998) found evidence to suggest that cigarette smoke may render the airway epithelium more susceptible to the adverse effects of allergens. Evidence from other studies indicates that O_3 and NO_2, with or without SO_2, can enhance the airway allergic response in susceptible individuals such as those with asthma and rhinitis. Studies investigating cellular and subcellular mechanisms suggest that pollutants are likely to influence the actions and interactions of a variety of cells and lead to the synthesis of proinflammatory mediators that modulate the activity and functions of inflammatory cells.

Despite factors that may affect the figures, worldwide data provide compelling evidence that the prevalences of both asthma and allergic rhinitis have increased. Prevalence rates and increases in prevalence appear to be greatest in children and young adults. Major risk factors for the development of asthma are family history, own smoking (adults) or the mother smoking (children) and factors related to house dampness (children). Several studies provide evidence that sensitization to allergens in early life are important risk factors for both asthma and allergic rhinitis. Outdoor air pollution, climatic and „lifestyle" factors may also play a role in the development of these conditions (Lundback 1998).

The knowledge of risk factors in the environment, which promote aero-allergenic exposures, is of practical importance from the point of view of community prevention. Significant environmental factors included cockroach infestation, occupational exposure, past smoking habit, outdoor air pollution and frequent heavy exposure to cooking fumes. Keeping pets, having rugs or carpets in the home and passive exposure to tobacco smoke showed weak and statistically insignificant associations. There was no apparent association with the use of mosquito coils or incense. The significant determinants after multivariate adjustment of all risk factors were age, race, flat size, area of residence, cockroach infestation, past smoking and occupational and cooking fumes exposure. The study underscores the importance of environmental control of inhalational exposure to common allergens and irritants in the prevention of allergic rhinitis (Ng and Tan 1994).

The prevalence of allergic rhinitis is increasing around the world. The cause of this increase is unknown; however, contributing factors may include higher concentrations of airborne pollution, rising dust mite populations, less ventilation in homes and offices, dietary factors and the trend towards more sedentary lifestyles. Allergic rhinitis symptoms typically begin in childhood and adolescence and continue into adulthood. In general, allergic rhinitis symptoms slowly improve and skin-test reactivity tends to wane with increasing age (Schoenwetter 2000).

Asthma is a significant public health problem in many communities. Symptoms of asthma occur as a direct or indirect result of many contributing factors, including influences from the natural and built environments, human behaviour and the adequacy of techniques used in its management. Beggs and Curson (1995) developed a model to integrate many of these contributing factors, highlighting the characteristics or the atmosphere, i.e. climate, irritants and allergens.

Parental asthma, plants, perfume, dust storm, humidity and pets are indicated to be significant predictors of asthma, which is a multifactorial disease related to both familial and environmental influences (Bener et al. 1996).

Women and smokers showed a significantly higher prevalence of asthma symptoms (Serda et al. 2005). The prevalence of allergic rhinitis was higher in male than female high school students (Lee et al. 2008). Living conditions or areas, diet, tobacco use, climate and atopy are important for the presence of symptoms (Backer et al. 2004).

In Norway, despite a favourable climate, little mite sensitization and low outdoor pollution, asthma prevalence was surprisingly high in Upper Hallingdal. Sensitization to animal dander was the most important contributing factor for current asthma (Nja et al. 2000). Home dampness is thought to have health consequences because it has the potential to increase the proliferation of house-dust mites and moulds, both of which are allergenic (Peat and Dickerson 1998). Curson (1993) discusses the relationship between topography, meteorology, air pollution to asthma in Sydney with special emphasis to biophysical and socio-economic factors and the role played by outdoor and indoor air pollution. It argues also that climate change will greatly influence the prevalence and distribution of the disease. Home dampness, moulds are strongly associated with the risk of respiratory infections and symptoms in adults (Pirhonen et al. 1996). There is also some evidence of impacts on other aeroallergens, such as mould spores (Beggs 2004).

