

Snow crab allergy and asthma among Greenlandic workers – a pilot study

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Objectives. To study snow crab sensitization, occupational allergy and asthma in the snow crab industry in Greenland, as high rates have been found in Canada, but no reports have emerged from the same industry in Greenland.

Study design. Pilot survey.

Methods. Twenty workers (19 of Inuit and 1 of other origin) in a snow crab (*Chionoecetes opilio*) and Atlantic shrimp (*Pandalus borealis*) processing plant in Greenland were assessed with skin prick tests (SPTs) with common aeroallergens and specific allergens from snow crab and shrimp extracts, spirometry, blood sampling for total IgE and specific IgE determination. Eighteen workers contributed a questionnaire-based medical interview.

Results. Positive skin prick test reactions were common to snow crab (40%) and shrimp (20%). Specific IgE to snow crab were positive in 4 workers (21%). Two workers had elevated total IgE levels. Symptoms suggestive of asthma were common (45%). Work-related symptoms of skin rash, rhinitis, and/or conjunctivitis were reported by 50%, and symptoms from the lower airways by 39%. Combining history of work-related symptoms with results from specific SPTs and/or specific IgE determination suggested that 11 and 22% of workers suffered from probable and possible occupational asthma, respectively, whereas 22% had possible occupational dermatitis or rhinitis.

Conclusions. Greenlandic Inuit do not appear to be protected against sensitization to snow crab or shrimp when occupationally exposed to these. This pilot study suggests that occupational allergy and asthma may be as common a problem in Greenlandic workers as in Canadian.

Keywords: *occupational allergy; occupational asthma; organic dusts; sensitizers; crustacea; Anisakis*

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The harvesting and processing of seafood is an important industry in Greenland (GL) employing at least 5% of the Greenlandic workforce of approximately 27,500 persons according to Statistics Denmark (1). In 2007 the total catch of seafood in GL was 202 kT, of which shrimp constituted 60 kT and snow crab 2.2 kT (2). Snow crab (*Chionoecetes opilio*) has been caught commercially in GL since the mid-1990s (3). Earlier, most of the catch was processed on large industrial vessels spending weeks at sea with a mostly non-Greenlandic workforce. Only a minor part of the catch was processed locally in GL. Because of a declining population of snow crab and stronger enforcement of regulation of catch since 2004, the snow crab is now

processed only in a few land-based facilities and only by the local Greenlandic workforce.

Although a high number of workers in GL have been processing different species of seafood in past decades, no claims of occupational seafood allergy or asthma have been reported (personal communication from the GL Ministry of Industry and Mineral Resources). Considering that shrimp and particularly snow crab processing is an important cause of both occupational asthma (OA) and allergy (OAI) defined as skin rash or rhinoconjunctivitis, affecting up to 16% of snow crab workers in Eastern Canada (4,5), the lack of reported occupational allergic reactions in GL is surprising. OA and OAI to snow crab have been shown to be IgE-mediated (6);

positive skin prick tests (SPTs) and specific IgE to snow crab cooking water, raw and cooked meat frequently, but not always, being seen in symptomatic workers. The lack of reports of OA in Greenlandic snow crab workers could suggest that Greenlanders, of which most are of Inuit origin, are protected against sensitization and allergic disease. This would be consistent with a lower prevalence of atopy observed in Greenlandic children (7).

We hypothesized that the lack of reports of OAI or OA in the snow crab industry in GL reflected either a low prevalence of sensitization to snow crab, or a lack of awareness among employees, employers, and health professionals that seafood processing may cause allergy or asthma. We therefore conducted a pilot study in a snow crab processing facility in GL to obtain preliminary data on the rates of work-related allergy and asthma in GL snow crab processing workers. Our objective was to conduct the first study of this kind among Greenlandic seafood workers and to elucidate if protection against allergic sensitization was a likely explanation for lacking reports of occupational allergies in Greenland.

Materials and methods

Through the Directory of Fisheries under the GL government and GL Institute of Natural Resources, 4 facilities which processed snow crab in the 2006 season were identified. The largest of these facilities with 20 part-time and full-time employees was contacted, and they agreed to participate. All current seasonal and full-time workers with regular contact with snow crab irrespective of their job position, as well as a few former workers, were invited to participate. The investigation took place in September 2007 towards the end of the harvesting season. The study was approved by the Ethics Committee for Health Research in GL and by the Ethics Committee of Hôpital du Sacré-Coeur de Montréal. All participants gave informed consent before the study.

