

Respiratory protective equipment reduces occurrence of sensitization to laboratory animals

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Background	Respiratory protective equipment (RPE) has been shown to reduce exposure to laboratory animal allergens, but there are no studies that have examined its effect on the development of sensitization.
Aims	To examine the effect of RPE on the risk of sensitization to laboratory animals.
Methods	Survey of UK laboratory animal workers conducted between 1999 and 2001. Information was recorded on the type of RPE used when first exposed to animals and at the time of the survey. Sensitization to rat urinary proteins was assessed using skin-prick tests and assays of specific serum IgE antibodies.
Results	There were 776 workers surveyed of whom 228 had been exposed for fewer than 5 years. Those more recently employed were more likely to have used RPE. In employees with <5 years of exposure the use of face masks at first employment was associated with a lower prevalence of sensitization, irrespective of the intensity of exposure to laboratory animals. This reduction was significant only in those who entered the animal house daily.
Conclusions	The use of simple RPE at first exposure to laboratory animals may help to reduce the incidence of specific sensitization.
Key words	Exposure; laboratory animal allergy; respiratory protective equipment; sensitization.

Introduction

Laboratory animal allergy (LAA) is an important occupational health problem affecting between 11 and 44% of exposed workers [1,2]. Allergens from rodents are the most common cause of LAA; since the major determinant of LAA is the level of exposure to rodent allergens [3], the most effective means to reduce the risk of sensitization will be those that reduce (personal) exposures. 'Substitution' is rarely possible and thus attention has been focused on engineering solutions and work practices, and on the use of respiratory protection equipment (RPE). A recent review concluded that RPE can lead to a significant reduction in respiratory symptoms and changes in functional parameters, although it fails to provide complete protection [4].

The use of respiratory protection in this setting seems to be inconsistent. In the USA, for example, a survey of 198 animal facilities revealed wide variation in its mandated use [5]. In contrast, in 2011 the UK Health and Safety Executive issued guidance on the primary prevention of

LAA [6] that effectively requires the use of face-fitted, filtered RPE by all exposed workers. The evidence base for such a recommendation is very limited, which is presumably why, at least in part, there is such variation in international practice and guidance. A study in Swedish workers suggested that the use of face masks can substantially reduce workplace exposure to inhaled allergens from rats and mice [7] but did not include measures of either immunological sensitization or asthma. In a UK facility, a comprehensive exposure reduction programme, including the introduction of RPE, was reported to have reduced the incidence of LAA but any effect of RPE alone could not be disentangled from the other measures [8]. Finally there is limited evidence that the use of an airstream helmet respirator can be effective in improving symptoms in those with established asthma and rhinitis caused by laboratory animals [9].

On this background we examined the association between RPE use and LAA in a cross-sectional population of animal workers in the UK pharmaceutical research sector.

Methods

Between September 1999 and May 2001 we surveyed workers in the laboratory animal facilities of six pharmaceutical companies in the UK. All were potentially exposed to rat proteins as animal technicians, scientists, maintenance workers or office staff. Details of their selection have been published previously [10]. All were invited to complete a questionnaire and undergo skin-prick tests and venesection. The Royal Brompton Hospital/National Heart and Lung Institute ethics committee approved the study and written, informed consent was obtained from all participants.

In addition to recording demographic details, the questionnaire was used to categorize prior exposure to rat proteins. We collected information on the first ever date of contact with live laboratory animals or tissues since leaving school until the present, along with duration of exposure. Employees were categorized according to the highest ever frequency of entering an animal housing facility (daily, weekly, monthly, 3 monthly, 6 monthly) and the maximum ever number of rats handled in a single day (none, 1–10, 11–50, 50+) [11]; we further categorized employees by their 'highest ever' job exposure (office/maintenance worker = 'low'; scientist = 'medium'; animal technician/cage cleaner = 'high') [12]. We also asked employees to record what type of RPE they used when they were first exposed to laboratory animals or their tissues, and their current use of RPE.

