Self-Reported Allergic Rhinitis Prevalence and Risk Factors in Employees of the China National Railway

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BACKGROUND: Allergic rhinitis (AR) is a common allergic disease globally and its prevalence is increasing year by year. This study aimed to analyze the prevalence and risk factors of self-reported AR among the Chinese National Railway train crew in the China Railway Beijing Group.

METHODS: This prospective questionnaire study surveyed 1511 randomly recruited train crewmembers from 20 cities in the China National Railway network, and 494 reported having AR. A structured questionnaire was tailored, designed, and delivered electronically to all subjects. Prevalence of and risk factors for AR were analyzed based on self-reported results.

RESULTS: The prevalence of self-reported AR among train crewmembers was 32.6%. Among respondents, 86.03% worked in passenger cars and 64.6% reported having worse AR symptoms while on trains. AR frequencies were 40.15% perennially and 59.85% seasonally. Among the Total Nasal Symptoms Scores (TNSS), significant differences were found between rhinorrhea and sneezing and between nasal itching and sneezing. The Rhino-Conjunctivitis Quality of Life Questionnaire (RQLQ) showed significant correlations between all seven sections. TNSS was significantly associated with the RQLQ. Scores of both the TNSS and RQLQ showed that the severity of AR symptoms ($r_p = 0.103$) and the impact on quality of life ($r_p = 0.113$) correlated significantly with seniority.

CONCLUSIONS: The prevalence of self-reported AR among train crew working in passenger cars is higher than that of the general Chinese population. The severity of AR symptoms and the impact on quality of life are associated with seniority, meaning the number of years working on trains.

KEYWORDS: allergic rhinitis, self-reported prevalence, train crew, Rhino-Conjunctivitis Quality of Life Questionnaire, Total Nasal Symptoms Scores.

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Allergic rhinitis (AR) is a noninfectious chronic inflammatory disease of the nasal mucosa mainly mediated by immunoglobulin E antibodies produced after the body is exposed to allergens. The clinical symptoms include rhinorrhea, sneezing, nasal congestion, and nasal itching.[1,18] AR is a common upper respiratory disease and is also associated with many other allergic diseases, including allergic asthma, sinusitis, eczema, dermatitis, and eye symptoms.[1] Long-term AR affects patients' moods and sleep quality, while severe AR reduces the patients' learning and working efficiency.

Epidemiological surveys have shown that the prevalence of AR has increased significantly in recent years, resulting in a larger disease burden.[16] AR is now one of the most common allergic diseases in the world. A 2013 report on allergies by the World Allergy Organization indicated that global allergic diseases have caused a huge financial and public health burden in both developed and developing countries.[13] In recent years, the rapid development of industry has resulted in serious air pollution, leading to a rapid increase in the number of people affected by AR in China.[15] In mainland China, the railway network is an important part of the national infrastructure and a

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popular means of transportation between major cities, and it plays a key role in the comprehensive transportation system. In 2019, the yearly passenger volume of the national railway reached 3.66 billion passengers in mainland China.[6] Therefore, the occupational safety and health of railway staff is related to the life and safety of passengers, which is worth noting. This study aimed to analyze the prevalence and risk factors of self-reported AR among Chinese National Railway employees.

METHODS

Subjects

This prospective survey study randomly recruited members of the train crew of the China National Railroad Beijing Group. The working positions of train crewmembers in CR Beijing include engineering, logistics, vehicle service, passenger services, and maintenance. The train crewmembers were from 20 cities in the China National Railway network. A structured questionnaire was tailored and designed and train crewmembers were randomly recruited to participate in this study to investigate the prevalence of self-reported AR by questionnaire. The study protocol was approved by the Ethics Committee of our institution. Signed informed consent was provided by all subjects prior to inclusion.

