Upper airway symptoms among workers with work-related respiratory complaints

D. Miedinger[1,2], D. Gautrin[3] and R. Castano[3,4]

[1]Clinic of Internal Medicine, University Hospital, Basel, Switzerland, [2]Department of Occupational Medicine, Suva, Lucerne, Switzerland, [3]Axe de recherche en santé respiratoire, Hôpital du Sacré-Coeur de Montréal, Université de Montréal, Montreal, Canada, [4]Department of Surgery/Otolaryngology, Hôpital du Sacré-Coeur de Montréal, Montreal, Canada

Correspondence to: R. Castano, Department of Surgery/Otolaryngology, Axe de recherche en santé respiratoire, Hôpital du Sacré-Coeur de Montréal, 5400, boulevard, Gouin Ouest, Montréal (Québec) H4J 1C5, Canada. Tel: +1 514-338-2222, # 7271; fax: +1 514-338-3543; e-mail: roberto.castano@umontreal.ca

Background	Work-related rhinitis and asthma symptoms frequently co-exist.
Aims	To determine the prevalence and nature of nasal, pharyngeal, laryngeal and sinus symptoms among individuals with work-related respiratory symptoms.
Methods	Individuals referred to a tertiary occupational asthma clinic for investigations with specific inhalation challenges were evaluated using the RHINASTHMA quality of life questionnaire and a questionnaire that assessed the nature and frequency of upper airway symptoms, their relationship to the workplace and their temporal relationship with the onset of asthma symptoms.
Results	There were 83 study participants. At least one upper airway symptom was reported by all of these individuals: nasal in 92%; pharyngeal in 82%; laryngeal in 65% and sinus in 53% of participants. Overall, there were no significant differences in the frequencies of nasal, pharyngeal, laryngeal and sinus symptoms when comparing these with occupational asthma (OA), work-exacerbated asthma (WEA) and work-related respiratory symptoms (WRS), except that nasal bleeding was most frequent among those with WRS. The presence of laryngeal symptoms was significantly associated with rhinitis-specific quality of life impairment. Individuals with workplace exposures to high molecular weight agents had greater impaired quality of life than those who were exposed to low molecular weight agents (RHINASTMA Upper Airway sub-scores: 24.0 ± 10.4 versus 19.8 ± 6.8; $P < 0.05$).
Conclusions	Individuals who were referred for work-related respiratory symptoms experienced high rates of work-related nasal, pharyngeal, laryngeal and sinus symptoms, regardless of having OA, WEA or WRS.
Key words	Laryngitis; occupational asthma; pharyngitis; quality of life; rhinitis; sinusitis; workplace.

Introduction

The nose is the respiratory system's first defence mechanism against airborne contaminants, including occupational allergens and irritants. Thus rhinitis is frequently the first clinical manifestation of respiratory problems, which can often extend to the lower airways and manifest as asthma at a later stage. In the workplace workers are exposed to a variety of allergens and chemicals that can potentially cause different respiratory symptoms. Workplace exposures to high molecular weight (HMW) agents and low molecular weight (LMW) agents are associated with a wide spectrum of conditions that can range from mucous membrane irritation and aggravation of pre-existing rhinitis and asthma to clinically established occupational rhinitis (OR) and occupational asthma (OA) [1].

There is an extensive literature on the links between the upper and lower airways, although most available evidence describes the co-expression of rhinitis and asthma symptoms in the general population [2]. However there is sufficient evidence to show that these relationships also apply to rhinitis and asthma symptoms that are of occupational origin [3,4]. However, surprisingly little

has been published on the frequencies of pharyngeal, laryngeal and sinus symptoms among workers that manifest as work-related respiratory symptoms.

In this study, we characterized the nature and frequency of upper airway symptoms (nasal, pharyngeal, laryngeal and sinus) and the severity of rhinitis symptoms both 'at work' and 'away from work' among subjects with complaints of work-related respiratory symptoms. These individuals had been evaluated using specific inhalation challenges (SIC) and were also diagnosed with either OA, work-exacerbated asthma (WEA) or work-related respiratory symptoms (WRS). We also examined the impact of rhinitis and asthma symptoms on quality of life (QOL) using a disease-specific questionnaire and determined if the frequency and nature of symptoms differed according to the type of occupational agents to which these workers were exposed.

Methods

We recruited subjects who had been referred to a tertiary clinic specializing in occupational respiratory diseases for the evaluation of WRS. Each subject completed a disease-specific QOL questionnaire and a questionnaire on upper airways symptoms. An initial investigation included a detailed medical and occupational history and skin prick testing to common aeroallergens to assess atopy. Atopy was defined as at least one positive reaction to a common aeroallergen.