The questionnaire also enquired into chest symptoms defined by wheezing, tightness of the chest or difficulty in breathing since starting work with laboratory animals. Employees who reported these symptoms on contact with something at work or with improvement away from work were considered to have 'work-related chest symptoms'. Skin-prick tests were undertaken as previously described [10] with rat urinary extract (Royal Brompton Hospital, London, UK) and common aeroallergens (Allergopharma, Reinbek, Germany). Specific IgE to an extract of rat urine was measured using an in-house radioallergosorbent assay (RAST) with $\geq 2\%$ binding considered a positive response [10]. Employees were considered to be atopic if they had a positive response to skin tests with one or more of the common aeroallergens. We deemed employees to be specifically sensitized if they had a positive skin-prick test (mean wheal diameter $\geq 3\text{mm}$) and/or RAST to rat urine.

The analyses were limited to employees who had been exposed to rat proteins at work for at least one month. In order to minimize any potential 'healthy worker' bias and the effects of any other changes in environmental control we further (and *a priori*) restricted analyses to employees who had five years' or fewer exposure. We investigated associations between categorical variables using chi-square tests or, where numbers were

low, Fisher's exact test. We included RPE in the analysis as a binary variable (facemask versus no RPE) excluding ventilated cabinets/powered helmets due to small numbers. We used logistic regression analysis to test an association between the use of RPE (facemask) at first exposure and specific sensitization to rat proteins in those who had been exposed ≤ 5 years, adjusting *a priori* for atopy. As a secondary outcome we also investigated work-related chest symptoms with an adjustment for atopy in logistic regression.

Results

There were 776 workers available for inclusion in the study of whom 718 (93%) had been exposed to rat proteins at work for at least one month, 53% were male and 44% ($n = 314$) were atopic (Table 1). A small majority ($n = 415$, 58%) of the surveyed employees reported that they had not used RPE on first exposure to laboratory animals; in contrast most (514, 72%) reported that they currently used RPE, in most cases a face mask ($n = 415$, 81%). Employees who had a specific sensitization to rat urine were less likely to have used a face mask on first exposure compared with those who were not sensitized (34% versus 40%), although the difference was not significant. Similarly, a lower incidence of mask use (excluding ventilated cabinets/powered helmets) was observed in those with work-related chest symptoms when compared with those without (56% versus 67%, not significant).

Employees who had been first exposed more recently (including those with five years' or fewer exposure) were more likely to have used some form of RPE on first exposure to laboratory animals e.g. face mask, powered helmet or ventilated cabinet (Table 2).

In an analysis restricted to 228 workers with ≤ 5 years duration of exposure, the prevalence of specific sensitization to rat urinary protein was 11% ($n = 25$) and the prevalence of work-related symptoms 7% ($n = 16$). The prevalence of atopy was significantly lower in those who wore a mask at first exposure than those who did not (46% versus 62%, $P < 0.05$). Employees who were sensitized to rat urinary protein were less likely to have used a face mask on first exposure (50% versus 64%) although the difference was not significant. Similarly, a lower incidence of mask use was observed in those with work-related chest symptoms when compared with those without (56% versus 63%, not significant).

In regression analysis of all 228 employees, and after adjustment for atopy, the risk of sensitization was reduced in those who wore a mask on first exposure (OR 0.64, 95% CI: 0.27–1.53, not significant). We did not find a significant relationship between the prevalence of work-related chest symptoms and the use of a mask at

