

Associations between workplace exposure, work related respiratory symptoms, workplace sensitisation and lung function in insect breeders

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Introduction

There are a number of specialist food suppliers breeding and distributing insects and insect larvae such as crickets, locusts and mealworms, specifically as a food source for exotic pets such as reptiles, amphibians and invertebrates. Allergy to insects is relatively common, and previous research has documented respiratory symptoms in workers exposed to insect and mite allergens (as a contaminant of their workplace) such as grain handlers (1-2), laboratory workers (3-5) and bakers (6-7). However, there is little if any information focusing on the respiratory health effects associated with specialist live food breeding. The aim of this study was to investigate the presence of work related respiratory disease and workplace specific IgE in workers who are potentially exposed to a variety of biological contaminants including insect and insect larvae allergens, endotoxin and cereal allergens.

Methods

Study Population

32 individuals consented to take part in the study, 23 male and 9 female. Employees were recruited from all work areas of the site including the locust and cricket room, packing and dispatch area, mealworm breeding area and office. The main substrates for feeding the insects and larvae were bran, carrots and cabbage with added nutrients.

Respiratory Questionnaire

All volunteers completed an interviewer-led respiratory symptoms questionnaire adapted from the MRC (Minette 1989) and ECRHS (Burney 1994) questionnaires. The questionnaire focused on the presence of work related respiratory symptoms and recorded full work history. Work related symptoms were defined as those described as worse at work or improving on rest days. Symptoms of work-related cough, shortness of breath, chest tightness or wheeze were categorised as lower respiratory symptoms. Work-related nose, eye, mouth or throat irritation were categorised as upper respiratory symptoms. Any workers reporting either lower or upper symptoms were taken to have work related respiratory symptoms (WRRS).

Pulmonary function measurement

Volunteers were asked to perform a reproducible measurement of their lung function using a calibrated spirometer (Alpha 2, Vitalograph, Buckinghamshire, UK), following ATS guidelines. Measurements of the absolute and predicted forced expiratory volumes in one second (FEV₁), forced vital capacity (FVC), forced expiratory flow at 25-75% of vital capacity (FEF₂₅₋₇₅ in litres per second), and peak expiratory flow rate (PEFR in litres per minute) were recorded.

Extract preparation and specific IgE determination

Frozen samples of locusts, mealworms and bran from the worksite were used to produce protein extracts. Whole insects and bran were separately blended with phosphate buffered saline solution (PBS) (20% w/v) and rotated overnight at room temperature. Each solution was then homogenized, filtered and then centrifuged at 4°C at 10000rpm for 30mins. The resulting supernatant was dialysed overnight against PBS and the protein concentration determined (Smith 1985). 18 volunteers provided a blood sample for the determination of specific IgE antibodies to potential workplace allergens. Radioallergosorbent (RAST) analysis was performed using discs prepared by conjugating either, locust, mealworm or bran extract to cyanogen bromide activated discs. Atopy discs were prepared using equal amounts of pollen, cat dander and house dust mite extracts. A RAST score of 2 or more was considered positive.

Exposure sampling

Personal long term samples were collected in the workers' breathing zone using IOM sampling heads with either glass fibre filters (GF/A, 1.6mm, Millipore) at a calibrated flow rate of 2L/min analysis. Field blanks were included for each sampling visit. The glass fibre filters were weighed twice in a preconditioned room before and after sampling was undertaken and the personal dust exposure (mg/m³) and total protein exposure (mg/m³) was calculated as a 8-hour time weighted average (8-hour TWA).

Statistical analysis

All analyses were performed by cross tabulation in SPSS (Statistical Package for Social Scientists v 10, SPSS Inc., Chicago, USA). Chi squared analyses were used to compare proportions. Lung function data was not normally distributed, therefore data was compared using non-parametric Mann-Whitney tests. Logistic regression was used to derive independent odds ratios.

Table: Comparison of workers reporting and not reporting WRRS

	Insect Breeders		P Value
	Symptomatic	Non-symptomatic	
Current smoker %	64	67	0.87
No.	7/11	14/21	
Age Median	33	28	0.34
Range	19-52	17-56	
Length of service Median	1.5	1.3	0.12
Range	<1-6	<1-7	
Atopy %	38	0	0.03
No.	3/8	0/10	
Work related sensitisation %	38	10	0.16
No.	3/8	1/10	
FVC Median	102	107	0.97
Range	92-97	78-129	
FEV1 Median	89	105	0.19
Range	65-122	74-119	
PEF Median	94	90	0.70
Range	67-106	56-126	
FEF25-75 Median	67	91	0.05
Range	22-97	41-127	

Figures in red denote where significant (P<0.05) between group differences were found

Table: Comparison of FEF25-75 in sensitised and non-sensitised and symptomatic and non-symptomatic insect workers

	Insect workers		Insect workers	
	Sensitised	Non-sensitised	Symptomatic	Non-symptomatic
FEF25-75 median	49	77	67	91
range	22-97	56-127	22-97	41-127