3. CLIMATE, WEATHER AND METEOROLOGICAL ELEMENTS

Breton et al. (2006) evaluated the influence of meteorological factors on Ambrosia pollen concentrations and its impact on occurrences of allergic rhinitis. The authors found a significant association between the pollen levels and the number of patients. The rate was higher from low-income residents than for high-income inhabitants.

Concerning the prevalence of respiratory diseases according to geo-climatic factors, asthma-like symptoms seem to show a north-south trend: the prevalence increases at decreasing latitude, at a decreasing distance from the sea, at higher annual mean temperatures and at smaller annual temperature ranges. Of the geo-c1imatic variables, temperature range has the greatest influence on most asthma-like symptoms, which are more common in Mediterranean climate than in areas with a continental climate (Zanolin et al. 2004).

Both the seasonality of pediatric asthma admissions and associations with air pollutants and climate factors vary by age group. The number of weather and pollutant predictors increases with age (Xirasagar et al. 2006).

The number of children with asthma attacks increased significantly, when climate conditions showed a rapid decrease from higher barometric pressure, from higher air temperature and from higher humidity, as well as lower wind speed (Hashimoto et al. 2004). In Trinidad, there were more acute asthma visits during the wet season than the dry. Season, barometric pressure, temperature difference, minimum temperature and wind speed were predictors of paediatric visits; while season, relative humidity, minimum temperature and temperature difference were those of adult visits (Ivey et al. 2003).

Respiratory symptoms in cold weather are more prevalent in the north (cold climate), while hay fever and respiratory symptoms provoked by allergens were more com-

mon in lower latitudes. On the whole, environmental factors have a substantial effect on respiratory symptoms, but less effect on the prevalence of asthma (Kotaniemi et al. 2002).

Prevalence of pollinosis in the Atlantic climate area was lower than in the Oceanic climate area. There are no differences between people living in a rural environment and those living in an urban setting. Furthermore, pollinosis is more frequent in individuals aged 30-40 years than in younger (Azpiri et al. 1999).

The prevalence of asthma is in direct relation to temperature: lower temperatures result in a lower prevalence of asthma, while, higher temperatures are associated with increased occurrences of asthma (Hales 1998). Cold air is unlikely to be a causal factor initiating respiratory diseases but a symptom trigger. The cold air provoked respiratory symptoms mainly depend on the individual's susceptibility and the ventilation level during the cold exposure (Koskela 2007). The presence of cold and very cold days was closely related with increases of bronchial asthma in adults and children (Estela 1998).

In a mild climate with relatively low levels of pollution, minor pollution and meteorological disturbances result in substantial changes in nasal reactivity symptoms in non-allergic non-infectious perennial rhinitis patients (Braat et al. 2002).

Significant variation in the prevalence of asthma symptoms, asthma attacks and use of asthma medication between Canadian sites and international sites suggests environmental influences (Manfreda el al. 2001).

Aberg et al. (1996) illustrate the interaction between genetic and environmental risk factors of the prevalence of asthma and allergic rhinitis, with special emphasis on factors related to an unventilated indoor climate, which may substantially contribute to the increase of the diseases.

Thunderstorms have been linked to asthma epidemics, especially during the pollen seasons and there are descriptions of asthma outbreaks associated with thunderstorms, which occurred in several cities, prevalently in Europe. In other words, there is evidence that under wet conditions or during thunderstorms, pollen grains may release into the atmosphere part of their content, including respirable, allergen-carrying cytoplasmic starch granules that can reach lower airways inducing asthma reactions in pollinosis patients (D'Amato el al. 2007).

Laaidi (2001) showed that pollen dispersal was favoured by windy conditions, low relative humidity, precipitation below 2 mm and temperatures above 6°C. Such weather also favours pollinosis. Strong winds were associated with many cases of conjunctivitis and asthma, owing to the irritant effect of cold or wind. Asthma was favoured by temperature inversions with fog, probably because such weather corresponds to high levels of pollution, which act on bronchial hyper-reactivity.

