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Association of *Blattella germanica* sensitization with atopic diseases in pediatric allergic patients

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ABSTRACT

The extent to which the sensitization to the German cockroach *Blattella germanica (BG)* affects onset/ presence of rhinoconjunctivitis (RC) in children is unknown. The present work was aimed to assess the prevalence of *BG* sensitization in an outpatient pediatric population from an allergy clinic, the association with allergic diseases, and the effect of age in children with allergic sensitization. Five hundred and four consecutive children with at least one positive skin test to a panel of 17 food and inhalant allergens, including *BG,* and with personal history of atopic diseases, were enrolled in an Allergy Unit of Palermo, Mediterranean area of Southern Italy. A questionnaire was administered to obtain data on epidemiologic and clinical characteristics. Atopy index was computed as the number of the individual positive skin prick tests. Logistic regression was used to estimate the associations between age classes and *BG* sensitization and RC, as well as the population attributable risk (PAR) for RC. Prevalence of *BG* sensitization was 10.5 % (5.2% and 15.8% in lower and upper age classes respectively, p=0.0001). Atopy index significantly increased from the lower to the higher age class (p<0.0001). The older age class (OR 3.12; 95% CI 1.57-6.19) and a higher atopy index (OR 37.16; 95% CI 5.04-274.13) were recognized as main risks factors for *BG* sensitization. In the upper age class, the PAR of *BG* sensitization for RC was 20.6%. *BG* sensitization increases in the higher ages, along with atopic index, and *BG* sensitization is associated with rhinoconjunctivis in older allergic children.

KEY WORDS:

age

asthma

Blattella germanica

children

rhinoconjunctivitis

INTRODUCTION

The German cockroach *Blattella germanica* (*BG*) is a nocturnal insect belonging to the *blattellidae* family, which lives and proliferates in humid and dark environments. Exposure to cockroach has been recognized in most countries as a relevant cause of sensitization and asthma (1), and contributes to increased asthma morbidity in inner-city children. (2). Although the relevance of cockroaches as allergen sources depends on climatic and socio-economic features of the local community, in some geographical regions the number of cockroach-sensitive patients is uncommonly high (3, 4). In Italy a rate of cockroach sensitization of 1.8 - 13% (5, 6) in adults and 12.7% in the pediatric age (7) has been previously reported. In the latter study amongst cockroach-sensitized subjects, no correlation between cockroach allergy and the clinical characteristics of the study population was found (7).

The causal links between cockroach allergy and childhood asthma or asthma exacerbation (8) are plausible. The relationship with rhinoconjunctivitis is less explored: the Odds ratio for rhinitis was significantly higher among children who had an increased anti-cockroach IgE level (9).

The aim of our study is to assess the prevalence of sensitization to *BG* in a cross-sectional survey of allergic pediatric patients from Southern Italy, its association with rhinoconjunctivitis and asthma, and the effect of age. In addition, we evaluated the relevant determinants and estimated the population-attributable risks (PAR) of *BG* sensitization for rhinitis.

METHODS

Study design

This was a cross-sectional evaluation of the prevalence of *BG* sensitization in a large group of 504 consecutive children with at least one positive skin test to a panel of 17 food and inhalant allergens, including *BG,* and with personal history of atopic diseases. For each subject a detailed clinical history, total serum IgE assay, and peripheral eosinophil count were collected. The study was approved by an Institutional Ethical Committee, and all parents signed a written informed consent.

Clinical history

Between January 2007 and July 2008, 972 consecutive outpatients of the Allergy Unit within the Children's Hospital in Palermo, Mediterranean area of Southern Italy, with symptoms of asthma, rhinoconjunctivitis, urticaria, atopic dermatitis, and food allergy were evaluated.

An interview-administered questionnaire was completed by parents to collect information on the demographic characteristics (age, gender), season of birth, family history of asthma or rhinitis, number of households, place of residence (urban or rural) and clinical history of the children. Household Crowding Index (HCI) was defined as the total number of co-residents per household, divided by the total number of rooms, excluding the kitchen and bathrooms. Presence of mould/dampness at home and bedroom, post-natal environmental tobacco smoke exposure at home (ETS), presence of pets, age at the onset of atopic disease, and history of previous hospital admissions for asthma were recorded. Family educational level, as a proxy of the socio-economic status, was classified as *primary-middle-high-university*: parental education was defined as "low" if the father and/or the mother had completed low or middle education, otherwise as "high" (10).

