Rev Saúde Pública 2006;40(5)

Neice Müller Xavier Faria[I]

Luiz Augusto Facchini[II]

Anaclaudia Gastal Fassa[II]

Elaine Tomasi[III]

Farm work, dust exposure and respiratory symptoms among farmers

ABSTRACT

OBJECTIVE: Environmental working conditions in rural areas, notably exposure to organic and mineral dusts, have been associated with increases in respiratory diseases. The objective of this study was to evaluate the prevalence of respiratory symptoms among farmers and the associations of these with occupational risk factors.

METHODS: This cross-sectional study was undertaken in 1996 with 1,379 farmers from Southern Brazil. Sociodemographic and farming-production parameters were collected, as were levels of exposure to organic and mineral dusts. Respiratory symptoms were assessed by a modified version of American Thoracic Society-Division of Lung Disease questionnaire. Multiple logistic regression analysis was used in analyses, controlling for confounding factors.

RESULTS: The majority (52%) of interviewees worked in activities with intense exposure to dust. Workers on farms with better economic indicators had a lower prevalence of respiratory symptoms. Poultry workers showed more symptoms of chronic respiratory disease (OR=1.60; 95% CI: 1.05-2.42). Farmers exposed to high concentrations of dust had more than 70% higher risk of asthma symptoms (OR=1.71; 95% CI: 1.10-2.67) and chronic respiratory disease symptoms (OR=1.77; 95% CI: 1.25-2.50).

CONCLUSIONS: The rural workers studied herein were exposed to high levels of organic and mineral dusts. Those exposed to higher dust concentrations, such as poultry workers, showed an increased risk of work-related respiratory symptoms. The implementation of respiratory protection programs is recommended, emphasizing workers involved with poultry production.

KEYWORDS: Rural workers. Air pollutants, occupational, adverse effects. Occupational risks. Respiratory tract diseases. Cross-sectional studies. Dust.

[I] Programa de Pós-Graduação em Epidemiologia. Departamento de Medicina Social. Universidade Federal de Pelotas (UFPel). Pelotas, RS, Brasil

[II] Departamento de Medicina Social. UFPel. Pelotas, RS, Brasil

[III] Programa de Pós-Graduação em Saúde Pública. Universidade Católica de Pelotas. Pelotas, RS, Brasil

Correspondence:
Neice M. Xavier Faria
R. República, 80/1401 Cidade Alta
95700-000 Bento Gonçalves, RS, Brasil
E-mail: neicef@italnet.com.br

Received: 8/8/2005 Reviewed: 2/16/2006
Approved: 4/27/2006

INTRODUCTION

Certain environmental conditions in the rural workplace, principally animal and plant dusts, have been associated with increases in respiratory illnesses including asthma,[11,13,16,20] chronic bronchitis[2,17,20] and hypersensitivity pneumonitis.[1,16] Several agricultural activities involve high levels of exposure to dusts[3,19] and substances such as toxic gasses,[1,4] endotoxins[1,3,4,11] and agrotoxins.[1,10] Fungal spores, which generally occur in organic dusts, further increase the risks from exposure.[1,19]

Agriculture can lead to higher risks of respiratory problems.[1,14] A broad multicentric study among European farmers found that 22% had respiratory symptoms related to rural work (wheezing, shortness of breath/or cough with expectorant).[20] Those working in swine production comprised the group of highest risk, based on dose-response in relation to the number of hours in the workplace.[18] In New Zealand, 18% of farmers showed work-related respiratory problems associated with contact with birds, swine, equines and grains (during harvest and storage).[14] In Switzerland, farmers showed twice the level of chronic bronchitis and 4.5 times chronic expectoration relative to the overall population.[2] In Norway, non-atopic farmers who worked with two or more types of livestock showed nearly twice the rate of asthma than those that did not work with animals.[4]

High levels of respiratory symptoms in farmers and rural workers[1,20] have been found in specific workplaces, such as swine[14,18,20] and poultry[11,14,18] enclosures and areas of grain production.[14] Reduction in pulmonary function among those working with animals within enclosed spaces, such as aviaries[3] and swine barns,[17,22] has also been observed.

The present study is part of a broader project evaluating the health of rural workers in the context of family farming.[5] The objective of the project was to undertake a population epidemiological study of respiratory problems among agricultural workers. In a previous article,[6] the prevalence of various respiratory symptoms was shown to be associated with the use of pesticides. The present work aimed to analyze rural production – particularly agricultural and livestock activities – in relation to exposure to agricultural dusts (organic and mineral) and to examine the associations between occupational factors and respiratory symptoms of asthma and of chronic respiratory disease.

METHODS

The target population, for this cross-sectional epidemiological study, were family farmers (either owners or tenants) resident in the municipalities of Antônio Prado and Ipê, in the Serra Gaúcha, during 1996. Assuming an estimate of three workers per property, 20% of rural properties were randomly chosen in each municipality based on official lists of rural producers.*

The resulting sample showed a statistical power of 80% and a 95% confidence level to evaluate associations with a relative risk of 1.6 or more, depending on the exposure evaluated.

