Original Article

The Impact of Work-Related Rhinitis on Quality of Life and Work Productivity: A General Workforce-Based Survey

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What is already known about this topic? There is only scarce and discordant information on the burden of work-related rhinitis (WRR).

What does this article add to our knowledge? WRR imposes an incremental adverse impact on both rhinitis-specific and general health-related quality of life, and work productivity compared with rhinitis unrelated to work.

How does this study impact current management guidelines? The findings highlight the need to the identification and management of WRR in order to reduce the global burden of rhinitis.

BACKGROUND: The specific burden of work-related rhinitis (WRR) on quality of life (QoL) and work productivity has received little attention.
OBJECTIVE: The aim of this study was to investigate to what extent WRR affects QoL and work productivity as compared with subjects with rhinitis unrelated to work and those without rhinitis.
METHODS: This cross-sectional survey was conducted among workers randomly recruited at the time of their periodic occupational health visit in the French-speaking part of Belgium. The survey instruments consisted of rhinitis-specific and generic questionnaires: Mini-Rhinitis QoL Questionnaire, Medical Outcome Study Short Form-8, and Work Productivity and Activity Impairment-General Health questionnaire. Eligible participants were categorized into 3 groups: non-WRR (current nasal symptoms not related to work, n = 329); WRR (current rhinitis with ≥2 nasal symptoms at work, n = 161); and controls (no nasal symptom; n = 1155).
RESULTS: WRR showed significantly lower scores in all domains of the Mini-Rhinitis QoL Questionnaire compared with non-WRR. Multivariate analysis confirmed that WRR exerted an independent adverse effect on rhinitis-specific QoL. Both WRR and non-WRR were associated with greater impairment in the physical and mental health components of the Medical Outcome Study Short Form-8 instrument and the overall work productivity compared with controls, whereas these outcomes were more impacted in WRR than non-WRR. Multivariate analyses demonstrated that both WRR and non-WRR had an independent adverse impact on the physical and mental health status and overall work productivity.
CONCLUSION: WRR has an incremental adverse impact on QoL and work productivity that should be addressed in order to reduce the global burden of rhinitis. © 2020 American Academy of Allergy, Asthma & Immunology (J Allergy Clin Immunol Pract 2020;8:1583-91)

Key words: *Quality of life; Rhinitis; Work productivity; Work-related rhinitis*

Allergic (AR) and nonallergic (NAR) rhinitis are highly prevalent conditions that generate a substantial health and societal burden predominantly through their adverse impacts on patients' health-related quality of life (QoL) and work productivity.[1-4]

Workplace exposures account for a substantial—though still poorly quantified—fraction of rhinitis in adults[5-8] and have been associated with different phenotypes of work-related rhinitis (WRR), including sensitizer-induced occupational rhinitis caused by either high-molecular-weight protein allergens or

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Abbreviations used
AR- Allergic rhinitis
MCS- Mental Component Summary
Mini-RQLQ- Mini-Rhinitis Quality of Life Questionnaire
NAR- Nonallergic rhinitis
PCS- Physical Component Summary
QoL- Quality of life
SF-8/36- Medical Outcome Study Short Form-8/36 items
WPAI-GH- Work Productivity and Activity Impairment-General Health
WRR- Work-related rhinitis

low-molecular-weight chemicals; irritant-induced rhinitis; and work-exacerbated rhinitis.[6,8,9] Despite the increased emphasis on the burden of rhinitis, there is still limited information on the specific impact of WRR on QoL.[10-12] Available studies focused on IgE-mediated occupational rhinitis caused by proteins[10-12] and provided discordant findings. In addition, the influence of WRR on work productivity has never been investigated in the general population.

The aim of this cross-sectional study was to further characterize the relative impact of WRR on health-related QoL and work productivity compared with both non−work-related rhinitis (non-WRR) and a control population without nasal symptoms in a sample of a general workforce.

METHODS

Study design

This cross-sectional survey was designed as a 2-step integrated questionnaire that was administered under the supervision of clinical research assistants. In the first step, the participants were asked to complete a "screening questionnaire" aimed at identifying those with rhinitis and/or AR. In the second step, all subjects who screened positive were invited to complete a "rhinitis-related questionnaire" during the same visit. This report conformed to the Strengthening of the Reporting of Observational Studies in Epidemiology statement for cross-sectional studies (www.strobe-statement.org).

Setting

This questionnaire-based survey was conducted in a sample of workers employed in various industrial sectors in the French-speaking part of Belgium (Table E1, available in this article's Online Repository at www.jaci-inpractice.org).

Population

The participants were recruited at the time of their periodic visit to medical examination centers of an external intercompany occupational health service (Service de Prévention et Protection au Travail—Centre de Service Interentreprises—CESI, Brussels, Belgium) from 2008 to 2011. Periodic examination of salaried workers by internal or external occupational health services is mandatory in Belgium.

The recruitment days and centers were randomly sampled with a probability proportional to the annual number of medical evaluations performed in each center. Exclusion criteria included pre-employment, post sick leave, and pregnancy evaluations, vocational training, and illiteracy. All eligible workers attending an occupational health center on a randomized day were invited to complete the survey.

Ethics

The study protocol was approved by the Ethics Committee of the Centre Hospitalier Universitaire UCL Namur (approval no. B0392006772), and a written informed consent was obtained from each participant.

Procedures

Screening questionnaire. The screening questionnaire gathered information on: (1) demographic, medical, and occupational characteristics; (2) rhinitis and asthma symptoms as well as their relationship with work exposure and medications; (3) nonrespiratory comorbidities; (4) general health-related QoL using the Medical Outcome Study survey Short Form-8 (SF-8); and (5) impairment in work productivity due to health assessed through the Work Productivity and Activity Impairment-General Health (WPAI-GH) generic instrument (Table E2, available in this article's Online Repository at www.jaci-inpractice.org).

Rhinitis-related questionnaire. Participants with a symptom-based diagnosis of rhinitis or with a self-reported or physician-based diagnosis of AR were administered a "rhinitis-related questionnaire" aimed at collecting information pertaining to the impact of rhinitis, including rhinitis-specific QoL assessed through the Mini-Rhinitis Quality of Life Questionnaire (Mini-RQLQ),[13] and work disability and health care utilization due to rhinitis.

Identification of diseases

A diagnosis of current rhinitis was assigned to participants reporting that they regularly experienced at least 2 nasal symptoms (ie, runny nose, stuffy nose, or sneezing) when they did not have a cold or the flu during the previous 12 months.[14] Subjects were regarded as having AR when they met the criteria for either self-reported or physician-based AR.[15] The "control population" consisted of those participants who reported neither current nasal symptom nor AR (Figure 1).

Rhinitis severity was categorized as mild (ie, symptoms present, but not troublesome) or moderate/severe (ie, symptom rated as troublesome or very troublesome) according to the Allergic Rhinitis and its Impact on Asthma guidelines.[16]

WRR was defined by the presence of 2 or more nasal symptoms temporally related to workplace exposure.[17] Work-related conjunctivitis was identified by reporting itchy and red eyes at work.

