

Evaluation of the sensitisation to grains and its pulmonary impact in employees of the port of Brest silos

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ABSTRACT

Background: Evaluation of the sensitisation and levels of exposure to grains and its pulmonary impact in a population of Brest port silo employees.

Materials and methods: We included exposed workers. The study consisted of clinical examination with a standardised questionnaire, blood samples, prick-tests, and spirometry tests. The atmospheric concentration of total dust in the workplace was also associated.

Results: Eight workers were included in the study. No case of occupational asthma was found, but 3 cases of occupational rhinitis were noted and occupational prick-tests were positive in 4 cases. The mean total dust concentration in the three atmospheric samples was 4.87 mg/m³ for 8 hours but it was under the detection limits for alveolar fractions.

Conclusions: Port silo workers are exposed to total dust concentrations below the French legal limit (10 mg/m³) but higher than Canadian and American recommendations. Levels of exposure in our study are similar to other studies developed in port silos. Symptoms developed by workers may be due to high exposure to dust with an irritant effect rather than an allergic effect. Despite this fact, a specific medical survey is needed, and ventilation and respiratory masks have to be promoted for prevention.

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Key words: occupational allergy, port workers, port health

INTRODUCTION

Grains and, in particular, soy are extensively used as a source of protein in the feed of European livestock. The main producers of soy are found in American and the consumers are found in Europe and America. Soy is shipped in bulk, in the form of flour or, most often, in the form of oil cakes. Other grains are mainly shipped in bulk. In the port, the grain is moved from the hold to silos by cranes and cargo handling gear brought down to the hold. Large volumes are shipped. For example, in 2011, 617,000 tons of soy and 256,000 tons of other grains (mainly wheat, corn, sunflower, and barley) passed through the port of Brest [1]. The existence

of allergic symptoms resulting from exposure to the dust from grains was underlined by epidemics of asthma in the 1980s in Barcelona. The role of the soy unloaded in this port and, in particular, the particles found in the tops or flours were then demonstrated. Other episodes have been noted in the ports of New Orleans and Cartagena [2]. Besides these environmental exposures, a Brest study was carried out on Brest and Lorient dockers in 1989 [3]. Different job studies and an evaluation of professional risks determined that workers in port silos were also exposed to dust from grains. For this reason, we decided to carry out a study on the existence of occupational allergic diseases related



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Table 1. Characteristics of the study population

Sex	Age	Body mass index [kg/m ²]	Arterial pressure [mm Hg]	Antecedents personal or familial	Time at work-place	Tobacco status
M	30	27.5	130/80	None	6	+
M	42	26.6	120/80	None	6	-
M	38	22.5	130/80	Lumbago	7	+
M	35	40.7	140/80	None	10	-
M	37	23.5	120/80	None	10	-
M	42	20.9	130/80	None	3	+
M	35	27.5	130/80	None	9	+
M	32	27.3	125/80	Allergy to antibiotic	3	+

to this exposure and the factors of the risk of emergence within this population.

MATERIALS AND METHODS

The criteria for the inclusion of employees in the study were as follows: regular and daily contact with grains when unloaded from cargos, handling in silos, and assignment to the workstation for at least one year. The criteria for exclusion were the existence of counter-indications to the complementary examinations, the refusal of the employee, or a period of exposure of less than one year.

The study consisted of a clinical examination by a doctor specialised in occupational diseases. The questioning included a validated IUATLD and a search for signs of rhinitis and occupational allergic dermatitis (see Supplement). Paraclinical examinations were associated: blood analysis with blood count, erythrocyte sedimentation rate, and search for total and specific IgE of common allergens (pollen from trees, grasses, herbaceous plants, animal dander, moulds, latex, cockroaches, and acaridae). We also associated prick-tests by intradermal reaction to the standard allergens and grains professionally handled (soybeans and soya meal, hulls, cakes and rape seeds, cakes of sunflower, sorghum, wheat, manioc). We used Stallergenes laboratory products, or, if not possible, we made a preparation with physiologic serum and cereals professionally handled by workers in the port of Brest. Results were compared with positive and negative prick-test with, respectively, histamine and water. To complete paraclinical exams, spirometry tests on a plethysmograph Jaeger Body Master screen were also carried out.