Verlato et al. (2003) found a remarkable geographical variability in the prevalence of asthma and asthma-like symptoms in individuals aged 20-44 yr. In their studies, respiratory symptom prevalence was directly related to temperature in the coldest month and was related inversely to the temperature in the hottest month.

The results showed that weather conditions with low temperature, low water vapour pressure and cold anticyclonic presence were significantly correlated with an increase in the number of asthma admissions among children in Athens. (Nastos et al. 2006).

McGregor et al. (1999) defined specific air mass types to classify the daily mean PM_{10} concentrations and all respiratory hospital admissions for the Birmingham area, UK.

Estela (1998) performs an objective classification of weather types for biometeorological purposes in a tropical-humid climate (Cuba), related to the seasonal pattern of asthma and acute respiratory infections.

The beneficial effects of climate therapy are related to the reduced allergenic load and to the fact that mites do not survive at high altitudes. Less exposure to allergens leads to improved respiratory function, decreased bronchial hyper-reactivity and lower levels of total and specific IgE as well as markers of inflammation. These different actions combine to produce a lower prevalence of asthma at higher altitudes (Juchet et al. 1999).

4. BIOLOGICAL AIR POLLUTION

Pollen allergy has become a widespread disease by the end of the 20th century. Nowadays, every 5th or 6th person, as an average, suffers from this immune system disease in Europe. Pollinosis involves unpleasant symptoms and can become asthma. It has been proved that people fallen ill with pollen allergy can not concentrate on their work, feel unwell and can be on sick leave many times (Makra et al. 2004). According to annual totals of pollen counts of various plants measured between 1990 and 1996 in Southern Hungary, ragweed (Ambrosia) produces about half of the total pollen production (47.3%). Though this ratio highly depends on meteorological factors year by year (in 1990 this ratio was 35.9%. while in 1991: 66.9%), it can be considered the main aero-allergen plant in Hungary (Makra et al. 2005).

Pollen allergenicity can also increase as a result of these changes in climate (Beggs 2004). Singer et al. (2005) observed significant increase in Amb a I allergen (ragweed's major allergen) between pre-industrial and projected future CO_2 levels and between current and projected future CO_2 levels. Traidl-Hoffmann et al. (2003) found that pollen grains are not only releasing proteins eliciting specific immune responses, but they also liberate bioactive lipid mediators. Exposure in early life to a more allergenic environment may also provoke the development of other atopic conditions, such as eczema and allergic rhinitis (Lundback 1998, Bjorksten 1999, Beggs and Bambrick 2005). Although the etiology of asthma is complex, the recent global rise in asthma could be an early health effect of anthropogenic climate change (Beggs and Bambrick 2005).

Emberlin (1994) focuses on pollen from, among other species, Ambrosia, but also examines the response of the plans to climatic change in relation to the potential migration rates of the species. Furthermore, she studies the effect of changing airflow trajectories on the long-range transport of pollen, with pollution from central and northern Europe into Scandinavia.

5. CHEMICAL AIR POLLUTION

Laboratory studies confirm the epidemiological evidence that the inhalation of some pollutants, either individually or in combination, adversely affect lung function in asthmatics. Air pollutants may not only increase the frequency and intensity of symptoms in already allergic patients but may promote airway sensitization to airborne allergens in predisposed subjects. By attaching to the surface of pollen grains and of plant-derived paucimicronic particles, pollutants can modify the morphology of these antigen-carrying

agents and alter their allergenic potential. In addition, by inducing airway inflammation, pollutants may overcome the mucosal barrier and so „prime" allergen-induced responses. In other words, airway mucosal damage and impaired mucociliary clearance induced by air pollution may facilitate the access of inhaled allergens to the cells of the immune system (D'Amato 2002).

