Original Article

Respiratory manifestations and respiratory diseases: prevalence and risk factors among pig farmers in Braço do Norte, Brazil*

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Abstract

Objective: To describe the prevalence of signs and symptoms of respiratory disease among pig farmers in Braço do Norte, Santa Catarina, Brazil, evaluating the characteristics of swine confinement buildings and identifying potential risk factors. **Methods:** An exploratory, cross-sectional, observational study involving interviews and pulmonary function tests (spirometry). Aspects related to job history, work conditions, and environment, as well as to respiratory status and smoking, were evaluated. Odds ratios were used to estimate the chances of exposure when comparing pig farmers according to the signs and symptoms of respiratory disease. **Results:** The prevalence of clinical signs and symptoms of respiratory disease was 84.3%, clinical manifestations of bronchial asthma were detected in 5.6% of the farmers evaluated, and chronic bronchitis was diagnosed in 5.1% of the workers over the age of 40. Only 2.6% used specific individual respiratory protection devices. Respiratory disease was positively associated with low socioeconomic level, low level of education, smoking, the use of wood stoves, and the use of disinfectants. Work load and length of employment were both apparently associated with a lower prevalence of respiratory disease. **Conclusion:** The association between duration of employment and lower prevalence of respiratory disease can be attributed to the healthy worker effect. However, the evident respiratory impairment among pig farmers and the limited use of personal protective equipment draw attention to the need to implement a program to monitor exposure and regulate environmental factors.

Keywords: Occupational Exposure; Occupational Diseases/epidemiology; Swine; Animal husbandry; Respiratory tract diseases.

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Introduction

In the last 30 years, interest in studying respiratory health among pig farmers has increased greatly. Although the first report in the literature was in 1974, the same authors drew attention to the appearance of new sources of occupational disease in pig farming in 1977.[1] Different studies, principally those conducted in the United States,[2-4] Canada,[5] Holland,[6] Denmark,[7] and Sweden,[8] demonstrated that the prevalence of respiratory alterations is higher among pig farmers than in the general population, as well as being higher than that observed among individuals involved in agricultural activities other than pig farming.[9] Among pig farmers, the most common symptoms include acute and chronic cough, expectoration, dyspnea, and sibilance, and the most common conditions are laryngitis, chronic bronchitis, and bronchial asthma. It has been demonstrated that levels of IgG4, which is related to pork-based foods and porcine antigens, are higher in pig farmers who work more hours per week, although no correlation between elevated IgG4 and loss of pulmonary function has been established.[8-10] Functional studies have demonstrated a temporal decrease in forced expiratory volume in one second (FEV_1) over the course of the years of exposure, as well as a 59% prevalence of bronchial hyperreactivity among pig farmers.[8] The bronchial hyperreactivity, the inflammation of the bronchial mucosa observed through fiberoptic bronchoscopy, and the predominance of neutrophils in the analysis of the bronchoalveolar lavage have been used to confirm the alterations related to this occupation.[1] Reactive airways dysfunction syndrome – an acute and more severe condition – has been reported to occur as a result of the inhalation of gases in a closed swine confinement building in which the ventilation system is not functioning.[10] In addition, the effects of exposure to organic dust in pig farming, for periods longer than three hours, cause intense inflammation of the respiratory airways, detecting the involvement of interleukins 1 and 6 and of tumor necrosis factor alpha in the mediation of this inflammatory process. The use of disinfectants, especially ammonia, for prolonged periods is closely associated with pulmonary function alterations and with the presence of respiratory symptoms.[11]

According to the Brazilian Agency for Agricultural Research,[12] the state of Santa Catarina is responsible for 75% of the Brazilian exportation of pork, for one-third of the total slaughters, and for 40% of industrial slaughters. The Laguna Region Association of Cities area accounts for approximately 12% of the statewide production of pork, concentrated mainly in the cities of Braço do Norte, São Ludgero, and Rio Fortuna, the first being the one with the largest herd. Considering the extent of pig farming activity in the region and the paucity of data regarding the occupational effects on the respiratory manifestations among pig farmers, the present study aimed to describe the prevalence of signs and symptoms of respiratory disease, evaluating the characteristics of the swine confinement buildings, and identifying potential risk factors for the development of such manifestations among the workers of this region.