Each subject then underwent an SIC using both a control agent and the suspected occupational agent. A diagnosis of OA was established based on a positive SIC result. A diagnosis of WEA was based on a negative SIC result and a positive methacholine test result defined as PC20 ≤ 16 mg/ml [4]. Subjects who did not meet these diagnostic criteria were categorized as having WRS. For this study, we assumed that exposure to the suspected occupational agent was responsible for both lower and upper respiratory symptoms. This study was approved by the hospital medical ethics committee and all study participants gave their written informed consent.

Each subject completed a questionnaire regarding the nature and frequency of upper airway symptoms, symptoms' relationships to the workplace and symptoms' temporal relationships with the onset of asthma symptoms (either prior to, at the same time or after onset). This questionnaire was based on the standardized questionnaire of the International Union against Tuberculosis and Lung Disease and the 1988 National Health Interview Survey occupational health supplement [5,6]. In this questionnaire, symptoms were grouped as nasal, pharyngeal, laryngeal and sinus. Nasal symptoms included obstruction, rhinorrhoea, sneezing, itching, nasal bleeding, nasal crusting and impaired olfaction. Pharyngeal symptoms included sore throat, throat dryness, throat clearing and throat burning. Laryngeal symptoms included dry cough and hoarseness. Sinus symptoms included mucopurulent nasal discharge, facial pain/pressure and post-nasal drip.

Subjects also completed the RHINASTHMA questionnaire [7]. This consisted of 30 items regarding the impact of rhinitis and asthma while subjects were working, recorded on a five point Likert scale (not at all, a little, fairly often, often, very often). Questionnaire response analysis provided sub-scores related to the Upper Airways (UAS), Lower Airways (LAS), Respiratory Allergy Impact (RAI) and a Global Score (Global Summary). Answers to the RHINASTHMA items were then converted to scores ranging from 0 (minimal impact) to 100 (maximum impact). Both questionnaires were administered on the first day of the scheduled investigation prior to the clinical investigation and SIC.

A visual analogue scale (VAS) ranging from 0 (not at all bothersome) to 10 (extremely bothersome) was used to assess the severity of combined rhinitis symptoms both 'at work' and 'away from work' [8].

SICs were performed according to a previously described methodology following international recommendations [9]. On the first day, a subject was exposed to a control substance to ensure that asthma, if present, was stable. On subsequent days, a subject was progressively exposed to increasing doses of the occupational agent suspected of causing the respiratory symptoms. After the control and active challenge were administered, FEV_1 was monitored at regular intervals for 6 h. A methacholine test was performed at the end of the control and last active challenge day. A SIC was considered positive if there was a decline in FEV_1 of ≥ 20% [9].

Results for categorical variables are given as absolute numbers and relative frequencies (percentages). Results for continuous variables are given as means ± SDs or as medians and 25th and 75th percentiles for non-normally distributed variables. Categorical frequencies were compared using a Chi-squared or Fisher's exact test. Continuous variables were compared using Student's *t*-test or Mann-Whitney *U* test. Spearman's rho was used for correlation analysis. We created binary categorical variables for each of the groups of upper airways symptoms (*Nasal_Symptoms*, *Pharyngeal_Symptoms*, *Laryngeal_Symptoms* and *Sinus_Symptoms*). For example, a subject was categorized as having nasal symptoms if he reported having one or more of the several symptoms in the nasal symptoms group. Individual scores from the Rhinasthma UAS were log-transformed to generate a near-normal distribution. We then did a linear regression analysis using the UAS sub-scores as the dependent variables and the variables of *Nasal_Symptoms*, *Pharyngeal_Symptoms*, *Laryngeal_Symptoms* and *Sinus_Symptoms* as predictors. Data analyses used SPSS V.19 (SPSS, Inc., Chicago, IL, USA).

Results

There were 83 study participants. The study subjects' baseline characteristics are shown in Table 1. After SICs, 29 (35%) were diagnosed with OA, 21 (25%) were diagnosed with WEA and 33 (40%) were diagnosed with WRS. These three groups were comparable with respect to age and gender (data not shown).

At least one symptom was frequently reported by all of the study subjects: nasal 92% (76/83); pharyngeal 82%; laryngeal 65% and sinus 53%. Most of the study subjects reported that upper airways symptoms occurred 'almost every day' or 'one day or more per week.' Also all categories of upper airways symptoms were reported as occurring more often in the workplace than when away from work (Figure 1).

In general, there were high frequencies of upper airway symptoms among all of the SIC diagnosis groups (Table 2). Nasal symptoms and pharyngeal symptoms were reported by the majority of individuals who were referred for investigating work-related respiratory symptoms. However, there were no significant differences in the frequencies of nasal, pharyngeal, laryngeal and sinus symptoms after comparing the subjects with OA, WEA and WRS, except that 'nasal bleeding' was significantly more frequent among subjects with a final diagnosis of WRS.