All data were obtained through interviews, using the American Thoracic Society/Division of Lung Diseases[6] (ATS-DLD-78) questionnaire. Those workers selected for the study were aged 15 or over and worked at least 15 hours per week with agriculture and/or livestock. The interviewers were teacher trainees and rural schoolteachers, who initially participated in training sessions (40 hours) and in a pilot study (56 interviews). Field work was undertaken during five weeks of the summer harvest. Further details of sampling, fieldwork logistics and the questionnaire were presented in previous publications.[5,6] Two questionnaires were used: one to obtain data relating to the farm and another relating to farmer characteristics.

The data collected relating to properties were:

- agro-economic indicators: area used for agriculture, level of mechanization and gross production – the latter two were constructed indicators[5] and evaluated in three categories (low, intermediate and high);
- type of agricultural production: primary agricultural production (fruits in general, pumpkin, onion, corn, bean and greens) and primary livestock (poultry, cattle, swine and equines);
- use of industrial animal feeds on the property.

Individual data for farmers included:

- socio-demographic indicators: gender, age, schooling (years completed). Information on smoking was evaluated in categories (never smoked, ex-smoker, smoker) and by the quantity of tobacco consumed (pack/years of smoking, analyzed in three and four groups);
- agricultural dusts: occurrence of dusts in the workplace. Interviewees were asked whether they were exposed to elevated levels of dust and other inhalants. Each type of dust was classified,

*Lists provided by Instituto Nacional de Colonização e Reforma Agrária (INCRA) (*National Institute for Colonization and Agrarian Reform*) and Associação Rio-Grandense de Empreendimentos de Assistência Técnica e Extensão Rural (EMATER-RS) (Association for Technical Assistance and Rural Extension of Rio Grande do Sul).

according to its perceived intensity in the workplace, into three categories: absent (no exposure), low or high. Twelve types of dusts were evaluated: bird feathers, animal hair, manure dust, cereal grains, flower pollen, straw, cotton, soil dust, ashes, fumes (excluding that from tobacco), stone dust and toxic gases. The synthetic indicator of intense exposure was constructed by grouping the various dusts classified as intense (high dust concentration) and analyzed in three categories: little or no exposure to dust, intense exposure to one type of dust, intense exposure to two or more types of dust;

- duration of exposure: amount of agricultural work per day (during and between harvests), years living on the farm;
- exposure to pesticides: intense (indicator grouping two or more types of pesticide exposure, occurring at least three times per month) and history of acute poisoning by pesticides. The exposure to pesticides was evaluated as a confounding factor.

Various respiratory symptoms were evaluated using an adaptation of the ATS-DLD-78 questionnaire.[6] Two conditions were analyzed based on these symptoms. Asthma symptoms: having had two or more wheezing episodes with accompanying shortness of breath.[12] Symptoms of chronic respiratory disease, with at least one of the following symptoms: chronic cough or expectoration (during most days of the week and during three or more months per year); symptoms of chronic bronchitis (chronic cough and catarrh during at least two years), persistent wheezing (during most days and nights) or two or more wheezing episodes with shortness of breath.[21]

Approximately 10% of rural properties were revisited to assess the consistency of responses to the principal questions of the questionnaire. The Kappa test was used to evaluate the concordance between answers given during these two interview sessions.

A bivariate analysis was undertaken using Chi-square, Pearson and linear tendency tests. During this phase of analysis, an attempt was made to characterize the types of properties and the activities involving most exposure to dusts. These were used to define the variables to be included in the multiple regression analysis, which was developed using unconditional logistic regression, with a hierarchical model in two levels:

- Level 1 – Socio-demographic factors (gender, age, schooling, smoking status), economic indicators (area used for agriculture, level of mechanization, income from gross production) and type of agricultural production.
- Level 2 – Exposure to dust (synthetic indicator of intense dust), use of industrial animal feeds (included only in analyses of economic and agricultural indicators), duration of exposure, exposure to pesticides (grouped intense exposure and acute poisoning, both evaluated as binary variables – yes/no).

In each level, the criterion for the maintenance of factors in the regression model was a p-value equal to or lower than 0.20. The variable for smoking status (amount/years of smoking) was not included in the model because it was not shown to be associated with any of the principal occupational exposures. The smoking variable, included in this analysis as a confounding factor, was examined as the main exposure factor in a previous article.[6]

Employees (7% of the sample) worked on properties with higher agricultural production. As the agro-economic indicators were constructed based on data from rural properties, employees characteristically had higher economic indicators than those of owners. As a result, employees were excluded from the analysis.

Interaction models were tested to evaluate if persons who smoked or who were ex-smokers responded differently from those who had never smoked.

RESULTS

A total of 1,479 rural workers were interviewed (selected from 495 rural properties); 1,281 were owners, 98 tenants or partners and 100 employees; with a response rate of 95%. Because of reasons indicated previously, only data from 1,379 farmers (471 properties) were used: 93% owners and 7% tenants or partners.