Skin prick tests and atopic status

Skin prick tests (SPT) were performed by the same trained Pediatrician (SLG) to ensure uniformity of interpretation. The panel of inhalant and food allergens included: mite, *Parietaria judaica*, *Alternaria alternata*, *Cladosporium herbarum, Aspergillus fumigatus,* mugwort, grasses,

olive, dog and cat dander, *BG*, *latex*, cow's milk, hen's egg, cod, wheat, apple, almond, and peanut. Standardized extracts at the concentration of 100 I.R./ml were used (Stallergenes, Waterloo, Belgium). Skin tests were performed according to international standard procedures (11). A positive test was defined as a mean wheal size ≥ 3mm, after subtraction of the negative control. H1-antihistamines, if any, had to be discontinued at least 14 days before SPT. Atopy index was computed as the number of the individual positive SPT and classified as 1: one or two positive skin tests; 2: three or more positive skin tests (12).

Total serum IgE were assayed by latex nephelometry (Behring Institute, L'Aquila, Italy), log-transformed and expressed as Z-scores according to age tertiles (<7 years; ≥7 and<11 years; ≥11 years). A blood eosinophil count was performed in all the subjects and data were used as natural log for computations.

Diagnosis of Allergic Disease

Current asthma was defined as a) doctor diagnosis of asthma or hospitalisation for asthma during the previous 12 months or use of asthma medication or b) asthma ever in life and presence in the previous 12 months of: wheezing or exercise-induced wheezing or shortness of breath with wheezing or dry cough at night or chest tightness with wheezing. *Current rhinoconjunctivitis* (CR) was defined by frequent sneezes or a runny or blocked nose not associated with common cold or flu, with itching/watery eyes, in the previous 12 months. *Current eczema* (CE) was defined as skin reddening with itching, at least once in life, in one or more of the following sites: elbow folds, back of the knees, ankles, under the gluteus zone, around the neck, around the ears or around the eyes. *Food allergy***,** was defined by immediate type clinical reactions to food and identified by history (13). *Urticaria* (U) was defined by pruritic, erythematous, blanching, circumscribed macular or raised lesions involving the superficial layers of skin (14).

Statistical analysis

Descriptive analysis was used to study the prevalence of cockroach sensitization according to age and gender in an outpatient population from an allergy clinic. Analysis of variance and

frequency distribution tables (χ^2) for parametric variables were performed to study the differences among age categories and between genders. Mann-Whitney U test was used for non parametric variables. Logistic regression model was used to assess the independent variables influencing the risk for *BG* sensitization and for current asthma and CR development: Odds ratios (OR) with 95% confidence intervals (CI) were calculated. In each specific exposure-outcome evaluation, we adjusted for the following confounders chosen a priori: sex, season of birth, parental history of asthma or rhinitis, parental smoking, presence of mould/dampness in children's bedroom, parental education, number of households, presence of pets, sensitization to other allergens. Continuous variables were dichotomized at the level of their 50th percentile (median). All analyses were performed using StatView statistical software package (SAS Institute, Cary, NC, USA). A probability level of $p<0.05$ was selected as statistically significant. To ascertain how much of allergic disease is attributable to *BG* sensitization, we estimated the population-attributable risk (PAR%) following the equation: [p (RR-1)] / [p (RR-1) + 1] where p is the proportion of the population exposed and RR is the adjusted relative risk of the exposed vs the unexposed (15).

RESULTS

Five hundred and four subjects (51.9% of 972 patients) had at least one positive SPT. Among them, 300 were males (59.5%). Age range was 5 - 215 months (0.4 -17.9 years), median 100 months (8.3 years), mean age 7.8 years ± 3.1 SD. Fifty-three out of 504 studied children (10.5%) had a positive SPT response to *B. germanica.* Asthma was present in 364 subjects (72.2%); in 30 of these asthma was associated with rhinoconjunctivitis. Rhinoconjunctivitis alone was present in 81 (16.1%) individuals. In Table 1 the socioeconomic and clinical characteristics of the study sample are depicted for all the subjects and separately for each age class (cut-off value at 50th percentile of age). Among different age classes gender was equally distributed, as well as no difference was found regarding the place of residence (urban 71.0%, rural 29.0%) and the HCI.