Methods

The city of Braço do Norte, in the south of Santa Catarina, was chosen for being the greatest swine producer in the region. As an initial phase of the present study, a census carried out in Braço do Norte identified 480 pig farmers. For sample calculation, having data from the literature as a basis, a prevalence of 20% of chronic bronchitis among these pig farmers was anticipated. A random sample of 163 pig farmers was considered sufficient to measure the estimated prevalence with a margin of error of 5%, using a 95% confidence interval ($p < 0.05$). A final sample of 180 pig farmers was obtained, including in this number contingencies in relation to potential losses. A second calculation estimated the potential of this sample for the detection of possible differences in the distribution of the chances of respiratory disease according to the exposure factors of interest. A total of 180 pig farmers selected was considered sufficient to detect differences of at least three times in the odds ratio (OR) of respiratory disease when comparing exposed to unexposed pig farmers.

The 180 pig farmers were selected by simple random sampling. They answered a modified questionnaire to detect the presence of symptoms of respiratory diseases and were submitted to spirometry (spirometer Beatrice - AT version 4.y 2000, with flow-volume curve; EBEM, Recife, Brazil), according to standardized criteria.[13]

The questionnaire was composed of 85 questions, among which 62 were closed, 14 open, and

9 mixed, disposed in blocks representing independent or exposure variables (blocks 1, 2, and 3), dependent or outcome variables (block 4) and other variables (blocks 5 and 6).

Block 1 questions: Classification of the pig farmers by age and gender.

Block 2 questions: Classification of pig farmers by socioeconomic level.

Block 3 questions: Description of the system and work environment adopted by the farm.

Block 4 questions: Classification of pig farmers by respiratory manifestations.

Block 5 questions: Classification of pig farmers as smokers, former smokers, or users of wood-burning stoves.

Block 6 questions: General review of all issues raised during the interview.

The research instrument was applied to the individuals selected within and outside of their working hours, after the acceptance by the employers and workers. The spirometric test was performed away from the work environment and outside of working hours. On the occasion, each surveyed individual was requested to pay close attention to the explanations of the field team, among which were the instructions regarding the procedures of the interview and the spirometry test, as well as to the clarifications regarding the research objectives.

A short questionnaire was administered to 30 pig farmers in the city of São Ludgero. The data obtained suggested the need for modifications in the questionnaire, in order to facilitate both the work of the field team as to the filling out of the questionnaire itself and the understanding by the surveyed individuals. In addition, the researchers were oriented in cases of anomaly detection or disease diagnosis during the study, and in such circumstances, recommendations were made so that the worker would be referred to medical treatment.

The case definition follows different approaches according to the specific outcomes explored by the study. In the broadest approach, the participants were classified as presenting or not presenting respiratory manifestations of the upper and lower airways. The respiratory symptoms and signs were classified as acute (occurring for up to three weeks) or chronic (persisting for more than three weeks). Individuals who reported nasal pruritus, nasal secretion, sneezing, or nasal obstruction were classified as presenting upper airway-specific signs and symptoms. Individuals reporting wheezing, cough, expectoration, dyspnea, chronic expectoration, dyspnea at work, wheezing at work, or chronic cough (three or more weeks in duration), as well as those having been clinically diagnosed with bronchial asthma or chronic bronchitis, were classified as presenting lower airway-specific signs and symptoms. A second approach to the outcome measure refers to the presence of specific respiratory signs and symptoms investigated as isolated events. In this group are cough, expectoration, and dyspnea. A third outcome measure referred to the diagnosis of chronic bronchitis in individuals over 40 years of age and included as positive the cases which presented cough with expectoration on the majority of the days, for at least three months a year, two years in a row, ruling out other diseases. Individuals presenting symptoms consistent with chronic bronchitis, even if the spirometry did not show obstruction, were considered cases.

