

BRIEF COMMUNICATION

Gas, dust, and fumes exposure is associated with mite sensitization and with asthma in mite-sensitized adults

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Abstract

Occupational exposure to gas, dust, and fumes (GDF) increases the risk of asthma and eczema. We investigated the role of sensitization in the association between GDF and allergic conditions. A population-based sample of 788 adults from the West Sweden Asthma Study completed questionnaires and skin prick tests. After adjustment for confounders, GDF exposure was associated with a doubled risk of sensitization to mites, but not with other allergens. Mite sensitization also modified the effect of GDF on asthma. In mite-sensitized subjects, GDF was associated with physician-diagnosed asthma, adjusted OR 2.9 (1.2–7.2), and with wheeze, OR 2.4 (1.1–5.3). In non-mite-sensitized subjects, the corresponding ORs were 1.1 (0.5–2.6) and 0.6 (0.3–1.3). GDF was independently associated with eczema regardless of mite sensitization, but not with rhinitis. These novel findings suggest that components of GDF may act as adjuvants that facilitate sensitization to mites and that mite-sensitized individuals may be especially susceptible to inhalant occupational exposures.

A number of occupational exposures are associated with an increased risk of asthma. The question on exposure to gas, dust, or fumes at work (GDF) has been proven a reliable marker of such exposures in epidemiological studies (1–4). GDF has not only been linked to asthma but also to self-reported rhinitis (5) and to eczema (6). We have recently reported preliminary data on an independent association of GDF exposure with sensitization to house dust mites (7). It is not known whether the association of GDF with allergic conditions is related to mite sensitization. This study thus aimed to investigate in detail the links between GDF with mite sensitization and allergic conditions.

Methods

The population-based West Sweden Asthma Study (WSAS), which is part of the Global Allergy and Asthma European Network (GA²LEN) (1), has been described previously (4), including a study of nonresponders (8). A random sample of 30 000 adults (16–75 years) in West Sweden were invited to a questionnaire study, and 60%

participated. A random sample of the participants ($n = 2000$) were invited to clinical examinations in 2009–2012, which included skin prick testing (SPT) of all eligible participants aged ≤ 60 years ($n = 802$) for the following allergens: timothy, birch, mugwort, cat, dog, horse, *D. pteronyssinus*, *D. farinae*, *Alternaria*, *Cladosporium*, and cockroach. The 788 subjects with valid SPT results formed the study population.

The definitions are given in detail in previous publications (1, 5, 6): *GDF*, substantial exposure to gas, dust, or fumes at work; *Wheeze*, wheeze or whistling in the chest in the last 12 months; *Rhinitis*, nasal allergies or hay fever in the last 12 months; *Eczema*, itchy rash for at least 6 months, present in the last 12 months.

For statistical analyses, IBM SPSS Statistics for Windows, Version 21.0 (IBM Corp. Armonk, NY, USA), was used. *P*-values < 0.05 were considered statistically significant. Odds ratios (OR) were calculated by multiple logistic regression adjusting for demographic characteristics and factors that were associated with allergic outcomes in this population (1, 5–7).

Results

Subjects with GDF exposure were more likely to be male and current smokers ($P < 0.001$ each), and to report wheeze ($P = 0.012$) and eczema ($P = 0.037$) (Table 1). Sensitization to mites ($P < 0.001$), but not pollens, animals, or molds, was associated with GDF exposure, and this was confirmed after adjustment for other known predictors of sensitization (Table 1, right side).

In bivariate analyses, GDF with concomitant mite sensitization was statistically significantly associated with asthma, wheeze, rhinitis, and eczema (risk ratios 1.8–3.7) but with neither condition in the absence of mite sensitization (data not shown in table). After adjustment for confounders including sensitization to pollens or animals (Fig. 1), GDF with concomitant mite sensitization was independently associated with physician-diagnosed asthma, adjusted odds ratio (OR) 2.89 (95% CI 1.16–7.19), but not in non-mite-sensitized subjects, OR 1.10 (0.47–2.58). For wheeze, the corresponding figures were OR 2.37 (1.06–5.28) vs OR 0.59 (0.27–1.27). The

association of GDF with eczema was less related to the presence/absence of mite sensitization, OR 1.87 (1.10–3.18) vs OR 1.96 (0.77–4.95), and GDF was not independently associated with rhinitis, regardless of mite sensitization. Conversely, mite sensitization in the absence of GDF exposure was not associated with any allergic condition.