Questionnaire

A questionnaire on the past and present job history and medical history was delivered in Danish or Greenlandic depending on the workers' preference. It was based on a questionnaire derived from questionnaires for asthma previously used in an earlier study (8). It was translated into Greenlandic by a professional translator. The workers filled in the questionnaires themselves with a local translator present who, after an instruction by the investigators and with access to the investigators present on site, helped in case of difficulties with understanding or responding. Information was obtained on symptoms of upper and lower respiratory symptoms in general and on exposure to non-allergenic (i.e. on exercise, on strenuous work, on exposure to cold air, with flu or cold, on exposure to strong odours) or allergenic triggers (cat, dogs, house dust); personal & family history of asthma;

family history of atopy; smoking habits; and work-related symptoms of skin rash, rhinitis, and conjunctivitis (suggestive of allergy), and of wheezing, cough, and/or shortness of breath (suggestive of asthma) that improved at the end of the snow crab season.

Skin prick tests and IgE assays

Extracts at a final concentration of 10 mg/ml (in 50% glycerol) for SPTs and specific IgE antibody determination were prepared from snow crab cooked meat, and snow crab cooking water obtained from a Newfoundland & Labrador plant according to the methods described previously (9), and from snow crab raw meat blended in PBS and similarly processed. SPTs were performed on the ventral aspect of the forearm with snow crab extracts, Atlantic shrimp (*Pandalus borealis*) and cod (*Gadus morhua*) extracts (Soluprick, ALK-Abelló, Hørsholm, Denmark) and with the most common arctic aeroallergens grass (*Phleum pratense*), mugwort (*Artemisia vulgaris*), birch (*Betula verrucosa*), dog (*Canis domesticus*), cat (*Felis domesticus*), and the dustmites *D. farinae* and *D. pteronyssimus* (7). Reactions were read after 15 min and considered positive if the largest wheal diameter was ≥ 3 mm with a positive reaction to histamine phosphate (1 mg/ml) and negative to saline. Atopy was defined as a positive reaction to at least one common aeroallergen.

Venous blood, collected in EDTA coated tubes, was kept on ice until centrifugation, after which the sera were refrigerated and stored at -20°C until arrival in Montreal (Canada) where they were frozen at -80°C until analysis. A quantitative enzyme-linked immunosorbent assay-based test kit for the detection of human total IgE in subjects' sera was used according to the manufacturer's instructions (ICL, Inc., Newberg, OR, USA). Sera were diluted in 1:2 or 1:10, and 2 samples in 1:100. Because hyperlipidemic serum may interfere with antibody binding in immunoassay procedures, sera with evidence of hyperlipidemia were filtered through a 0.22 μm cellulose acetate membrane. The range of the standard curve is 3.9–250 ng/ml total IgE. This kit used the IgE World Health Organization (WHO) IgE 75/502 calibrator; therefore, IgE expressed in ng/ml was converted to kU/L (1 IU/ml = 2.4 ng/ml).

Sera were also assayed for IgE-specific antibodies to snow crab by the Radioallergosorbent test (RAST). Cyanogen bromide-activated paper discs were coupled with aqueous corn extract (preparation described in subsequent section) at 100 $\mu\text{g}/\text{disc}$. One hundred microlitres of serum was added to duplicate discs, incubated overnight on a rotator at 24°C , and washed 3 times with 0.9% saline. One hundred microlitres of ^{125}I -labelled equine anti-human IgE diluted to contain 15,000 cpm (Sanofi Diagnostics Pasteur, Chaska, MN, USA) was added to each tube, discs incubated overnight, and washed as described. Bound ^{125}I -IgE was counted in a Beckman

5500 gamma counter and binding expressed as the mean percent of total ^{125}I added (10). A positive serum was defined as a measurement $>2\%$ binding of ^{125}I labelled anti-IgE, corrected for nonspecific binding to HSA control disc. Anisakis spp (Type 1)-specific IgE antibodies in the sera were measured using a commercial Immuno-CAP Allergy and Asthma Assay (Phadia ApS, Allerød, Denmark).

Spirometry

Spirometry was performed according to American Thoracic Society Guidelines (11) with a MicroDL portable spirometer (Micro Medical, Rochester, UK) with software developed by Dr Martin Miller, Birmingham, UK. Flows were recorded at 10 ms intervals and integrated to get volume. On screen prompts indicated if the blow had a satisfactory start, based on back extrapolated volume and rise time to peak expiratory flow. This information together with comparison with volumes of previous blows was used to accept or reject a blow. FEV₁ values were calculated using the back extrapolation technique. The best FEV₁ and FVC were taken from the stored blows and could be from separate blows and the ratio FEV₁/FVC calculated from these values. Salbutamol was administered with a spacer device in the case of significant obstruction during testing. Predicted values for FEV₁, FVC and FEV₁/FVC were derived from the ECSC equations as provided by Roca and colleagues (12).