Nasal symptoms more frequently preceded those of asthma among subjects with OA (56%) as compared with subjects with WEA (40%). In contrast, pharyngeal symptoms more frequently preceded those of asthma among subjects with WEA (38%) compared with subjects with OA (29%). The same patterns were observed regarding laryngeal (OA: 40% versus WEA: 50%) and sinus (OA: 46% versus WEA: 56%) symptoms. However, these differences between the groups were not statistically significant (Table 2).

From univariate analysis, the symptom categories of *Throat_Symptoms*, *Larynx_Symptoms* and *Sinus_Symptoms* were statistically significantly associated with Rhinasthma UAS. In our model 6, after incorporating all of the symptom categories and controlling for sex and age, only *Larynx_Symptoms* remained significantly associated with Rhinasthma UAS (Table 3).

Subjects who were exposed at work to HMW agents reported higher frequencies of nasal and sinus symptoms, while subjects who were exposed to LMW agents reported higher frequencies of pharyngeal and laryngeal symptoms; however these observed differences in individual symptom categories were not statistically significant (data not shown). In addition, as shown in Table 4, QOL assessed by the Rhinasthma questionnaire indicated that those exposed to HMW agents had greater impairments in QOL than those exposed to LMW agents (24.0 ± 10.4 versus 19.8 ± 6.8; $P < 0.05$).

Subjects had significantly higher VAS scores 'at work' as compared with VAS scores 'away from work' (4.7 ± 3.0 versus 2.4 ± 2.7; $P < 0.001$). Rhinitis symptoms 'at work' were considered as moderate/severe by 59% and mild by 41% of these subjects. In contrast, only 23% of these subjects considered rhinitis symptoms 'away from work' as moderate/severe and 77% regarded these symptoms as mild. A comparison of rhinitis severity levels 'at work' and 'away from work' based on the final diagnosis after SIC showed the same pattern, with significantly higher VAS scores 'at work' as compared with 'away from work' in all groups: for OA, at work median = 5.0 (25th percentile, 75th percentile: 2.6, 7.2) versus away from work: 2.7 (0.5, 5.0); $P = 0.001$; for WEA, 4.0 (0.6, 6.0) versus 0.8 (0.2, 4.0); $P < 0.05$ and for WRS, 5.7 (2.9, 8.2) versus 0.9 (0.3, 3.2); $P < 0.001$. However, no statistically significant differences were found between the SIC diagnosis groups.

Subjects who rated their rhinitis 'at work' as moderate or severe reported significantly more rhinorrhea than subjects who rated rhinitis symptoms as mild (Table 5). However the differences in symptoms prevalence (sneezing and stuffy nose) as well as the difference in mean RAI sub-score and Global Summary score

Table 1. Baseline characteristics of the study participants ($n = 83$)

Characteristics	*n* (%)
Male: female	59 (71) : 24 (29)
Age, years	41.8 ± 10.8
Atopy	61 (74)
Smoking status, current : ex : never	20 (24) : 20 (24) : 43 (52)
Duration of exposure in years	8.0 (3.0; 21.0)
Oral antihistamines	9 (11)
Nose medication	10 (12)
Asthma medication	39 (47)
FEV1% predicted	95.8 (86.2; 106.4)
Nature of agents	
HMW : LMW	27 (33) : 56 (67)
HMW agents	
Flour	14
Animal proteins	5
Various cereals	3
Enzymes	2
Other various agents	3
LMW agents	
Isocyanates	13
Resins, glues, paints	7
Formaldehyde	6
Woods	6
Welding fumes	4
Acrylates	5
Cleaning agents	2
Other various agents	13

Results are *n* (%), mean ± SD or median (25th percentile, 75th percentile).

FEV_1, forced expiratory volume in one second; HMW, high molecular weight; LMW, low molecular weight. Other various HMW agents: e.g. seafood, drugs, enzymes, bio-aerosols. Other various LMW agents: e.g. persulfates, colophony, metals.

