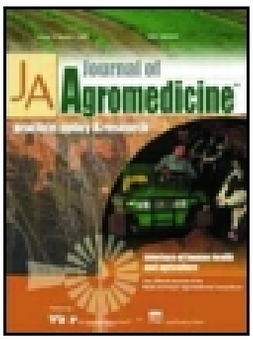

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Work-related Symptoms and Asthma among Fish Processing Workers

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ABSTRACT

After observing several clinical patients with respiratory symptoms, we initiated a questionnaire survey to assess prevalence of and predictors for asthma and work-related symptoms among workers in fish processing plants. A questionnaire with items on work conditions, work-related symptoms, and respiratory symptoms/diseases was sent to 916 fish processing workers, the 1836 licenced fishermen in Sweden, and 1965 controls; of those, 43%, 57%, and 53%, respectively, responded. Risks, hazard ratios (HRs), and prevalence ratios (PRs) were calculated with Cox regression, and 95% confidence intervals (CIs) were computed. The risk of asthma among fish filleting workers was increased during the years working in the fish processing industry when compared to the other fish processing workers and controls (HR 3.6, 95% CI 1.6–8.1, adjusted for atopy, gender, and ever smoking). The filleters had an increased PR for most of the work-related respiratory symptoms investigated. All fish processing workers had a higher PR for flu-like symptoms. Use of a pressure sprayer was identified as a risk for asthma and respiratory symptoms among both fish processing workers and controls. Filleters had changed work tasks because of respiratory symptoms more often (Fisher's exact test, $p = 0.02$) than other fish processing workers. In conclusion the fish filleters and pressure sprayer users reported more adult asthma and cough with phlegm compared to the other fish processing workers and controls. The use of pressure sprayers must be reduced and machinery should be completely encased to reduce workers' exposure to bioaerosols and its effects on the respiratory tract.

KEYWORDS

Bioaerosols; respiratory symptoms; fish filleting; pressure sprayer

Introduction

Among the Nordic countries, Sweden is one of the smaller fishing nations, in terms of numbers of employees working in fish processing plants and on fishing vessels. Many studies have described airway symptoms and asthma caused by allergens and irritants during handling and processing of seafood,[1–4] but only a few studies have performed exposure measurements at fish processing plants or on board of fishing vessels.[2,5–7]

In the seafood processing industry, the occupational exposure of workers is very complex due to various components of the aerosols produced in the different processes. The aerosols can contain microorganisms and particles from the fish, including particles from the intestinal flora as well as various proteins.[8] The exposure can vary from one plant to another. Fish processing used to be manual work but has now become more or less fully automated. The newer, faster machinery was often installed in the facilities without changing the ventilation system. This machinery needs large amounts of water, and the process often creates a moist environment and requires effective local exhaust ventilation to reduce the number of particles in the working environment. Clinically, we have seen more patients with airway symptoms such as asthma and bronchitis, but rarely with allergies from these plants during recent years. We already know that workers are highly exposed to parvalbumin during herring filleting. A previous study by our group reported that levels of herring parvalbumin were nearly at a magnitude higher in the filleting and controlling/inspection workstations than in the loading and packing areas.[6] In that study, the occupational exposure of workers to herring antigens and organic particles was characterized.[6] It was recommended that fish-processing workers reduce their use of the high-pressure sprayer and instead use a hose during cleaning to reduce exposure to fine bioaerosols. The aim of the current study was to survey work-related symptoms and asthma among

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fish processing workers in Sweden, especially filleters.

Methods

Questionnaires

We performed a questionnaire study of work-related symptoms and respiratory diseases in workers in the fish processing industry and among licensed fishermen in Sweden. Part of the questionnaire was a modified version of a questionnaire used in Norwegian exposure studies.[7,9] A control group of 2000 individuals of working age was sampled from the general population in Sweden, except those living in the three main cities: 1965 were found with addresses. Postal questionnaires were answered by 53%. Twelve fish processing plants, from very small to bigger (one) were included, and 916 workers with addresses were contacted, 43% of whom answered the questionnaire. Of all 1866 licensed fishermen in Sweden, we had an address for 1836, and 57% of these answered the questionnaire. There were 932 fishermen currently working as fishermen who answered the full questionnaire. We excluded office workers in the fishing industry and also among controls. We also excluded workers older than 65 years (mainly fishermen) and individuals who had not worked in the last year. Among controls, four had been working in the fishing industry, and they were also excluded. Consequently, 704 controls, 285 fish processing workers, and 805 fishermen were included in this study, with the main focus being on the fish processing workers. The questionnaire items concerned work tasks and work conditions, work-related symptoms, asthma, and other respiratory symptoms and diseases, atopy, allergy, and smoking habits. Based on items about working tasks, we divided the fish processing workers into filleters (who filleted every day or week, n = 106) and other fish processing workers (n = 179, some of whom prepared ready meals with fish). The filleting workers came from all plants, but made up more than half of the workers in four plants.