A significant difference between age classes was observed for medians of serum total IgE (from 300 to 357 KU/L, p=0.0001). Also atopy index was significantly different between age classes (median atopy index [and interquartile range] 3 [2-4] vs 3 [2-5], p<0.0001). Lastly, no significant difference between age classes was found regarding the frequency distribution of current asthma, ETS, mould/dampness in children's bedroom, presence of cat at home, parental history of asthma and rhinitis, food allergy. Similarly, no significant between-class difference was found in eosinophil count.

~~Individual rates of sensitization were as follows: *Dermatophagoides pteronyssimus* 84.3% (n=425), olive pollen 35.3% (n=178), *Parietaria judaica* 30.8% (n=155), *Alternaria alternata* 27.6% (n=139), mixed grass pollens 18.5% (n=93), cat 15.1% (n=76), *Artemisia* 12.1% (n=61), *BG* 10.5% (n=53), *Cladosporium herbarum* 5.6% (n=28), dog 2.4% (n=12), latex 3.2% (n=16), hen's egg 4.0% (n=20), cow's milk 2.2% (n=11), cod 0.4% (n=2), wheat 0.6% (n=3), almond 0.6% (n=3) and peanut 1.0% (n=5). Out of the 364 asthmatic subjects, 87.1% had a sensitization to *Dermatophagoides*, 36.0% to olive pollen, 31.6% to *Parietaria judaica,* and 10.2% to *BG*.~~

In Table 2 the individual rates of sensitization, separately for the whole sample and for the subgroup of asthmatic subjects are indicated. A significant association was found between

distributions of *Dermatophagoides* and *BG* sensitizations: 12.2% of children sensitized to *Dermatophagoides* was also sensitized to BG, while only 1.3% of individuals not sensitized to *Dermatophagoides* was sensitized to *BG* (p=0.004, χ^2). Out of 81 subjects with CR (not associated with asthma), 80.2% had a sensitization to *Dermatophagoides*, 37.0% to olive pollen, 38.0% to *Parietaria judaica,* and 16.0% to *BG*. Among BG positive individuals, 69.8% had current asthma: this distribution was not significantly different from that of the whole study sample (72.4%). No significant differences between *BG* positive asthmatics (n=37) were found in comparison with the negative ones (n=327) as concerns: parental education, HCI, ETS, mould/dampness exposure in children's room, total IgE Z-score, eosinophil count and place of residence. Conversely, median atopy index (and interquartile range) was 5 (4-8) in *BG* sensitized and 3 (2-4) in *BG* non sensitized subjects (p<0.0001, Mann-Whitney U test) and *BG* sensitized asthmatics (mean age 10.2 yrs ± 3.4 SD) were significantly older than non sensitized asthmatics (8.2 yrs ± 3.1).

Sensitizations for *Parietaria judaica*, *Artemisia,* grass pollen, cat and dog dander, latex, and *BG* were significantly more frequent in higher age class (Table 3). Conversely, sensitization for milk was less frequent. Proportion of sensitization of seven different allergens by age class are shown in Figure 1. P values (χ^2) were: for *Dermatophagoides* (0.18), Olea (0.06), *Parietaria* (0.001), *Artemisia* (<0.0001), Grass pollen (0.0006), Cat (0.0007), *BG* (0.0001). In particular, the sensitization to *BG* significantly increased with age, from 5.2% (95% CI 3.2-7.2%) for the lower age class up to 15.8% (95% CI 11.8-19.8%) for the upper class. The age standardized frequencies of *BG* sensitization were significantly different by gender: 12.1% in males (CI 12.0-12.2) *vs* 14.7% in females (CI 14.6-14.8, p=0.02, χ^2). *BG* sensitization was also more frequent in CR subjects (Table 4), but not associated with either increased IgE Z-score or eosinophil count. ~~In Figure 2 the relationships between current asthma (left panel) and CR (right panel) durations and age are separately depicted for males and females. Analysis of covariance showed that both slope differences were statistically significant (p=0.0037 for current asthma and p=0.0175 for CR).~~

In a logistic regression model, children from the higher age class (compared with the lower age class) (OR 3.12, 95% CI 1.57-6.19) and subjects with increased atopy index (OR 37.16, 95% CI 5.04-274.13) had an increased risk of *BG* sensitization, while male children had a risk of about one half with respect to females (OR 0.42; 95% CI 0.22-0.78) (Table 5 A). Parental education, HCI, and IgE Z-score did not show any significant effect on *BG* sensitization.