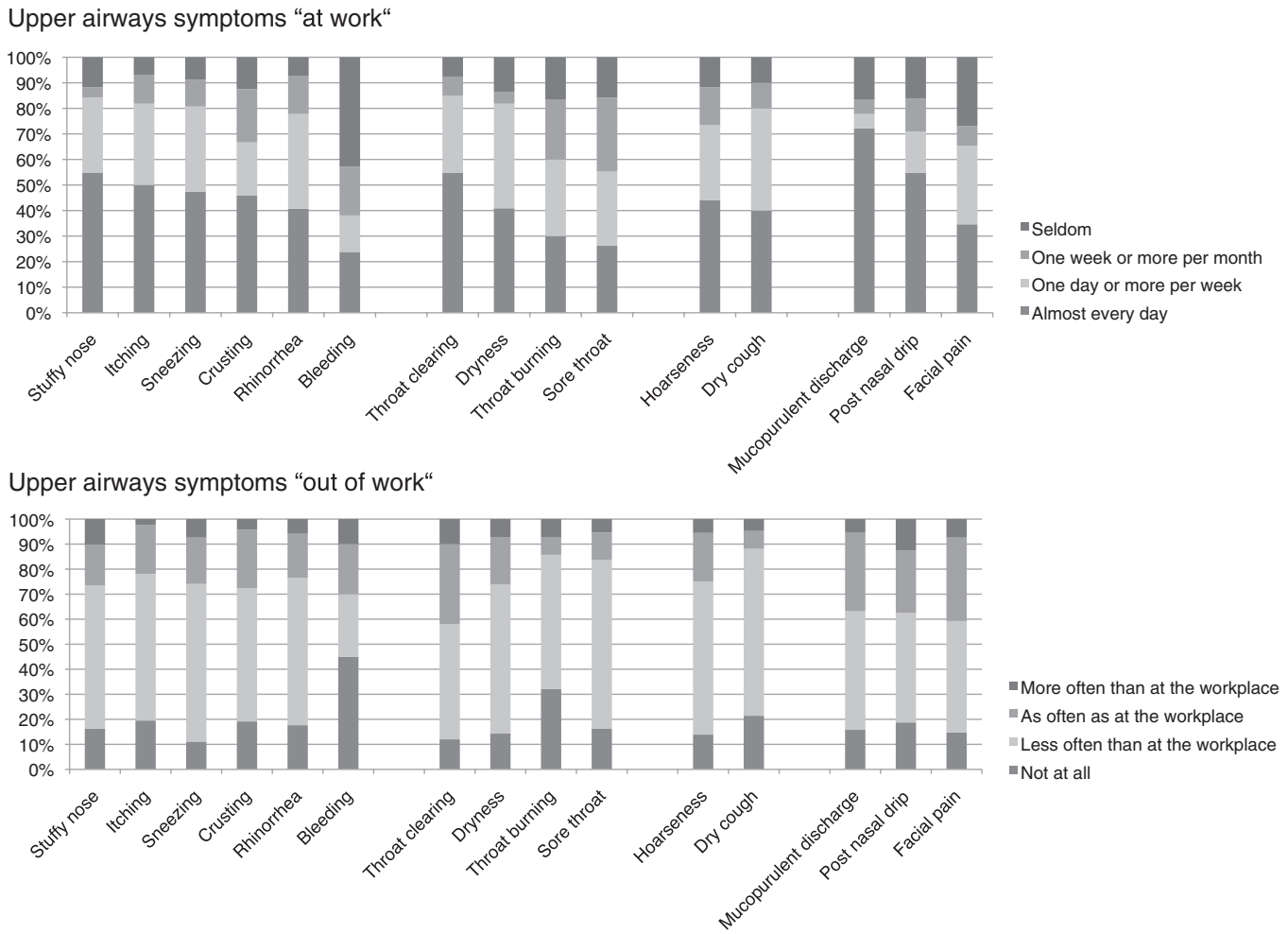

Figure 1. Upper airways symptoms and their frequency distributions based on occurrence when 'at work' (upper panel) and when 'away from work' (lower panel). Upper panel: answer to the question: What is (was), on average, the frequency of your symptoms (if the symptoms have actually stopped, answer for the period when you had symptoms)? Lower panel: answer to the question: While away from work, how often do your symptoms occur?

were not significant. Subjects who rated their rhinitis as moderate or severe when they were 'away from work' had greater QOL impairments for all RHINASTHMA scores, although these differences in UAS scores were not significant.

Discussion

Individuals with work-related respiratory symptoms who were investigated in an OA referral centre reported high frequencies of various upper respiratory symptoms that included not only nasal symptoms but also a wide range of sinus, laryngeal and pharyngeal symptoms. Pharyngeal symptoms were most strongly related to impairments in rhinitis-specific QOL.

To our knowledge, this is the first comprehensive examination of upper airways symptoms in a study population with a history suggestive of work-related asthma. All of these individuals underwent specific inhalation testing, which is considered the reference standard for investigating OA, WEA and WRS. We made extensive evaluations of upper respiratory symptoms and also determined their impact on rhinitis and asthma-specific QOL for each individual in this study.