Procedure

The questionnaire consisted of two parts. The first part was the screening questionnaire, in which each subject was asked the following question: "Do you often have problems with continuous sneezing, profuse runny nose, nasal congestion or itching?" If the answer was "yes", the subject continued to answer the first specific questions in Part Two. Part Two consisted of three parts to collect the following information. 1) AR history: self-reported allergens (triggering factors); complications; history of nasal surgery; family history of allergic disease; whether the duration of nasal symptoms, perennial AR, or seasonal AR was worsened in passenger cars; and whether it correlated with working hours in the train. 2) The Total Nasal Symptoms Score (TNSS) scale included runny nose, sneezing, nasal congestion, and nasal itching. Severity of symptoms was indicated by a score from 0–4, where: 0 = asymptomatic, 1 = mild, 2 = moderate, 3 = severe, and 4 = extremely severe. 3) The Rhinitis-Conjunctivitis Quality of Life Questionnaire (RQLQ) scale included 7 sections and 28 factors. The factors affecting quality of life included these problems: activity limitation, sleep problems, performance, practical problems, nasal symptoms, eye symptoms, and emotions. A score of 0–6 indicated varying degrees of activity disturbed by nasal/ocular symptoms, where: 0 = no trouble, 1 = hardly troubled, 2 = somewhat troubled, 3 = moderately troubled, 4 = very troubled, 5 = very troubled, and 6 = extremely troubled.

AR was then diagnosed according to the criteria of Allergic Rhinitis and its Impact on Asthma guidelines. The severity and duration of AR were classified as mild, moderate/severe, intermittent, or persistent. AR was divided into perennial and seasonal AR. All subjects completed a screening questionnaire. Subjects with self-reported AR continued to complete the second part, while those without AR were automatically terminated and not included.

Statistical Analysis

Continuous data are presented as mean ± SD. Categorical data are presented as *N* (%). Differences between the four symptoms from the TNSS were measured by the Kruskal-Wallis test and the post hoc multiple comparisons by the Steel-Dwass-Critchlow-Fligner pairwise ranking nonparametric method. Additionally, Spearman rank correlation analysis was used to assess the correlations between seven sections of the RQLQ scale and the correlations between RQLQ and TNSS with the factors of seniority and worktime. All *P*-values were two-sided and $P < 0.05$ was established as statistical significance. All statistical analyses were performed using the statistical software package SAS software version 9.4 (SAS Institute Inc., Cary, NC, USA).

RESULTS

A total of 1511 train crewmembers participated in and completed the study. Among them, 494 had self-reported AR. The overall prevalence of self-reported AR was 32.6%. The train crewmembers came from 20 cities (**Table I**). Most subjects lived in Beijing, Hebei, Tianjin, Shandong, and Shanxi. The characteristics of subjects with self-reported AR are shown in **Table II**. More than half of the subjects with AR were men (56.48%) and working in the passenger traffic section (86.03%). The mean age, seniority, history of AR, and workdays per week of the subjects with AR in this study were 33.15 ± 8.20 yr, 11.74 ± 7.93 yr, 6.32 ± 5.52 yr, and 3.64 ± 0.55 d, respectively. The most common serious symptom was nasal congestion (39.04%). A total of 67.36% of subjects thought that having AR symptoms was related to their working hours on the trains, and 64.60% reported that symptoms were exacerbated when they were on the trains. More than half of the crew with AR reported that symptoms were seasonal (59.85%) and affected their quality of life (70.63%). The common allergens were cold air (51.82%), dust mites (50.20%), and plant pollen (23.48%). The comorbidities of AR included sinusitis (20.04%), eczema (18.83%), and allergic dermatitis (12.75%). The mean TNSS was 10.20 ± 3.16, with nasal congestion (2.71 ± 0.94), rhinorrhea (2.45 ± 1.04), nasal itching (2.50 ± 0.97), and sneezing (2.54 ± 0.99). Furthermore, the RQLQ scores included activity limitation (9.68 ± 3.94), sleep problems (10.21 ± 5.02), performance (24.25 ± 11.39), practical problems (11.22 ± 5.20), nasal symptoms (14.35 ± 6.37), eye symptoms (12.8 ± 6.58), and emotions (13.06 ± 7.03). The mean RQLQ score was 94.50 ± 40.88.

