

Symptoms and longitudinal changes in lung function in young seasonal grain handlers

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ABSTRACT A total of 119 seasonal grain handlers (mean age 23) were assessed before and towards the end (mean work period 18 days) of the 1983 Western Australian grain harvest to determine if respiratory symptoms that occur with exposure to grain dust are associated with changes in ventilatory capacity or non-specific bronchial reactivity to methacholine. Eighteen per cent of subjects had wheeze, breathlessness, or chest tightness and 18% had cough or sputum production at work. Subjects complaining of wheeze, chest tightness, or breathlessness at work had a significantly greater decline in FEV₁ than subjects who did not experience these symptoms ($p < 0.05$). Symptoms were not associated with changes in bronchial reactivity. In young grain handlers who develop respiratory symptoms on short term exposure to grain dust changes in FEV₁ but not in non-specific bronchial reactivity have been demonstrated.

Exposure to dusts of wheat, oats, and barley at work is commonly associated with wheeze, breathlessness, cough and sputum, and airflow obstruction in both smokers and non-smokers.¹⁻⁵ Factors associated with the development of grain related respiratory effects in previous investigations include cigarette smoking,^{6,7} increased bronchial reactivity,⁸ and atopy.^{3,9} In these previous studies most workers had had many years of exposure to grain dust and probably represented survivor populations, workers with troublesome symptoms having resigned. In one previous study of subjects with little or no previous occupational exposure to grain a history of wheeze, the presence of increased non-specific bronchial reactivity, and positive skin tests to fungal allergens were related to the development of respiratory symptoms occurring with exposure to grain dust at work.¹⁰ In the present study a similar group of seasonal workers was examined before and after a period of work at grain storage sites to determine if those subjects who experienced work related respiratory symptoms also developed changes in respiratory function (including bronchial reactivity) or skin test responses to grain or other common allergens.

Subjects

In Western Australia the transport, storage, and marketing of grain is carried out by a single, government administered cooperative. Each year temporary workers are hired as grain samplers, weighbridge officers, and general hands at grain receipt and storage sites. About a third of these are employed from outside the wheat growing district, at the central Perth office: 143 consecutive subjects were included in the study when applying at the Perth office for work in the north western region of the wheat growing district. They represented 34% of all seasonal workers employed from this office. They were currently unemployed or students working during their summer vacation. Thirteen of the applicants included in the preseason assessment were not subsequently employed and were excluded from further study. Of the remaining 130 subjects, 119 (92%) were available for follow up at the end of the season. Nine were retrenched or resigned for non-medical reasons during the season, one refused to participate further, and one left his job because of a gastrointestinal illness. There were no differences in the preseason characteristics between subjects who were not employed or who left work and the subjects who were available for follow up.

Methods

Preseason assessment was carried out at the time of application for work. The British Medical Research Council questionnaire on respiratory symptoms (1976) was administered regarding history of cough and sputum, breathlessness, wheeze, chest tightness, sneeze or itchy nose, and history of asthma, hayfever, eczema, or allergy. A smoking history was recorded and additional questions regarding occupational history and previous exposure to grain dust were also included.

Prick skin tests were performed using extracts of the following groups of commercially available allergens; "common" (cat and dog dander, house dust, house dust mite), "grain" (whole grain wheat, rye, oats, barley, wheat pollen, wheat mite), "fungi" (*aspergillus* mix, *alternaria*, *penicillium*, *cladosporium*), and "grasses" (canary grass, perennial rye grass, wild oats, and bermuda grass)—(Hollister-Stier, Elkhart, USA). A weal of 3 mm or more greater than the negative control was considered a positive reaction. If one or more prick skin test to any allergen was positive the subject was considered to be atopic. Subjects were further categorised as being positive to grass, grain, or fungi according to their having positive skin test responses to allergens in each of these groups.

Forced expiratory volume in one second (FEV₁) and forced vital capacity (FVC) were measured using a wedge spirometer (Vitalograph, Buckingham, England). Three forced expiratory manoeuvres which were within 5% of the best FVC were recorded.¹¹ From these the best FEV₁ and FVC were measured and corrected to BTPS.¹²

Bronchial reactivity was measured using the method of Yan *et al*¹³ to a maximum cumulative inhaled dose of methacholine of 120 μ moles. Bronchial reactivity was expressed as the provocative dose of methacholine required to produce a 20% fall in FEV₁ from the postsaline control value (PD20).