This study had several limitations. First, the sample size was small and the data collected were restricted to one specialized health centre only. Second, symptoms were self-reported and thus only represented subjective evidence of upper airways conditions that might have been over- or under-reported. Third, we did not do environmental exposure assessments with which to link the upper airways symptoms reported by the study subjects. Considering the high prevalence of upper airways symptoms observed in this study, we cannot be certain of the extent of over-reporting in this study.

However, it is important to note that these subjects had been referred to our hospital for OA investigations. Thus they were selected based on their lower

Table 2. Prevalence of upper airways symptoms and quality of life scores in the three SIC diagnosis groups

Characteristics	OA (n = 29)	WEA (n = 21)	WRS (n = 33)
Nasal symptoms n (%)			
Rhinorrhoea	24 (83)	14 (67)	25 (76)
Itching	19 (66)	13 (62)	18 (55)
Sneezing	25 (86)	16 (76)	26 (79)
Obstruction	22 (76)	15 (71)	23 (70)
Nasal bleeding	6 (21)	3 (15)	14 (42)*
Nasal crusting	17 (59)	15 (71)	23 (70)
Hyposmia	12 (41)	10 (50)	17 (52)
≥2 common nasal symptoms	25 (86)	16 (76)	26 (79)
≥3 common nasal symptoms	21 (72)	15 (71)	22 (67)
4 common nasal symptoms	17 (59)	10 (48)	16 (49)
≥2 less common nasal symptoms	11 (38)	10 (48)	20 (61)
Timing of nasal symptoms in relation to onset of asthma-like symptoms			
- Before	15 (56)	6 (40)	9 (36)
- At the same time	9 (33)	7 (47)	10 (40)
- After	3 (11)	2 (13)	6 (24)
Pharyngeal symptoms n (%)			
Sore throat	14 (48)	12 (60)	21 (66)
Dry throat	17 (59)	12 (60)	21 (66)
Throat clearing	19 (66)	15 (71)	24 (73)
Throat burning	10 (35)	7 (33)	15 (46)
Timing of pharyngeal symptoms in relation to onset of asthma-like symptoms			
- Before	6 (29)	6 (38)	10 (42)
- At the same time	9 (43)	7 (44)	10 (42)
- After	6 (29)	3 (19)	4 (17)
Laryngeal symptoms n (%)			
Dry cough	14 (48)	9 (43)	24 (73)
Hoarseness	14 (48)	9 (43)	24 (73)
Timing of laryngeal symptoms in relation to onset of asthma-like symptoms			
- Before	6 (40)	5 (50)	6 (28)
- At the same time	5 (33)	4 (40)	13 (62)
- After	4 (27)	1 (10)	2 (10)
Sinus symptoms n (%)			
Mucopurulent nasal discharge	8 (28)	6 (29)	8 (24)
Facial pain/pressure	11 (38)	5 (24)	15 (46)
Postnasal drip	13 (45)	9 (43)	16 (49)
Timing of sinusal symptoms in relation to onset of asthma-like symptoms			
- Before	6 (46)	5 (56)	9 (53)
- At the same time	5 (39)	3 (33)	7 (41)
- After	2 (15)	1 (11)	1 (6)
Rhinasthma quality of life scores (mean (SD))			
UAS	22.2 (9.5)	20.1 (6.9)	21.2 (8.1)
LAS	32.8 (12.5)	33.7 (11.5)	33.1 (12.0)
RAI	20.5 (8.3)	17.5 (6.7)	18.6 (6.7)
Global summary	75.5 (27.9)	71.2 (22.1)	72.9 (22.9)

OA, occupational asthma; WEA, work-exacerbated asthma; WRS, work-related respiratory symptoms; UAS, upper airways sub-score; LAS, lower airway sub-score; RAI, respiratory allergy impact. *$P < 0.05$ between groups comparison. Common nasal symptoms = rhinorrhoea, obstruction, itching, sneezing. Less common nasal symptoms = nasal bleeding, nasal crusting, hyposmia.

airways symptoms and not for upper airways complaints. In addition it is more likely that there would be under-reporting of symptoms in this type of study population, as asthma-like symptoms engender greater concerns, whereas upper-airways symptoms are often not perceived as significant health problems.