In addition, the atmospheric concentration of the total dust as well as the inhalable and alveolar fraction was measured. To define the methodology, we made, with the silo manager and security manager of Brest port, a specific study group to define a homogeneous exposure workers group. To reduce the impact of the uncertainty of the measurements, three samples were taken. The authors used individual

CIP10 dust sensors, worn by the operators on their chest for 8 hours during a typical working day. The inhalable and alveolar dust was analysed by an approved agency using European weighing standards.

RESULTS

On the basis of the inclusion criteria, eight of the ten employees in the management department of the port of Brest silos were included in the study. Two workers were excluded; one for allergic asthma diagnosed and treated, and the other refused. This population of 8 employees was entirely male (mean age: 37 years). In total 62.5% of them were smokers and the mean period of employment was 6.75 years (3–10 years) (Table 1).

Table 2 describes the clinical symptomatology of the employees and their paraclinical examinations.

Allergic rhinitis was noted in 3 employees. An atopic predisposition was found in 5 of them. The occupational prick-tests were positive in 4 cases (mainly soy and rapeseed), on the limit in one case, and negative in 3 cases. All of the spirometry tests were normal. In the 3 cases of rhinitis, the relationship between the occupational exposure and the development of the symptoms led to the conclusion of probable cases of occupational allergic rhinitis. This was confirmed by the positive reaction in the skin tests to the occupationally handled grains. No cases of occupational asthma reaction to grains were found.

Three samples of the atmospheric dust concentrations were taken during the same day on three different employees. The duration of the sampling was 7.5 hours for all three. The results are presented in Table 3.

DISCUSSION

Port silo employees are exposed to dust from shipped grains during the unloading phases and when working in warehouses and storage silos. The intensity of the occupational respiratory exposure was assessed by atmospheric samples, which showed total dust concentrations under

Table 2. Clinical and paraclinical findings for each worker

Age	Time at work-place	Tobacco	Clinical findings	Blood sample	Prick-tests	Spirometry
38	7	+	–	Normal	– Standard – Occupational	Normal
30	6	+	Occupational Rhinitis	IgE tot	+ Standard + Occupational	Normal
42	3	+	–	Normal	– Standard and occupational	Normal
32	3	+	Respiratory symptoms	Normal	+ Standard + Occupational	Normal
37	10	–	–	Normal	+ Standard – Occupational	Normal
42	6	–	Occupational Rhinitis	Normal	+ Standard + Occupational	Normal
35	9	+	Occupational Rhinitis	Normal	+ Standard + Occupational	Normal
35	10	–	–	Normal	– Standard and occupational	Normal

+: results of the prick-tests are positive compared to histamine; -: results of the prick-tests are negative compared to histamine

Table 3. Atmospheric dust concentration in the workplace

Type of sample	Duration [h]	Tasks made during samples	Total dust concentration for 8 h [mg/m ³]	Percentage of the French legal concentration value	Alveolar dust concentration [mg/m ³]
Individual	7.5	Cleaning silos Unloading cargos Walking in grain stores Office	2.42	24	< 0.05
Individual	7.5	Cleaning silos Unloading cargos Walking in grain stores Office Cleaning grain stores	7.29	73	< 0.05
Individual	7.5	Cleaning silos Unloading cargos Walking in grain stores Office	4.87	49	< 0.05

the prescribed French Occupational Exposure Limits (OEL). In spite of the compliance with these values, we noted a mean of 4.87 mg/m³ with a maximum of 7.29 mg/m³ for the weighted concentrations over 8 hours. As regards the alveolar fractions of the dust, the concentrations were very low and under the detection limits of the material used in our study. Our results are inferior to those found by Robinet and Dewitte in 1989 for docker workstations. In fact, they noted total alveolar values of 258 mg/m³ for the vacuum workstation and 147 mg/m³ for the scraper workstation. These measurements were taken over 75 minutes and the weighting over 8 hours providing figures of 129 and 1.1 mg/m³, respectively, for the vacuum workstation and 73.5 and 4.6 mg/m³ for the scraper workstation [3]. However,

