Pest sensitization to cockroach, mouse, and rat: An Italian multicenter study

Allergens of common pests such as cockroach (C), mouse (M), and rat (Rt) represent an important cause of allergic sensitization worldwide. Pest allergens, both in private and public indoor environments, can be correlated with endotoxins[1] and trigger cross-reactions with other allergenic materials. Their frequency of allergic sensitization has been widely assessed in United States and other countries,[2] but only few clinical studies have been conducted in Western Europe on C[3] and rodents.[4]

The aim of our multicenter study, promoted by the "Italian Association of Hospital and Territorial Allergists" (AAIITO), was to investigate the frequency of allergic sensitization to pests in an urban atopic population in Italy. We included consecutive patients with rhinitis and/or asthma diagnosed with International Guidelines and who tested positive to at least one allergenic extract.

Subgroup and risk factor analyses considering baseline and clinical characteristics (e.g., concomitant sensitizations) were also performed. Detailed information on patients' characteristics (Table S1), methods, key messages (Figure S1), and additional references are provided in additional online material.

The frequency of allergic sensitizations to pest allergen extracts and their kindred allergenic materials (from dust mites, dog, and cat), in the total 1559 enrolled patients, is reported in Table 1. Overall, the prevalence is not negligible for C (8%), but rather low for M (3%) and Rt (1%) allergens.

The potential risk factors of pest sensitization are shown in Table 1 (unadjusted analysis) and Figure 1 (adjusted analysis).

From a general point of view, environmental factors such as poor housing conditions, low socio-economic status, dampness, and poor ventilation[5] were strongly associated with pest sensitization (OR: 3.7–6.2).

It is likely that such environments, usually associated with poverty and poor hygiene, promote ideal conditions for development of allergic sensitizations to pests. However, it is difficult to identify the actual or main mechanism of pest sensitization.

The linear positive correlation of skin reactivity between allergen extracts of C and *Dermatophagoides pteronyssinus* ($r = 0.2018$, 95% CI: 0.154–0.249, $p = 0$) and between allergen extracts of M and Dog ($r = 0.118$, 95% CI: 0.067–0.169, $p = 0$) could be explained by a co-sensitization mechanism caused by exposure to sources of allergens which are different, but that live in the same environments. In fact, although none of our patients have reported the presence of C, Rt, or M at home, the unrecognized exposure to these pests cannot be ruled out.

Other non-specific factors related to degraded indoor environments such as humidity and presence of endotoxins, as well as behavioral factors like smoking (OR 1.8–3.5, Figure 1), could contribute to increase the risk of allergic sensitization.

It is likely that sensitization to pests, in our population, may be the result of a combined action of all the factors we have reported, in the context of a multifaceted mechanism in the airways.

Overall, sensitizations to pests alone (i.e., without additional sensitizations to any other allergenic extract) were not found. However, some patients were sensitized to pests without their kindred allergenic extracts: 35 C (27%), 36 M (73%), and 15 Rt (75%) (Figure 1). The interaction test showed no significant differences in environmental exposure within these subgroups, compared to patients sensitized to both pests and kindred allergenic extracts.

In conclusion, this is the first systematic assessment of sensitivity to pest commercial allergenic extracts in Italy when contextually analyzed in the same population. Although their prevalence in Italy is lower compared with other countries, it is not negligible for C (8%) (Table 1). Furthermore, several indoor environmental, behavioral, and allergen-related factors showed significant correlations with pest sensitizations (Figure 1), suggesting that pest sensitization in Italy might be the result of a combination of these factors, in the context of a multifaceted mechanism in the airways, where no single factor can be reasonably considered the only or predominant cause.

Further studies, supported by molecular diagnostics, might help to confirm our finding (Figure S1).

TABLE 1 Pest sensitizations: frequency and potential risk factors ($N = 1559$, unadjusted analysis)

Sensitizations (Skin prick test)		Cockroach	*D.p.*	*D.f.*	Mouse	Rat	Dog	Cat
Nr. Positive		130 (8%)	615 (39%)	561 (36%)	49 (3%)	20 (1%)	142 (9%)	254 (16%)
Skin reactivity	+	20/130 (15%)	52/615 (8%)	49/561 (9%)	12/49 (25%)	6/20 (30%)	53/142 (37%)	33/254 (13%)
	++	67/130 (52%)	188/615 (31%)	174/561 (31%)	27/49 (55%)	3/20 (15%)	63/142 (44%)	83/254 (33%)
	+++	42/130 (32%)	270/615 (44%)	244/561 (44%)	10/49 (20%)	10/20 (50%)	21/142 (15%)	101/254 (40%)
	++++	1/130 (1%)	105/615 (17%)	94/561 (17%)	0	1/20 (5%)	5/142 (4%)	37/254 (14%)