Bronchial asthma was defined as the presence of dyspnea, cough, wheezing, or recurrent retrosternal oppression in the last few years, after the flu or not, especially when the individual was off work or on a trip. Occupational asthma was defined as the presence of these symptoms during the period in which the individual was working. Childhood asthma was defined as a history of attacks of wheezing and dyspnea in childhood.

The pig farmers who presented purulent expectoration during the interview (n = 30) were submitted to X-ray of the chest and paranasal sinuses in order to detect other specific diseases, facilitating the differential diagnosis. Two individuals who changed jobs during the performance of the tests were excluded.

Bivariate analyses and unconditional logistic regression were used in the investigation of the independent effects of the exposures of interest in the occurrence of respiratory disease, adjusted for age and smoking. The chi-square test, with a 95% confidence interval ($p < 0.05$), was used to test for differences in the occurrence of respiratory diseases.

The study was approved by the Ethics in Research Committee of the University of Southern Santa Catarina.

Results

The mean age of the pig farmers was 37.7 ± 12.2 years (range, 15-63 years), and males

predominated (82.6%). The mean number of years of schooling was 6.4, and nearly half of the sample had completed the fourth grade. As to the socioeconomic classification, 78% of the pig farmers were categorized as class C according to the criteria of the Brazilian National Business Association.[14] Table 1 shows the distribution of the pig farmers according to the work environment variables and work characteristics. Of the 178 pig farmers examined, 81 (45.5%) lived within 50 meters of the farm. Nearly half (46.1%) stated that they had been engaged in this activity since the beginning of their working lives. Cattle farming predominated as a parallel activity to pig farming in 72%. The mean time of daily work in the pigsty was 8 ± 3.6 h. The mean time working in the area of pig farming was 14 ± 9 years. Only 5 (2.8%) of the 178 pig farmers used personal protective equipment for the respiratory system (masks) and, of those 5, 4 presented chronic cough.

Respiratory manifestations were detected in 150 (84.3%) of the pig farmers investigated. Of those 150, 103 (69%) presented acute signs and symptoms, whereas only 47 (31%) presented chronic signs and symptoms. Table 2 presents the prevalence of upper and lower airway signs/symptoms, as well as of the diseases diagnosed. The most common upper airway manifestations in the pig farmers were as follows: nasal obstruction, in 76 (42.7%); sequential sneezing, in 68 (38%); and nasal secretion/pruritus, in 41 (23%). Among the lower airway manifestations, cough, expectoration and dyspnea were observed in, respectively, 73.6, 69 and 30.9% of the individuals. Only one-third of the occurrences of cough were diagnosed as chronic. Wheezing was detected in nearly 15% of the pig farmers, and just over 5% were diagnosed with bronchial asthma. In the population of pig farmers as a whole, 9 (5.1%) presented chronic bronchitis. Post-exposure dyspnea, i.e., during work, was reported by 17 (9.6%), and wheezing was reported by 12 (6.7%). Of the 23 pig farmers (13%) who presented symptoms consistent with occupational asthma, 10 (5.6%) presented definitive clinical diagnosis. Of the 14 pig farmers reporting childhood asthma, 3 still presented the diagnosis. Wheezing during work was detected in 12 (6.7%).

In 30 (17%) of the pig farmers, X-rays of the chest and paranasal sinuses were indicated. Of

Table 1 - Characteristics of work environment of 178 pig farmers in Braço do Norte, Brazil in 2003.

Variable	n	%
Ventilation in the barn		
Natural	177	99.4
Automated	1	0.6
Farm environment		
Open	1	0.6
Closed	1	0.6
Semi-open	176	98.8
Type of animal feeding		
Manual	167	93.8
Mechanical	11	6.2
Use of disinfectants		
Yes	174	97.6
No	11	2.4
Type of disinfectant		
Iodine	24	70.1
Ammonia	43	24.7
Cresol	37	21.3
Virgin whitewash	33	18.4
Other	61	34.5
Use of personal protective equipment		
Yes	120	67.4
No	07	3.9
Rarely	51	28.7

Table 2 - Prevalence of upper and lower airway signs/symptoms, as well as of diagnoses of chronic bronchitis and bronchial asthma, in 178 pig farmers in Braço do Norte, Brazil, in 2003.