Discussion

In this population-based sample, occupational exposure to gas, dust, and fumes (GDF) was independently associated with allergic sensitization to house dust mites. In adults, 20–30% of incident asthma is attributable to GDF exposure (3, 4), and GDF is a strong predictor of work change due to respiratory conditions (9). This is the first study to report that GDF is associated with asthma and wheeze only in the presence of mite sensitization, that is an effect modification.

Mite sensitization increases the risk of asthma only when it occurs as co-sensitization (10), and mono-sensitization has been described as an intermediate phenotype of allergic disease (11).

Table 1 Baseline characteristics of the study sample and relation to exposure to gas, dust, and fumes (GDF). Also multivariate associations (adjusted odds ratios with 95% confidence intervals) of GDF exposure with sensitization, as measured by skin prick test. Statistical significance is denoted by bold text

	All	Exposure to gas, dust or fumes, GDF			Multivariate* association OR (95% CI)
	(<i>n</i> = 788)	No (<i>n</i> = 588) % (<i>n</i>)	Yes (<i>n</i> = 195) % (<i>n</i>)	<i>P</i>	
Male sex	42.5 (335)	35.5 (209)	63.6 (124)	<0.001	
Age (years)					
16–30	27.5 (217)	28.2 (166)	25.6 (50)		
31–45	36.4 (287)	35.9 (211)	38.5 (75)		
46–60	36.0 (284)	35.9 (211)	35.9 (70)	0.733	
Smoking					
Never	58.0 (455)	62.1 (363)	45.6 (89)		
Previous	29.2 (229)	27.5 (161)	34.4 (67)		
Current	12.9 (101)	10.4 (61)	20.0 (39)	<0.001	
Family history					
Asthma	21.6 (164)	20.7 (118)	25.0 (46)	0.215	
Rhinitis	38.2 (289)	38.2 (216)	38.2 (71)	0.989	
GDF	24.9 (195)	–	–		
Conditions					
Asthma diagnosis	12.1 (93)	11.0 (63)	15.5 (30)	0.096	
Wheeze	23.6 (186)	21.4 (126)	30.3 (59)	0.012	
Rhinitis	28.3 (223)	28.1 (165)	29.7 (58)	0.652	
Eczema	15.4 (121)	13.8 (81)	20.0 (39)	0.037	
Sensitization					
Any allergen	41.9 (330)	41.3 (243)	42.6 (83)	0.761	1.04 (0.71–1.53)
Any pollen	34.3 (270)	35.2 (207)	30.8 (60)	0.258	0.82 (0.55–1.24)
Any animal	22.8 (180)	23.6 (139)	21.0 (41)	0.452	0.78 (0.50–1.23)
Any mold	2.0 (16)	1.7 (10)	3.1 (6)	0.239	0.82 (0.20–3.34)
Any mite	12.6 (99)	10.0 (59)	20.0 (39)	<0.001	1.99 (1.19–3.32)
<i>D. pteronyssinus</i>	11.3 (89)	9.2 (54)	17.9 (35)	0.001	1.82 (1.06–3.10)
<i>D. farinae</i>	9.6 (76)	8.0 (47)	14.4 (28)	0.009	1.94 (1.11–3.40)

*Each sensitization outcome was analyzed separately with adjustment for sex, age (16–30, 31–45, 46–60 years), family history of rhinitis, family history of asthma, keeping cats or dogs in childhood, keeping livestock in childhood, smoking (never, previous, current), and low birth-weight (<2500 g).

