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Passive smoking and respiratory allergies in adolescents

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Abstract. – *Objective:* **The aim of our study was to investigate impact of active and passive smoking on total and specific serum IgE levels and on incidence of developing allergic diseases (i.e. asthma, rhinitis) in a group of Croatian adolescents.**

Methods: **Our study consisted of random sample of one hundred fifty-five (155) voluntary pupils (80 males and 75 females), with mean age of 16.72±1.25 years, from one high school in the city of Varaždin (north-west part of Croatia). Their smoking habits were examined by interview administered by a single trained survey worker while diagnosis of allergic disease (i.e. asthma and allergic rhinits) had to be previously confirmed by physician. Total and specific serum IgE levels were determined using enzyme-linked immunosorbent assay (ELISA) method in Central Laboratory of Clinic for lung diseases Jordanovac, Zagreb (Croatia).**

Results: **Statistically significant higher prevalence of allergic diseases was found in the group of passive smokers as opposed to non-smokers (χ^2=9.29, p=0.002) as well as in active smokers compared to nonsmokers (χ^2=4.45, p=0.034). Also, total IgE (IU/ml) was significantly higher in passive smokers when compared to non-smokers (t=13.039, p<0.01), and in passive smokers as opposed to active smokers as well (t=4.960, p<0.01), while difference in its level between active smokers and non-smokers was not statistically significant. The level of specific IgE to *Dermatophagoides pteronyssinus* between active smokers, passive smokers and non-smokers resulted to be not statistically significant.**

Conclusions: **Results of the study indicate that clinical manifestations of allergic diseases are more frequent in smokers (both active and passive) than in nonsmokers. Our investigation leads us to a presumption of a possibly more harmful effect of passive than active smoking in the adolescent high school population. Statistically highest IgE level in passive smokers as opposed to non-smokers or smokers could be attributed to longer duration of exposure to tobacco smoke in passive smokers and tobacco's potential cumulative effect on allergic senzitisation, although investigations with more precised and detailed mesures including higher number of participants are warranted.**

Key Words:

Tobacco smoke, Allergic diseases, Asthma, Rhinitis, IGE, Dermatophaigodes pteronyssinus.

Introduction

Allergic diseases with the incidence of nearly 20%[1] represent a significant part of the morbidity rate worldwide, and their prevalence is becoming even higher[2]. Allergic reactions belong to type I hypersensitivity reactions and are mediated by antibodies belonging to the immunoglobulin E (IgE) class[3]. Among others, tobacco smoke is listed as a potential trigger that can cause allergic reactions[4]. Tobacco smoke may precipitate allergic sensitization by directly affecting the IgE production on the cellular level[5] or indirectly by increasing the permeability of respiratory epithelium and subsequent reduction of its protective barrier[6,7], thus, enabling the entry of many other allergens. It is possible that the mechanism which causes the increase of IgE level does not differ substantially between active and passive smoking, which can be further confirmed by the data that impact of passive consumption of tobacco smoke on the severity of the asthma is very similar to the impact of active smoking[8,9].

A whole series of studies conducted have found a greater incidence of allergic diseases in

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smokers (those who have actively consumed tobacco smoke as well as those who have been passively exposed to it) as opposed to non-smokers[10-12]. The increased level of IgE was found in persons who were active smokers[13,14] as well as in persons who passively consumed tobacco smoke[15,16] although some investigations did not support their results. Thus, some Authors[17] discovered a negative correlation between active smoking and the increase of specific IgE (the increase was smaller in smokers than in non-smokers), while in the other research[18] the effect of passive smoking on the IgE level has not been proven to been statistically significant. Others[19] performed the study on animal (mice) model and found that tobacco smoke in low, but not in high doses, inhibits T-cell response and thus suppresses the development of inflammatory processes.

The number of adolescent smokers increases each year[20] and until now there have not been reported studies investigating association between active or passive consumption of tobacco smoke and IgE levels, as well as passive and active smoking and allergic diseases (i.e. asthma and rhinitis) performed only in adolescent population. Our study was the the first one investigating association between smoking habits and IgE levels and allergic diseases exclusively in adolescents and also the first one revealing impact of smoking habits (active and passive smoking) on IgE levels and developing allergic diseases in Croatian citizens.