Risk factors	Cockroach		Mouse		Rat	
	OR (95% CI)	*p*	OR (95% CI)	*p*	OR (95% CI)	*p*
Age	1 (1–1)	ns	1 (1–1)	ns	1 (1–1)	ns
Male gender	1.5 (1.1–2.1)	0.006	1.5 (1.0–2.2)	0.024	1.4 (0.9–2.3)	ns
Southern Italy	1 (0.6–1.7)	ns	2.1 (0.9–4.9)	ns	3.2 (1.0–9.6)	0.043
Smoking	**2.4 (1.5–3.7)**[*]	**<0.001**	1.8 (0.9–3.7)	ns	**4.4 (1.7–11.1)**[*]	**0.002**
Pets at home	0.9 (0.6–1.4)	ns	1.2 (0.6–2.1)	ns	1.1 (0.4–2.7)	ns
Exposure to pets	1 (0.6–1.5)	ns	0.6 (0.5–1.9)	ns	1.2 (0.4–3.4)	ns
Env. risk[a]	**3.8 (2.4–6.1)**[*]	**<0.001**	**6.2 (3.3–11.6)**[*]	**<0.001**	**6.4 (2.5–16.3)**[*]	**0.001**
Family history of allergy	1.3 (0.9–1.9)	ns	1.4 (0.8–2.4)	ns	0.8 (0.3–1.9)	ns
Rhinitis	0.8 (0.5–1.4)	ns	0.7 (0.3–1.6)	ns	0.6 (0.2–1.7)	ns
Conjunctivitis	0.9 (0.6–1.3)	ns	0.7 (0.4–1.4)	ns	0.3 (0.1–1)	ns
Asthma	1.3 (0.9–1.9)	ns	3.2 (1.8–5.7)	<0.001	3.5 (1.4–8.5)	0.005
Persistent symptoms	1.5 (1.0–2.1)	0.030	1.4 (0.8–2.5)	ns	1.5 (0.6–3.6)	ns
Symptoms: severity	1.9 (1.4–2.5)	<0.001	1.4 (0.9–2.1)	ns	1.6 (0.8–3)	ns
Symptoms: early onset	1 (1–1)	ns	1 (1–1)	ns	1 (1–1)	ns
D.p.	**4.5 (3.0–6.8)**[*]	**<0.001**	3.9 (2.1–7.4)	<0.001	1.2 (0.5–3)	ns
D.f.	**3.8 (2.6–5.5)**[*]	**<0.001**	3.4 (1.9–6.2)	<0.001	1.2 (0.5–2.9)	ns
Cat	2.0 (1.3–3.1)	0.001	2.0 (1.0–3.7)	0.037	2.1 (0.8–5.5)	ns
Dog	2.1 (1.2–3.4)	0.005	**3.8 (1.9–7.3)**[*]	**<0.001**	**3.3 (1.2–9.3)**[*]	**0.022**
Cockroach	\		**10.4 (5.7–19)**[*]	**<0.001**	11.1 (4.3–28.4)	<0.001
Mouse	**10.4 (5.7–19)**[*]	**<0.001**	\		**168.1 (53.3–530.3)**[*]	**<0.001**
Rat	**11.1 (4.3–28.4)**[*]	**<0.001**	**168.1 (53.3–530.3)**[*]	**<0.001**	\	
Aspergillus fumigatus	**6.0 (1.7–20.8)**[*]	**0.005**	6.3 (1.3–29.9)	0.02	n.a.	
Artemisia vulgaris	2.08 (0.68–3.9)	ns	2.1 (0.8–5.3)	ns	n.a.	
Corylus avellana	1.7 (1–2.9)	ns	2.3 (1.1–4.8)	0.029	1.8 (0.5–6.1)	ns
Alternaria alternata	1.7 (1–3.1)	ns	1.7 (0.7–4.1)	ns	n.a.	
Parietaria	1.6 (1–2.5)	ns	2.6 (1.4–4.8)	0.002	1.7 (0.6–4.8)	ns
Grass mix	1.2 (0.8–1.7)	ns	1.4 (0.8–2.4)	ns	0.4 (0.1–1.3)	ns
Betula pendula	1.1 (0.6–1.8)	ns	2.1 (1–4.1)	ns	0.8 (0.2–3.3)	ns
Ambrosia	1.7 (0.8–4)	ns	3.4 (1.3–9.0)	0.014	n.a.	
Olea europea	2.0 (1.4–3.0)	<0.001	2.8 (1.6–5.1)	0.001	1.9 (0.7–4.9)	ns
Cupressus	1.9 (1.3–2.9)	0.001	1.4 (0.7–2.7)	ns	1 (0.3–2.9)	ns

Note: *D.p.* and *D.f.*: *Dermatophagoides pteronyssinus* and *farinae*, respectively; ns: not statistically significant ($p \geq 0.05$); n.a. Not Applicable due to low number of cases.