Participants were considered as having work-related asthma when they reported current asthma[18] and experienced at least 2 asthma symptoms (ie, wheezing, chest tightness, shortness of breath, or cough) related to work exposure.[19]

Outcomes

Quality of life. Health-related QoL was assessed using 2 validated instruments: (1) the generic SF-8 questionnaire (4-week recall French version 1.0 for Belgium, kindly provided by QualityMetric Incorporated, Lincoln, RI) administered to all participants; and (2) the rhinitis-specific Mini-RQLQ questionnaire[13] that was completed by participants who reported current nasal symptoms or AR. These questionnaires were used because they cover different aspects of QoL and the SF-8 instrument allowed for comparing QoL between control individuals without nasal symptoms and those with rhinitis.[20]

The SF-8 questionnaire is a shortened generic instrument assessing 8 health concepts—general health, physical functioning, role physical, bodily pain, vitality, mental health, role emotional, and

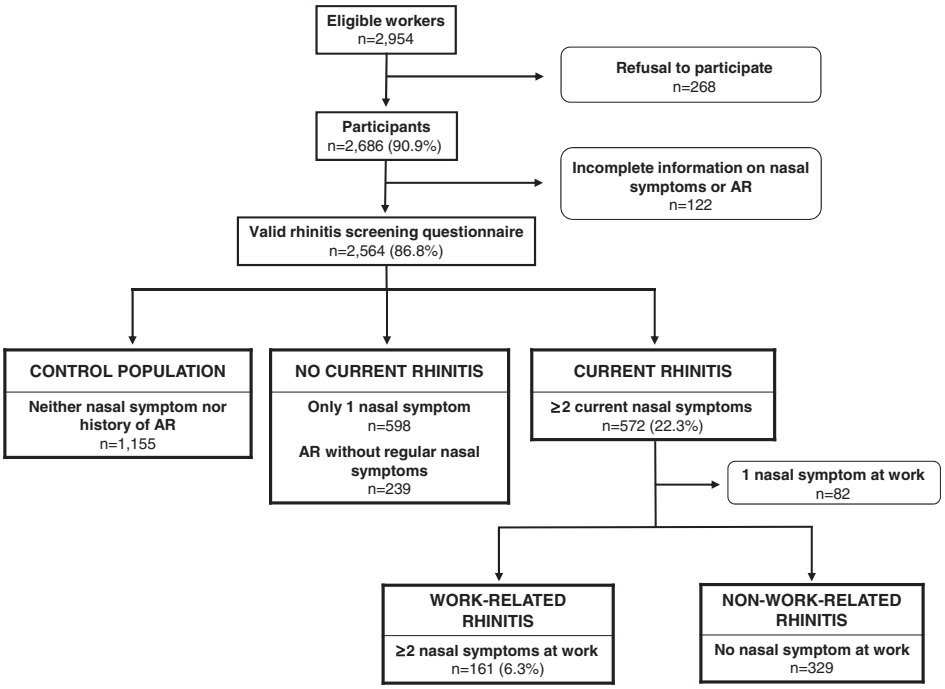

FIGURE 1. Flowchart of the study recruitment. *AR*, Allergic rhinitis (self-reported or physician-based).

social functioning—that are summarized into 2 aggregate scores: the Physical Component Summary (PCS) and the Mental Component Summary (MCS) measures.[21] The SF-8 raw scales are transformed into 0 to 100 scales, with higher scores indicating better health status. The summary measures are standardized using scoring algorithms in order to have a mean value of 50 and a standard deviation of 10.

The Mini-RQLQ measures the impact of rhinoconjunctivitis symptoms on 5 domains: activity limitation, practical problems, nose symptoms, eyes symptoms, and other symptoms.[13] Each item is scored on a 7-point scale from 0 (not troubled) to 6 (extremely troubled). The answers are summarized into 5 domain scores and a mean overall score.

Work productivity. The impact of general health on work productivity was assessed in all participants using the French version of the WPAI-GH self-administered instrument (www.reillyassociates.net).[22] This questionnaire is designed to produce 4 outcome measures evaluated over the last 7 days: (1) the work time missed due to general health (ie, absenteeism); (2) the productivity impairment while working due to health (ie, impaired presenteeism); (3) the overall work impairment as the sum of absenteeism and impaired presenteeism; and (4) impairment in usual off-work activities. These metrics are expressed as percentages from 0% to 100%, with higher percentages indicating greater impairment. The generic "general-health" version of the WPAI was used because this instrument is generalizable across diseases and allowed for comparing impairment in work productivity between participants with rhinitis and those without rhinitis.

In addition, participants who reported nasal symptoms or AR were asked whether they ever had to change their tasks, leave their job, or reduce their working time because of their nasal symptoms in order to identify "rhinitis-related work disability" similar to what has been defined by Blanc et al for asthma.[23,24] The questionnaire also collected information about work days missed, perceived loss of income, and visits to general practitioners or specialists due to nasal symptoms over the previous 12 months.

Data analysis

Data are presented as the median and interquartile range for continuous variables and percentages for categorical variables. Comparisons between groups of subjects were made using the χ^2 test or Fisher's exact for categorical variables and the Mann-Whitney or Kruskal-Wallis test for numerical variables. The factors that affected the Mini-RQLQ overall score and SF-8 PCS/MCS scores were explored through multivariate linear regression analysis. A multivariable logistic regression analysis was used to identify the determinants of the WPAI-GH overall work impairment score that was dichotomized into "any impairment" (ie, WPAI-GH score >0) and "no impairment." The independent variables incorporated into these regressions were selected based on univariate comparisons with a P value of $<.10$. Missing values were not imputed and subjects with missing data were not incorporated into the multivariable analyses. Statistical analyses were performed using the IBM SPSS Statistics version 25 (IBM Corp., Armonk, NY). A P value $<.05$ was considered significant.

RESULTS

Population characteristics

The flowchart of the population recruitment is illustrated in Figure 1. Of the 2954 eligible workers, 2686 (90.9%) agreed to participate in this survey. Among the 2564 (86.8%) participants who provided a valid screening questionnaire for rhinitis, 1170

TABLE I. Demographic and clinical characteristics of participants with work-related rhinitis, rhinitis unrelated to work, and the control population

Characteristics	Missing values	Control population (n = 1155)	Non–work-related rhinitis (n = 329)	Work-related rhinitis (n = 161)	*P* value
Sex, female	3/0/0	528 (45.8)	165 (50.2)	83 (51.6)	.198
Age	27/7/4	40.6 (32.3-48.6)	37.9 (29.3-47.7)	35.1 (28.2-43.3)	**<.001**
<35 y		353 (31.4)	130 (40.4)	77 (49.4)	**<.001**
Smoking status	17/4/0				.389
Current smoker		344 (30.2)	97 (29.8)	60 (37.3)	
Ex-smoker		212 (18.6)	62 (19.1)	31 (19.3)	
Never smoker		582 (51.1)	166 (51.1)	70 (43.5)	
Body mass index	81/13/13				
<25 kg/m^2		25.0 (22.4-28.1)	24.2 (22.1-27.4)	24.2 (21.5-27.3)	**.011**
≥25 kg/m^2		538 (50.1)	134 (42.4)	68 (45.9)	**.048**
No. of household members	24/4/4	3.0 (2.0-4.0)	3.0 (2.0-4.0)	3.0 (2.0-4.0)	.624
Net monthly income <1500 EUR	218/32/16	271 (28.9)	78 (26.3)	45 (31.0)	.532
Education level, <12 y	35/6/3	721 (64.5)	196 (60.7)	98 (62.0)	.410
Mother language other than French	9/0/0	96 (8.4)	28 (8.5)	19 (11.8)	.350
Self-reported allergic rhinitis	na/0/0	na	181 (55.0)	112 (69.6)	**.002**
Physician-based allergic rhinitis	na/0/0	na	118 (35.9)	77 (47.8)	**.011**
Allergic rhinitis*	na/0/0	na	188 (57.1)	117 (72.7)	**.001**
Rhinitis pre-existing to current job	na/245/104	na	70 (83.3)	45 (78.9)	.511
Moderate/severe rhinitis severity†	na/108/48	na	106 (48.0)	80 (70.8)	**<.001**
Rhinitis treatment					
Oral H_1-antihistamine	na/109/47	na	68 (30.9)	43 (37.7)	.211
NCS	na/110/47	na	57 (26.0)	41 (36.0)	.060
Oral H_1-antihistamine and NCS	na/109/47	na	26 (11.9)	24 (21.1)	**.026**
Conjunctivitis[c]	0/0/0	111 (9.6)	172 (52.3)	106 (65.8)	**<.001**
Work-related conjunctivitis‡	0/0/0	29 (2.5)	9 (2.7)	51 (31.7)	**<.001**
Current asthma	0/0/0	29 (2.5)	59 (17.9)	43 (26.7)	**<.001**
Work-related asthma§	3/5/7	12 (1.9)	19 (5.9)	29 (18.8)	**<.001**
Chronic phlegm	58/13/2	43 (3.9)	44 (13.9)	34 (21.4)	**<.001**
Depression, physician-based	3/1/1	113 (9.8)	55 (16.8)	25 (15.6)	**.001**
≥1 nonrespiratory comorbidity	3/1/1	605 (52.5)	214 (65.2)	114 (71.3)	**<.001**