Of those interviewed, 55% were male, 12% smokers and 12% ex-smokers. The average time of smoking was 19.8 years (SD=15.1) with an average consumption of 12 cigarettes/day (SD=10.1). The mean age was 42 years (SD=15.6), with the highest being 92. Average schooling was of 4.8 years (SD=2.7), with 6% of interviewees without schooling and 6% having completed elementary school or higher.

The average area of properties was 31.5 hectares (SD=38.2), with 7.4 (SD=8.5) of these allotted for agriculture. Farmers had lived on the same property for 25 years (SD=16.0) and worked with pesticides, on average, for 16.7 years (SD=11.8). At least 75% of workers used pesticides and more than 40% had intense exposure: two or more types of occupational exposure during more than two days per month.

Table 1 - Prevalence of respiratory symptoms according to socio-demographic factors, municipalities of Ant nio Prado and Ip , Southern Brazil, 1996.

Variable	N	Asthma %	Chronic respiratory disease %
Gender		p=0.003	p=0.09
Male	764	9.9	20.3
Female	615	15.2	24.1
Age quartile		p<0.001*	p<0.001*
15-29 years	330	6.4	12.1
30-40 years	349	9.2	14.6
41-53 years	353	13.9	25.2
≥54 years	347	19.2	35.4
Schooling (years)		p<0.001*	p<0.001*
<1	115	21.1	35.7
2 to 4	545	14.8	26.1
5 to 7	500	10.0	18.6
≥8	219	6.4	12.3
Smoking		p=0.30	p=0.003
Never smoked	1,042	11.5	20.0
Ex-smoker	169	14.9	30.8
Smoker	168	14.4	25.6
Tobacco consumption**		p=0.02*	p=0.001*
<1 pack/year	1,049	11.6	20.1
1 to 182 packs/year	131	11.5	24.4
≥183 packs/year	172	18.6	31.4
Total	1,379	12.2	22.0

p: p-value for Chi-square test
*Linear trend test
**Number of pack years of cigarette smoking, divided into three categories
Obs.: Missing values were excluded from the table

In the analysis of respiratory symptoms, women showed more asthma symptoms: the prevalence was of 15% among women and 10% among men (p<0.01) (Table 1). Symptoms of chronic respiratory disease showed a similar pattern, although not significant, with prevalence of 24% in women and 20% in men (p=0.09). Symptoms of both conditions were more prevalent among persons above 40 years of age and those with low levels of schooling (up to four years). Smokers and, mainly, ex-smokers indicated more symptoms of chronic respiratory disease. The group with highest tobacco consumption (above 182 packs year) showed increased respiratory symptoms (Table 1). This association was confirmed in the adjusted analysis both in relation to asthma symptoms (OR=2.16; 95% CI: 1.32-3.54) and chronic respiratory disease (OR=2.01; 95% CI: 1.34-3.01).

More than half of farmers (52%) worked in areas with high concentrations of at least two types of dust. Exposure to dusts was more intense among farmers on properties with lower economic indicators (gross production income, level of mechanization and car ownership) (Table 2). Likewise, farmers on properties with more animals – poultry, cattle and swine – and who used industrial animal feeds, stated that they worked in environments with higher concentrations of dusts (Table 2). The groups with highest exposure to dusts were those that worked with poultry; approximately 76% of these declared being exposed to two or more types of dust, in high intensity, during activities in bird enclosures. Thus, intense exposure to dusts was higher among poultry workers than farmers that did not produce poultry (PR=1.56; 95% CI: 1.36-1.79).

The evaluation of respiratory symptoms in relation to the characteristics of the rural property showed that the prevalence of asthma symptoms was lower among farmers whose properties produced fruits and onions (Table 3). Likewise, those on farms with higher economic indicators (area, level of mechanization and car ownership) and that produced onions showed fewer symptoms of chronic respiratory disease (Table 3).

Farmers from properties with poultry production declared higher frequencies of symptoms related to chronic respiratory disease. This association was confirmed by specifically evaluating those that worked directly with animals (Table 4). The majority of poultry farmers were aged up to 40, had higher schooling (p=0.02) and worked on properties with high levels of mechanization (linear tendency p<0.001). All poultry farmers were in the higher quartile of gross production income. Poultry workers showed similar levels of smoking status and consumption to other farmers.

Asthma symptoms were more frequent among farmers who worked on properties where industrial animal feeds were used.

Although not statistically significant, equine production also showed a tendency for higher prevalence of respiratory symptoms in both conditions evaluated. There was no relation between swine, bovine or other types of animal production and the respiratory symptoms evaluated (Table 4).

Increases in chronic respiratory disease symptoms were associated (in linear tendency) with intense exposure to bird feathers, straw, manure dust, ashes and fumes. Exposure to corn straw also showed a linear association with asthma symptoms (Table 5).

The synthetic indicator of intense exposure to agricultural dusts was shown to be linearly associated with the increase of respiratory symptoms for the two outcomes investigated.