Because atopy index significantly increased with age, we computed the risk factor of *BG* sensitization for rhinitis (not associated with asthma) in logistic models stratifying for age class and correcting for confounding variables, including the sensitization to other allergens (*Dermatophagoides pt.*, pollens, moulds, pet dander, foods, latex). Odds ratios were 0.72 (95%IC 0.08-6.40) in the lower age class and 2.65 (95%IC 1.06-6.59) in the higher class (Table 5 B). Consequently, the PAR% of *BG* sensitization for rhinitis in the higher age class was 20.6%. Sensitization to *BG* was not a significant risk factor for asthma.

DISCUSSION

We found a 10.5% prevalence of *BG* sensitization, lower than 12.7% previously referred in Italian atopic children (7). In Italy, a prevalence of cockroach sensitization ranging from 1.8 to 13% of the general population (5), with a peak of 20% in immigrants (6), has been reported. In a recent epidemiological survey performed on 2150 schoolchildren of Palermo (16), we found a prevalence of BG sensitization of 4.0% in the general population sample and of 10.1% in the subsample of subjects with allergic sensitization (data on file), value very close to the value found in the present paper among atopic subjects. We should point out that our patients were living in the southern of Italy, where the typical dry-hot weather with low humidity (17) determines an unfavorable environment for cockroach survival. This might explain the lower rate of sensitization in comparison from the previous results from the northern Italy (7). In our sample, no significant difference among age classes was found regarding gender, family history of asthma or rhinitis, parental education, HCI, ETS, mould/dampness exposure in the children's bedroom, and cat ownership at home. Interestingly, patients who reported current asthma, as we defined as presence of wheezing in the previous 12 months, are slightly less prevalent in the higher age class. This is in agreement with the findings of the SIDRIA time-trend survey, in which wheezing (past 12 months) with asthma was more common among children than in adolescents (18).

Compared to other surveys in asthmatic children (19), in our whole study sample and also in the current asthma subgroup we found a lack of association between place of residence, urban/rural, and prevalence of *BG* sensitization and mite allergens, in agreement to other results showing similar exposures to common indoor allergens in children with and without asthma (20). In regards to the prevalence of the environmental factors in our allergic patients between the two age classes, no significant differences were found about ETS, or the high level of mould/dampness in the children's room. On the contrary, although no significant result of cat ownership in the different age classes was found, the prevalence of cat sensitization was significantly higher in the upper age class

(p=0.0007, Table 3). Sensitization to cats could be explained by cat exposure in places other than homes (e.g. schools) (21).

Taking into account that the incidences of sensitization to inhalant allergen increase with age from 1.5% at 1 year to 8% at 6 years as reported by longitudinal data (22), even in our study sample, the increase of age was significantly associated with increases in atopy index (from 3 [2-4] to 3 [2-5]) and with the higher rate of RC occurrence (from 18.4% to 25.6%). This figure is in agreement with other studies showing that the prevalence of RC is steadily increased with age (23) and that a significant association between prevalence of sensitization and RC is more frequent in children older than 6 years (24). Lastly, no relationships between total serum IgE and asthma was found in current asthma subjects, unlike previous data in asthmatic children (25).

Considering the course of specific sensitization in our study sample, along with age increase, we also found significant differences in prevalence distribution of the specific sensitization for: *Parietaria judaica*, *Artemisia*, grass pollen, cat and dog danders, *B. Germanica* and latex. Furthermore, we confirmed a higher prevalence of food allergens in the younger age and an increasing relevance of aeroallergens in the following years of life (26). As shown for *BG* in Figure 1 and Table 3, our results provide important data for the role of cockroach sensitization in older children, suggesting that the cockroach sensitization is a relevant indoor allergen in this age group, about threefold with respect to younger children (27).

In our study, 12.2% of patients sensitized to *Dermatophagoides* were also sensitized to *BG*: to explain this result, the cross-reacting tropomyosin allergen of mites and cockroaches should be taken into account (28).