Signs, symptoms, and diseases	n	%
Nasal obstruction	76	42.7
Sequential sneezing	68	38
Nasal secretion	41	23
Nasal pruritus	41	23
Cough	131	73.6
Chronic cough	40	23.6
Expectoration	124	69
Chronic expectoration	35	19.7
Dyspnea	55	30.9
Wheezing	26	14.7
Wheezing at work	12	6.7
Chronic bronchitis	9	5.1
Bronchial asthma	10	5.6
Dyspnea at work	17	9.6
Symptoms consistent with occupational asthma	23	13

those 30, only 3 presented altered X-rays: 2 presented interstitial infiltrate; and 1 presented an enlarged cardiac silhouette. The X-rays of the paranasal sinuses were normal in 26 (14.6%) of the patients and altered in 4 (2.2%). All of the alterations were consistent with a diagnosis of bacterial sinusitis. Of the pig farmers diagnosed with chronic bronchitis, 1 presented a normal chest X-ray, 1 presented an altered X-ray consistent with a diagnosis of chronic bronchitis, and 7 were not submitted to X-ray. Among the X-rays of the pig farmers with bronchitis, only 2 presented alterations in the paranasal sinuses.

Of the 178 pig farmers who took the spirometry test, only 3 presented altered results. The first individual presented mild restrictive respiratory disorder, the second presented mild obstructive respiratory disorder, without response to the bronchodilator, and the third presented severe obstructive respiratory disorder, with moderate reduction of the vital capacity, without response to the bronchodilator. There were only two cases in which the spirometry findings contributed to the diagnosis of chronic bronchitis. In one case (in an asymptomatic individual), the diagnosis was made on the basis of the spirometry findings alone.

When exploring the prevalence of respiratory manifestations according to sociodemographic characteristics (Table 3), we found that the chance of such manifestations increased by more than 50% (OR > 1.5) in the pig farmers with lower levels of education, and that the chance of presenting respiratory signs and symptoms was also greater in this less privileged class. Among the smokers and former smokers we found that the chance of respiratory manifestations was four times greater (OR = 3.8; $p < 0.05$) than among the other pig farmers. In the same group, we found a 40% greater chance of presenting cough and a 20% greater chance of expectoration. The pig farmers who used wood-burning stoves had a 25% greater chance of presenting respiratory manifestations when compared to those who did not use such stoves. The prevalence of chronic bronchitis was twice as high among those who used wood-burning stoves.

The prevalence of respiratory manifestations was 20% higher among the pig farmers who used disinfectants (Table 4) and 80% higher among those who fed the animals manually. The prevalence of chronic bronchitis was much higher among those who used disinfectants. Those individuals also presented a 70% greater prevalence of acute respiratory mani-

Table 3 - *Odds ratios*, adjusted for age and smoking habit, for the development of respiratory manifestations in 178 pig farmers in Braço do Norte, Brazil, in 2003.

Variable	n	(%)	OR	p value
Gender				
Male	126/147	(85.7)	1.75	0.21
Female	24/31	(77.4)	reference	-
Age				
15-35 years	56/67	(83.6)	reference	0.73
36-68 years	94/111	(84.7)	1.09	-
Schooling				
Up to grade 5	66/75	(88.0)	1.66	0.24
Grade 5 to college	84/103	(81.6)	reference	-
Socioeconomic index				
Class A2, B1, or B2	13/23	(56.5)	reference	< 0.01
Class C or D	137/155	(88.4)	5.82	-
Smoking				
Current/former smoker	35/37	(94.6)	3.80	0.05
Nonsmoker	115/141	(81.6)	reference	-
Wood stove				
Yes	78/91	(85.7)	1.25	0.58
No	72/87	(82.8)	reference	-

OR: *odds ratio*.