Subjects were reassessed toward the end of the harvest season at their workplaces. A second interviewer-administered questionnaire concerning duration of employment, the nature of their jobs, and work related symptoms (cough, sputum, shortness of breath, wheezing, chest tightness, difficulty breathing, sneezing, or itchy nose or eyes) was completed. They were also asked, "Did work with grain affect your chest?" Skin tests were repeated using the same batch of allergen extracts as at first assessment and FEV₁, FVC, and bronchial reactivity were remeasured. Bronchial reactivity was categorised as having increased or decreased during the season if the PD20 changed by more than one doubling concentration.¹⁴ The same technicians performed the measurements at

both assessments. Two spirometers were used for measurements and were calibrated directly against each other and with a three litre syringe.

Results

A total of 102 men and 17 women completed the study; their mean age was 23 (range 18–63) and 52% were smokers. Fifty per cent had had previous exposure to grain dust as seasonal grain handlers, although no subject had handled grain within the past 10 months. There were no significant differences in symptoms, skin test responses, ventilatory capacity, or bronchial reactivity at the beginning or at the end of the harvest season between subjects with history of exposure to grain and those without. Fifty one per cent of subjects were atopic and 62% had a PD20 of less than 120 μ moles of methacholine (table 1). Cough and sputum, before and after the work period, were related to cigarette smoking ($p < 0.05$). As in the previous study¹⁰ the presence of preseason atopy and a positive prick skin test to grain antigen were associated with a history of asthma, wheeze, or hay fever ($p < 0.05$). Preseason bronchial reactivity was greater in subjects with atopy ($p < 0.01$) and a history of asthma ($p < 0.05$).

Eighteen per cent of subjects experienced work related lower respiratory tract symptoms (breathlessness, wheeze, chest tightness, or cough and sputum) and 72% experienced work related upper respiratory symptoms (sneeze and itchy nose or eyes) (table 2). The development of wheeze, breathlessness, or chest tightness at work was associated with a history of wheeze ($p < 0.001$) or asthma ($p < 0.002$).

Table 1 Preseason characteristics in 119 subjects

	No of subjects	Percent
History:		
Hay fever	32	27
Cough or sputum	21	18
Wheeze	35	29
Asthma	9	8
Prick skin tests:		
Any antigen	61	51
Grass antigens	45	38
Grain antigens	43	36
Fungal antigens	16	13
Bronchial reactivity		
PD20 (μ moles methacholine)		
≤ 4	11	9
$> 4 \leq 15$	23	19
$> 15 \leq 45$	16	13
$> 45 \leq 120$	12	10
> 120	57	48
Ventilatory capacity:	Mean	SD
FEV ₁ (l)	4.14	0.72
FVC (l)	4.85	0.84

Table 2 Incidence of work related symptoms over the work period in 119 seasonal grain handlers

	No of subjects	Per cent
Symptoms at work:		
Upper respiratory tract		
Any	97	82
Sneeze	79	66
Itchy eyes or nose	44	37
Cough and sputum	21	18
Lower respiratory tract		
Any	22	18
Breathlessness	8	6
Wheeze	15	13
Chest tightness	11	9

These symptoms were also associated with atopy ($p < 0.05$) as in the previous study.¹⁰ In the present study, however, the preseason level of bronchial reactivity was not related to the subsequent development of symptoms at work. Work related upper respiratory symptoms were associated with a history of hay fever ($p < 0.01$). Symptoms at work were not related to the particular job that was performed during the season or to changes in skin test responses between the beginning and the end of the season.

During the course of the season FEV₁ fell by 0.074 l (SD 0.021 l, $p < 0.001$) in all subjects. The fall in FEV₁ was significantly associated with work related breathlessness (table 3) and was greater in those who considered that work with grain had affected their chests. The fall in FEV₁ during the course of the season was not related to skin test responses to any group of allergens either before or after the season or to preseason PD₂₀ or the fall in PD₂₀ over the work

period. Changes in FEV₁ and FVC were not related to preseason atopy or bronchial reactivity, type of job, previous grain exposure, or smoking.

Wheeze, breathlessness, or chest tightness occurred in 37% (7/19) of subjects whose bronchial reactivity increased during the season, 8% (1/13) in those with no change, and in 24% (8/33) of those whose bronchial reactivity decreased over the season. These differences were not significant.

Discussion

This study has shown that subjects who complained of breathlessness when exposed to grain dust at work experienced a significant decrease in FEV₁ during the season. It extends the previous work which showed that respiratory symptoms at work in a similar group of seasonal grain handlers were frequent and were related to a history of wheeze, asthma, or hay fever, an increased level of bronchial reactivity, and positive prick skin test responses to a variety of allergens¹⁰ by showing that of these symptoms breathlessness at work is associated with a significant decline in FEV₁ during the course of the season. Thus it indicates that adverse respiratory effects may be measured after short periods of exposure in subjects with little or no previous exposure to grain dust.

A separate (unexposed) control group was not included in this study because subjects lacking a characteristic of interest acted as the "control" or "comparison" group for those with the particular characteristic.