The respiratory tract extends from the nose to the lungs. Thus, exposures of the mucous membranes of the nose, sinuses, pharynx and larynx to allergens and irritants in the workplace should theoretically induce not only nasal symptoms but also pharyngeal, laryngeal and sinus symptoms. In the medical literature, these

Table 3. Associations between different upper respiratory symptom categories and UAS scores from the Rhinasthma questionnaire (n = 83)

	Log10(Rhinasthma UAS)					
Covariates	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Nasal_Symptoms	−0.32 (0.16)	.	.	.	−0.17 (0.17)	−0.17 (0.17)
Pharyngeal_Symptoms	.	−0.27 (0.13)*	.	.	−0.07 (0.14)	−0.10 (0.14)
Laryngeal_Symptoms	.	.	−0.39 (0.10)***	.	−0.29 (0.12)*	−0.27 (0.12)*
Sinus_Symptoms	.	.	.	−0.32 (0.10)**	−0.16 (0.12)	−0.13 (0.12)
Sex	.	.	.	.	.	−0.14 (0.11)
Age						0.01 (0.01)
Adjusted R^2	0.03	0.04	0.16	0.11	0.18	0.21

UAS: upper airway score. Results are estimates of the regression coefficient, (standard error of the estimate) and statistical significance *P < 0.05, **P < 0.01, ***P < 0.001, no indicator = P-value NS obtained by linear regression analyses. Models 1–4 are univariate analyses; model 5 incorporated all symptom categories as co-variates and model 6 incorporated all symptom categories variables and was adjusted for sex and age.

Table 4. Rhinasthma quality of life scores based on type of a etiologic agent (n = 83)

	HMW (n = 27)	LMW (n = 56)	P-value
UAS	24.0 (10.4)	19.8 (6.8)	*
LAS	31.9 (12.5)	33.8 (11.7)	
RAI	19.3 (7.6)	18.8 (7.2)	
Global summary	75.2 (28.3)	72.5 (22.9)	

HMW, high molecular weight; LMW, low molecular weight; UAS, upper airway symptoms; LAS, lower airways symptoms; RAI, respiratory allergy impact. Results are means (standard deviations), *P < 0.05, no indicator = P-value NS.

symptoms are not reported as frequently as work-related nasal symptoms, probably because nasal and bronchial symptoms are often more prominent and relevant for patients. Symptoms like dry throat, sore throat and throat clearing are frequently self-reported in occupational epidemiological surveys that focus on the prevalence of respiratory symptoms among workers exposed to diverse irritants (e.g. welding fumes, metal-working fluids) [10,11].

In addition, occupational pharyngitis and laryngitis are less frequently reported as compared with OR. Kanerva *et al.* reported on the occurrence of occupational pharyngitis that was confirmed by challenge tests using exposures to acrylate compounds that are used in orthodontics and dentistry [12]. Occupational laryngitis has been reported in individuals who were exposed to formaldehyde, welding fumes and acrylate compounds and chemicals used in hairdressing [13–16]. Occupational laryngitis often occurs concomitantly with OR or OA [17]. After analysing data from specialized clinics that investigated patients with WRA, Vandenplas *et al.* reported that loss of voice was negatively associated with the presence of OA to HMW agents [18].

The frequent co-existence of work-related rhinitis and asthma symptoms has been demonstrated in clinical and epidemiological studies [19]. We recently reported a high prevalence of rhinitis symptoms among subjects with a confirmed diagnosis of OA after SIC [1]. Other studies have found high frequencies of rhinitis symptoms among patients who were referred to specialized clinics for investigating work-related asthma [4,20]. In addition, the present study demonstrated that rhinitis symptoms 'at work' were regarded as moderate or severe by a higher proportion of subjects and this severity pattern was associated with a tendency for higher QOL impairment in the RAI and Global Summary scores of the Rhinasthma questionnaire.

A temporal relationship between work-related rhinitis symptoms and the onset of work-related asthma symptoms has been documented in previous studies. Malo *et al.* showed that OR more often appeared before OA for exposures to HMW agents (58%) as compared with exposures to LMW agents (25%) [21]. Vandenplas *et al.* showed that nasal symptoms less frequently preceded those of asthma in subjects with WEA (17%) than in those with OA (43%) [4]. Our study confirmed the results from these studies. However, in addition, we showed that pharyngeal, laryngeal and sinusal symptoms more frequently preceded those of asthma in subjects with WEA than in those with OA. It remains to be determined if there is any clinical value in documenting pharyngeal, laryngeal and sinusal symptoms with respect to their potential to correctly identify patients with OA and WEA.

Generic QOL measures have been shown to be moderately correlated with rhinitis symptoms scores and nasal hyperreactivity [22,23]. Nasal congestion and ocular symptoms were identified as the most disturbing symptoms that could decrease rhinitis specific QOL and work productivity [24,25]. Among greenhouse workers, sensitization to bell pepper pollen had a negative impact on rhinitis-specific QOL scores and the pattern in impairment was different when compared with individuals with non-occupational perennial rhinitis [26]. A follow-up study of these workers showed that OR symptoms were a risk factor for a job change, but that symptom scores and rhinitis-specific QOL could return to baseline when complete exposure cessation was achieved [27]. However, continued exposure to the causative agent led to further declines in QOL among subjects with OR [28].