Table 4 - *Odds ratios*, adjusted for age and smoking habit, for the development of respiratory manifestations according to the work environment and conditions in 178 pig farmers in Braço do Norte, Brazil, in 2003.

Variable	n	(%)	OR	p value
Type of feeding				
Manual	141/167	(84.4)	1.49	0.63
Mechanical	9/11	(81.8)	reference	-
Use of disinfectants				
Yes	147/173	(84.5)	2.38	0.48
No	3/4	(75.0)	reference	-
Time in pig farming				
Above the mean (≥11 years)	68/82	(82.9)	0.88	0.77
Below the mean (<11 years)	82/96	(85.4)	reference	-
Daily hours on the farm				
Above the mean (≥8 h)	67/86	(77.9)	0.34	<0.05
Below the mean (<8 h)	82/92	(90.1)	reference	-
Use of personal protective equipment				
No/rarely	53/58	(91.4)	2.69	<0.05
Yes	97/120	(80.8)	reference	-

OR: *odds ratio*.

festations. As for the specific type of disinfectant, cresol and iodine presented significant associations with respiratory manifestations. Ammonia was significantly associated with dyspnea, doubling the chance of developing this symptom ($p < 0.05$).

Greater length of employment, in years of pig farming, and longer hours spent on the farm weekly both appeared to be protective against the development of respiratory manifestations. As we analyzed the specific symptoms, such as cough, dyspnea, and expectoration, more years and more hours per week of work in pig farming were again found to be protective factors.

Discussion

Among the pig farmers in Braço do Norte, the prevalence of respiratory manifestations was 84.3%, whereas this rate has varied from 22.6 to 82% in other studies.[2-4] In the population of Brazilian farmers as a whole, this information is not available. However, among European farmers, regardless of the type of activity, the prevalence of respiratory symptoms is approximately 22.1%.[15]

Few studies have investigated the prevalence of upper and lower airway respiratory manifestations. However, the rates of approximately 30% reported by some authors[1,17] are slightly lower than that found in our study. The prevalence of cough, defined as any type of cough, among pig farmers in Braço do Norte was higher than that reported in the great majority of studies, although no significant differences were found for chronic cough. The prevalence of dyspnea and wheezing reported in other studies was two times higher than that found in the present study, whereas the opposite occurred for expectoration.[16,18] Despite the fact that our findings regarding the clinical diagnosis of asthma are within the spectrum of the variation in the literature, the use of different diagnostic criteria in the various studies precludes the drawing of any conclusions. However, similar to the findings of some other authors,[19] the prevalence of asthma in the pig farmers in Braço do Norte was lower than what is expected among non-pig farmers, which could be explained by vocational selection, in which sick individuals would not choose or be selected for such a task.

The prevalence of chronic bronchitis found among pig farmers was 5.1%. This finding is slightly lower than the values found in pig farmers over 40 years of age in other countries.[6,8] One factor that might explain this lower prevalence is the fact that pig farming in Brazil occurs in a different environment from that described in the international literature, especially in the countries with low temperatures where, for that reason, the system involves closed environments. Another important factor to be discussed is the fact that we did not exclude the individuals who reported clin-

ical history consistent with the diagnosis of chronic bronchitis whose spirometry values did not reveal airflow obstruction. The use of the FEV_1/FVCratio as the functional criterion led to a diagnosis of this disease in only two individuals. One group of authors[20] drew attention to those asymptomatic pig farmers who presented spirometric alterations, demonstrating greater sensitivity when this method was used for detecting cases. Great variations in the prevalence of respiratory signs and symptoms and of the diagnosis of respiratory diseases[16,18,19] might be explained by different profiles of the various systems employed in raising the animals, as well as by the different diagnostic criteria applied. In the international literature, we found that 96% of the farms are closed, with appropriate ventilation and built with concrete and metal.[6] This is in contrast with the semi-open farm system with natural ventilation found in Braço do Norte (Figure 1). Climatic, and possibly economic, differences explain the contrasts observed in the environment and in the results found.[11] Very closed pigsties, found in the colder climates, cause a greater concentration of exposure to pollutants. The mean work time spent in the pigsties was similar to that found in the literature,[18] and the length of employment presented exactly the same mean as that reported by some other authors.[19] In the same context, in Braço do Norte the confirmation of the acute symptoms (69%) also demonstrates the regional and environmental characteristics influencing the outcomes. Age did not influence the appearance of respiratory signs and symptoms. Low educational levels increased the chance of the disease by more than 50% among pig farmers, even after adjusting for age and smoking effects. Smoking, in addition to being a factor that increased the risk of developing respiratory manifestations and disease by nearly four times among the pig farmers studied, might have presented an additive effect on the manifestation of chronic symptoms, as previously described by other authors.[1,8,22,23] However, in the pig farmers of Braço do Norte, no significant difference was found between smokers and nonsmokers in the prevalence of chronic bron-