na, Not applicable; *NCS*, nasal corticosteroid spray.

Data are presented as numbers (percentages) of subject or medians (interquartile ranges). Bold indicates statistical significance ($P < .05$).

*Allergic rhinitis defined by either self-reported or physician-based allergic rhinitis.

†Rhinitis severity graded according to the Allergic Rhinitis and its Impact on Asthma (ARIA) guidelines.

‡Conjunctivitis defined by itchy and red eyes and work-related conjunctivitis as itchy and red eyes at work.

§Work-related asthma defined as current asthma associated with ≥2 work-related asthma symptoms.

(45.6%) had at least 1 rhinitis symptom whereas 572 (22.3%) reported ≥2 nasal symptoms and were considered as having current symptom-based rhinitis (Figure 1). Among the 572 subjects with rhinitis, 161 (28.1%) reported 2 or more work-related nasal symptoms and were categorized as having WRR. Eighty-two participants with rhinitis experienced only 1 nasal symptom at work and were excluded from both the WRR and non-WRR groups. One thousand one hundred and fifty-five participants reported neither nasal symptom nor AR and were regarded as the control population.

When compared with the control population, WRR and non-WRR were both associated with a younger age, a lower median body mass index, and a higher prevalence of conjunctivitis symptoms, current asthma, work-related asthma symptoms, chronic phlegm, physician-based diagnosis of depression, and nonrespiratory comorbid conditions (Table I).

When compared with rhinitis unrelated to work, WRR was associated with a slightly younger age and a higher prevalence of work-related conjunctivitis ($P = .001$), AR ($P = .001$), current asthma ($P = .025$), work-related asthma ($P < .001$), and chronic phlegm ($P = .040$). A higher proportion of subjects with WRR reported moderate/severe rhinitis symptoms (70.8%) and the use of both oral antihistamine and nasal corticosteroid spray (21.1%) as compared with those with non-WRR (48.0%, $P < .001$, and 11.9%, $P = .001$, respectively). There were a high proportion of missing data for these variables (29.8% in WRR and 32.8% in non-WRR), but the demographic and clinical characteristics of responders to the question on rhinitis severity did not differ from nonresponders (data not detailed).

TABLE II. Rhinitis-specific quality of life and socioeconomic outcomes in work-related rhinitis compared with rhinitis unrelated to work

Outcomes	Missing values	Non–work-related rhinitis (n = 329)	Work-related rhinitis (n = 161)	*P* value
Mini-RQLQ domains				
Overall	133/68	1.4 (0.9-2.1)	2.4 (1.5-3.2)	**<.001**
Activities	118/53	1.0 (0.3-2.0)	1.7 (1.0-3.0)	**<.001**
Practical problems	123/56	2.0 (1.0-3.0)	3.0 (2.0-4.0)	**<.001**
Nasal symptoms	123/60	2.0 (1.3-3.0)	3.3 (2.0-4.3)	**<.001**
Eye symptoms	124/55	0.7 (0.0-1.7)	1.7 (0.3-3.0)	**<.001**
Other symptoms	122/55	0.7 (0.0-2.0)	1.8 (0.7-3.3)	**<.001**
Rhinitis-related work disability*	108/46	0	3 (2.6)	**.039**
≥1 work day missed due to rhinitis last 12 mo	110/48	19 (8.7)	15 (13.3)	.190
Any income reduction due to rhinitis	108/48	6 (2.7)	8 (7.1)	.082
≥1 general practitioner visit last 12 mo	111/48	72 (33.0)	51 (45.1)	**.031**
≥1 specialist practitioner visit last 12 mo	108/47	24 (10.9)	15 (13.2)	.534

Mini-RQLQ, Mini-Rhinitis Quality of Life Questionnaire.
Data are presented as numbers (percentages) of subject or medians (interquartile ranges). The Mini-RQLQ domains are scored on a 7-point scale from 0 (not troubled) to 6 (extremely troubled). Bold indicates statistical significance ($P < .05$).
*Defined as ever having had to change or leave job or reduce working time due to nasal symptoms.

Quality of life impairment

Rhinitis-specific quality of life. The subjects with WRR showed significantly higher Mini-RQLQ overall and subdomain scores than those with non-WRR, indicating higher level of QoL impairments (Table II). Univariate associations with overall Mini-RQLQ score are detailed in Table E3 (available in this article's Online Repository at www.jaci-inpractice.org). The multivariate linear regression analysis conducted among subjects with current rhinitis (Table III, model 1) revealed that a greater impairment in rhinitis-specific QoL was independently associated with WRR, work-related conjunctivitis, AR, female gender, and current smoking. When rhinitis severity was incorporated into the multivariate model (Table III, model 2), moderate/severe rhinitis appeared as a significant risk factor for worse rhinitis-specific QoL, whereas AR became only marginally associated with the overall Mini-RQLQ score.

General health-related quality of life. The analysis of the SF-8 questionnaire (Table IV) revealed that the median PCS score was worse in participants with WRR (48.6) and non-WRR (50.9) as compared with the control population (54.2, $P < .001$). Subjects with WRR and non-WRR also showed lower MCS score (46.5 and 49.4, respectively) than controls (52.1, $P < .001$). The PCS and MCS scores were significantly lower in subjects with WRR than in those with non-WRR.

Univariate analyses of the factors that determined PCS and MCS impairments are summarized in Table E3 (available in this article's Online Repository at www.jaci-inpractice.org). In multivariate models (Table V), both WRR and non-WRR were significantly and independently associated with lower PCS and MCS scores. In addition, PCS was adversely affected by an older age, female gender, overweight, lower level of education, AR, chronic phlegm, and the presence of nonrespiratory comorbidities. When incorporated into the multivariate model, moderate/severe rhinitis failed to show any significant effect on PCS (Table E4, available in this article's Online Repository at www.jaci-inpractice.org). MCS demonstrated a negative association with female gender, a low household income, a physician-based diagnosis of depression, work-related conjunctivitis symptoms, and nonrespiratory comorbidities.