Table 1. Characteristics of included participants

	Total population <i>n</i> (%)	Sensitization <i>n</i> (%)		Work-related chest symptoms <i>n</i> (%)	
		Yes	No	Yes	No
Number of employees	718	115	603	65	635
Male	379 (53)	64 (56)	315 (52)	31 (48)	336 (53)
Atopy	314 (44)	82 (72)	232 (39)**	46 (72)	257 (41)**
Ever/current smoking	245 (35)	36 (32)	209 (35)	21 (32)	222 (35)
Age (years)					
<30	243 (34)	41 (36)	202 (34)	23 (35)	214 (34)
30–39	259 (36)	49 (43)	210 (35)	29 (45)	227 (36)
40+	216 (30)	25 (22)	191 (32)	13 (20)	194 (30)
Maximum duration (years)					
5 or less	228 (32)	25 (22)	203 (34)	16 (25)	205 (32)
>5	490 (68)	90 (78)	400 (66)*	49 (75)	430 (68)
First exposure RPE use					
No protective equipment	415 (58)	74 (64)	341 (56)	39 (60)	365 (57)
Face mask	266 (37)	38 (33)	228 (38)	26 (40)	234 (37)
Ventilated cabinet/ powered helmet	37 (5)	3 (3)	34 (6)	0 (0)	36 (6)
Current RPE use					
No protective equipment	204 (28)	29 (25)	175 (29)	19 (29)	180 (28)
Face mask	415 (58)	64 (56)	351 (58)	33 (50)	371 (58)
Ventilated cabinet/ powered helmet	99 (14)	22 (19)	77 (13)	13 (20)	84 (13)

* $P < 0.05$; ** $P < 0.001$.**Table 2.** Use of RPE on first exposure, stratified by duration of exposure

	Total (<i>n</i> = 718) <i>n</i> (%)	Duration of exposure			<i>P</i> value
		<5 years (<i>n</i> = 228) <i>n</i> (%)	5–10 years (<i>n</i> = 165) <i>n</i> (%)	>10 years (<i>n</i> = 316) <i>n</i> (%)	
No protective equipment	415 (58)	78 (34)	89 (54)	240 (76)	<0.001
Face mask	266 (37)	131 (58)	65 (39)	69 (22)	
Ventilated cabinet/powered helmet	37 (5)	19 (8)	11 (7)	7 (2)	
Entered animal house					<0.001
daily	526 (74)	128 (56)	130 (79)	265 (84)	
<daily	189 (26)	99 (44)	34 (21)	51 (16)	
Job exposure group					<0.001
Low	84 (12)	48 (21)	16 (10.0)	16 (5)	
Medium	488 (68)	147 (64)	119 (72)	217 (69)	
High	146 (20)	33 (15)	30 (18)	83 (26)	
Number of rats handled					<0.001
0	120 (17)	73 (32)	19 (12)	22 (7)	
1–10	166 (23)	77 (34)	36 (22)	51 (16)	
11–50+	428 (30)	77 (34)	109 (67)	242 (76)	

Information on duration of exposure was unavailable for nine employees.

first exposure in those with ≤ 5 years exposure (adjusted OR = 0.85; 95% CI: 0.30–2.43, not significant).

Among those who had worked with animals for ≤ 5 years, and after stratification by each category of exposure intensity, the prevalence of sensitization to

rat urinary protein was consistently lower in those who had worn a simple face mask at the time of first exposure (Figure 1). The only statistically significant difference was seen in those entering the animal house daily ($P < 0.05$).