Table 5. Prevalence of nasal symptoms and quality of life scores according to self-reported severity of rhinitis symptoms based on visual analogue scale on days away from work and days at work (n = 70)

	Away from work			At work		
	Mild (n = 54)	Moderate/severe (n = 16)	P-value	Mild (n = 29)	Moderate/severe (n = 41)	P-value
Symptoms n (%)						
Rhinorrhoea	39 (72)	15 (94)		18 (62)	36 (88)	**
Itching	31 (57)	11 (69)		15 (52)	27 (66)	
Sneezing	43 (80)	14 (88)		21 (72)	36 (88)	
Stuffy nose	37 (69)	14 (88)		18 (62)	33 (81)	
Bleeding	16 (30)	3 (20)		7 (25)	12 (29)	
Crusting	36 (67)	12 (75)		20 (69)	28 (68)	
Hyposmia	23 (43)	10 (63)		13 (45)	20 (49)	
Rhinasthma scores mean (SD)						
UAS	20.0 (8.2)	24.4 (8.0)		19.1 (8.3)	22.4 (8.2)	
LAS	30.9 (11.5)	37.6 (11.2)	*	30.2 (11.5)	34.0 (11.8)	
RAI	17.2 (6.6)	23.4 (7.7)	***	16.9 (6.9)	19.4 (7.3)	
Global summary	68.1 (23.5)	82.4 (22.3)	**	66.1 (24.6)	76.2 (23.4)	

UAS, upper airway symptoms; LAS, lower airway symptoms; RAI, respiratory allergy impact. *P < 0.05, **P < 0.01, ***P < 0.001, no indicator = P-value NS.

In our study population, laryngeal symptoms were associated with impairments in rhinitis-specific QOL. Laryngeal symptoms were reported as more frequent among patients with allergic rhinitis than in patients with non-allergic rhinitis and were negatively associated with voice-related QOL [29]. The number of positive skin prick test results to common allergens was positively associated with greater voice impairments among patients who presented to a rhinology clinic in the UK without specific voice-related complaints [30].

We acknowledge that these findings should be confirmed in a larger study, particularly with regard to potential differences between subjects with OA and WEA. Also, occupational surveys should consider including assessments for pharyngeal, laryngeal and sinus symptoms in addition to nasal symptoms when examining the effects of environmental and occupational noxious exposures.

Key points

- Individuals with work-related respiratory symptoms investigated in an occupational asthma referral centre reported high frequencies of various upper respiratory symptoms.
- Individuals complained not only of nasal symptoms as previously reported but also of a wide range of sinus, laryngeal and pharyngeal symptoms.
- Presence of laryngeal symptoms was most strongly related to impairments in rhinitis-specific quality of life.

Funding

This work was supported by the Swiss National Science Foundation Bern/Switzerland; the Center for Asthma in the Workplace in Montreal/Canada and the Fonds de Recherches en Santé du Québec (FRSQ).

Conflicts of interest

D.M. is employed by the Swiss Accident Insurance Fund (Suva). Suva is an independent, non-profit company under Swiss public law.

References

1. Castano R, Malo JL. Occupational rhinitis and asthma: where do we stand, where do we go? *Curr Allergy Asthma Rep* 2010;**10:**135–142.
2. Bousquet J, Khaltaev N, Cruz AA, *et al.* Allergic Rhinitis and its Impact on Asthma (ARIA) 2008 update (in collaboration with the World Health Organization, GA(2)LEN and AllerGen). *Allergy* 2008;**63**(Suppl 86):8–160.
3. Castano R, Gautrin D, Theriault G, Trudeau C, Ghezzo H, Malo JL. Occupational rhinitis in workers investigated for occupational asthma. *Thorax* 2009;**64:**50–54.
4. Vandenplas O, Van Brussel P, D'Alpaos V, Wattiez M, Jamart J, Thimpont J. Rhinitis in subjects with work-exacerbated asthma. *Respir Med* 2010;**104:**497–503.
5. Burney PG, Laitinen LA, Perdrizet S, *et al.* Validity and repeatability of the IUATLD (1984) Bronchial Symptoms Questionnaire: an international comparison. *Eur Respir J* 1989;**2:**940–945.
6. Massey JT. Overview of the National Health Interview Survey and its sample design. *Vital Health Stat 2* 1989: 1–5.
7. Baiardini I, Pasquali M, Giardini A, *et al.* Rhinasthma: a new specific QoL questionnaire for patients with rhinitis and asthma. *Allergy* 2003;**58:**289–294.
8. Bousquet PJ, Combescure C, Neukirch F, *et al.* Visual analog scales can assess the severity of rhinitis graded according to ARIA guidelines. *Allergy* 2007;**62:**367–372.