Definitions

A FEV₁/FVC ratio of 70% or less, with FEV₁ $>80\%$ of the predicted, and some sputum production, was considered suggestive of mild COPD in accordance with the GOLD criteria (13). If a worker reported at least 2 chest symptoms on exposure to 2 or more non-allergic or allergic triggers, it was considered suggestive of asthma. The likelihood of OA and OAI was based on the history of symptoms that were reported as work-related and results from snow crab-specific SPT and specific IgE determination. For both outcomes, 4 categories were defined according to an algorithm used earlier (5): *probable OA*: a history of at least one respiratory symptom suggestive of asthma at work improving at the end of the snow crab season or away from work, and sensitization to snow crab defined by positive SPT or specific IgE test to ≥ 1 snow crab extract, or a history of physician diagnosed asthma after starting work with snow crab and specific sensitization; *possible OA*: a history of at least one respiratory symptom at work improving away from work, but no objective evidence of sensitization; *negative*: negative history and no sensitization; *probably negative*: negative history but sensitized to snow crab; the last 2 categories were grouped for presentation of statistics. The likelihood of OAI was based on symptoms reporting at least one of the following symptoms: skin rash, rhinitis, and/or conjunctivitis at work improving away from work with or

without symptoms suggestive of work-related asthma, and on specific SPT or specific IgE test to ≥ 1 snow crab extract; the same categories as for OA were defined: probable, possible, negative, and probably negative.

Walk-through survey and description of processes and machinery used

A walk-through survey of the snow crab processing facility was performed by JHB, DG, TS and AC together with the management of the plant. Snow crabs were delivered in ice-filled boxes directly on the wharf of the factory from 3 local fishing vessels which only harvested snow crab at a distance of approximately 1 day's travel, assuring delivery of live crab. All snow crabs were processed within the day of arrival. Butchering, brushing, and scraping of barnacles took place manually on the ground floor. Further processing took place after automatic transport to one large room on the first floor. Cooking of the snow crab was the first process in that room, and further processing (cleaning, weighing, sorting, packaging, and freezing) was done manually once the snow crab had been cooked. Good exhaust ventilation was in function over the partly enclosed cooking area. Otherwise, only general room ventilation was observed. Machinery was Canadian and processing did not appear to differ from common methods in Canada known to the investigators.

Statistical analysis

As this was a pilot study, only descriptive statistics are presented: means and standard deviations for continuous variables and frequencies and percentages for categorical variables. The statistics were performed using SPSS 17.0 for Windows (Statistical Package for Social Sciences, Chicago, IL, USA).

Results

Nineteen of the 20 eligible current workers on the facility participated. Two were employees from the administration who were regularly in contact with the snow crab. In addition 1 former worker participated. The demographics, job history, and baseline clinical data of the participants are shown in Table I. All workers answering the questionnaire were current or former workers.

Eighteen workers responded to the questionnaire. Seven reported any phlegm (39%) and 2 reported phlegm lasting more than 3 months a year (11%). Asthma diagnosed by a physician was reported by 3 employees (17%). In all cases the asthma had been diagnosed after start of work in the snow crab factory. Of the 20 workers, 4 (20%) had a positive reaction to 1 or more of the common inhaled allergens and were thus considered atopic.

The mean FEV₁/FVC ratio was 81.0% corresponding to 99.5% of the predicted (Table I). Two employees (44 and 47 years of age) had a low FEV₁/FVC ratio and symptoms suggestive of mild COPD.