No significant interactions were observed between the various exposures (agro-economic factors and the various types of dusts) and smoking. However, for the association between bird feathers and chronic respiratory disease, the interaction model with smoking was nearly significant (p=0.06). A reevaluation of this association, with stratification of the three smoking categories, showed that the "bird feather" factor remained as an indicator of risk just for the 1,042 farmers that never smoked (p=0.001, with a linear tendency). The adjusted odds ratio (OR) adjusted for the group with low exposure was of OR=1.01 (95% CI: 0.69-1.48) and for intense exposure was of OR=2.22 (95% CI: 1.44 -3.43). Among the 168 smokers and 169 ex-smokers, the association between bird feathers and respiratory diseases was not significant.

DISCUSSION

The present study suggests an increase in respiratory symptoms associated with intense exposure to organic and mineral dusts during agricultural work. Moreover, it revealed that work in poultry production presents elevated risks of chronic respiratory disease. These findings are significant, as there are no other known population studies of rural farmers/employees in Brazil.

The referred information provided by the farmers allowed estimates about specific types of dust and various chemical products encountered in the workplace. However, the lack of environmental measurements limits the accuracy of exposure estimates. In this study, a lower than desired agreement was found for some exposures, such as some dusts, which showed Kappa tests lower than 0.43. The quality control evaluation found a higher proportion of farmers exposed to intense concentrations of dusts (of several types) and to pesticides. Thus, exposure estimates should be considered as approximations, being potentially higher than reflected in the data.

Other authors have found high concordance between respiratory symptoms and alterations in pulmonary

Table 2 - Percentage of farmers with intense exposure to dusts, according to economic indicators and type of agricultural production (n=1,379), municipalities of Ant nio Prado and Ip , Southern Brazil, 1996.

Variable Agro-economic	Exposure to dusts* (% exposed)	Variable Animal production	Exposure to dusts* (% exposed)
Gross income	p<0.001**	Poultry	p<0.001**
Low income	45.4	none	49.3
Average income	48.9	Up to 2,000 heads	48.2
High income	61.2	>2,000 heads	76.1
Area for agriculture	p=0.10	Have enclosure and interact with animals	p<0.001
Up to 5 hectares	49.8	No	48.9
6 or more hectares	54.2	Yes	76.6
Level of mechanization	p<0.001**	Cattle	p=0.02**
No machines	30.2	Up to 10 heads	49.0
Low mechanization	53.4	11 to 20 heads	48.5
High mechanization	57.1	>20 heads	57.7
Own car	p<0.001	Have >20 cattle and interact with animals	p=0.001
No	45.3	No/have few	48.6
Yes	55.5	Yes	58.1
Fruit production	p=0.36	Swine	P=0.001**
No	50.3	None	49.2
Yes	52.8	Up to 20 heads	48.9
Onion production	p=0.11	>20 heads	65.4
No	50.4	Have >20 swine and interact with animals	p<0.001
Yes	55.0	No/up to 20 swine	48.9
Corn production	p=0.07	Yes	65.9
No	46.7	Horses	p=0.28
Yes	53.0	None	52.3
Bean production	p=0.22	Yes	47.4
No	53.1	Have horses and interact with animals	p=0.24
Yes	49.6	No	52.3
		Yes	46.9
		Use industrial feeds	p<0.001
		No/organic	42.8
		1 type	55.8
		2 or more types	57.0

*Exposure to two or more types of dust, classified as intense concentration
**Linear trend

Table 3 - Association between property characteristics and respiratory symptoms (n=1,379), municipalities of Ant nio Prado and Ip , Southern Brazil, 1996.

Variable	N	Asthma symptoms		Chronic respiratory disease	
		OR Crude (IC 95%)	OR Adjusted** (IC 95%)	OR Crude (IC 95%)	OR Adjusted** (IC 95%)
Area for agriculture		p=0.03	p=0.09	p=0.01	**p=0.04**
Up to 5 hectares	743	1	1	1	**1**
6 or more hectares	636	0.69(0.49-0.96)	0.74(0.53-1.05)	0.70(0.54-0.91)	**0.75(0.57-0.99)**
Gross income		p=0.03*	p=0.34	p=0.08*	p=0.38
Low income	460	1	1	1	1
Average income	460	0.72(0.49-1.07)	0.76(0.50-1.15)	0.72(0.53-0.99)	0.82(0.59-1.15)
High income	459	0.65(0.44-0.97)	0.76(0.48-1.19)	0.77(0.56-1.04)	1.02(0.72-1.45)
Level of mechanization		p=0.09*	p=0.41	p=0.02*	**p=0.05***
No machines	159	1	1	1	1
Low mechanization	684	0.76(0.47-1.24)	0.79(0.48-1.32)	0.70(0.47-1.03)	0.70(0.47-1.06)
High mechanization	503	0.64(0.38-1.06)	0.69(0.39-1.20)	0.59(0.39-0.88)	**0.62(0.40-0.97)**
Own car		p=0.15	p=0.27	p=0.009	**p=0.03**
No	492	1	1	1	**1**
Yes	870	0.79(0.56-1.10)	0.82(0.58-1.17)	0.71(0.54-0.92)	**0.74(0.56-0.97)**
Fruit production		p=0.01	**p=0.02**	p=0.06	p=0.30
No	533	1	1	1	1
Yes	846	0.65(0.47-0.90)	**0.65(0.46-0.93)**	0.78(0.61-1.01)	0.87(0.66-1.14)
Onion production		p=0.04	**p=0.03**	p=0.01	**p=0.03**
No	937	1	1	1	**1**
Yes	442	0.67(0.47-0.97)	**0.65(0.44-0.95)**	0.69(0.52-0.92)	**0.72(0.54-0.97)**
Corn production		p=0.70	p=0.57	p=0.62	p=0.34
No	255	1	1	1	1
Yes	1,124	0.92(0.62-1.39)	0.89(0.58-1.34)	0.92(0.67-1.27)	0.85(0.61-1.19)
Bean production		p=0.24	p=0.16	p=0.13	p=0.36
No	901	1	1	1	1
Yes	478	1.22(0.87-1.70)	1.29(0.91-1.85)	1.22(0.94-1.59)	1.14(0.86-1.51)