Adult asthma hospitalization propensity is highest in spring and seasonal variations in adult asthma admissions were significantly positively correlated with levels of PM_{10} (Gyan et al. 2005), SO_2, CO, NO_2 and atmospheric pressure are negatively correlated with temperature and hours of sunshine (Chen et al. 2006). Altitude and the annual variation of temperature and relative humidity outdoors were negatively associated with asthma symptoms (Weiland et al. 2004). Ozone and aeroallergens combined have a modest synergistic adverse effect to asthma morbidity (Dales el al. 2004).

Allergic rhinitis was found to be associated with higher non-summer (September-May) warmth and traffic-related air pollutants, including CO, NO_x and O_3 (Lee et al. 2008).

Mediterranean areas have a significantly higher prevalence of asthma-like symptoms, than sub-continental ones. An increase in NO_2 levels moderately increases the risk of asthma attacks. When the levels of outdoor NO_2 exposure rise the prevalence of allergic rhinitis increases significantly in the Mediterranean region but not in the sub-continental region (de Marco et al. 2002).

Non-summer temperature, winter humidity and traffic related air pollution, especially carbon monoxide and nitrogen oxides, were positively associated with the prevalence of asthma in middle·school students in Taiwan (Guo et al. 1999).

Clinical and aerobiological studies show that the pollen map of Europe is changing as a result of cultural factors (e.g., import of plants for urban parklands) and greater international travels (e.g. the expansion of the ragweed genus Ambrosia in France, Northern Italy, Austria. and Hungary) (D'Amato et al. 1998).

Increases in ozone, nitrogen dioxide and sulfur dioxide equivalent to their interquartile ranges correspond to an 11% and 13% increase in daily hospitalizations for respiratory and cardiac diseases, respectively (Burnett et al. 1997).

Exposure to traffic related air pollutants increases the risk of non-allergic respiratory symptoms and to a lesser degree the risk of hay fever and allergic sensitization but not the risk of asthma in adults (Heinrich et al. 2005).

Bonay and Aubier (2007) analysed increased non-specific airway hyper-responsiveness and airway resistance in man. They found that diesel exhaust particles can both induce and exacerbate in vivo allergic responses. They can also modify the immune system's handling of the allergen.

Sole et al. (2007) suggest a relationship between higher exposure to photochemical pollutants and high prevalence or risk of symptoms of asthma, rhinitis and atopic eczema. Individual markers of traffic are found to be risk factors for chronic bronchitis among females (Sunyer et al. 2006).

Living close to high traffic flows might increase the asthma incidence in adults, while the tendency for nitrogen dioxide was only seen among atopics. Traffic flow and nitrogen dioxide had a lower than expected correlation (Modig et al. 2006).

Several epidemiological studies suggested an association between traffic density close to places of children's residence and prevalence of respiratory symptoms and more specifically of asthma or allergic rhinitis symptoms in them. Chronic exposure during infancy to traffic related pollutants may accelerate or even provoke, among genetically

sensitive subjects, disruption of the normal regulatory and repair processes eventually contributing to the increase of asthma incidence (Just et al. 2006).

Persistent exposure to NO_x, CO and SO_2 may increase the prevalence of allergic rhinitis in children. However, O_3 and PM_{10} do not indicate any effect (Hwang et al. 2006).

Penard-Morand et al. (2005) associated a moderate increase in long-term exposure to background ambient air pollution with an increased prevalence of respiratory and atopic indicators in children.

The environmental pollution was found to have a detrimental effect on the respiratory system of children, mainly attributable to the occurrence of rhinitis and infectious bronchitis. As for the indoor pollution, maternal smoking was found to increase the prevalence of respiratory problems in children. Finally, the father's educational level and a past history of nursery school attendance increase the prevalence of respiratory diseases during childhood (Sichletidis et al. 2005a).