Table 1. Demographics, atopy, clinical and functional characteristics and work history of snow crab workers in a Greenland processing plant

Characteristic	
Participants, n	20
Age (years), mean \pm SD (range)	35.9 \pm 11.4 (18–56)
Gender (M/F), n	6/14
Ethnic group (Inuit/other), n	19/1
Smoking (S/Ex-S/NS), n	15/3/0 ^c
Education (school/high school/technical), n	4/11/3 ^c
Atopy, n (%) ^a	4 (20)
Symptoms suggestive of asthma n (%) ^b	9 (50) ^c
Physician-diagnosed asthma, n (%)	3 (17) ^c
FEV ₁ , % predicted, mean \pm SD (range)	100% \pm 12.3 (78–122%)
FEV ₁ /FVC, mean \pm SD (range)	81.0% \pm 6.9 (68.4–91.1%)
Duration of work with crab (years), mean \pm SD	3.0 \pm 3.0 ^c
Duration of work in current plant (years), mean \pm SD	2.3 \pm 1.7 ^c
Exposure to shrimp, n (%)	14 (77.8) ^c

^aDefined by positive skin prick test to at least one common inhaled allergen; ^bTwo of the following: cough, wheeze, chest tightness or shortness of breath on exposure to 2 or more triggers; ^cData available for 18 participants.

The mean length of work in the processing plant was 2.3 years (\pm 1.7). One worker indicated change of job type 3 months prior to the survey moving to snow crab packing due to health problems related to snow crab processing, having difficulty to support the fog near the boilers in the production area where he had been working for almost 4 years. Fourteen workers reported that occasionally they were also processing shrimp.

Data on atopy, SPT responses to shrimp and snow crab extracts, specific IgE to snow crab and *Anisakis*, total IgE, work-related symptoms, physician diagnosis of asthma and likelihood of OA and OAI are given in Table II.

A total of 8 employees (40%) were SPT positive to snow crab. Four employees (20%) were positive to shrimp, and 2 (10%) to cod (not shown); all of these employees had positive snow crab SPT tests. Three of the 8 employees with a positive SPT to snow crab were atopic. Four employees (21%) had positive IgE to at least one snow crab extract, and these employees also had positive SPT reaction to snow crab. Total IgE varied between 7 and 2,503 kU/L with a mean value of 227 kU/L and a median value of 29 kU/L. Positive, specific IgE responses to *Anisakis* (\geq 0.35 kU/L) were found in 5 employees (26%). The 2 highest levels were seen in the employees with the highest total IgE levels. In one employee (no. 14, Table II)

these elevated IgE levels were not associated with reported symptoms suggestive of OAI or OA. No clinical data was available for the other employee (no. 19, Table II). In the remaining 3 employees with positive specific IgE to *Anisakis*, OAI or OA was suspected. A total of 9 employees (50%) reported at least one symptom of allergy in their current job: 8 (44%) reported runny or stuffy nose at work, 4 (22%) reported ocular symptoms, and 4 (22%) skin rash; 6 workers (33%) reported at least 2 of the above symptoms among which 3 reported improvement when away from work. Seven workers (39%) reported at least one chest symptom at work that improved away from work in 5 of them. Probable OA was seen in 2 (11.1%) workers and possible OA in 4 (22%), while 4 (22%) workers had a likely diagnosis of possible OAI according to the algorithm described above.

One of the 3 employees with a physician's diagnosis of asthma was SPT positive to snow crab, but reported no work-related symptoms. The other 2 were SPT negative to snow crab but reported work-related upper and lower respiratory symptoms.

Discussion

In this pilot study, the rate of specific sensitization to snow crab was surprisingly high (40%) among the 20 employees. The combination of a high rate of specific sensitization and of work-related airway symptoms more evocative of allergy and asthma than of chronic bronchitis suggests that occupational allergy and asthma does occur in Greenlandic snow crab workers and does not preclude that the prevalence may be in the same range as found in Canadian studies (4,5). The study included, however, too few workers to justify stronger conclusions on the prevalence of occupational allergy and asthma in the population of snow crab processors.

The observed rate of sensitization to shrimp (20%) among these workers was similar to previous findings (14). Work-related airway symptoms were common among the workers of this study. Although the prevalence of smoking was high (83%), only 11% of the workers reported typical symptoms suggestive of chronic bronchitis. Despite the consistent use of a skilled local interpreter, language issues may have caused bias in the reporting of 1 or more symptoms among the studied workers. Nevertheless, an important fraction of the airway symptoms could be due to work-related airway disease.

The means of FEV₁ and FVC calculated as percentage predicted were high despite the high prevalence of smoking and airway symptoms. This could be signalling a healthy worker's selection. However, young Greenland Inuit have been observed to have greater spirometry values for the same age and height than do ethnic Danes (15). Unfortunately no exact predictive equations specific to Inuit, allowing for correction, existed.