in the Dimich-Ward study published in 1995, the median total dust concentrations for the individual and environmental atmospheric samples were 1.77 and 1.6 mg/m³, respectively. These analyses were carried out on dockers during the unloading of 5 ships of grain containing wheat and barley over two hours for the individual and three hours for the work environment [5]. In addition, in a more recent study by Oldenburg (2009) on employees of port silos handling green coffee, mean concentrations of inhalable dust of 7.05 and 0.85 mg/m³, respectively, were noted for the inhalable fractions. This is very similar to our values [6]. This reduction in the mean atmospheric concentrations in dust from grains in the storage and handling zones has also been demonstrated in the analysis of five studies on Brit-

ish Columbia employees with total dust concentrations of 8.28 mg/m³ in 1978 and 2.06 mg/m³ in 2008 [7]. In our study, if we analyse the list of jobs carried out during a working day, we find that certain non-exposing or barely exposing situations probably reduce the mean exposure values. As with the dockers, we are faced with occupational exposure with peaks, and these peaks do not exceed the mean values recommended in France.

In Canada, to better take into account these short-term exposures and their possible effects on health, a regulatory value of 5 mg/m³ in total dust over 8 hours was established. The conclusions of the expert's report reveal the difficulties in providing a scientifically justified short-term value for exposure, and this long-term value is a precautionary measure. In the U.S. the ACGIH recommends a limit value of 4 mg/m³ for the mean exposure over 8 hours in total dust for wheat, barley, and oats [8]. If we compare the mean of our results with these values, we can see that it is higher. This suggests that the population of port workers runs the risk of developing disorders related to exposure to dust from grains.

The clinical impact of occupational exposure to dust from grains in the populations of port employees is very scarce in the literature. A Canadian exposed/not exposed study on 118 dockers and 555 silo workers vs. 128 non-exposed workers concluded that the risk of developing a cough was 8 times higher in dockers compared with non-exposed workers. Exploration of the Functional Residual Capacity on all employees included did not demonstrate a significant difference in the forced expiratory volume in 1 second (FEV₁) and the forced vital capacity (FVC) between exposed and non-exposed workers except for an increase in these parameters in the category of silo workers who were subject to more intense exposure over a longer period of time [6].

In a recent study carried out in Hamburg, two groups of workers: highly exposed if the concentration in inhalable dust > 10 mg/m³ (n = 28) and moderately exposed for the others. A significant increase in the prevalence of skin symptoms such as erythema, rhinoconjunctivitis, and non-specific bronchial reactivity was found at the beginning of the week and a significant increase in all work-related symptoms as the week went by in the highly exposed workers. Three cases of chronic bronchitis in non-smokers and the absence of cases of asthma were also noted [7]. In another study, long-term occupational exposure was assessed using 5 case-control surveys carried out between 1976 and 1988 in a population of grain silo workers, with a clinical examination, skin prick-tests, and spirometry. The authors noted a significant increase in the frequency of respiratory signs in the exposed workers as well as a reduction in the FEV₁ and FVC but reduction in FEV₁/FVC ratio. They concluded that pulmonary lesions on the parenchyma or small airways were the cause [10].

In addition, as in the Dewitte study, a healthy worker effect was found during the follow-up [3].

As in the Oldenburg study, the high prevalence of workers with allergic rhinitis (37.5%) associated with the absence of cases of occupational asthma raises questions in our study. One of the hypotheses advanced by Oldenburg was: the population studied is at risk of developing mainly irritative symptoms, reinforced by the existence of two cases of asthma aggravated by the work, due to high exposure to the dust from grains, with a preponderance of dust having a diameter exceeding 0.5 µ, and the quasi-absence of alveolar dust [7]. This was also put forward by the Dimich-Ward study, which demonstrated a significantly higher prevalence of ocular and cutaneous irritative signs in dockers. The variations in exposure with periods of high intensity during certain jobs would result in this phenomenon. We are faced with a mainly irritative problem, as confirmed by the preponderance of the types of symptoms and the relationship with the intensity of exposure [6]. However, what about the high proportion (5/8) of workers sensitised to the occupationally handled grains found in our study? Are the cases of rhinitis pre-existing ORL disorders that were aggravated by the work?