Interestingly, no significant difference between the *BG* positive asthmatic patients and the negative ones was found, concerning both individual and outdoor/indoor environmental risk factor. Moreover, in asthmatics, the detection of a significantly higher atopy index only among *BG* positive patients, might suggest that *BG* sensitization plays a role as relevant allergen exposure to achieve multiple sensitization. Of note, in our *BG* positive asthmatics no difference in the severity of

disease, or related to the different place of residence (urban or rural), was found. It's noteworthy in our sample that the rate of sensitization to *BG* in the higher age class was higher in subjects with RC (20%) than in subjects with current asthma (14.4%), CE (17.4%), or U (16%).

The hypothesis that the risk of *BG* sensitization is primarily associated with a higher atopy index is confirmed by multiple logistic regression analyses, in which atopy index produced the highest Odds ratio.

In our study sample, *BG* sensitization was not a significant risk factor for asthma. This is in contrast with previous data, in which *BG* sensitization is prevalent in asthma and it is recognized as an important risk factor for a higher severity of the disease (29). Since in our sample a significant relationship between *BG* sensitization and rhinoconjunctivitis was found, the PAR% estimation allowed us to assess the rhinoconjunctivitis case effect and to estimate the proportion of rhinoconjunctivitis (not associated with asthma) which would not have occurred in the absence of *BG* sensitization. The 20.6% PAR% of *BG* sensitization for rhinoconjunctivitis in the higher age class indicates that *BG* sensitization is a determinant factor for rhinoconjunctivitis in so far as abating *BG* exposure would prevent about one fifth of cases of rhinoconjunctivitis. In our opinion, this is an important issue in view of the opportunity to implement measures of indoor intervention aiming to reduce the risk of sensitization and also to modify the impact of *BG* on the occurrence of RC. Indeed, in contrast to many published data on the effectiveness in reducing asthma morbidity through tailored intervention measures for diminishing indoor levels of cockroach allergen, there are currently no data on rhinitis (30).

In conclusion, on the basis of our results we confirm a relatively lower prevalence of skin test reactivity to *BG* (10.5%) in atopic children living in Southern Italy. The increasing age, the female sex, and the atopic degree (i.e. the higher atopy index) are the main determinants of the *BG* sensitization. Finally, the significant association of *BG* sensitization with RC in pediatric allergic patients as well as the PAR% estimation suggest the need for studies aimed at testing the effectiveness of environmental control in this population.

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FIGURE LEGEND

Figure 1 - Relative frequencies of sensitization for each age class as concerns seven different allergens in a pediatric outpatient population from Palermo, Italy. Age classes were separated on the basis of median age value (100 months, 8.3 years). The p value (χ^2) was computed for each allergen.

Table 1 - Descriptive characteristics, gender and atopy index of the patients according to age classes (cut-off value at 50th percentile - 100 months, 8.3 years).

	Total sample (No. = 504)	**Lower age class** (No. = 250)	**Upper age class** (No. = 254)	***P*** **(χ^2)**
Age range per class (years)	0.4-17.9	0.4-8.3	8.3-17.9	
Males No. (%)	300 (59.5)	142 (56.8)	158 (62.2)	0.20
Low parental education (*primary-middle*) No. (%)	273 (54.3)	130 (51.8)	143 (56.7)	0.27
High Household Crowding Index No. (%)	119 (23.7)	65 (26.1)	54 (21.3)	0.20
At least one parent current smoker No. (%)	272 (53.9)	129 (51.4)	143 (56.3)	0.27
Family asthma or rhinitis No. (%)	265 (52.5)	133 (53.0)	132 (52.0)	0.81
Mould/dampness in children's bedroom No. (%)	212 (42.1)	101 (40.6)	111 (43.7)	0.48
Presence at home of dog No. (%)	57 (11.3)	17 (6.8)	40 (15.7)	0.002
Presence at home of cat No. (%)	24 (4.8)	14 (5.6)	10 (3.9)	0.37
Current asthma No. (%)	364 (72.2)	185 (74.0)	179 (70.5)	0.34
Current rhinoconjunctivitis No. (%)	111 (22.0)	46 (18.4)	65 (25.6)	0.054
Current eczema No. (%)	59 (11.7)	36 (14.4)	23 (9.1)	0.060
Food allergy No. (%)	15 (3.0)	9 (3.6)	6 (2.4)	0.41
Urticaria No. (%)	44 (8.7)	19 (7.6)	25 (9.8)	0.38
Atopy index (median and interquartile range)	3 (2-4)	3 (2-4)	3 (2-5)	<0.0001*
Serum total IgE (KU/L, median and interquartile range)	320 (200-550)	300 (185-500)	357 (250-580)	0.0001*
Eosinophil count (median and interquartile range)	420 (276-666)	450 (269-680)	400 (290-640)	0.34*