Work productivity impairment

Rhinitis-related work disability and health care utilization. Although rhinitis-related work disability was infrequent in this population, it was significantly more frequent in WRR (2.6%) than in non-WRR (0%; $P = .039$) (Table II). Overall, any workday missed and income loss self-attributed to rhinitis were reported by 10.2% and 4.2% of the participants with rhinitis, respectively, and did not differ between WRR and non-WRR. Participants with WRR reported more frequently a visit to their general practitioner because of rhinitis symptoms (45.1%) than those with non-WRR (33%; $P = .031$).

General health-related work productivity. Table IV shows that any work time missed as well as any impairment in at-work productivity (presenteeism), overall work productivity, and off-work activities due to general health were more frequent in WRR (16.3%, 53.9%, 54.8%, and 50.7%, respectively) as compared with both non-WRR (10.6%, 27.0%, 29.0%, and 33.5%) and the control population without nasal symptoms (7.4%, 14.9%, 16.2%, and 18.1%).

Univariate analyses of the potential explanatory variables for any WPAI-GH impairment in overall work productivity are detailed in Table E5 (available in this article's Online Repository at www.jaci-inpractice.org). In the multivariate logistic regression analysis (Table VI), WRR and non-WRR were both associated with a higher likelihood of experiencing any overall work productivity impairment (odds ratio [95% confidence interval]: 4.74 [2.67; 8.40]; $P < .001$ and 1.57 [1.01; 2.45]; $P = .047$, respectively). Female gender, overweight, a physician-based diagnosis of depression, and nonrespiratory comorbidity were also significant predictors of overall work productivity impairment.

TABLE III. Multivariate models for rhinitis quality of life overall score

Independent variables	Unstandardized β coefficient (95% CI)	*P* value
Multivariate model 1 (n = 469)		
Gender, female	0.460 (0.254 to 0.707)	**<.001**
Current smoker	0.367 (0.112 to 0.621)	**.005**
Work-related rhinitis*	0.518 (0.259 to 0.777)	**<.001**
Work-related conjunctivitis†	0.680 (0.303 to 1.058)	**<.001**
Allergic rhinitis‡	0.339 (0.106 to 0.573)	**.005**
Work-related asthma§	0.269 (−0.171 to 0.709)	.114
Chronic phlegm	0.256 (−0.147 to 0.551)	.256
Depression, physician-based	0.170 (−0.152 to 0.491)	.300
≥1 nonrespiratory comorbidity	0.087 (−0.159 to 0.332)	.487
Multivariate model 2 (n = 320)		
Gender, female	0.410 (0.197 to 0.623)	**<.001**
Current smoker	0.305 (0.066 to 0.543)	**.013**
Work-related rhinitis*	0.368 (0.122 to 0.615)	**.004**
Work-related conjunctivitis†	0.677 (0.320 to 1.034)	**<.001**
Allergic rhinitis‡	0.199 (−0.023 to 0.422)	.079
Moderate/severe rhinitis‖	0.708 (0.491 to 0.926)	**<.001**
Work-related asthma§	0.251 (−0.168 to 0.670)	.239
Chronic phlegm	0.093 (−0.237 to 0.423)	.578
Depression, physician-based	0.167 (−0.136 to 0.470)	.278
≥1 nonrespiratory comorbidity	0.083 (−0.147 to 0.313)	.478

CI, Confidence interval.

Multivariate model 1 incorporated as independent variables those with a *P* value of <.1 in univariate analyses (see Table E2, available in this article's Online Repository at www.jaci-inpractice.org) with the exception of rhinitis severity, whereas model 2 included rhinitis severity among independent variables. Bold indicates statistical significance ($P < .05$).

*Work-related rhinitis defined by the presence of 2 or more nasal symptoms at work.

†Work-related conjunctivitis defined by red and itchy eyes at work.

‡Allergic rhinitis defined as self-reported or physician-based allergic rhinitis.

§Work-related asthma defined as current asthma associated with ≥2 work-related asthma symptoms.

‖Rhinitis severity graded according to the Allergic Rhinitis and its Impact on Asthma (ARIA) guidelines.

DISCUSSION

This study is, to the best of our knowledge, the first that has attempted to investigate the impact of WRR on QoL and work disability in a large sample of a general workforce. The findings indicated that work-related nasal symptoms, regardless of their underlying pathophysiologic mechanisms,[6,8,9] impose a significant incremental impact on rhinitis-specific and general health-related QoL and work productivity compared with rhinitis unrelated to work.

Quality of life

In contrast to the significant literature on the impairment of the QoL in AR and NAR,[2,3] there is only scarce and nonconclusive information on the level of impairment of QoL in patients with WRR. Studies of workers with IgE-mediated occupational rhinitis found either more impairment[10] or a similar level of impairment[11] in RQLQ domains as compared with adults with nonoccupational rhinitis. However, in the study by Groenewoud et al,[10] Dutch greenhouse workers with occupational rhinitis due to bell pepper pollen were compared with a French cohort with perennial rhinitis, although these 2 populations were recruited in different settings. By contrast, the generic SF-36 instrument indicated a worse general health-related QoL in Finnish workers with occupational rhinitis to protein allergens compared with control subjects with AR and healthy controls without rhinitis.[11]

The current study indicated that WRR resulted in a significantly greater impairment in all domains of the Mini-RQLQ compared with non-WRR. The rhinitis-specific QoL impairment found in WRR was similar to those reported in large cohorts of patients with AR[25-27] or NAR[3] recruited by general practitioners or specialists. Of note, WRR showed higher mean Mini-RQLQ scores than in greenhouse workers with occupational rhinitis due to bell pepper pollen.[10] Participants with rhinitis unrelated to work in our study had a mean Mini-RQLQ score comparable with those reported in patients with seasonal AR before the pollen season[28] and patients with AR recruited by primary care physicians and specialists independently from the pollen season.[29] In our population, the multivariate analysis demonstrated that WRR exerted a significant and independent adverse effect on rhinitis-specific QoL. In addition, this analysis confirmed that work-related conjunctivitis symptoms have an additional independent deleterious effect on rhinitis-specific QoL.[30,31] Our findings that the female gender and severe rhinitis symptoms were associated with lower Mini-RQLQ scores are consistent with previous studies in AR.[29,31,32] Current smoking showed an independent adverse effect on rhinitis-specific QoL, although the detrimental role of smoking was either not reported or not documented[32] in previous surveys.

The physical (PCS) and mental health (MCS) status assessed through the generic SF-8 instrument was worse in WRR and non-WRR compared with controls, whereas these 2 domains were more impacted in WRR than non-WRR. These results accord with Airaksinen et al,[11] who used the 36-item Short Form (SF-36) questionnaire in patients with occupational rhinitis due to protein allergens. In the population-based European Community Respiratory Health Survey,[33] nonoccupational AR was associated with a decrease in the PCS score of the same magnitude as that observed in our subjects with non-WRR, whereas there was no difference in the MCS score between subjects with AR without asthma and control subjects. In addition, the multivariate analysis confirmed that both WRR and non-WRR, independently, had significant impacts on both the physical and mental components of general health-related QoL in our population. These analyses also documented an impact of demographic characteristics and comorbidities on SF-8 scores: age, female gender, chronic phlegm, and nonrespiratory comorbidities on PCS and female gender, low income, depression, and nonrespiratory comorbidities on MCS, whereas smoking had no effect. These findings are consistent with previous studies as regards female gender,[32] age,[11] low education level,[11] and smoking,[32] although the interactions between rhinitis and sociodemographic factors on general-health QoL have been scarcely explored and require further investigation.