If we take a more global view of the population of exposed port workers, allergic manifestations in dockers are known with castor oil seeds [11] and green coffee [6, 12].

The wearing of adapted respiratory protection for the most risky jobs, such as the discharge of grains in warehouses and the cleaning of the bottom of silos and hulls, should be promoted and will most likely be effective in reducing the work-related symptomatology mainly of an irritative nature.

CONCLUSIONS

The silo workers in the port of Brest are exposed to average concentrations of total dust complying with French regulations although there are high peaks in exposure during certain jobs. They are at the limit of the values recommended in North America.

The respiratory and ORL impairment is mainly irritative. Even if we do not find any cases of occupational asthma, this population of workers should be considered at risk of developing occupational allergic diseases. In fact, signs of occupational allergic rhinitis have been noted in 37.5% of the workers, as well as a high rate of sensitisation to the grains they are professionally exposed to. In addition, the exposure to high concentrations of dust may exacerbate pre-existing disorders. The value of an initial assessment and regular monitoring is reinforced by the now well-established chronological relationship between rhinitis and occupational asthma. This assessment should include the search for clinical ORL, cutaneous and respiratory signs, atopic disposition, sensitisation to occupationally handled agents, and explorations of

spirometry. Employee information, the establishment of preventive measures – both collective (filters on silos) and individual (masks during the high-exposure jobs), should also be highly encouraged.

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SUPPLEMENT**Evaluation of the sensitisation to grains and its pulmonary impact in employees of the port of Brest silos****Date:**

Name:

Surname:

Birth date:

Occupational task:

Period of employment:

Medical status:

Personal antecedents:

Asthma Eczema Allergic rhinitis

Family antecedents:

Asthma Eczema Allergic rhinitis

Medications:

Smoking habit:

number of cigarettes by day and packets/year; if stopped, date of stop:

ORL, cutaneous, pulmonary clinical symptoms:

ORL:

Nasal itchy Limpid secretions Symptoms in two nostrils Repetitions of sneezing Nasal blockage Anosmia

Work-related:

YES NO

Cutaneous:

Eczema on hands Itchy in cereal dust exposed places

Work-related:

YES NO **Questionnaire IUATLD:**

- 1) Have you had wheezing or whistling in your chest at any time during the last 12 months?
- 2) Have you woken up with a feeling of tightness in your chest first thing on any morning at any time during the last 12 months?
- 3) Have you at any time during the last 12 months had an attack of shortness of breath that came on during the day when you were not doing anything strenuous?
- 4) Have you had an attack of shortness of breath that came on after you stopped exercising at any time during the last 12 months?
- 5) Have you at any time during the last 12 months been woken at night by an attack of shortness of breath?
- 6) Have you at any time during the last 12 months been woken at night by an attack of coughing?
- 7) Do you usually cough first thing in the morning?
 - If yes 7a) Have you had a coughing period more than three times in a year?
 - 7b) When did it begin?
- 8) Do you usually bring up phlegm from your chest first thing in the morning?
 - 8a) Have you brought up phlegm more than three times in a year?
 - 8b) When did it begin?
- 9) Which of the following statements best describes your breathing (choose only one)?
 - 9a) I never or only rarely get trouble with my breathing.
 - 9b) I get regular trouble with my breathing, but it always gets completely better.
 - 9c) My breathing is never quite right.
- 10) When you are in a dusty part of a house or with animals (for instance dogs, cats, or horses) or near feathers (including pillows, quilts, and eiderdowns) do you ever:
 - 10a) get a feeling of tightness in your chest
 - 10b) start to feel short of breath
- 11) Have you ever had asthma?
- 12) Have you had an attack of asthma at any time in the last 12 months?
- 13) Are you currently taking any medicines (including inhalers, aerosols, or tablets) for asthma?
 - Work related symptoms
- 14) Have you had any pulmonary symptoms since your first employment in the silos of Brest?
 - Can you describe them?
- 15) Have you had any of those symptoms at work but none of them when you are away from work?
 - YES
 - NO