Subjects and Methods

Our study included random sample of one hundred fifty-five (155) voluntary pupils (80 males and 75 females), with mean age of 16.72±1.25 years from one high school in the city of Varaždin (north-west part of Croatia). 31 of participants were active smokers, 60 of investigated subjects were passive smokers and 64 of them were non-smokers. All subjects participated in the study were Croatian citizens. Informed consent was taken from parents or from pupils before including in the study. The study was approved by the Ethical Commitee of the Medical School of the University of Zagreb, and of the Clinic for lung diseases Jordanovac, Zagreb, Croatia.

As a part of interview, all subjects answered detailed questions on smoking habits administered by a single trained survey worker. An *active smoker* was defined as one who regulary smoked more than five cigarettes a day. *Non-smokers* were those subjects who never smoked cigarettes. *Passive smokers* were defined as non-smokers who reported living with one or more smokers during their life. Active smokers were asked about duration of smoking period and number of cigarettes they consumed per day. Passive smokers were asked about duration of the period they were exposed to tobacco smoke, about number of cigarettes consumed by the persons from their environment, as well as about number of persons in their environment who smoked. Depending to the brand, one cigarette consisted of an average of 1 g of tobacco. Those 1 g of tobacco included 3.0-30.0 mg nicotine respectively. Other sources of tobacco except cigarettes (i. e. pipes, cigarillos or cigars) were not reported. Pupils who were smoking for some time and that quit the smoking were excluded from the study. Diagnosis of allergic diseases (i.e. asthma and allergic rhinits) was adopted only if it has previously been confirmed by physician.

Specimens of venous blood were taken from all subjects and serum frozen until determination of total and specific IgE antibodies by enzyme-linked immunosorbent assay (ELISA) method (UNI-CAP). The examination was performed on a UNI-CAP 100 apparatus of the firm Pharmacia & Upjohn Diagnostics AB, Uppsala, Sweden. All determinations were done in one central laboratory of Clinic for pulmonary diseases Jordanovac, Zagreb. For total IgE antibodies results were expressed in international units IU/ml, and for *Dermatophagoides pteronyssinus* specific IgE antibodies antibodies as a reactivity class from 1 to 6: 1. very low or nonspecific level, 2. low level, 3. moderately raised level, 4. high level, 5. very high level, 6. extremely high level. Values of both total and specific IgE antibody levels were expressed as a geometric mean (GM). IgE analyses were been able to performe in all pupils examinated by interview.

Statistical Analysis

By descriptive statistics we calculated mean pupils' age and we also expressed values of total and specific IgE levels. Difference in frequency of allergic diseases (asthma or/and allergic rhinitis) between three groups of participants (active smokers, passive smokers and non-smokers) were revealed using chi-square (χ^2) test. Differ-

ences in total and specific IgE levels between our subjects previously devided to active smokers, passive smokers and non-smokers were determined by *t*-test for independent samples. *P*-values less than 0.01 (<0.01) were considered statistically significant. All statistical analyses were performed using statistical software package for Windows 2001 (by Statsoft, Inc).

Results

Diagnosis of allergy, confirmed by physician, was established in 17 of 64 non-smokers (26.6%), 15 of 31 active smokers (48.4%) and 32 of 60 passive smokers (53.3%). Among those presenting allergy diseases, rhinitis diagnosis resulting much more common than asthma (94.1% vs 5.9% in non-smokers, 86.7% vs 13.3% in active smokers and 75.0% vs 25% in passive smokers). Pupils with allergy had been suffered only from asthma or only from rhinitis, except in two cases (one was non-smoker, another passive smoker) where were confirmed both diagnosis (those pupils had both asthma and allergic rhinitis).

Mean period of smoking duration in those pupils who were active smokers was 1.69±1.79 years, while mean period of environment exposure to cigarette smoke in passive smokers was 16.18±2.20 years. In 31.2% of passive smokers there were two or more persons with smoking habits in their living surrounding. According to intensity of smoking (smoking index=SI), calculated from smoking years multiplied by the cigarette, all smokers were categorizated as a mild smokers.