*Analysis of variance, after natural log transformation

Table 2 - Individual rates of sensitizationin the whole sample and among subjects with current asthma

Allergens	**Whole sample** (No. = 504)		**Asthmatic subjects** (No. = 364)	
	No.	%	No.	%
Dermatophagoides pteronyssinus	425	84.3	317	87.1
Olive pollen	178	35.3	131	36.0
Parietaria judaica	155	30.8	115	31.6
Alternaria alternate	139	27.6	102	28.0
Mixed grass pollens	93	18.5	65	17.9
Cat	76	15.1	61	16.8
Artemisia	61	12.1	42	11.5
Blattella germanica	53	10.5	37	10.2
Cladosporium herbarum	28	5.6	21	5.8
Latex	16	3.2	9	2.5
Dog	12	2.4	11	3.0
Hen's egg	20	4.0	9	2.5
Cow's milk	11	2.2	8	2.2
Peanut	5	1.0	2	0.5
Wheat	3	0.6	1	0.3
Almond	3	0.6	1	0.3
Cod	2	0.4	2	0.5

Table 3 - Prevalence (%) of specific sensitizations for age class (cut-off value at 50th percentile - 100 months, 8.3 years) and significance of differences in distribution (χ^2). No difference was observed for allergens which caused few reactions such as aspergillus, wheat, egg, almond, peanut, and apple.

Allergens	**Lower age class** (0.4-8.3 years)	**Upper age class** (8.3-17.9 years)	**P**	**Upper/lower class ratio**
Dermatophagoides pt.	82.3	86.6	NS	1.05
Alternaria	24.1	31.1	NS	1.29
Cladosporium	5.6	5.5	NS	0.98
*Parietaria***	24.1	37.4	0.001	1.55
Olive	31.3	39.4	NS	1.26
Artemisia§	6.0	18.1	<0.0001	3.02
Grass pollen	12.5	24.4	0.0006	1.95
Cat*	9.6	20.5	0.0007	2.14
Dog	0.4	4.3	0.004	10.75
Blattella germanica§§	5.2	15.8	0.0001	3.02
Latex	0.8	5.5	0.002	6.88
Milk	3.6	0.8	0.03	0.22
Egg's§§	5.6	2.4	NS	0.43

Table 4 - Prevalences of sensitization for *Blattella germanica* among subjects with atopic diseases by age class (expressed as absolute count separately per males and females and total percentage – age cut-off value at 50th percentile [100 months, 8.3 years]). Male/female fraction is expressed as a ratio between M and F sensitized to *BG*.

P-values were computed for differences in gender distribution of *BG* sensitized individuals within each age class (χ^2).

*Differences of *Blattella germanica* sensitizations for each age class among asthmatics and among rhinitics were significant (p=0.007 and p=0.046, respectively, χ^2)

Age class	**Asthma**[§] No.=364 (72.2%)	**Rhinoconjunctivtis**[§] No.=111 (22.0%)	**Urticaria** No.=44 (8.7%)	**Food Allergy** No.=15 (3.0%)	**Atopic dermatitis** No.=59 (11.7%)
All ages	10.2%	14.4%	9.1%	20.0%	10.2%
Lower (0.4-8.3 years)					
Male (No.)	107	28	11	7	22
Female (No.)	78	18	8	2	14
Total *BG* sensitized	5.9%*	6.5%*	0%	0%	5.5%
M/F ratio	6/5	1/2	0/0	0/0	1/1
p-value	0.82	0.31	-	-	0.74
Upper (8.3-17.9 years)					
Male (No.)	124	34	17	3	9
Female (No.)	56	31	8	3	14
Total *BG* sensitized	14.4%*	20.0%*	16%	50%	17.4%
M/F ratio	11/15	6/7	2/2	1/2	1/3
p-value	0.002	0.62	0.40	0.41	0.52