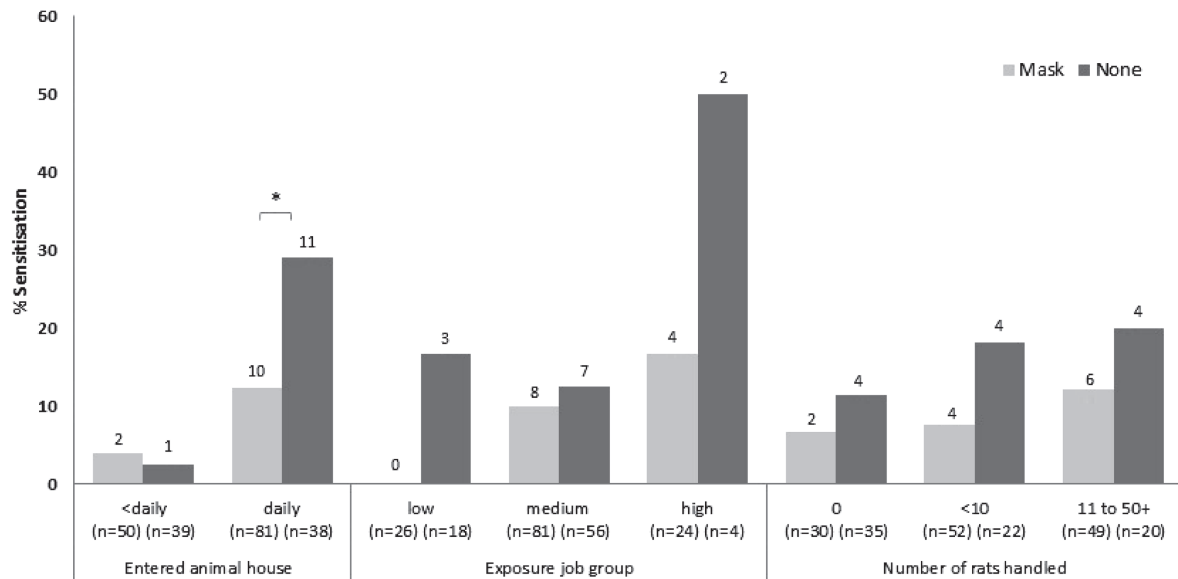


Figure 1. Prevalence of specific sensitization to rat urinary proteins by use of face mask at first exposure, stratified by maximum exposure intensity, among employees with ≤ 5 years exposure. The figures at the top of each column are the numbers of sensitized employees. * $P < 0.05$.

Discussion

These findings suggest that the use of simple face masks by those who work with laboratory animals in the UK pharmaceutical sector had increased, probably in response to the implementation of health and safety strategies within the workplace. Moreover it appears that the use of face masks was associated with a lower risk of specific sensitization to animal proteins. Apart from our current study, there is little evidence for RPE alone reducing sensitization to rat urinary protein in LAA. A comprehensive exposure reduction programme was able to demonstrate a reduction in the incidence of LAA, however there was no data on the effect of RPE alone [8]. Similarly, it has been shown that P2 face masks can decrease the amount of inhaled allergen by about 90%; however, there was no evidence that the wearing of the face mask can reduce the incidence of LAA [7].

We acknowledge several limitations to these observations. Perhaps the most important is the role of chance: the number of sensitized employees was small and few of the differences we report were statistically significant. The population was of current employees only and may, despite our restriction to those with recent employment only, reflect 'healthy survivors'; we think that any bias from this is likely to have been small but recognize that a formal, prospective cohort study would be preferable. We relied on self-reported use of RPE although we suspect that any bias introduced in this manner would act in the opposite direction to our findings. Finally, the setting of this study was one of open-caged housing of laboratory rats and we can only surmise that our findings can be generalized to facilities where enclosed caging and/or other rodent species are used.

If these observations are valid then they provide the first direct evidence that the use of simple RPE is an effective method of reducing (but not eliminating) the risk of LAA. Importantly, the type of face mask provided by the organizations we surveyed was basic and no 'face-fitting' was carried out. Recent guidance in the UK effectively mandates the use of FFP3 RPE with face-fitting [6]; it is a moot point whether this is unnecessarily stringent or whether it will prove to be more effective than the findings we report here.

Key points

- Our study suggests that the use of respiratory protective equipment on first exposure to laboratory animals may be important in reducing the risk of sensitization.
- In order to reduce the risk of developing specific sensitization, it is important to ensure that workers have access to respiratory protective equipment when first exposed to laboratory animals in the workplace.
- It remains to be seen whether recent more stringent respiratory protective equipment requirements for UK laboratory animal handlers will further reduce risks of laboratory animal allergy in future.

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Conflicts of interest

None declared.

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