In the present study, "asthma" was defined as self-reported, physician-diagnosed asthma, and if the reported year of onset was after 15 years-of-age, as adult asthma. As we had year of asthma onset and year of starting work in the fish industry, we could assess new asthma during work there. "Adult wheeze" was defined as wheeze starting after 15 years-of-age. "Atopy" was defined as a positive response to the questions about allergy in childhood and/or hay fever. Regarding work-related symptoms, participants were asked the question "While at work, during the last 12 months, have you had …" with 13 symptoms itemized. There were three response alternatives for each item: "Yes, daily/weekly," "Yes, a few times," and "No." In this paper, only the response alternative "Yes, daily/weekly" was regarded as indicating presence of the work-related symptom. We also asked for work-related flu-like symptoms in the past year, not including a real flu or a common cold, with response alternatives "Yes" or "No," and if they answered "Yes," respondents were asked to state how often they experienced them (1–2, 3–5, >5 times last year).

Statistical analyses

Years of work with fish and age when answering the questionnaire are given as means with standard deviations (SDs). When differences in prevalence between groups were analyzed, we used chi-square test or Fisher's exact test. Prevalence of symptoms among the fishermen is given as a comparison to the fish processing workers and controls but is not further analyzed in this paper. Symptoms among fish filleters and other fish processing workers, respectively, were compared to symptoms among controls and to each other, adjusting for gender, atopy, ever smoking, and age >50 years and analyzed as prevalence ratios (PRs) using Cox regression with constant time at risk and robust variance and 95% confidence intervals (CIs).[10] Prevalence ratios of symptoms among frequent users of pressure sprayers (daily or every week) compared to infrequent users were similarly analyzed. In addition, both use of sprayers and filleting were analyzed in the same model. Hazard ratios (HRs), with 95% CIs, for asthma during the years of working in the fish processing industry and, for controls, during the adult years were calculated with ordinary Cox regression comparing fish filleting workers with all

others (both other fish processing workers and controls). The follow-up starts from 1980 or, if later, start of fish industry work and for controls after 16 years-of-age. Individuals with childhood asthma and asthma onset before 1980 or work start in fish industry were excluded, leaving 930 of 989 persons for analysis. Adjustment for gender, atopy, and ever smoking was performed. Statistical analyses were conducted using the statistical software package SAS version 9.4 (SAS Institute, Cary, NC, USA).

Results

Characteristics of the fishermen, fish filleting, and other fish processing workers, and controls are presented in Table 1. The kind of fish handled did not differ between different fish processing workers; almost all had handled herring, about 40% salmon, and 45% cod, or other whitefish (data not shown). About one-third had handled shellfish. Reporting daily or weekly use of a pressure sprayer was more frequent among the filleters (Table 1). Furthermore, 21% of filleting workers reported daily use of a pressure sprayer of 30 minutes or more, compared to 15% of other fish processing workers (Table 1). Wearing respiratory protective equipment was rarely done by any of them; however, hearing protection was used by half of them (data not shown). The filleters reported more adult asthma compared to the other fish processing workers, fishermen, and controls (Tables 2 and 3). The risk of asthma during the years of working in the fishing industry was increased in filleters compared to the other fish processing workers and controls (HR 3.6, 95% CI 1.6–8.1) (Table 4). The eight cases among filleting workers were from five different plants.

Among the work-related symptoms (daily/weekly), cough with phlegm was frequent among filleters (13%), but not among the other groups (Table 2). Work-related symptoms more common among both filleters and other fish processing workers than among controls were runny nose, headache, and "head feels heavy" (Table 3). Symptoms from the lower airways were more frequent among the filleting workers. Flu-like symptoms related to work in the last year were reported by 33% of filleters and 16% of other fish processing workers, both were more common than among controls, and filleters reported this more frequently than other fish processing workers. Filleting workers reported that they had changed work tasks because of respiratory symptoms more often (Fisher's exact test, p = 0.02) than other fish processing workers (Table 2).