*Linear trend
**Odds ratio adjusted for gender, age schooling, smoking status, economic indicators, years lived on farm, industrial animal feed, intense exposure to dusts (except from grains) and to pesticides exposure
Boldface values: statistically significant (p<0.05)

tests,[12] including a study that specifically evaluated the ATS questionnaire.[9] In relation to the criteria used for asthma symptoms (wheezing episodes with shortness of breath), the information provided was of high specificity (93%) and reasonable sensitivity (45%) for actual asthma in comparison to the clinical interviews associated with spirometry.[12]

As information on the conditions studied was based on cumulative prevalence (lifetime prevalence), inaccurate recollections by farmers may have led to underestimation of exposure and effects, or reverse causality, thus limiting causality affirmations.

Although the proportion of smokers and ex-smokers was lower than other studies involving agricultural workers,[1] the analysis of tobacco consumption confirmed increased respiratory symptoms in the group with higher cigarette consumption.

The odds ratio can be reduced by the healthy worker effect and should be considered as a minimum effect. This sampling effect has previously been observed in other studies[11,13,24] and tends to underestimate the differences between groups. In Holland, a longitudinal study among swine workers showed evidence that a selection bias of non-asthmatics (asthmatics changed to other professions), masked the occupational risks for asthma, but not for chronic bronchitis.[24] Likewise the majority of exposure risks (poultry confinement and dusts) in the present study showed associations with chronic respiratory disease, but not with asthma.

There was a higher individual exposure to dusts on properties with higher economic indicators. However, the multivariate analysis indicated fewer respiratory symptoms among workers in these properties, even after adjusting for the effects of higher dust concentrations. Likewise, the principal economic crops (fruits and onions) showed a similar protective effect. Indicators of low socio-economic level have been associated with increased prevalence of asthma, although this remains controversial.* Socioeconomic status, as a main determinant of health conditions, may explain these results, overlapping even the risk originating from dust exposure in the work environment.

Among rural farmers, those who worked in poultry enclosures were notable because of their high levels of chronic respiratory disease symptoms. This result was confirmed among farmers that, in addition to raising poultry on their farms, dealt directly with these animals during daily work. This effect was seen even on rural properties with higher economic indicators. In addition, the dusts directly linked to poultry con-

*Global Initiative for Asthma. Global strategy for asthma management and prevention [workshop report]. Bethesda (MD): National Heart, Lung, and Blood Institute; 2002. Available from http://www.ginasthma.com/Guidelineltem.asp?intId=60 [access in 2006 Feb 19]

finement – such as bird feathers and manure dust – were also a risk effect for chronic respiratory symptoms. These results are consistent with other research that found an increase in respiratory symptoms among poultry workers.[2,3,11,14] A study[16] evaluating 9,027 European and American farmers found higher respiratory symptoms associated with some types of agricultural work, notably workers in poultry farming and other activities with confined animals. A European multicentric study[18] with 6,156 farmers found higher levels of wheezing among poultry workers during the year previous to the study, with dose-response related to the amount of time spent within poultry enclosures. In the USA, approximately 20,000 farmers who used pesticides were evaluated and a specific risk of wheezing symptoms was identified as associated with animal production and close contact with grains. Exposure related to poultry farming was the most important predictor of wheezing during the year prior to the study.[11]

In the region of the present study, animal farming, in the majority of cases, was undertaken on a large spatial scale, particularly for cattle, sheep and equines. Thus, activities involving these types of livestock were carried out in open and expansive areas. The quantity of animals was also relatively small: the majority of farmers owned less than 40 heads. In contrast, the production of confined poultry has expanded in the last decades, following a general Brazilian trend. In poultry confinement houses, approximately 14,000 animals were kept in each lot (a minimum of 2,000 and as many as 28,000 birds/enclosure, or approximately 23 birds per m^2) which increases significantly the concentration of dusts and toxic gases, such as ammonia and carbon dioxide.[7] In addition to the risks arising from direct contact with birds, the cleaning and maintenance of confinement houses can also be hazardous, primarily that involving the "aviary bed", on which reared birds are kept.[7,13] The annual removal and weekly turnover of the "bed" normally result in intense exposure to dusts and micro-organisms such as bacteria, fungi, viruses and endotoxins.[3,7,19] Results from the present study confirm other work that document the respiratory risk of raising animals in confined spaces[2,22] and, more specifically, the respiratory risks of poultry confinement.[3,11,18]

Concentrations of burning residues (fumes and ashes) also showed an association with increased chronic respiratory disease, as in previous studies in China,[23] Iran[8] and Califórnia,[15] where exposure to smoke from

Table 4 - Association between type of animal production and respiratory symptoms (n=1,379) municipalities of Ant nio Prado and Ip , Southern Brazil, 1996.