Table II. IgE antibody and skin prick test responses to crab allergens, work-related respiratory symptoms and likelihood of OA and OAI

Crab worker no.	Atopy	SPT ^a	RAST ^b	SPT	RAST	SPT	RAST	SPT	Anisakis IgE (kU/L)	Total IgE (kU/L)	Work-related symptoms ^d		Physician diagnosis of asthma	Likelihood of OA	Likelihood of OAI
		Shrimp (mm)	Raw crab ^c	Raw crab (mm)	Cooked crab	Cooked crab (mm)	Crab water ^c	Crab water (mm)			Lower airways	Nasal and/or ocular			
1	No	0	Neg.	0	Neg.	0	Neg.	0	0.11	84	No	Yes	No		Possible
2	Yes	0	Neg.	0	Neg.	0	Neg.	0	0.35	15	Yes	No	Yes	Possible	
3	No	0	Neg.	2	Neg.	4	Neg.	0	0.03	75	No	No	No		
4	No	0	Neg.	0	Neg.	0	Neg.	0	2.1	14	Yes	Yes	Yes	Possible	Possible
5	No	0	Neg.	0	Neg.	0	Neg.	0	0.00	93	No	No	No		
6	No	0	Neg.	0	Neg.	0	Neg.	0	0.00	8	No	Yes	No		Possible
7	No	0	Neg.	0	Neg.	0	Neg.	0	0.08	29	No	Yes	No		Possible
8	No	0	Neg.	0	Neg.	0	Neg.	0	0.01	26	Yes ^e	No	No	Possible	
9	No	0	Neg.	0	Neg.	0	Neg.	0	0.00	15	Yes	No	No	Possible	
10	No	3	Neg.	3	(1.6%)	0	Neg.	0	0.06	191	No	No	No		
11	Yes	0	2.4%	4	4.7%	3	4.4%	8	0.02	118	No	No	No		
12 ^f	Yes	3	–	0	–	3	–	3	–	–	No	No	No		
13	No	0	Neg.	0	Neg.	0	Neg.	0	0.09	7	No	No	No		
14	No	3	Neg.	4	(1.28%)	0	2.36%	0	> 100	2,503	No	No	No		
15	No	0	2.5%	3	2.1%	2	2.35%	3	0.48	20	Yes ^e	No	No	Probable	
16	No	2	7.8%	3	12.5%	8	Neg.	2	0.08	166	No	No	Yes	Probable	
17	No	0	Neg.	0	Neg.	0	Neg.	0	0.23	18	No	No	No		
18	No	0	Neg.	0	(0.62%)	0	(0.17%)	0	0.00	38	No	No	No		
19 ^g	Yes	3	Neg.	0	(0.47%)	2	(0.23%)	5	74.9	859	–	–	–		
20 ^g	No	0	Neg.	0	Neg.	0	Neg.	0	0.00	28	–	–	–		

^aSkin prick test, positive if wheal diameter \geq 3 mm; ^bRadioallergosorbent test (RAST) in crab workers' sera; ^cResult of RAST expressed as percentage binding of I¹²⁵ labelled anti-IgE, negative being < 2%; ^dAt least one symptom at work that goes away at the end of the working season; ^eSubject had work-related lower respiratory symptoms improving over weekends or holidays but did not know if they went away after working season; ^fSerum sample not available; ^gQuestionnaire data not available.

A possible or probable diagnosis of OA was seen in 33% (6/18) of employees, while a possible diagnosis of OAI (rhinitis, conjunctivitis, or dermatitis) was seen in 22% (4/18) of workers. Three of these employees had been diagnosed with asthma by a physician after the start of their current job. Due to lack of serial measurements of peak expiratory flows and of non-specific bronchial responsiveness or of specific inhalation challenges, the diagnosis of asthma (and OA) could not be confirmed. During discussions with the chief physician of the local hospital, with the director of the plant, and the employees themselves we received information that complaints about respiratory problems and suspicions of allergic reactions among workers at the factory were not uncommon. Anecdotal reports of workers leaving the factory due to respiratory complaints could not be formally investigated, and we did not obtain useful data on the turnover of workers.

The strength of the study was the high participation rate both among full term and seasonally employed workers. A professional translator with access to the investigators assured a high response rate and a standardized response to the questionnaire. Major weaknesses were the small population size and limited time not allowing for peak flow monitoring.

No clear association could be observed between the number of years worked with snow crab or with specific job tasks in the current job and the risk of symptoms from either nose, eyes, skin, or lower airways. However, longer histories of seafood exposure were reported by the workers with positive SPT to snow crab or shrimp (mean 4.0 years) compared with those without positive reactions (2.3 years).