As the use of a pressure sprayer was more common among fish filleting workers, this could be a factor responsible for the increased risk of symptoms. We, therefore, analyzed risk of symptoms for frequent use of a pressure sprayer and also for both pressure sprayer use and filleting in the same model (Table 5). Both showed a similar pattern, and the risk from filleting for most symptoms still remained.

Table 1. Characteristics of Swedish fishermen, fish processing workers, and controls. Use of a pressure sprayer is also indicated.

	Fishermen	Filleting workers	Other fish processing workers	Controls
Included, *n*	805	106	179	704
Years in the fishing industry, mean (SD)	26.0 (12.3)	16.3 (11.7)	14.7 (11.5)	n.a.
Gender, % male	99%	36%	56%	45%
Mean age, yrs (SD)	49 (11)	43 (11)	43 (13)	45 (13)
Age 16–35 years	13%	25%	34%	26%
Age 36–50 years	38%	49%	31%	33%
Age >50 years	49%	25%	35%	41%
Ever smoking	48%	54%	46%	42%
Current smoking	14%	21%	13%	12%
Atopy	23%	26%	26%	36%
Use of a pressure sprayer				
Yes	54%	65%	45%	17%
Daily or weekly	28%	50%*	35%	9.4%
Daily	5%	25%	22%	0%
Reported time using a pressure sprayer, mean per day				
No time	89%	73%	78%	91%
1–29 min	4.7%	6.6%	7.8%	6.0%
>30 min	6.7%	21%	15%	3.3%

*$p = 0.01$ compared to other fish processing workers and $p < 0.0001$ to fishermen and controls.
n.a. = not applicable; SD = standard deviation.

Discussion

In the present questionnaire study, we found that fish filleters exhibited a high prevalence of asthma compared to other fish processing workers, fishermen, and controls. The risk of developing asthma during employment with filleting work was higher. Work-related symptoms experienced daily or weekly, especially from the lower airways, were

Table 2. Prevalences of asthma and wheeze, work-related (w-r) symptoms during the last year and other items among fishermen, fish processing workers, and controls.

	Fishermen	Filleting workers	Other fish processing workers	Controls
Number	805	106	179	704
Prevalence of asthma and wheeze				
Physician-diagnosed asthma	5.6%	19%	4.5%	8.7%
Physician-diagnosed adult asthma	1.9%	10%	1.1%	5.0%
Adult wheeze	13%	24%	13%	17%
Thirteen work-related symptoms during the last year, experienced daily/weekly				
1. Cough without phlegm	3.4%	7.6%	4.5%	3.4%
2. Cough with phlegm	4.5%	13%	2.2%	3.3%
3. Wheeze in the chest	2.5%	5.7%	3.4%	1.6%
4. Dyspnea with wheezing	1.7%	4.7%	1.1%	1.1%
5. Dyspnea	0.8%	0.9%	0%	0.1%
6. Chest tightness	1.2%	3.8%	0.6%	1.1%
7. Nasal congestion	7.2%	8.5%	10%	6.7%
8. Runny nose	5.5%	12%	10%	4.8%
9. Irritated throat	3.0%	8.5%	2.2%	2.8%
10. Irritated eyes	4.1%	6.6%	2.8%	3.7%
11. Itching, flushing skin >2 days	1.9%	1.9%	1.7%	2.0%
12. Headache	5.3%	13%	8.9%	5.7%
13. Head feels heavy	5.8%	13%	7.3%	4.0%
Any of these frequent symptoms	23%	39%	32%	20%
Lower airway symptoms (3–6)	3.7%	10%	3.9%	2.7%
Lower symptoms including cough (1–6)	8.0%	20%	7.8%	7.1%
Upper airway symptoms (7–8)	10%	17%	18%	10%
Other items				
Work-related flu-like symptoms	12%	33%	16%	10%
>5 w-r flu-like episodes last year	3.2%	20%	8.9%	1.3%
Change of work task due to respiratory symptoms	1.4%	7.6%	1.7%	n.a.
Not in fairly good health	28%	34%	30%	24%

n.a. = not applicable

more common in the fish filleting group and among pressure sprayer users.