Animal production	N	Asthma symptoms		Chronic respiratory disease	
		OR Crude (IC 95%)	OR Adjusted** (IC 95%)	OR Crude (IC 95%)	OR Adjusted** (IC 95%)
Poultry		p=0.98	p=0.92	p=0.20	**p=0.04**
None	473	1	1	1	1
Up to 2.000 heads	741	1.03(0.73-1.47)	0.98(0.69-1.41)	1.00(0.75-1.32)	0.95(0.71-1.27)
>2.000 heads	159	1.00(0.58-1.74)	1.10(0.63-1.94)	1.41(0.93-2.13)	**1.62(1.05-2.51)**
Have enclosure and interact with animals		p=0.49	p=0.74	p=0.14	**p=0.03**
No	1,228	1	1	1	**1**
Yes	145	0.82(0.47-1.44)	0.91(0.51-1.60)	1.34(0.91-1.99)	**1.60(1.05-2.42)**
Cattle		p=0.63	p=0.44	p=0.38	p=0.44
Up to 10 heads	482	1	1	1	1
11 to 20 heads	433	1.14(0.77-1.68)	1.30(0.87-1.94)	1.04(0.77-1.42)	1.19(0.86-1.64)
>20 heads	461	0.94(0.63-1.40)	1.10(0.72-1.69)	0.84(0.62-1.15)	0.97(0.70-1.36)
Have >20 cattle and interact with animals		p=0.40	p=0.84	p=0.18	p=0.63
No/have few	925	1	1	1	1
Yes	451	0.86(0.60-1.22)	0.96(0.67-1.39)	0.83(0.63-1.09)	0.93(0.70-1.24)
Swine		p=0.58	p=0.68	p=0.74	p=0.97
None	358	1	1	1	1
Up to 20 heads	784	1.02(0.70-1.48)	1.12(0.76-1.64)	0.95(0.71-1.29)	1.03(0.75-1.41)
>20 heads	228	0.79(0.46-1.35)	0.91(0.53-1.58)	0.85(0.57-1.28)	1.05(0.69-1.61)
Have >20 swine and interact with animals		p=0.26	p=0.48	p=0.48	p=0.90
No/ up to 20 swine	1,147	1	1	1	1
Yes	223	0.76(0.47-1.22)	0.84(0.52-1.37)	0.88(0.62-1.26)	1.02(0.71-1.48)
Horses		p=0.07	p=0.06	p=0.06	p=0.08
No	1,240	1	1	1	1
Yes	133	1.57(0.97-2.54)	1.62(0.98-2.65)	1.47(0.99-2.20)	1.45(0.96-2.20)
Have horses and interact with animals		p=0.14	p=0.13	p=0.08	p=0.11
No	1,245	1	1	1	1
Yes	128	1.46(0.89-2.40)	1.49(0.89-2.48)	1.43(0.95-2.16)	1.42(0.93-2.16)
Use industrial feeds		p=0.05	**p=0.05**	p=0.20	p=0.36
No/organic	456	1	1	1	1
1 type	514	1.62(1.09-2.41)	**1.65(1.10-2.46)**	1.30(0.96-1.77)	1.25(0.91-1.72)
2 or more types	409	1.25(0.81-1.92)	1.28(0.82-2.00)	1.07(0.77-1.49)	1.08(0.77-1.51)

*Linear trend
**Odds ratio adjusted for gender, age schooling, smoking status, economic indicators, years lived on property and use of pesticides
Boldface values: statistically significant (p<0.05)

Table 5 - Association between exposure to agricultural dusts and respiratory symptoms (n=1,379), municipalities of Ant nio Prado and Ip , Southern Brazil, 1996.