9. Vandenplas O, Malo JL. Inhalation challenges with agents causing occupational asthma. *Eur Respir J* 1997;**10:** 2612–2629.
10. Jaakkola MS, Suuronen K, Luukkonen R, *et al.* Respiratory symptoms and conditions related to occupational exposures in machine shops. *Scand J Work Environ Health* 2009;**35:**64–73.
11. Rosenman KD, Reilly MJ, Kalinowski D. Work-related asthma and respiratory symptoms among workers exposed to metal-working fluids. *Am J Ind Med* 1997;**32:** 325–331.
12. Kanerva L, Estlander T, Jolanki R, Pekkarinen E. Occupational pharyngitis associated with allergic patch test reactions from acrylics. *Allergy* 1992;**47:**571–573.
13. Hannu T, Piipari R, Toskala E. Immediate hypersensitivity type of occupational laryngitis in a welder exposed to welding fumes of stainless steel. *Am J Ind Med* 2006;**49:** 402–405.
14. Piirila P, Kanerva L, Keskinen H, *et al.* Occupational respiratory hypersensitivity caused by preparations containing acrylates in dental personnel. *Clin Exp Allergy* 1998;**28:**1404–1411.
15. Roto P, Sala E. Occupational laryngitis caused by formaldehyde: a case report. *Am J Ind Med* 1996;**29:**275–277.
16. Sala E, Hytonen M, Tupasela O, Estlander T. Occupational laryngitis with immediate allergic or immediate type specific chemical hypersensitivity. *Clin Otolaryngol Allied Sci* 1996;**21:** 42–48.
17. Hannu T, Sala E, Toskala E. Long-term prognosis of immediate hypersensitivity type of occupational laryngitis. *Respir Med* 2009;**103:**130–135.
18. Vandenplas O, Ghezzo H, Munoz X, *et al.* What are the questionnaire items most useful in identifying subjects with occupational asthma? *Eur Respir J* 2005;**26:**1056–1063.
19. Moscato G, Vandenplas O, Gerth Van Wijk R, *et al.* Occupational rhinitis. *Allergy* 2008;**63:**969–980.
20. Chiry S, Boulet LP, Lepage J, *et al.* Frequency of work-related respiratory symptoms in workers without asthma. *Am J Ind Med* 2009;**52:**447–454.
21. Malo JL, Lemiere C, Desjardins A, Cartier A. Prevalence and intensity of rhinoconjunctivitis in subjects with occupational asthma. *Eur Respir J* 1997;**10:**1513–1515.
22. Leynaert B, Neukirch C, Liard R, Bousquet J, Neukirch F. Quality of life in allergic rhinitis and asthma. A population-based study of young adults. *Am J Respir Crit Care Med* 2000;**162:**1391–1396.
23. Bousquet J, Bullinger M, Fayol C, Marquis P, Valentin B, Burtin B. Assessment of quality of life in patients with perennial allergic rhinitis with the French version of the SF-36 Health Status Questionnaire. *J Allergy Clin Immunol* 1994;**94:**182–188.
24. Shedden A. Impact of nasal congestion on quality of life and work productivity in allergic rhinitis: findings from a large online survey. *Treat Respir Med* 2005;**4:**439–446.
25. Stull DE, Schaefer M, Crespi S, Sandor DW. Relative strength of relationships of nasal congestion and ocular symptoms with sleep, mood and productivity. *Curr Med Res Opin* 2009;**25:**1785–1792.
26. Groenewoud GC, de Groot H, van Wijk RG. Impact of occupational and inhalant allergy on rhinitis-specific quality of life in employees of bell pepper greenhouses in the Netherlands. *Ann Allergy Asthma Immunol* 2006;**96:**92–97.
27. Gerth van Wijk R, Patiwael JA, de Jong NW, de Groot H, Burdorf A. Occupational rhinitis in bell pepper greenhouse workers: determinants of leaving work and the effects of subsequent allergen avoidance on health-related quality of life. *Allergy* 2011;**66:**903–908.
28. Airaksinen LK, Luukkonen RA, Lindstrom I, Lauerma AI, Toskala EM. Long-term exposure and health-related quality of life among patients with occupational rhinitis. *J Occup Environ Med* 2009;**51:**1288–1297.
29. Turley R, Cohen SM, Becker A, Ebert CS, Jr. Role of rhinitis in laryngitis: another dimension of the unified airway. *Ann Otol Rhinol Laryngol* 2011;**120:**505–510.
30. Randhawa PS, Nouraei S, Mansuri S, Rubin JS. Allergic laryngitis as a cause of dysphonia: a preliminary report. *Logoped Phoniatr Vocol* 2010;**35:**169–174.