In this study, the prevalence of asthma in fish filleting workers was 19%, compared to 4.5% in other fish processing workers, 1.9% among fishermen, and 8.7% among controls. Similar results have been published from Norway, where the prevalence of asthma in salmon workers (including filleting) was 7.2% and in controls 9.3%.[11] Another study reported a prevalence of asthma of 3.9% among trawler fishermen.[12] Most studies have reported prevalence, but few have reported new cases during employment.[1–3] Those reported have mainly been allergic cases. A limitation of this study is that it was not known whether they were allergic or not. As only those at work last year were studied, doing the calculations back in time, could imply that cases that stopped their work due to asthma were missed – a healthy worker effect.

Another limitation could be the response rate, and that those with problems were more prone to answer, which could be part of the relatively high prevalence of atopy in controls. But that could not explain the difference between fish filleters and other fish processing workers. The higher prevalence of atopy in controls versus fish processing workers could also be a healthy worker effect. The same pattern of atopy was observed in the study of salmon workers in Norway.[11]

In the questionnaire, 21% of filleters reported daily use of a pressure sprayer for 30 minutes or more. A similar problem with aerosols from a high-pressure sprayer has been reported in metal working plants, where workers use compressed air.[13] Lillienberg et al. showed that the workers who reported frequent use of compressed air (>30 min/day), or used more open machines with synthetic metalworking fluid, had significantly more symptoms, such as wheeze, and more chronic bronchitis compared to the controls.[13]

In fish processing, a great deal of water is used in different processes (degutting, beheading, and cooking/boiling; as well as cleaning the processing

Table 3. Prevalence ratios (PRs) for asthma and wheeze, work-related (w-r) symptoms during the last year, and other w-r items among fish processing workers.

	Control cases n	Cases A n	PR (A/C) (95% CI)	Cases B n	PR (B/C) (95% CI)	PR (A/B) (95% CI)
		Filleting workers compared to controls		Other fish processing workers compared to controls		Filleting workers compared to other fish processing workers
Prevalence of asthma and wheeze						
Physician-diagnosed asthma	61	20	2.5 (1.6–4.0)	8	0.7 (0.3–1.3)	3.5 (1.7–7.5)
Physician-diagnosed adult asthma	35	11	2.5 (1.3–4.9)	2	0.3 (0.1–1.2)	6.9 (1.3–36)
Adult wheeze	121	25	1.4 (0.9–2.0)	24	0.8 (0.6–1.2)	1.6 (0.95–2.7)
Thirteen work-related symptoms during the last year, experienced daily/weekly						
1. Cough without phlegm	24	8	2.4 (1.1–5.6)	8	1.3 (0.6–3.0)	2.1 (0.8–5.7)
2. Cough with phlegm	23	14	4.1 (2.0–8.1)	4	0.6 (0.2–1.8)	7.0 (2.5–20)
3. Wheeze in the chest	11	6	3.5 (1.2–10)	6	2.0 (0.7–5.2)	1.9 (0.6–5.7)
4. Dyspnea with wheezing	8	5	3.9 (1.1–14)	2	0.8 (0.2–4.1)	5.3 (1.1–26)
5. Dyspnea	1	1	n.a.	0	n.a.	n.a.
6. Chest tightness	8	4	3.6 (1.2–11)	1	0.6 (0.1–4.7)	6.6 (0.8–53)
7. Nasal congestion	47	9	1.3 (0.6–2.5)	18	1.5 (0.9–2.5)	0.8 (0.4–1.7)
8. Runny nose	24	13	2.5 (1.3–4.6)	18	2.3 (1.3–3.9)	1.3 (0.7–2.4)
9. Irritated throat	20	9	3.2 (1.4–7.2)	4	1.0 (0.3–2.8)	3.6 (1.0–12)
10. Irritated eyes	26	7	1.9 (0.8–4.3)	5	0.8 (0.3–2.1)	3.0 (0.98–9.0)
11. Itching, flushing skin >2 days	14	2	1.2 (0.3–5.1)	3	0.9 (0.3–2.7)	0.9 (0.1–8.1)
12. Headache	40	14	1.9 (1.0–3.4)	16	1.7 (0.9–2.9)	1.3 (0.7–2.6)
13. Head feels heavy	28	13	2.6 (1.4–4.8)	13	2.0 (1.1–3.8)	1.3 (0.6–2.8)
Any of these frequent symptoms	139	41	1.9 (1.4–2.6)	57	1.7 (1.3–2.2)	1.2 (0.9–1.7)
Lower airway symptoms (3–6)	19	11	3.8 (1.8–8.3)	7	1.5 (0.6–3.4)	2.9 (1.2–7.0)
Lower symptoms including cough (1–6)	50	21	2.9 (1.8–4.8)	14	1.1 (0.6–2.0)	2.8 (1.5–5.3)
Upper airway symptoms (7–8)	69	18	1.7 (1.1–2.8)	33	1.9 (1.3–2.9)	0.9 (0.6–1.6)
Other items						
Work-related flu-like symptoms	73	35	3.2 (2.2–4.5)	29	1.6 (1.1–2.4)	1.8 (1.2–2.8)
>5 w-r flu-like episodes last year	9	21	12 (5.7–26)	16	7.7 (3.3–18)	1.8 (1.0–3.3)
Not in fairly good health	172	36	1.6 (1.1–2.4)	54	1.4 (1.0–1.9)	1.1 (0.7–1.7)