Types of dust	N	Asthma symptoms		Chronic respiratory disease	
		OR Crude (IC 95%)	OR Adjusted ** (IC 95%)	OR Crude (IC 95%)	OR Adjusted ** (IC 95%)
Bird feathers		p=0.10	p=0.39	p=0.03*	**p=0.05***
No	862	1	1	1	1
Low	339	1.49(1.03-2.15)	1.29(0.88-1.89)	1.10(0.81-1.49)	1.01(0.73-1.39)
High	178	1.24(0.76-2.02)	1.19(0.72-1.96)	1.55(1.08-2.24)	**1.56(1.07-2.28)**
Animal hair		p=0.92	p=0.99	p=0.95	p=0.88
No	621	1	1	1	1
Low	576	1.00(0.71-1.42)	0.99(0.70-1.41)	1.04(0.79-1.37)	1.04(0.79-1.38)
High	182	1.11(0.68-1.81)	1.02(0.62-1.68)	1.06(0.71-1.57)	1.11(0.73-1.68)
Straw		P=0.03*	**p=0.04***	p=0.006*	**p=0.01***
No	224	1	1	1	1
Low	676	1.15(0.69-1.89)	1.13(0.67-1.90)	1.44(0.96-2.15)	1.34(0.88-2.04)
High	479	1.60(0.96-2.65)	1.58(0.93-2.67)	1.77(1.17-2.66)	**1.69(1.10-2.61)**
Grain dust		p=0.18	p=0.30	p=0.06*	p=0.11
No	353	1	1	1	1
Low	624	0.93(0.62-1.41)	0.97(0.63-1.49)	0.96(0.70-1.33)	0.94(0.67-1.33)
High	402	1.31(0.86-2.01)	1.29(0.83-2.02)	1.36(0.97-1.91)	1.30(0.91-1.86)
Manure		p=0.07	p=0.10*	p=0.001*	**p<0.001***
No	409	1	1	1	**1**
Low	601	1.61(1.07-2.43)	1.50(0.98-2.28)	1.46(1.06-2.01)	**1.42(1.01-1.99)**
High	369	1.50(0.95-2.36)	1.48(0.93-2.36)	1.76(1.24-2.49)	**2.07(1.42-3.00)**
Soil dust		p=0.28	p=0.27	p=0.11	p=0.26
No	154	1	1	1	1
Low	434	0.68(0.40-1.14)	0.67(0.39-1.14)	0.65(0.42-0.98)	0.71(0.46-1.10)
High	371	0.69(0.43-1.12)	0.67(0.41-1.11)	0.68(0.46-1.01)	0.73(0.49-1.10)
Ashes		p=0.05	p=0.25	p=0.001*	**p=0.004***
No	1,071	1	1	1	**1**
Low	249	1.62(1.11-2.38)	1.40(0.94-2.08)	1.50(1.09-2.05)	**1.42(1.02-1.97)**
High	59	1.07(0.48-2.41)	0.97(0.43-2.21)	2.04(1.17-3.57)	**1.95(1.10-3.45)**
Fumes		p=0.18	p=0.24	p=0.07*	**p=0.02***
No	943	1	1	1	1
Low	356	1.39(0.97-1.98)	1.38(0.95-1.99)	1.18(0.88-1.57)	1.25(0.93-1.70)
High	80	1.00(0.48-2.05)	1.07(0.51-2.23)	1.54(0.92-2.56)	**1.79(1.04-3.09)**
Intense dust***		p=0.06*	**p=0.03***	p=0.03*	**p=0.001***
No/low	353	1	**1**	1	1
1 type of dust	311	1.66(1.02-2.70)	**1.82(1.09-3.02)**	1.11(0.75-1.62)	1.30(0.86-1.97)
2 or more types	715	1.57(1.03-2.41)	**1.71(1.10-2.67)**	1.40(1.02-1.92)	**1.77(1.25-2.50)**

*Linear trend
**Odds ratio adjusted for gender, age schooling, smoking status, economic indicators, years lived on farm and use of pesticides
***Synthetic indicator grouping dusts classified as intense exposure
Boldface values: statistically significant (p<0.05)

domestic and agricultural incineration (cereal straw and other production by-products) was associated with an increase in asthma or respiratory symptoms. In the USA, the Environmental Protection Agency defines all of these particles suspended in air as particulate matter, and has developed specific programs to investigate exposure to this type of dust.

Overall, the present study revealed that agricultural work involves substantial exposure to various types of dusts, both organic and mineral. Farmers who work in environments with higher dust concentrations, particularly poultry workers, showed more respiratory symptoms of asthma and of chronic respiratory disease, which is consistent with the international literature.

The shortage of Brazilian studies on rural workers highlights the need for further research on respiratory health of workers in different agricultural contexts. In future studies, it is suggested the use of methodologies able to identify causality between occupational exposure and respiratory problems. Measures of environmental exposure may contribute to more precision and objectivity in estimates of dust concentrations and other environmental hazards. Likewise, tests of pulmonary function might diagnose respiratory illnesses and their severity. In order to reduce recall bias, limits should be set for the evaluation of symptoms from more recent periods, such as, for example, the 12 months prior to interviews.

Results from the present study emphasize the need to invest in respiratory protection of workers on family farms and rural employees, primarily during activities where they are exposed to high levels of agricultural dusts. Considering the risk evidenced for poultry workers and the rapidly expanding poultry industry, the implementation of specific programs that address respiratory protection for all workers involved in poultry farming is recommended.

REFERENCES

1. American Thoracic Society - ATS. Respiratory health hazards in agriculture. *Am J Respir Crit Care Med.* 1998;158(5 Pt 2):S1-76.

2. Danuser B, Weber C, Kunzli N, Schindler C, Nowak D. Respiratory symptoms in Swiss farmers: an epidemiological study of risk factors. *Am J Ind Med.* 2001;39:410-8.

3. Donham KJ, Cumro D, Reynolds SJ, Merchant JA. Dose-response relationships between occupational aerosol exposures and cross-shift declines of lung function in poultry workers: recommendations for exposure limits. *J Occup Environ Med.* 2000;42:260-9.