By χ^2 test we found higher frequency of allergic diseases in active and passive smokers than in subjects who did not smoke. Frequency resulted to be statistically significant (active smokers vs non-smokers: χ^2=4.45, p=0.034; passive smokers vs non-smokers: χ^2=9.29, p=0.002). However, frequency of prevalence of allergic diseases between passive and active smoke group was not shown to be statistically significant.

The values of total and specific IgE levels we presented in Table I. As shown, the highest values were found in the group of passive smokers. Performing *t*-test for independent samples we found statistically significant difference in total IgE level between passive smokers and non-smokers, as well as between passive smokers and active smokers. Total IgE levels did not differ significantly between active smokers and passive smokers. Differences in specific IgE levels between all three investigated groups of pupils (active smokers, passive smokers and non-smokers) resulted to be no statistically significant.

Discussion

Our research revealed statistically significant increased prevalence of allergic diseases both in active and passive smokers as opposed to non-smokers as well as statistically significant increased level of total IgE antibodies in passive smokers vs non-smokers, and passive smokers vs active smokers.

A number of studies also found a greater prevalence of allergic diseases in smoking subjects (active or passive) as opposed to non-smokers[10-12]. However, some investigations while investigating levels of IgE antibodies in smokers (active or passive) as opposed to non-smokers, as we previously reported, did not yielded uniform results. IgE levels were found to correlate positive[13], or negative with active smoking habits[17]. Between passive smoking and IgE levels was found statistically significant positive correlation[16] or correlation did not exist[18].

Table I. Values of total IgE and specific serum IgE (in IU/ml) in non-smokers, passive smokers and active smokers[a].

Lung disease	[a]Nonsmokers (N = 64)	[b]Passive smokers (N = 60)	[c]Active smokers (N = 31)
Total IgE[b,c]	47.07	76.69	53.67
Specific IgE	2.21	3.10	2.71

[a]Values are expressed as geometric mean (GM); [b]Passive smokers vs non-smokers: t=13.039, p<0.01; [c]Passive smokers vs active smokers: t=4.960, p<0.01.

IgE synthesis is regulated by cytokines interleukin-2 (IL-2), interleukin-4 (IL-4) and gamma interferon[21] and it is believed that both active and passive smoking lead to increase of IgE through a similar mechanism which most probably involves the stimulation of IL-4 production[15]. Also, impact of passive tobacco consumption on the severity of asthma was found to be very similar to the impact of active tobacco consumption[8,9].

Some Authors pointed out the statistically significant correlation of the number of cigarettes smoked per day by the parents and the level of IgE[15], while the others[22] found the highest level of IgE in children whose both parents smoked indicating that quantity of IgE increased with quantity of smoked cigarettes. A statistically significantly higher concentration of IgE was found in children whose mothers were smokers, as opposed to children whose fathers were smokers[22,23] One possible interpretation is that mothers in most cases spend more time with their children, especially in the period after the child is born and through the child's early childhood.

Beside the quantity of passive smoke exposition, its longer duration was also found to have enhanced risk of developing allergic sensitization. Some Authors described the cumulative effect of the duration of passive smoking on allergic sensitization to food allergens (the risk of allergic sensitization was greater in children who were prenatally and postnatally exposed to tobacco smoke, than in those who were passive smokers only in the postnatal phase)[24]. Therefore, the IgE level in the cord blood was highest in children who were passive smokers during both the prenatal and the postnatal period, altough the correlation with passive tobacco smoke exposure duration was not statistically significant.

Considering that both active and passive smoking lead to increase of IgE possibly through a similar mechanism and that prolonged passive smoking duration may have cumulative effect and, therefore, greater impact on IgE levels/developing allergic sensitization than shorter active smoking period like those in our adolescentes, we may explain statistically significant higer IgE level in passive smokers as opposed to active smokers in our study.

Our study included small number of participants, but it was first one of that type performed only on adolescents, first one in Croatian population as well as the first showing statistically significant higher total IgE levels in passive smokers as opposed to active smokers.

As adolescents are a group that is at the greatest risk of developing allergic diseases[12] and since the habits aquired during adolescence are difficult to change afterwards, it is of utmost importance to approach the problem of smoking, active as well as passive, more seriously and to educate parents and children about its detrimental effects and consequences.

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