(A = mostly filleting – n = 106; and B = other fish processing – n = 179) compared to controls (C – n = 704 controls) and each other. Adjusted PRs[a] with 95% confidence intervals (CIs) are given.
[a]Adjustments were made for gender, atopy, ever smoking, age >50 years.

Table 4. Risk of asthma onset during years working in fish processing industry and adult years among controls. Full model with hazard ratios (HR) and 95% confidence intervals (CIs) are given.

(37 cases of adult asthma onset)	HR (95% CI)
Filleting work (yes/no)	3.6 (1.6–8.1)
Atopy (yes/no)	3.4 (1.8–6.7)
Ever smoking (yes/no)	1.5 (0.8–3.0)
Gender (female/male)	2.6 (1.2–5.6)

line), which will generate aerosols in the work environment. We have shown in a previous study that the way in which workers use water (e.g., using a high-pressure sprayer) at one of the included plants influences the size and lifetime of the particles.[6] Type of machinery was also shown to be important; newer machines had a better casing compared to older machines, which resulted in significantly lower concentrations of particles around the new machines. Our measurements in the fish processing and in metal working plants show the importance of (a) using machines preventing aerosol spread with good casings and (b) not using high-pressure sprayers .[13,14] We found that most particles in the aerosols were <0.5 μm.

The questionnaire answers showed that work-related flu-like symptoms during the last year were twice as common among fish filleting workers as among other fish processing workers, and three times as common compared to fishermen and controls, probably due to exposure to bioaerosols. When we conducted the exposure measurements at the herring plant, the workers reported feeling worse during the night shift when the day shift workers had cleaned the floor with a high-pressure sprayer, in addition to when the herring had eaten krill and their bellies had become swollen after capture.[6] The fishermen knew immediately whether the whole catch contained herring that had eaten krill and transported it to the plant as soon as possible, since this affected the quality of meat. We have no information about similar

Table 5. Prevalence ratios (PR) for asthma and wheeze, work-related (w-r) symptoms during the last year, and other w-r items among subjects (fish processing workers and controls) using a pressure sprayer daily or weekly (n = 182) compared to those not using a pressure sprayer. In next model use of sprayer as well as filleting (n = 106) are analysed in the same model. Adjusted PRs[a] with 95% confidence intervals (CIs) are given.