4. Eduard W, Douwes J, Omenaas E, Heederik D. Do farming exposures cause or prevent asthma?: results from a study of adult Norwegian farmers. *Thorax.* 2004;59:381-6.

5. Faria NMX, Facchini LA, Fassa AG, Tomasi E. Processo de produ o rural e sa de na Serra Ga cha: um estudo descritivo. *Cad Sa de P blica.* 2000;16:115-28.

6. Faria NMX, Facchini LA, Fassa AG, Tomasi E. Pesticides and respiratory symptoms among farmers. *Rev Sa de P blica.* 2005;39:973-81.

7. Fernandes FC, Furlaneto A. Riscos biol gicos em avi rios. *Rev Bras Med Trab.* 2004;2:140-52.

8. Golshan M, Faghihi M, Roushan-Zamir T, Masood Marandi M, Esteki B, Dadvand P, et al. Early effects of burning rice farm residues on respiratory symptoms of villagers in suburbs of Isfahan, Iran. *Int J Environ Health Res.* 2002;12:125-31.

9. Hopp RJ, Biven RE, Degan JA, Bewtra AK, Townley RG. The usefulness of questionnaire-derived information to predict the degree of nonspecific bronchial hyperresponsiveness. *Allergy Proc.* 1995;16:129-34.

10. Hoppin JA, Umbach DM, London SJ, Alavanja MC, Sandler DP. Chemical predictors of wheeze among farmer pesticide applicators in the Agricultural Health Study. *Am J Respir Crit Care Med.* 2002;165:683-9.

11. Hoppin JA, Umbach DM, London SJ, Alavanja MC, Sandler DP. Animal production and wheeze in the Agricultural Health Study: interactions with atopy, asthma, and smoking. *Occup Environ Med.* 2003;60(8):e3.

12. Kilpelainen M, Terho EO, Helenius H, Koskenvuo M. Validation of a new questionnaire on asthma, allergic rhinitis, and conjunctivitis in young adults. *Allergy.* 2001;56:377-84.

13. Kimbell-Dunn M, Bradshaw L, Slater T, Erkinjuntti-Pekkanen R, Fishwick D, Pearce N. Asthma and allergy in New Zealand farmers. *Am J Ind Med.* 1999;35:51-7.

14. Kimbell-Dunn MR, Fishwick RD, Bradshaw L, Erkinjuntti-Pekkanen R, Pearce N. Work-related respiratory symptoms in New Zealand farmers. *Am J Ind Med.* 2001;39:292-300.

15. McCurdy SA, Ferguson TJ, Goldsmith DF, Parker JE, Schenker MB. Respiratory health of California rice farmers. *Am J Respir Crit Care Med.* 1996;153:1553-9.

16. Monso E, Schenker M, Radon K, Riu E, Magarolas R, McCurdy S, et al. Region-related risk factors for respiratory symptoms in European and Californian farmers. *Eur Respir J.* 2003;21:323-31.

17. Monso E, Riu E, Radon K, Magarolas R, Danuser B, Iversen M, et al. Chronic obstructive pulmonary disease in never-smoking animal farmers working inside confinement buildings. *Am J Ind Med.* 2004;46:357.

18. Radon K, Danuser B, Iversen M, Jorres R, Monso E, Opravil U, et al. Respiratory symptoms in European animal farmers. *Eur Respir J.* 2001;17:747-54.

19. Radon K, Danuser B, Iversen M, Monso E, Weber C, Hartung J, et al. Air contaminants in different European farming environments. *Ann Agric Environ Med.* 2002;9:41-8.

20. Radon K, Monso E, Weber C, Danuser B, Iversen M, Opravil U, et al. Prevalence and risk factors for airway diseases in farmers - summary of results of the European Farmers' Project. *Ann Agric Environ Med.* 2002;9:207-13.

21. Salameh PR, Baldi I, Brochard P, Raherison C, Abi Saleh B, Salamon R. Respiratory symptoms in children and exposure to pesticides. *Eur Respir J.* 2003;22:507-12.

22. Vogelzang PF, Van der Gulden JW, Tielen MJ, Folgering H, Van Schayck CP. Health-based selection for asthma, but not for chronic bronchitis, in pig farmers: an evidence-based hypothesis. *Eur Respir J.* 1999;13:187-9.

23. Vogelzang PF, Van der Gulden JW, Folgering H, Heederik D, Tielen MJ, Van Schayck CP. Longitudinal changes in bronchial responsiveness associated with swine confinement dust exposure. *Chest.* 2000;117:1488-95.

24. Xu X, Niu T, Christiani DC, Weiss ST, Chen C, Zhou Y, et al. Occupational and environmental risk factors for asthma in rural communities in China. *Int J Occup Environ Health.* 1996;2:172-6.

Supported by Conselho Nacional de Desenvolvimento Cient fico e Tecnol gico (National Council for Scientific and Technological Development CNPq - Process n. 400569/92-2).
Based on a doctorate thesis presented to the Postgraduate Program in Epidemiology of the Universidade Federal de Pelotas, in 2005.