Work disability and productivity

A retrospective Swedish cohort study[34] reported that bakers changed job due to nasal symptoms more often (6.1%) than control subjects from the general population (1.6%). In a follow-up study of greenhouse workers exposed to bell pepper pollen,[12] those with occupational rhinitis were more likely to leave their job (odds ratio: 1.62, 95% confidence interval: 0.95-2.75). Our

TABLE IV. General health-related quality of life and work productivity impairments in participants with work-related rhinitis, non–work-related rhinitis compared with the control population

Outcomes	Missing values	Control population (n = 1155)	Non–work-related rhinitis (n = 329)	Work-related rhinitis (n = 161)	*P* value*	Work-related rhinitis vs non–work-related rhinitis *P* value
General health-related quality of life (SF-8)						
SF8-Physical Component Summary	61/5/8	54.2 (48.9-56.7)	50.9 (43.6-55.2)	48.6 (38.6-54.1)	**<.001**	**.005**
SF8-Mental Component Summary	61/5/8	52.1 (46.4-57.5)	49.4 (37.8-53.4)	46.5 (40.5-54.7)	**<.001**	**.040**
General health-related work productivity (WPAI-GH)						
Any work time missed	121/28/20	76 (7.4)	32 (10.6)	23 (16.3)	**.001**	.092
Impairment at work	198/44/33	0.0 (0.0-0.0)	0.0 (0.0-10.0)	10.0 (0.0-30.0)	**<.001**	**<.001**
Any impairment at work		143 (14.9)	77 (27.0)	69 (53.9)	**<.001**	**<.001**
Overall work impairment	205/46/35	0.0 (0.0-0.0)	0.0 (0.0-10.0)	10.0 (0.0-40.0)	**<.001**	**<.001**
Any overall work impairment		153 (16.2)	82 (29.0)	69 (54.8)	**<.001**	**<.001**
Activity impairment	94/19/17	0.0 (0.0-0.0)	0.0 (0.0-20.0)	10.0 (0.0-30.0)	**<.001**	**.001**
Any activity impairment		192 (18.1)	104 (33.5)	73 (50.7)	**<.001**	**<.001**

SF-8, Medical Outcome Study Short Form-8; *WPAI-GH*, Work Productivity and Activity Impairment-General Health.
Data are presented as numbers (percentages) of subject or medians (interquartile ranges). The SF-8 Physical Component Summary (PCS) and the Mental Component Summary (MCS) scores are expressed into a 0-100 scale, with higher values indicating better health status. The WPAI-GH metrics are expressed as percentages from 0% to 100%, with higher percentages indicating greater impairment. Bold indicates statistical significance ($P < .05$).
*Comparison between the 3 groups using the Kruskal-Wallis test.

survey showed that WRR was associated with a higher prevalence (2.6%) of rhinitis-related work disability, defined as ever leaving job or changing job tasks or reducing work time due to nasal symptoms,[35] compared with non-WRR (0%). However, these figures were lower than those found among adults with rhinitis in a US population-based sample of employed adults (18%)[35] and a longitudinal cohort of pulp and paper mill workers exposed to irritants (6.1%).[24]

More importantly, our survey revealed a significantly higher rate of impaired performance at work (ie, presenteeism) related to general health in subjects with WRR than in those with non-WRR and controls, whereas absenteeism did not differ among the 3 groups. In multivariate analysis, both WRR and non-WRR had an independent adverse impact on general health-related presenteeism. The level of impaired presenteeism assessed through the WPAI-GH in subjects with WRR was, however, much lower than the pooled estimate of 35.9% of impaired presenteeism found in a systematic review of studies that used the allergy-specific version of the WPAI to evaluate the impact of nonoccupational AR on work productivity.[4] By contrast with our data, available studies on AR indicated that the most consistent determinants for a more detrimental effect on "allergy-related" work productivity included the severity of AR symptoms[4,27,36,37] and concomitant conjunctivitis.[4,30] These discordant findings between WRR and nonoccupational AR likely resulted from the use of different instruments (ie, WPAI-General Health vs WPAI-Allergy Specific questionnaires) in different populations (ie, a general workforce vs cohorts of patients with AR). In addition, most studies on AR were affected with a potential selection bias toward a more severe disease and failed to disentangle the impact of AR on work productivity from that resulting from non-respiratory comorbid conditions.[4]

Limitations

The concomitant administration of the screening and disease-specific questionnaires during routine occupational health visits contributed to reach a high participation rate (90.8%), thereby minimizing potential selection biases. Nevertheless, several limitations to the generalizability of our findings deserve further consideration. This random sample of workers may not be fully representative of the whole workforce and of all workers with WRR. The mode of recruitment through an occupational health service made it possible to reach a large sample of active workers in various industrial sectors, but we were unable to ascertain that this process provided a weighted sample of the full spectrum of occupations, especially those with a high risk of WRR. The periodic examination of workers by an occupational health service being restricted to salaried workers in Belgium, self-employed workers with a high risk of WRR, such as bakers, farmers, and hairdressers, might have been underrepresented in our population.[5-8] Nevertheless, the prevalence of rhinitis defined by the presence of at least 1 nasal symptom in our population (45.6%) was similar to that reported in a previous survey of the Belgian population (39.2%).[38] Although the information on rhinitis severity was missing in a high proportion of participants (31.8%), there is no indication that our findings might have been affected by a bias toward the recruitment of workers with more severe rhinitis symptoms. The characteristics of the subjects who completed the question on Allergic Rhinitis and its Impact on Asthma–based rhinitis severity did not differ from nonresponders. In addition, the overall rate of moderate/severe rhinitis (55.7%) was lower than the figures reported in a previous Belgian survey (70.0%)[38] and in other nationwide samples of patients with AR (73.6%-85.7%).[29,39]

The identification of rhinitis and WRR was based on validated questionnaires, but did not allow for discriminating between occupational rhinitis and work-exacerbated rhinitis.[6,8,9] However, the primary aim of this study was to investigate the impact of work-related nasal symptoms irrespective of their cause and pathophysiological mechanisms. The questionnaires did not take into account the potential effects of other causes of nasal symptoms, especially chronic rhinosinusitis and anatomical

TABLE V. Multivariate models for physical and mental components of general health quality of life