	Cases n	PR sprayer use (95% CI)	PR sprayer use and filleting in same model (95% CI)	
Prevalence of asthma and wheeze			PR sprayer	PR filleting
Physician-diagnosed asthma	89	1.8 (1.2–2.9)	1.5 (0.9–2.3)	2.4 (1.5–3.7)
Physician-diagnosed adult asthma	48	2.1 (1.1–4.1)	1.7 (0.9–3.3)	2.4 (1.2–4.6)
Adult wheeze	170	1.5 (1.1–2.1)	1.5 (1.1–2.0)	2.3 (1.7–3.0)
Thirteen work-related symptoms during the last year, experienced daily/weekly				
1. Cough without phlegm	40	1.4 (0.7–2.9)	1.1 (0.5–2.5)	2.2 (0.95–5.2)
2. Cough with phlegm	41	3.1 (1.6–6.2)	2.1 (1.2–4.1)	3.5 (1.8–6.4)
3. Wheeze in the chest	23	4.7 (2.0–11)	4.0 (1.7–9.9)	1.7 (0.6–4.6)
4. Dyspnea with wheezing	15	4.4 (1.4–14)	3.3 (1.1–10)	2.8 (0.9–9.0)
5. Dyspnea	2	n.a.	n.a.	n.a.
6. Chest tightness	13	3.3 (1.1–10)	2.3 (0.7–7.2)	2.6 (0.8–7.9)
7. Nasal congestion	74	1.3 (0.7–2.1)	1.2 (0.7–2.1)	1.1 (0.5–2.1)
8. Runny nose	65	2.2 (1.3–3.8)	1.9 (1.1–3.3)	1.7 (0.9–3.1)
9. Irritated throat	33	2.1 (0.9–4.8)	1.6 (0.7–3.5)	2.7 (1.2–6.1)
10. Irritated eyes	38	0.9 (0.4–2.1)	0.8 (0.3–1.9)	2.1 (0.9–4.8)
11. Itching, flushing skin >2 days	19	0.7 (0.2–2.6)	0.7 (0.2–2.2)	1.1 (0.3–4.2)
12. Headache	70	1.6 (0.9–2.7)	1.4 (0.8–2.5)	1.5 (0.8–2.8)
13. Head feels heavy	54	1.3 (0.7–2.6)	1.0 (0.5–2.0)	2.2 (1.2–3.9)
Any of these frequent symptoms	237	1.6 (1.2–2.0)	1.4 (1.1–1.8)	1.5 (1.2–2.1)
Lower airway symptoms (3–6)	37	3.8 (2.0–7.3)	2.9 (1.5–5.8)	2.3 (1.1–5.0)
Lower symptoms including cough (1–6)	85	2.5 (1.6–4.0)	2.1 (1.3–3.2)	2.2 (1.4–3.6)
Upper airway symptoms (7–8)	120	1.6 (1.1–2.4)	1.5 (1.0–2.3)	1.3 (0.8–2.1)
Other items				
Work-related flu-like symptoms	137	2.5 (1.8–3.4)	2.0 (1.4–2.8)	2.2 (1.5–3.2)
>5 w-r flu-like episodes last year	46	3.8 (2.2–6.8)	2.2 (1.2–4.3)	4.6 (2.4–8.6)
Not in fairly good health	262	1.5 (1.1–2.0)	1.4 (0.99–1.9)	1.3 (0.9–2.0)

[a]Adjustments were made for gender, atopy, ever smoking, age >50 years.
n.a. = not applicable

biological processes that occur in other fish species after they are caught. The rinse water from a herring plant has been shown to be a powerful inducer of cytokine release in an ex vivo assay compared to the positive controls lipopolysaccharide (LPS) and β-glucan.[15] This may be because the rinse water could contain endotoxins and other organic substances. A Norwegian study suggested that inhalation of biological particles such as salmon trypsin could trigger inflammatory response in the airways.[16] Other studies have shown that flu-like symptoms are common among cotton workers and farmers and workers in food processing industries, who are exposed to other biological active agents in bioaerosols.[17–21] Melbostad and Eduard[9] showed that farmers who were exposed to fungal spores in their work environment had more eye symptoms and cough compared to controls.

Work-related cough with phlegm and runny nose were shown to be more common among Russian trawler fishermen who work with fish filleting on board compared to controls.[12] We describe similar results in this study of Swedish fish filleters, who reported work-related cough with phlegm four times as often compared to the controls. All fish processing workers reported runny nose twice as often as the controls. In a Danish study among greenhouse workers, the exposure to fungi or β-glucan in the inhalation zones of men (but not women) was shown to significantly correlate to the fungal or β-glucan content in their nasal lavage samples, and this was higher on Thursday than on Monday morning.[22] Those workers with runny nose had fewer fungi in nasal lavage compared to workers without runny nose. The authors concluded that workers who suffer from runny nose tend more often to breathe through the mouth, thus causing a larger deposition in the lower airways, but fewer fungi in the nose.

Our results on all fish processing workers, together with these interesting results, suggest that more research on bioaerosol exposure and also the health impact of the upper airways in different work tasks is needed, since the levels of bioaerosols and the specific components they contain are important factors for risk assessment.

Conclusion

In conclusion, the fish filleting workers in the present study reported more adult asthma and cough with phlegm compared to other fish processing workers, fishermen, and controls. The use of a pressure sprayer is more frequent among filleters, which results in exposure to fine bioaerosols. Flu-like symptoms were two times more common in our population of filleters compared to the other fish processing workers, and about three times more common compared to the controls and fishermen. The exposure to fine bioaerosols must be reduced.

Disclosure statement

ADH and EA do not have any conflict of interest to report.

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