P values denote results of tests for significant differences relative to those non-sensitised for sensitised workers and those non-symptomatic for symptomatic workers. Figures in red denote where significant (P<0.05) between group differences were found

Table 1: Work Area and Job Task

Work Area	Job Task
Packing and Dispatch Area	Weighing and packing locusts/crickets and mealworms for dispatch
Locust and Cricket Sheds	Rearing and feeding locusts and crickets.
Mealworm Rooms	Rearing and feeding mealworms
Office	Managerial and Administrative activities
General	General duties in the factory area

Table 2: Personal inhalable dust and total protein measurements

Work Area	N	Inhalable Dust (mg/m ³)			N	Total Protein (µg/m ³)		
		Median	Min	Max		Median	Min	Max
Office	5	0.6	0.13	0.72	5	6.65	0.54	47.22
Locust and Cricket Sheds	5	2.13	1.2	17.9	2	94.04	52.74	136.33
Mealworm Rooms	2	7.88	7.61	8.15	1	415.25	-	-
Packing and Dispatch Area	6	2.34	1.20	6.47	4	76.93	7.19	124.70
General	3	1.62	1.37	1.96	3	92.38	75.95	99.54

As a group, median dust and protein levels were significantly higher for the factory area samples (L&CS, P&DA, MWR and General), (median dust level=2.05mg/m³ and median protein level=88.64mg/m³, than the office area (median dust level=0.60mg/m³ and median protein level=6.65mg/m³), (p=0.001 and p=0.005 respectively).

Table: Odds of work related respiratory symptoms in insect factory workers versus office workers

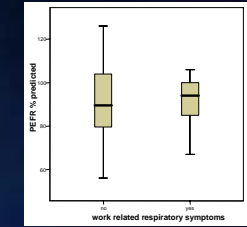
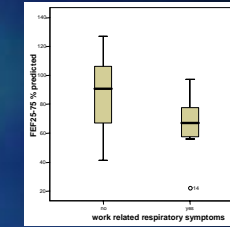
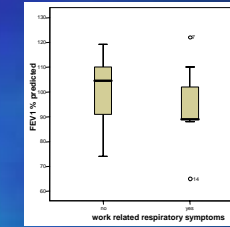
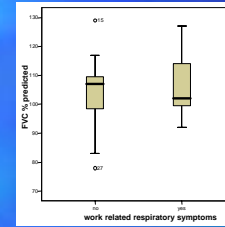
	Insect workers	
	Factory worker	Office worker
Adjusted symptoms OR (relative to office worker)*	2.63	RC
	0.34-20.39	

*adjusted for smoking, age, length of service (atopy and sensitisation not included because of strong collinearity with exposure)

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	Insect workers	
	Factory worker	Office worker
Adjusted symptoms OR (relative to office worker)*	2.63	RC
	0.34-20.39	

*adjusted for smoking, age, length of service (atopy and sensitisation not included because of strong collinearity with exposure)



Summary

The study documented a number of clinical and physiological endpoints associated with workplace exposure in the workers investigated.

Main Risks For WRRS

- ◆ Symptomatic workers were more likely to be atopic and have reduced FEF25-75 (median FEF25-75 in symptomatic workers was 67% of predicted).
- ◆ Sensitised workers were more likely to have reduced FEF25-75 also (median FEF25-75 in sensitised workers was 49% of predicted).
- ◆ Difference in proportion of symptomatic and non-symptomatic workers showing work related sensitisation was not statistically significant.
- ◆ Median dust and protein levels were significantly higher in the factory areas than in the office areas.
- ◆ Odds of WRRS (adjusted for smoking, age and length of service) were higher in sensitised (relative to non-sensitised) and in factory workers (relative to office workers) but differences were not statistically significant.

Interpretation and Conclusions

- ◆ This study observed a number of workers perhaps with early signs of occupational respiratory disease, characterised by a 30%+ reduced FEF25-75 from that predicted, employed in an insect breeding facility. These workers were more likely to be sensitised to workplace allergen and report work related respiratory symptoms than those with lung function within a more normal range. They also tended to be atopic.
- ◆ Given the average length of service at the facility was generally low, (median = 1.5 years, range = <1 to 7 years), the study suggests that sensitisation to allergen and the subsequent onset of lung function decline, that characterises workers with occupational respiratory diseases, may often be rapid. The study therefore highlights the importance of early removal of offending allergenic exposures, or at the very least the reduction of exposures to a safe minimum, to reduce the risk of occupationally related respiratory symptoms in workers exposed to allergens.
- ◆ The study had insufficient statistical power to determine whether the observed association between atopy and the reporting of work related respiratory symptoms was truly causal in nature. However, it may be that atopic workers are inherently more sensitive to certain agents exposed to in the workplace whether sensitised or not. If true, this is likely to have implications for the effective implementation of disease prevention strategies in workplaces.