Independent variables	Unstandardized β coefficient (95% CI)	*P* value
SF-8 Physical Component Summary score (n = 1387)		
Age <35 y	2.163 (1.298 to 3.028)	**<.001**
Gender, female	−1.662 (−2.488 to −0.836)	**<.001**
Current smoking	0.473 (−0.440 to 1.385)	.310
Body mass index ≥25 kg/m^2	−1.104 (−1.934 to −0.275)	**.009**
Education level ≤12 y	−0.938 (−1.789 to −0.087)	**.031**
Rhinitis unrelated to work	−2.927 (−4.256 to −1.599)	**<.001**
Work-related rhinitis*	−4.947 (−6.769 to −3.125)	**<.001**
Work-related conjunctivitis†	−0.746 (−2.732 to 1.240)	.461
Allergic rhinitis‡	0.419 (−1.097 to 1.936)	.588
Work-related asthma§	−0.823 (−3.233 to 1.586)	.503
Chronic phlegm	−1.673 (−3.234 to −0.112)	**.036**
Depression, physician-based	−0.535 (−1.827 to 0.757)	.417
≥1 nonrespiratory comorbidity	−3.297 (−4.175 to −2.420)	**<.001**
SF-8 Mental Component Summary score (n = 1262)		
Gender, female	−2.090 (−3.036 to −1.143)	**<.001**
Current smoking	−0.674 (−1.712 to 0.364)	.203
Household net income ≤1500 EUR	−1.595 (−2.648 to −0.542)	**.003**
Rhinitis unrelated to work	−3.283 (−4.817 to −1.749)	**<.001**
Work-related rhinitis*	−4.678 (−6.760 to −2.597)	**<.001**
Work-related conjunctivitis†	−2.326 (−4611 to 0.041)	**.046**
Allergic rhinitis‡	1.314 (−0.419 to 3.047)	.137
Work-related asthma§	−0.558 (−3.252 to 2.135)	.684
Chronic phlegm	−0.092 (−1.907 to 1.723)	.921
Depression, physician-based	−6.291 (−7.791 to −4.791)	**<.001**
≥1 nonrespiratory comorbidity	−1.990 (−2998 to −0.982)	**<.001**

CI, Confidence interval; *SF-8*, Medical Outcome Study Short Form-8.
Multivariate models for the SF-8 Physical Component Summary score incorporated as independent variables those with a *P* value <.1 in univariate analyses (see Table E2, available in this article's Online Repository at www.jaci-inpractice.org) with the exception of rhinitis severity due to the high proportion of missing values. Rhinitis severity was not retained as an independent variable in the multivariate model for the SF-8 Mental Component Summary score because of a *P* value >.1 in univariate analysis. Bold indicates statistical significance ($P < .05$).
*Work-related rhinitis defined by the presence of 2 or more nasal symptoms at work.
†Work-related conjunctivitis defined by red and itchy eyes at work.
‡Allergic rhinitis defined as self-reported or physician-based allergic rhinitis.
§Work-related asthma defined as current asthma associated with ≥2 work-related asthma symptoms.

deformities, but it is unlikely that this could explain the incremental impact of WRR.

CONCLUSIONS

Despite its inherent limitations, this study indicates that both WRR and non-WRR, independently, have significant adverse impacts on health-related QoL and work productivity. The results also provide convincing evidence that WRR is associated with a more detrimental impact on these outcomes than non-WRR. These findings highlight the need to improve the identification and management of work-related nasal and ocular symptoms in clinical practice and to enhance public health awareness about the contribution of occupational exposures in rhinitis morbidity. Further investigations are required to determine whether workplace environmental interventions or pharmacologic treatment would efficiently reduce the burden of rhinitis.

TABLE VI. Multivariate model for overall work impairment

Independent variables	Any WPAI-GH overall work impairment OR (95% CI)	*P* value
Sex, female	1.396 (1.039 to 1.876)	**.027**
Body mass index ≥25 kg/m^2	1.332 (0.992 to 1.789)	**.049**
Non−work-related rhinitis	1.568 (1.006 to 2.445)	**.047**
Work-related rhinitis*	4.736 (2.672 to 8.396)	**<.001**
Work-related conjunctivitis†	1.408 (0.749 to 2.647)	.289
Allergic rhinitis‡	1.223 (0.754 to 1.984)	.415
Chronic phlegm	1.410 (0.860 to 2.312)	.174
Work-related asthma§	0.842 (0.422 to 1.682)	.841
Depression, physician-based	1.647 (1.077 to 2.519)	**.021**
≥1 nonrespiratory comorbidity	1.831 (1.323 to 2.534)	**<.001**

CI, Confidence interval; *OR*, odds ratio; *WPAI-GH*, Work Productivity and Activity Impairment-General Health.
This multivariate model included 1218 subjects. Bold indicates statistical significance ($P < .05$).
*Work-related rhinitis defined by the presence of 2 or more nasal symptoms at work.
†Work-related conjunctivitis defined by red and itchy eyes at work.
‡Allergic rhinitis defined as self-reported or physician-based allergic rhinitis.
§Work-related asthma defined as current asthma associated with ≥2 work-related asthma symptoms.

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ONLINE REPOSITORY

TABLE E1. Number of participants by industry

Industry	Participants, n (%)
Agriculture, hunting, and forestry	
Agriculture, hunting, and related service activities	14 (0.6)
Forestry, logging, and related service activities	2 (0.1)
Manufacturing	
Manufacture of food products, except beverages	21 (0.8)
Manufacture of beverages	36 (1.4)
Manufacture of wood and wood products	12 (0.5)
Manufacture of pulp, paper, and paper products	31 (1.2)
Publishing, printing, and reproduction of recorded media	23 (0.9)
Manufacture of chemicals, chemical products, and man-made fibers	180 (7.0)
Manufacture of rubber products	10 (0.4)
Manufacture of other nonmetallic mineral products	6 (0.2)
Manufacture of basic metals	4 (0.2)
Manufacture of fabricated metal products, except machinery and equipment	76 (3.0)
Manufacture of machinery and equipment	13 (0.5)
Manufacture of electrical machinery and apparatus	1 (0.1)
Manufacture of medical, precision and optical instruments, watches, and clocks	28 (1.1)
Manufacture of motor vehicles, trailers, and semitrailers	2 (0.1)
Manufacture of furniture and other manufacture	1 (0.1)
Electricity, gas, and water supply	21 (0.8)
Construction	209 (8.2)
Wholesale and retail trade, repair of motor vehicles, motorcycles, and personal and household goods	
Sale, maintenance, and repair of motor vehicles and motorcycles, retail of automotive fuel	41 (1.6)
Wholesale trade and commission trade, except vehicles and motorcycles	35 (1.4)
Retail trade, except motor vehicles and motorcycles, repair of personal and household goods	63 (2.5)
Hotels and restaurants	30 (1.2)
Transport, storage, and communication	100 (3.9)
Financial intermediation	25 (1.0)
Real estate, renting, and business activities	
Real estate activities	6 (0.2)
Renting of machinery and equipment without operator and of personal and household goods	2 (0.1)
Computer and relates activities	4 (0.1)
Research and development	8 (0.3)
Other business activities	142 (5.5)
Public administration and defense, compulsory social security	208 (8.1)
Education	278 (10.8)
Health and social work	837 (32.6)
Other community, social, and personal service activities	
Sewage and refuse disposal, sanitation, and similar activities	6 (0.2)
Activities of membership organization	44 (1.7)
Recreational, cultural, and sporting activities	12 (0.5)
Other service activities	19 (0.7)
Nonidentified activities	14 (0.5)
Total	2564

Industries were classified using the statistical classification of economic activities (NACE Rev1.1 2002) of the European Community (https://ec.europa.eu/eurostat/ramon/nomenclatures/index.cfm).