[§]regardless rhinitis/asthma presence

Table 5

A - Multiple logistic regression analysis for sensitization to *Blattella germanica*. Data are expressed as Odds ratio and 95% confidence interval (95%CI), and corrected for Household Crowding Index, presence of mould/dampness at home, parental history for atopy, parental education, environmental tobacco smoke exposure at home, and IgE Z-score

	Odds ratio	**95%CI**
Gender (M vs F)	0.42	0.22-0.78
Atopic Index	37.16	5.04-274.13
Upper age class	3.12	1.57-6.19

B - Multiple logistic regression analysis for Rhinoconjunctivitis. Data are expressed as Odds ratio and 95% confidence interval (95%CI), separately for lower and higher age class, and corrected for environmental tobacco smoke exposure at home, presence of mould/dampness at home, and sensitization to other allergens (*Dermatophagoides pt.*, pollens, moulds, pet dander, foods, latex).

The PAR% of *BG* sensitization for rhinitis in the higher age class was 20.6%.

	Lower age class (0.4-8.3 years)		**Upper age class** (8.3-17.9 years)	
	Odds ratio	**95%CI**	**Odds ratio**	**95%CI**
Gender (M vs F)	0.96	0.43-2.15	0.55	0.28-1.06
Parental history for atopy	0.68	0.30-1.56	1.84	0.94-3.60
Sensitization to cat or dog dander	0.28	0.03-2.24	0.37	0.14-0.99
Sensitization to *Blattella germanica*	0.72	0.08-6.40	2.65	1.06-6.59

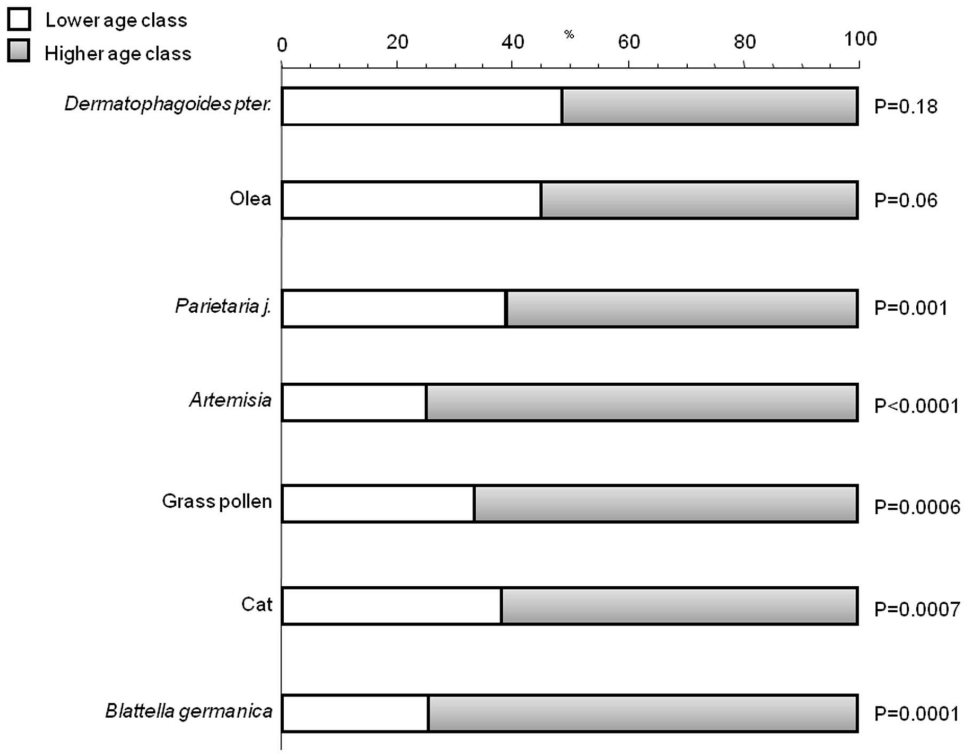

Figure 1 - Relative frequencies of sensitization for each age class as concerns seven different allergens in a pediatric outpatient population from Palermo, Italy. Age classes were separated on the basis of median age value (100 months, 8.3 years). The p value (chi^2) was computed for each allergen.
160x120mm (600 x 600 DPI)