We attempted to study subjects without previous

Table 3 Decrease in FEV₁ between preseason and follow up assessment, work related symptoms, prick skin test responses, and bronchial reactivity

Symptoms at work	Characteristic	
	Present	Absent
Present:		
Shortness of breath**	0.263 ± 0.120 (8)	0.060 ± 0.021 (112)
Chest tightness	0.023 ± 0.071 (14)	0.061 ± 0.021 (101)
Wheeze	0.167 ± 0.073 (15)	0.061 ± 0.022 (105)
Shortness of breath or chest tightness or wheeze*	0.177 ± 0.055 (22)	0.051 ± 0.023 (98)
Sneeze or itchy eyes or nose	0.067 ± 0.024 (97)	0.102 ± 0.050 (23)
Prick skin test positive:		
Preseason (any)	0.073 ± 0.037 (61)	0.075 ± 0.021 (59)
End season (any)	0.102 ± 0.030 (69)	0.036 ± 0.030 (51)
Preseason bronchial reactivity:		
PD ₂₀ < 4 μmol	0.050 ± 0.078 (14)	0.077 ± 0.022 (106)
PD ₂₀ < 15 μmol	0.078 ± 0.044 (37)	0.072 ± 0.024 (83)
PD ₂₀ < 120 μmol	0.084 ± 0.034 (65)	0.062 ± 0.025 (55)
Increase in bronchial reactivity during the season	0.094 ± 0.062 (28)	0.068 ± 0.021 (92)
"Did work with grain affect your chest?"*	0.191 ± 0.080 (14)	0.054 ± 0.021 (105)

Mean values ± SD (number of subjects).

Significance of difference in decrease of FEV₁ between subjects with characteristic present and absent * $p < 0.05$, ** $p < 0.02$.

exposure to grain dust to overcome the problem of selection bias when studying a population of long term workers. There was no evidence that selection had already occurred to a significant degree since the prevalence of atopy, history of asthma or wheeze, and the level of bronchial reactivity in this study was similar in those subjects with and those without previous occupational exposure to grain dust and similar to that in the general Australian population.^{15 16}

In the present study neither the preseason level of bronchial reactivity nor the change in bronchial reactivity with exposure to grain were related to the occurrence of symptoms at work or change in FEV₁ with grain exposure. In prevalence studies in the grain industry others have shown that symptomatic grain handlers have increased non-specific bronchial reactivity,^{17 18} but it is not clear whether the increased bronchial reactivity is present before, or develops after, exposure to grain dust. Unlike the present study, that of Cookson *et al* suggested that, in addition to atopy, the prior level of bronchial reactivity is important in determining symptoms on exposure.¹⁰ Possibly longer periods of exposure or higher levels of airborne grain dust, or both, occurring in the previous study account for the differences between the two studies.

The frequency of respiratory symptoms and changes in lung function are related to levels of grain dust exposure in long term grain handlers.¹⁹ Grain dust levels were not measured in this study because the nature of the work dictated that exposure was usually intermittent, brief, and intense, mostly being performed out of doors. Thus the frequency of symptoms in the subjects appeared lower than that seen in grain elevator workers elsewhere^{3 4} but similar to other groups of grain workers employed out of doors.^{19 20} Whereas the highest exposures to grain dust in our group were experienced inside storage bins or while unloading grain trucks, few of the subjects were concerned in these activities and we were unable to find a difference in frequency of symptoms and lung function between different job categories. A knowledge of the levels and the patterns of exposure to the various constituents of grain dust may further our understanding of the changes we have documented.

Other studies have examined the effects of grain in populations of older, long term grain handlers who were probably exposed to higher levels of dust and who had longer histories of smoking.^{1-6 19 20} These groups have a reduced prevalence of atopy compared with non-exposed populations, suggesting that selective exclusion of atopic subjects has occurred.⁸ This finding is compatible with the results of this and the previous study¹⁰ in which atopic subjects experienced more adverse respiratory symptoms, which may dis-

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incline them to employment in the industry in the future.

This study has shown that grain workers who develop breathlessness at work have a measurable decrease in FEV₁ during the course of a harvest season. Measurements of lung function were made only before and after a period of exposure to grain dust and were not coupled to direct measurements of grain dust levels. More frequent measurements of ventilatory capacity, bronchial reactivity, and dust constituents and levels are needed to examine their inter-relations and also to determine if recovery of lung function occurs after cessation of exposure.

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Request for reprints to: Dr AW Musk.

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- ¹ International Steering Committee of Medical Editors. Uniform requirements for manuscripts submitted to biomedical journals. *Br Med J* 1979;1:532-5.
- ² Soter NA, Wasserman SI, Austen KF. Cold urticaria: release into the circulation of histamine and eosinophil chemotactic factor of anaphylaxis during cold challenge. *N Engl J Med* 1976;294:687-90.
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