TABLE E2. Definition of symptoms/diseases and outcomes

Symptom/disease	Questions/criteria
Rhinitis[E1]	At least 2 nasal symptoms: "In the last 12 mo (when you did not have a cold or the flu); have you regularly had any of the following symptoms: Stuffy nose; runny nose; or episodes of sneezing?"
Conjunctivitis	Itchy and red eyes: "In the last 12 mo (when you did not have a cold or the flu); have you regularly had any of the following symptoms: Itchy eyes or red eyes?"
Self-reported allergic rhinitis[E2]	"Do you have nasal allergies including hay fever?"
	OR
	"When you are near animals; such as cats; dogs or horses; or in a dusty part of the house; do you ever get a runny or stuffy nose or start to sneeze?"
Physician-based allergic rhinitis	"Has a doctor ever told you that you have hay fever or nasal allergies?"
Allergic rhinitis	Self-reported or physician-based allergic rhinitis
Rhinitis severity[E3]	• Mild: nasal symptoms present, but not troublesome
	• Moderate/severe: nasal symptom rated as troublesome or very troublesome
Work-related rhinitis[E4,E5]	Rhinitis (ie, at least 2 nasal symptoms)
	AND
	A least 2 nasal symptoms at work: "When you are at work or during the following hours; do you notice the onset or worsening of: Stuffy nose; runny nose; or episodes of sneezing?"
Asthma[E6]	• Self-reported asthma: "Did you ever suffer from asthma or 'asthmatic bronchitis'?"
	• Physician-based asthma "Has a doctor ever told you that you have asthma or 'asthmatic bronchitis'?"
Current asthma[E6]	Self-reported or physician-based asthma
	AND
	"Have you had wheezing or whistling sounds in your chest apart from colds in the last 12 mo?"
	OR
	"Are you currently taking any medication for asthma?"
Work-related asthma	Current asthma
	AND
	A least 2 asthma symptom at work: "When you are at work or during the following hours, do you experience wheezing; chest tightness, shortness of breath, or cough?"
Quality of life (QoL)[E7]	• Rhinitis-specific: Mini-Rhinitis Quality of Life Questionnaire (Mini-RQLQ)
	• Generic: Medical Outcome Study Short Form-8 (SF-8) (www.qualitymetric.com)
General health work productivity impairment	• Work Productivity and Activity Impairment-General Health (WPAI-GH) (www.reillyassociates.net)
Rhinitis-related work disability[E8,E9]	• Rhinitis-related work disability: "Have you ever had to change your job or task or reduce your working time due to nasal symptoms?"
	• Number of work days missed due to nasal symptoms during the last 12 mo
Rhinitis-related sickness absence	• At least 1 self-reported work day missed due to nasal symptoms in the last 12 mo
Nonrespiratory comorbidities	• Depression
	• Diabetes, cancer, headaches, cardiovascular diseases, arterial hypertension, gastrointestinal diseases, musculoskeletal disorders, arthritis, chronic dermatitis

TABLE E3. Univariate associations with rhinitis-specific and general health-related quality of life

	Mini-RQLQ overall score		SF8 Physical Component Summary		SF8 Mental Component Summary	
Characteristics	**Median (IQR)**	***P* value**	**Median (IQR)**	***P* value**	**Median (IQR)**	***P* value**
Sex						
Female	2.0 (1.1; 2.8)	**<.001**	52.5 (45.6; 56.0)	**<.001**	52.4 (46.1; 57.5)	**<.001**
Male	1.3 (0.8; 2.1)		54.0 (48.1; 56.7)		49.7 (41.6; 54.9)	
Age						
<35 y	1.6 (1.0; 2.5)	.808	54.2 (49.4; 57.3)	**<.001**	51.0 (45.0; 56.3)	.562
≥35 y	1.6 (1.0; 2.6)		52.6 (45.0; 55.9)		51.0 (43.4, 57.3)	
Smoking habit						
Never smoker	1.6 (1.0; 2.4)	**.005**	53.5 (48.0; 56.5)	**.012**	51.1 (44.9; 57.0)	.054
Ex-smoker	1.1 (0.8; 2.0)		52.1 (44.6; 55.5)		51.7 (43.6; 57.5)	
Current smoker	2.1 (1.2; 2.9)		53.6 (46.8; 56.7)		50.6 (41.8; 55.8)	
Body mass index						
<25 kg/m^2	1.5 (1.0; 2.6)	.807	53.8 (48.4; 56.7)	**<.001**	51.3 (44.0; 57.3)	.553
≥25 kg/m^2	1.7 (1.0; 2.5)		52.6 (45.1; 55.7)		50.8 (43.8; 56.8)	
No. of household members						
<3	1.6 (1.0; 2.7)	.632	53.0 (46.7-56.4)	.594	51.1 (44.3; 56.2)	.471
≥3	1.6 (1.0; 2.5)		53.3 (47.1-56.6)		50.7 (43.6; 57.3)	
Household monthly income						
>1500 EUR	1.6 (1.0; 2.6)	.609	53.0 (46.3; 56.6)	.151	51.1 (44.7; 57.2)	**.015**
≤1500 EUR	1.8 (1.0; 2.8)		53.8 (48.1; 56.4)		50.2 (41.2; 55.8)	
Education level						
>12 y	1.4 (1.0; 2.4)	.358	53.6 (48.2; 56.7)	**.069**	50.8 (44.1; 57.0)	.690
≤12 y	1.8 (1.0; 2.7)		52.9 (45.8; 56.5)		51.1 (43.9; 57.2)	
Mother language						
French	1.6 (1.0; 2.5)	.470	53.2 (47.3; 56.5)	.225	50.9 (45.0; 57.5)	.172
Other language	2.0 (0.9; 2.9)		52.5 (44.5; 56.3)		52.0 (43.8; 56.6)	
Allergic rhinitis*						
Absent	1.4 (0.9; 2.1)	**.001**	53.8 (48.1; 56.7)	**<.001**	51.3 (45.2; 57.3)	**<.001**
Present	1.9 (1.0; 2.8)		50.0 (42.3; 54.7)		48.5 (40.0; 54.6)	
Current rhinitis†						
Absent	na	**<.001**	54.2 (48.9; 56.7)	**<.001**	52.1 (46.4; 57.5)	**<.001**
Non−work-related	1.4 (0.9; 2.1)		50.9 (43.6; 55.2)		49.4 (40.5; 54.7)	
Work-related‡	2.4 (1.5; 3.2)		48.6 (38.7; 54.1)		46.5 (37.8; 53.4)	
Rhinitis severity§						
Mild	1.0 (0.6; 1.7)	**<.001**	50.6 (43.1; 55.2)	.773	48.2 (39.4; 53.4)	.417
Moderate/severe	2.2 (1.4; 3.0)		50.6 (42.0; 55.4)		49.1 (39.9; 54.6)	
Rhinitis treatment						
Oral antihistamine	2.3 (1.4; 3.1)	**<.001**	49.8 (39.2; 54.3)	.102	49.3 (40.5; 54.8)	.172
NCS	2.4 (1.3; 3.0)	**<.001**	48.6 (38.6; 54.3)	**.021**	46.3 (38.1; 54.6)	.416
Oral antihistamine and NCS	2.7 (1.7; 3.2)	**<.001**	48.2 (36.7; 53.8)	**.013**	48.3 (38.3; 54.7)	.430
Work-related conjunctivitis‖						
Absent	1.4 (0.9; 2.4)	**<.001**	53.5 (47.5; 56.7)	**<.001**	50.0 (44.1; 57.3)	**<.001**
Present	3.0 (2.1; 4.0)		48.7 (42.4; 54.2)		46.7 (37.9; 54.4)	
Current asthma						
Absent	1.5 (0.9; 2.4)	**.004**	53.7 (47.7; 56.7)	**<.001**	51.1 (44.2; 57.3)	**.008**
Present	2.1 (1.1; 3.1)		48.9 (40.5; 53.0)		49.6 (40.5; 54.6)	
Work-related asthma¶						
Absent	1.5 (0.9; 2.4)	**.008**	53.6 (47.6; 56.7)	**<.001**	51.8 (44.1; 57.3)	**<.001**
Present	2.6 (1.2; 3.3)		48.1 (38.7; 52.8)		46.1 (36.8; 52.8)	
Chronic phlegm						
Absent	1.6 (1.0; 2.5)	.129	53.5 (47.6; 56.7)	**<.001**	51.2 (44.2; 57.3)	**<.001**
Present	1.9 (1.2; 3.2)		47.8(38.4; 51.1)		48.5 (40.2; 54.7)	
Depression; physician-based						
Absent	1.5 (1.0; 2.5)	**.038**	53.7 (47.8; 56.7)	**<.001**	51.5 (45.8; 57.2)	**<.001**
Present	2.1 (1.1; 3.0)		49.8 (42.0; 54.5)		40.8 (35.3; 51.9)	