[a]Exposure to possible risk factors of indoor pest infestation (evidence of pest presence, poor housing conditions, highly dense population, low socio-economic status, presence of holes or cracks in the wall or doors, dampness/molds, poor ventilation).

[*]Bold indicates statistically significant results ($p < 0.05$) in the adjusted analysis too (Figure 1).

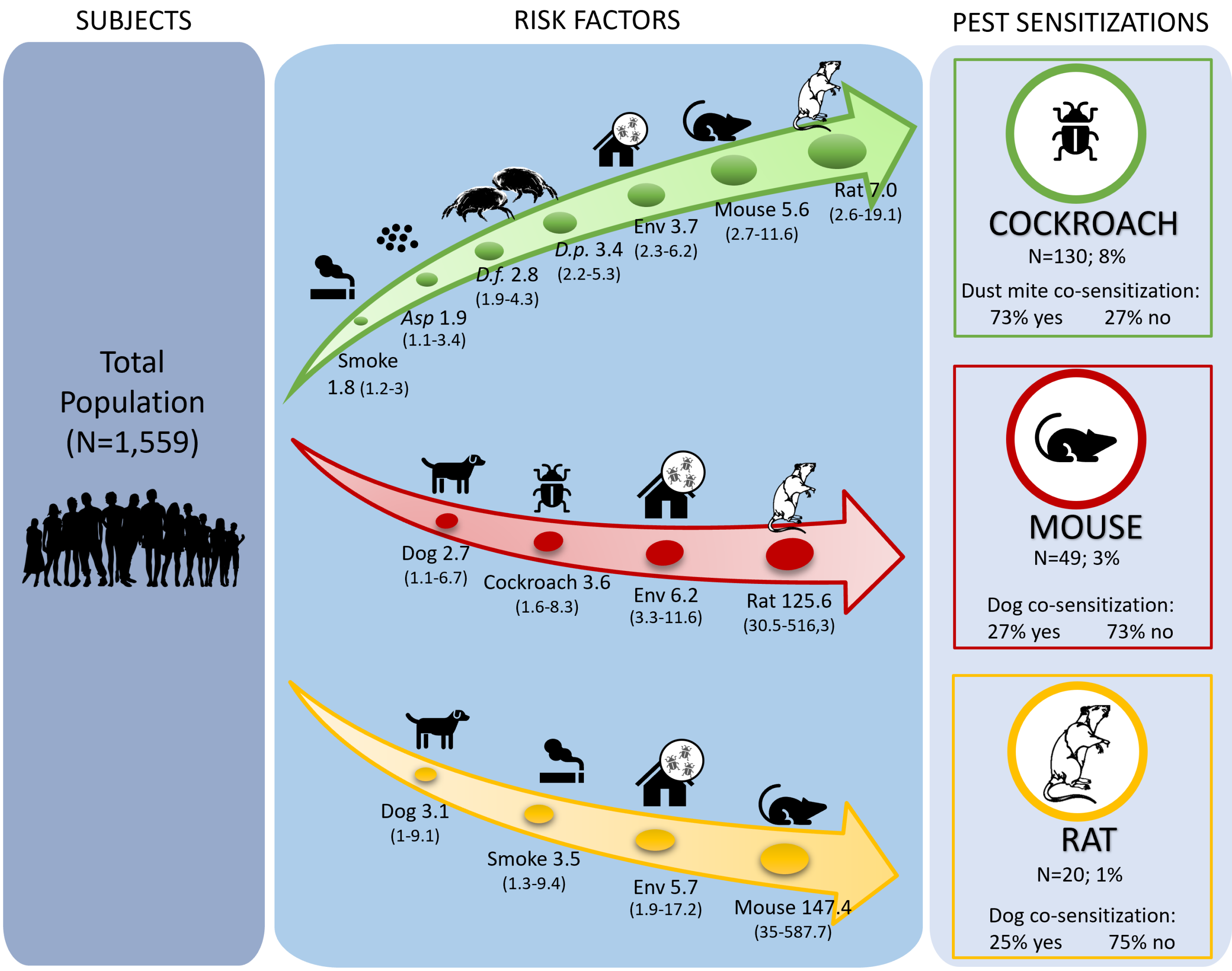

FIGURE 1 Sensitizations and other factors acting as potential risk factors of pest sensitizations ($N = 1559$, adjusted analysis)

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CONFLICT OF INTEREST

The authors have no conflicts of interest to declare.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

Depletion of Mcpt8-expressing cells reduces lung mast cells in mice with experimental asthma

Genetically engineered mouse models have exploited the basophil marker mast cell protease-8 (mMCP-8) to dissect the role of basophils in inflammatory diseases.[1–3] However, mast cell progenitors (MCps) also express *Mcpt8* transcripts in the allergic mouse lung.[4] Here, we investigated whether depletion of *Mcpt8*-expressing cells impacts

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