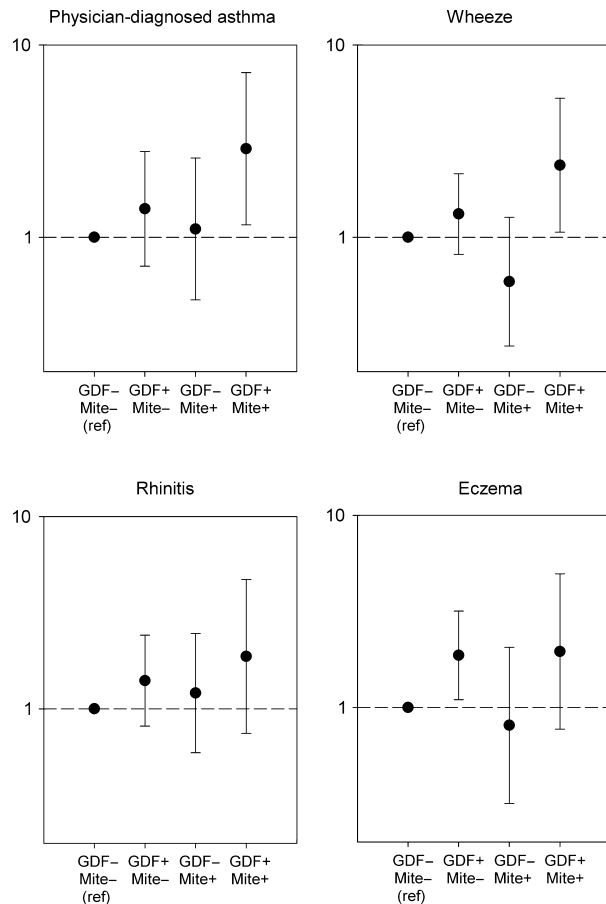


Figure 1 Independent associations of exposure to gas, dust, and fumes (GDF) and mite sensitization with allergic conditions. Four mutually exclusive categories, based on the presence (+) or absence (–) of GDF and mite sensitization, were tested using GDF– and Mite– as reference. Odds ratios (log scale) were adjusted for sex, age, family history of asthma and rhinitis, smoking status, farm childhood, pollen sensitization, and animal sensitization.

In our material, 78% of mite-sensitized subjects were cosensitized to pollens or animals, and it was in this group that the effect modification was seen (data not shown). A sensitivity analysis revealed that poly-sensitization without mite sensitization was not associated with any allergic condition. In Sweden, pollens and animals are the dominant sensitizers and mites are a minor allergen group. Sensitization to major allergens typically develops early in life and may later be followed by sensitization to minor allergens through molecular spreading (12), for example, in response to environmental exposures. Our findings suggest that atopic individuals with mite sensitization are especially susceptible to developing asthma from occupations associated with inhalant exposures.

Typically, occupational exposure to high-molecular weight allergens is associated with sensitization to the offending allergen. GDF exposure may include house dust

mite allergen, but also a variety of organic and inorganic airborne dusts, chemicals, and gases (2), which could act as adjuvants for mite sensitization. Irritant gases in swimming pool environments may increase the risk of allergic sensitization (13), and vehicle exhaust facilitates in particular sensitization to pollens (14). One mechanism could be an impaired epithelial barrier function due to inflammation, which is known to increase the risk of sensitization (15). Inhalant exposures such as smoking and GDF increase the risk of eczema (6), which is an archetypal disease of barrier dysfunction. This difference from asthma, which is more related to sensitization and associated Th1/Th2 imbalance, was further underscored by the finding that eczema was associated with GDF regardless of mite sensitization.

Strengths of the study include the large, population-based sample with high representativeness, well-established questionnaire, and objectively measured allergic sensitization. One limitation is that individual components of GDF exposure could not be disentangled. However, the questionnaire item on GDF has previously performed well when compared against specific questions on occupational exposures (2). Another limitation is the cross-sectional design. The definitions of wheeze, rhinitis, and eczema during the last 12 months were chosen to minimize the risk of outcomes preceding exposure, that is, reverse causation. In addition, we consider it improbable that subjects with allergic conditions had been more inclined to choose occupations with significant GDF exposures.

We conclude that occupational exposure to gas, dust, and fumes increased the risk of asthma, eczema, and sensitization to house dust mites. The association with asthma was further amplified in mite-sensitized subjects, a novel finding that merits further investigation as it may impact recommendations “on” or “regarding” occupational choice.

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Author contributions

KT, GW, and LE took part in study design. LE coordinated the study and was responsible for the study database. AB, ER, SH, and JE were involved in the data collection. AB planned and executed the analyses presented in this paper and wrote the manuscript. All the authors participated in data interpretation, review, and presentation of the results. All authors approved the final manuscript.

Conflicts of interest

The authors declare that they have no conflicts of interest.

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