Two workers (nos. 14 and 19) with specific IgE to snow crab had high total IgE levels. Even though these 2 workers had high specific IgE to *Anisakis*, it is unlikely that this reflects parasitic infestation alone. Indeed while *Anisakis* simplex is very common in seafood and whitefish in GL, a recent study suggested that the prevalence of *Anisakis* infestation among children in GL is low and not associated with high levels of IgE (16).

The other 3 workers with elevated IgE to *Anisakis* reported symptoms suggestive of OAI and/or OA: one of these (no. 15, Table II) was also sensitized to snow crab while the other 2 were not. Cross reactivity between crab and *Anisakis* has not, as far as we know, been documented. However, cross reactivity between shrimp and *Anisakis* has been documented (17) and could possibly explain the elevated specific IgE to *Anisakis* in subjects: nos. 14 and 19. Several studies have documented *Anisakis* allergens from seafood as a potential cause of allergy (18) and asthma (19). Therefore, in the 2 employees with specific IgE to *Anisakis* and work-related symptoms, but

no specific sensitization to snow crab nor shrimp (nos. 2 & 4), *Anisakis* may be the relevant work-related allergen. We also found a 20% rate of sensitization to shrimp in this population suggesting that employees may be at risk of developing OA or allergy during shrimp processing. However, since no information on the symptoms of these workers when they process shrimps was available, this should be addressed in a future study.

Previous experience from studies on snow crab workers in Canada has demonstrated the need to use both raw and cooked snow crab meat extracts in order to capture sensitization properly. The present study confirmed this as all 3 extracts identified at least one sensitized subject not identified by the 2 other and only one subject with a positive reaction to all 3. We used in-house extracts, as SPT extracts for snow crab are not commercially available. We cannot rule out that shrimp sensitivity would have differed by use of similar in-house extract SPT testing of shrimp. The finding that only 2 of the 9 workers suspected for OA/OAI demonstrated immune reactions to snow crab (with one additional worker reacting to *Anisakis*) might suggest insufficient sensitivity in the SPT tests. Alternatively, unidentified occupational agents such as detergents, allergens from snow crab or shrimp feed, or even whitefish proteins could have been of significance. Furthermore, as shown in other studies, symptoms are poorly specific and may not reflect an allergic reaction, but rather an irritant response to environmental conditions such as cold and humid air.

The lack of previous reports of OA in Greenland's snow crab workers had suggested that they were protected against sensitization and allergic disease. This is consistent with a lower prevalence of atopy, a known risk factor for sensitization to snow crab (4,5), observed in Greenlandic children (9). This is supported by studies showing that polymorphisms in the IL4RA gene, associated with lower risks of atopy, are common in Greenlandic Inuit (20). In a recent study, gene-environment interactions in the SCGB1A1 and ADRB2 genes among Inuit were observed, indicating that some variants of these genes were associated with decreased risk of rhinitis or asthma among Inuit living in GL, but with increased risk among Inuit living in Denmark (21). Whether these gene variants in Greenlanders play a role in determining responses to the occupational snow crab exposure that differ from other populations remains purely speculative. However, although the rate of atopy observed is indeed relatively low (20%) in the Greenlandic snow crab workers studied here, our data suggest that Inuit are not protected against sensitization to snow crab and are at risk of developing occupational allergy and asthma. The association between atopy and sensitization to snow crab was not assessed formally given the small number of subjects.

Underreporting is likely to contribute to the lack of reports of OAI and OA from the Greenlandic snow crab and shrimp processing industry. Possible reasons for underreporting include on one hand a lack of awareness of occupational allergy and asthma among workers, employers, and physicians, and on the other hand better access to alternative jobs in the Greenlandic community as opposed to the Canadian communities previously studied, resulting in symptomatic workers leaving the industry earlier and resulting in a possible healthy worker effect. As suggested by Jeebhay et al. (22) much of the world's seafood is processed in small coastal communities with less than average access to occupational surveillance, health care and alternative jobs. Increased awareness of the potential hazards from seafood processing in these communities is likely to be needed in order to get a truer picture of the incidence and prevalence of OA and OAI.

In conclusion this pilot study suggests that Greenlandic Inuit seafood processors have a high rate of sensitization to snow crab and shrimp, and do not appear to be protected against OA and allergy. We recommend that employees in the seafood industry in GL with airway symptoms should contact their physician in order to exclude OA or allergy. A survey in a larger population is needed to assess with confidence the prevalence of occupational allergic diseases in the seafood processing workforce in GL.

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