Calculations of Hwang et al. (2005) are consistent with the hypothesis that long term exposure to traffic related outdoor air pollutants such as NO_x, CO and O_3 increases the risk of asthma in children.

Worldwide, increases in allergic respiratory disease have mainly been observed in urban communities. Epidemiologic and clinical investigations have suggested a strong link between particulate air pollution and detrimental health effects, including cardiopulmonary morbidity and mortality. Riedl and Diaz-Sanchez (2005) provide an evidence-based summary of the health effects of air pollutants on asthma, focusing on diesel exhaust particles (DEPs) as a model particulate air pollutant.

Behrens et al. (2004) analyzed data related to self-reported truck traffic density and several symptoms and diagnoses of asthma and hay fever. No consistent associations were observed.

Burr et al. (2004) detected that a reduction in exposure to traffic related air pollutants alleviates rhinitis and rhino-conjunctivitis but has little effect on lower respiratory symptoms.

In addition to conventional lung function tests and symptom questionnaires, exhaled nitric oxide is found to be a suitable measure of airway inflammation (Steerenberg et al. 2003).

Holz et al. (2002) suggest that repeated exposure to ozone, at a peak ambient air level, can enhance both functional and inflammatory responses to inhaled allergen in subjects with pre-existing allergic airway diseases, and that these effects might reach a clinically relevant magnitude.

Braat et al. (2002) conclude that in a mild climate with relatively low levels of pollution, minor pollution and meteorological disturbances result in substantial changes in nasal reactivity symptoms in non-allergic non-infectious perennial rhinitis patients.

Among pollutants with an enhancing effect on allergy development pollution types with nitrogen oxides (NO_x), ozone (O_3), tobacco smoke, particulate matter and diesel exhaust particles are of special interest (Eberlein-Konig et al. 2002).

Hajat et al. (2001) suggests that air pollution worsens allergic rhinitis symptoms, leading to substantial increases in consultations. SO_2 and O_3 seem particularly responsible, and both seem to contribute independently.

Several studies have demonstrated increased exhaled nitric oxide in patients with pulmonary disease, including asthma. In addition, exhaled nitric oxide may be an elegant tool for monitoring the environmental health effects of air pollution and the prevalence of

atopy in epidemiological surveys. Van Amsterdam et al. (2000) analyse exhaled nitric oxide measurements.

Ramadour et al. (2000) demonstrated no consistent association between mean SO_2 and NO_2 levels and prevalence of rhinitis, asthma or asthmatic symptoms. In contrast, there were statistically significant associations between prevalence of asthmatic symptoms and mean ozone concentration. The interpretation of such findings is not straightforward, as these symptoms can be interpreted either as respiratory irritation due to exposure to non-specific airway stimuli or as a true asthmatic state.

Investigations of Sih (1999) suggest that chronic exposure to urban levels of air pollution may cause respiratory diseases in children.

Keles et al. (1999) suggest that outdoor pollution has adverse effects on the symptoms of allergic rhinitis, while it has no effect on the prevalence of atopy in Istanbul in the 1990s. Jammes et al. (1998) report that an association exists between actual environmental exposure to outdoor air pollution (i.e., NO_x and/or PM_{10}) and respiratory effects in sensitive adults represented by patients with chronic obstructive pulmonary disease or asthma.

The school children in urban communities had significantly more respiratory symptoms and diseases, when compared with those living in rural communities (Chen et al. 1998).

An East-West German comparative study examining different types and levels of air pollution, i.e. sulphurous (industrial; East) and oxidising (urban; West), showed that the prevalence of atopic eczema was greatest in East Germany. When various direct and indirect parameters of air pollution exposure were measured, the greatest association with atopic eczema was found with NO_x exposure (indoor use of gas without a cooker hood) and close proximity to roads with heavy traffic (Schafer and Ring 1997).

Epidemiological studies in Japan demonstrate that atopic subjects living in urban areas are more likely to suffer from the effects of air pollution with increased coughing, sputum production, wheezing and throat irritation. Furthermore, high concentrations of pollutant gases can promote airway sensitization (Miyamoto 1997).