(continued)

TABLE E3. *(Continued)*

Characteristics	Mini-RQLQ overall score		SF8 Physical Component Summary		SF8 Mental Component Summary	
	Median (IQR)	*P* value	Median (IQR)	*P* value	Median (IQR)	*P* value
Nonrespiratory comorbidity						
Absent	1.5 (0.9; 2.1)	**.025**	54.9 (51.1; 56.9)	**<.001**	53.6 (48.3; 57.5)	**<.001**
Present	1.6 (1.0; 2.8)		51.2 (42.9; 55.4)		49.7 (40.8; 54.9)	

IQR, Interquartile range; *Mini-RQLQ*, Mini-Rhinitis Quality of Life Questionnaire; *NCS*, nasal corticoid spray; *SF-8*, Medical Outcome Study Short Form-8.
Bold indicates statistical significance ($P < .05$).
*Allergic rhinitis defined by either self-reported or physician-based allergic rhinitis.
†Current rhinitis defined by the presence of 2 or more nasal symptoms (ie, stuffy nose, runny nose, or sneezing) on a regular basis during the last 12 months.
‡Work-related rhinitis defined as current rhinitis with ≥2 work-related rhinitis symptoms.
§Rhinitis severity graded according to the Allergic Rhinitis and its Impact on Asthma (ARIA) guidelines.
‖Work-related conjunctivitis defined by red and itchy eyes at work.
¶Work-related asthma defined as current asthma associated with ≥2 work-related asthma symptoms.

TABLE E4. Multivariate model for SF-8 Physical Component Summary score including rhinitis severity

Independent variables	Unstandardized β coefficient (95% CI)	*P* value
Age <35 y	3.614 (1.661 to 5.567)	**<.001**
Gender: female	−2.791 (−4.758 to −0.824)	**.006**
Current smoking	−1.329 (−3.580 to 0.923)	.246
Body mass index ≥25 kg/m^2	−1.155 (−3.152 to 0.842)	.256
Education level ≤12 y	−1.904 (−3.962 to 0.155)	.070
Work-related rhinitis*	−2.015 (−4.339 to 0.309)	.089
Work-related conjunctivitis†	−0.991 (−2.592 to 1.602)	.642
Allergic rhinitis‡	−0.495 (−2.276 to 1.770)	.710
Moderate/severe rhinitis§	0.237 (−1.759 to 2.232)	.815
Work-related asthma‖	−1.503 (−5.285 to 2.279)	.435
Chronic phlegm	−0.033 (−2.974 to 2.908)	.982
Depression; physician-based	−4.173 (−7.023 to −1.322)	**.004**
≥1 nonrespiratory comorbidity	−3.070 (−5.236 to −0.904)	**.006**

CI, Confidence interval; *SF-8*, Medical Outcome Study Short Form-8.
This multivariate linear regression model incorporated only subjects with rhinitis who answered the question pertaining to the severity of nasal symptoms (n = 314). Bold indicates statistical significance ($P < .05$).
*Work-related rhinitis defined by the presence of 2 or more nasal symptoms at work.
†Work-related conjunctivitis defined by red and itchy eyes at work.
‡Allergic rhinitis defined as self-reported or physician-based allergic rhinitis.
§Rhinitis severity graded according to the Allergic Rhinitis and its Impact on Asthma (ARIA) guidelines.
‖Work-related asthma defined as current asthma associated with ≥2 work-related asthma symptoms.

TABLE E5. Univariate associations with overall work impairment

Characteristics	Missing values	Any WPAI-GH overall work impairment		*P* value
		Absent (n = 1051)	Present (n = 304)	
Sex, female	1/0	475 (45.2)	162 (53.3)	**.013**
Age <35 y	4/2	373 (35.6)	105 (34.8)	.840
Smoking habit				
Never smoker	17/1	516 (49.9)	149 (49.2)	.166
Ex-smoker		192 (18.6)	70 (23.1)	
Current smoker		326 (31.5)	84 (27.7)	
Body mass index ≥25 kg/m^2	69/22	441 (45.0)	146 (51.4)	.051
No. of household members ≥3	18/5	611 (59.1)	162 (54.2)	.125
Household net monthly income ≤1500 EUR	176/39	230 (26.2)	77 (29.1)	.357
Education level ≤12 y	26/5	639 (63.3)	175 (58.5)	.233
Mother language other than French	3/0	85 (8.1)	29 (9.5)	.430
Allergic rhinitis*	0/0	156 (14.8)	98 (32.2)	**<.001**
Rhinitis pre-existing to current job	975/257	64 (84.2)	38 (80.9)	.630
Current rhinitis†	0/0			
Absent		793 (75.5)	153 (50.3)	**<.001**
Non−work-related		201 (19.1)	82 (27.0)	
Work-related‡		57 (5.4)	69 (22.7)	
Moderate/severe rhinitis§	876/203	94 (53.7)	62 (61.4)	.216
Rhinitis treatment				
Oral H_1-antihstamine	876/202	54 (31.0)	33 (32.4)	.820
NCS	878/202	47 (27.2)	32 (31.4)	.457
Oral H_1-antihstamine and NCS	878/202	23 (13.3)	17 (16.7)	.444
Work-related conjunctivitis‖	0/0	33 (3.1)	34 (11.2)	**<.001**
Current asthma	0/0	66 (6.3)	39 (12.8)	**<.001**
Work-related asthma¶	7/5	28 (2.7)	16 (5.4)	**.022**
Chronic phlegm	36/13	60 (5.9)	39 (13.4)	**<.001**
Depression; physician-based	2/0	86 (8.2)	56 (18.4)	**<.001**
≥1 nonrespiratory comorbidity	2/0	544 (51.9)	222 (73.0)	**<.001**

NCS, Nasal corticosteroid spray; *WPAI-GH*, Work Productivity and Activity Impairment-General Health.
Data are expressed as numbers and percentages. Bold indicates statistical significance ($P < .05$).
*Allergic rhinitis defined by either self-reported or physician-based allergic rhinitis.
†Current rhinitis defined by the presence of 2 or more nasal symptoms (ie, stuffy nose, runny nose, or sneezing) on a regular basis during the last 12 months.
‡Work-related rhinitis defined as current rhinitis with ≥2 work-related rhinitis symptoms.
§Rhinitis severity graded according to the Allergic Rhinitis and its Impact on Asthma (ARIA) guidelines.
‖Work-related conjunctivitis defined by red and itchy eyes at work.
¶Work-related asthma defined as current asthma associated with ≥2 work-related asthma symptoms.

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