Figure 1 - Pigsties in a semi-open system in Braço do Norte, Brazil.

chitis. Various studies have demonstrated that the prevalence of these manifestations is higher among pig farmers than among workers engaged in other agricultural activities.[5,7,9] However, in the present study, the prevalence of chronic bronchitis among those who also engaged in other agricultural activities was approximately 7%, a much lower rate than that found in other studies.[17,18]

The association between smoking and higher prevalence of cough, dyspnea, and expectoration is in accordance with the literature, in which it is suggested that smoking is the major promoter and an additive factor in the development of respiratory manifestations and diseases.[24,25] In the present study, the positive association found between the use of wood-burning stoves and respiratory signs/symptoms only confirms the known risk of passive exposure to smoke.

Our data demonstrate that the chances of the pig farmers presenting respiratory manifestations are almost six times greater among those who are less economically privileged. This correlation was not found in previous studies. In agreement with what has been reported in other studies, in Braço do Norte, no association was found between respiratory manifestations and the distance from the residence to the farm. The use of disinfectants and the manual feeding of the animals, as already reported by other authors,[17,18] increases the chances of developing disease. Exposure to the animal chow would increase the risk, since it generates more dust and consequently a greater accumulation of endotoxins.[19] The finding of an association between using a mask and the presence of disease probably indicates that the use of a mask is linked to previous disease in those few (five) pig farmers who used one. Among the pig farmers in Braço do Norte, the use of disinfectants presented a slightly higher prevalence than that referred to in the literature. The most commonly used disinfectant in Braço do Norte was iodine, whereas ammonia was the most common in other studies.[6,7,16] When investigating the relationship according to the specific product, cresol and iodine presented the most significant associations with signs and symptoms. The use of ammonia, the disinfectant most significantly associated with acute and chronic respiratory symptoms, doubled the chances of experiencing dyspnea. In contrast to what has been reported,[7,8] the years worked in pig farming presented a negative correlation with the prevalence of respiratory manifestations, as well as with the prevalence of disease. This difference in our findings probably expresses the joint effect of pig farming performed in the semi-open system and 'healthy worker effect'.[21] In Braço do Norte, a greater work load (over 8 hours daily and more than 11 years in pig farming) was protective against the development of cough, chronic cough, and acute symptoms. This apparent protective factor might be explained by two interrelated factors: the self-selection derived from those individuals found at work at the time of the interview ('healthy worker effect') and the frequent bias of reverse causality found in the studies with a cross-sectional design, in which the poor temporal relationship precludes the establishment of correlations between exposure and outcome. Therefore, the apparent outcome (disease) was in fact the cause of the apparent exposure (work).[21] In addition, since ours was a descriptive study, without a control group and in a specific population, it is not possible to determine with any degree of certainty the relationships between exposure and outcomes.

In conclusion, it is evident that pig farmers working in Braço do Norte, Brazil present respiratory system impairment. This fact, together with the low rate at which specific protection measures have been adopted in this population, indicates that there is a need to implement a program to monitor exposure and regulate environmental factors in the region studied. The 'healthy worker effect' might explain the fact that work load and length of employment were apparently associated with better respiratory health.

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