Results of Duhme et al. (1996) supports the hypothesis that exposure to motor vehicle traffic is related to symptoms of asthma and allergic rhinitis in children. Environmental tobacco smoke or outdoor air pollutants also influence respiratory health (Peat and Dickerson 1998).

Wang et al. (2007) suggest that acute exposure to NO and NO_2, at concentrations found at the curbside in heavy traffic during episodes of pollution, may "prime" eosinophils for subsequent activation by allergen in individuals with a history of seasonal allergic rhinitis.

Forastiere et al. (1994) suggests that living in an area with higher air pollution levels, albeit below the standard limits, may enhance bronchial responsiveness, independently from atopy and asthma.

According to the results of Corbo et al. (1993), environmental air pollution seems not to increase the prevalence of atopic status; it seems, however, to enhance the development of clinical symptoms among already sensitized subjects.

6. SOCIAL STATUS

Irrespective of individual socio-economic status, subjects living in areas in which educational levels were lower had a higher risk of asthma. This can partially explain geographic differences in asthma prevalence (Basagana et al. 2004).

'Socially mobile' pupils, i.e. those resident in the lowest Socio-economic status (SES) areas but attending higher SES schools showed significantly higher prevalence of eczema and some rhinitis symptoms than pupils attending lower SES schools. These findings may reflect differences in reporting related to language, culture and access to medical care rather than real differences in prevalence (Mercer et al. 2004).

Subjects with allergic rhinitis have a significantly higher risk of having asthma compared to subjects without AR. Age was negatively associated with asthma, and asthma associated with AR. The risk of AR without asthma was significantly higher in the upper social classes. Active current smoking exposure was positively associated with asthma alone and negatively associated with AR with or without asthma. In general, asthma and allergic rhinitis coexist in a substantial percentage of patients; bronchial asthma and allergic rhinitis, when associated, seem to share the same risk factors as allergic rhinitis alone, while asthma without allergic rhinitis seems to be a different condition, at least with respect to some relevant risk factors (Bugiani et al. 2005).

The prevalence of hay fever is associated with genetic predisposition, and some reports show an association with urban areas, socio-economic status and combined high allergen and automobile exhaust exposure. In asthma, there is also some evidence for geographical variations in prevalence; exercise challenge tests prove positive more often in urban areas than in rural areas. Although genetic predisposition is the strongest single risk factor for atopic eczema, air pollutants may aggravate the condition by acting as unspecific irritants and immuno-modulators, leading to increased immunoglobulin E expression (Schafer and Ring 1997).

Allergy is believed to vary by month of birth (Wjst et al. 2005). Effects of climate or environmental UV exposure by latitude and influences within language groups for adult allergy reflect unknown genetic or cultural risk factors (Wjst et al. 2005). Increasing age and current smoking are the strongest risk factors of respiratory diseases (Kotaniemi et al. 2002).

7. AIR POLLUTION AND PULMONARY FUNCTIONS

Pulmonary function measured by respiratory peak-flow rate in non-allergic asthmatics was associated with ambient, low-level, air-pollution concentrations of sulphur dioxide and nitrogen dioxide, temperature, relative humidity and medicine intake. As a result, high intake of medicine and high ambient temperatures corresponded to decreased peak flow. During frost periods peak-flow values decreased independently of medicine intake and levels of SO_2. During other times, increased levels of SO_2 and NO_2, increased temperature and increased intake of medicine and low relative humidity corresponded to decreased peak flow (Moseholm et al. 1993). Volatile organic compounds may influence lung function and are probably of importance as bronchial irritants (Harving et al. 1991).

COPD and rhinitis are related to common predisposing factors (smoking, age and sex). Moreover, rhinitis is related to particulate air pollution levels (Sichletidis et al. 2005b).

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