The differences in symptoms from the TNSS are summarized in **Table III**. Significant differences in TNSS were found between the four symptoms (all overall $P = 0.007$). A significant difference was also noted between rhinorrhea and nasal

Table I. Geographic Distribution of Subjects' Home Cities.

CITY	COMPLETED SCREENING QUESTIONNAIRE	SELF-REPORTED AR	PREVALENCE OF AR (%)
Beijing	731	265	36
Hebei	546	167	31
Tianjin	75	25	33
Shandong	28	12	43
Shanxi	27	3	11
Guangdong	13	5	38
Shanghai	8	3	38
Jiangsu	7	2	29
Henan	7	2	29
Hunan	7	0	0
Anhui	5	2	40
Sichuan	4	3	75
Liaoning	4	0	0
Chengdu	2	2	100
Hubei	2	2	100
Inner Mongolia	1	0	0
Jilin	1	0	0
Jiangxi	1	1	100
Zhejiang	1	0	0
Missing	41	-	-

AR: allergic rhinitis.

congestion; the mean rank for all TNSS scores for rhinorrhea was higher than the mean rank for nasal congestion (mean rank: 210.22 vs. 161.30, $P = 0.016$) (Table II). **Table IV** shows significant positive correlations between the seven sections of the RQLQ scale [all Spearman's correlation coefficients (r_p) > 0.65 and $P < 0.001$], particularly the correlation between Performance and Emotions, which was extremely high ($r_p = 0.90$). Significant positive correlations were found between seniority and the TNSS or RQLQ scale ($r_p = 0.103$, $P = 0.049$; $r_p = 0.113$, $P = 0.041$, respectively), but not with working hours (**Table V**).

DISCUSSION

In recent years, the global prevalence of AR has been 10–40% and the affected individuals' quality of life was severely reduced.[2,16] AR affects 20–30% of adults in both the United States and Europe, with perhaps a somewhat higher percentage among children.[17,19] In South Korea and Japan, the incidence of AR has also increased in the past decade.[7,12] In mainland China, a multiyear longitudinal study found that the number of individuals with AR also increased year by year.[20] A questionnaire survey reported that the AR prevalence in China was 11.1% (8.7–24.1%) in 38,000 adults in 2005, but increased to 17.6% (9.8–23%) in 47,216 adults in 2011.[20] These results show that the prevalence of AR in mainland China continued to increase rapidly in the 21st century.

The present study shows that the mean prevalence of self-reported AR among the train crew was 32.6%, which is significantly higher than the national average in China. The incidence of AR among train crew living in Beijing, Hebei, Tianjin, Shandong, Shanghai, and Jiangsu was higher than the average for all train crew with self-reported AR. The high prevalence of AR in the cities where the employees live may be associated with the degree of urban industrialization, because previous studies have noted a positive correlation between the degree of urban industrialization and the severity of air pollution.[20,22]

The prevalence of self-reported AR in train crew working in passenger cars is higher than the prevalence among their colleagues in other departments (0.5–6.5%) and the general population in China (17.6%).[20] The crewmembers with AR reported that the symptoms became worse at work, while the top three antigens that trigger allergies were cold air, dust mites, and pollen. Taking train attendants' working environment and duties together, the following conditions may apply. First, the train crew usually cross through different cities, so they may experience seasonal changes and temperature alterations. Pollen during spring and autumn, and cold air during winter months, easily stimulate nasal hyperactivity.[21] Hence, the crew's AR symptoms are perennial and become worse during spring and autumn. Second, passenger cars are a special working environment with poor air circulation and high microparticle levels. The inner environment, including sponge-cushion seats, carpeted corridor, and old blankets in the sleeper, all provide suitable places for dust mites. Cha et al. investigated the concentrations of airborne particles inside trains and found that the highest exposure to PM10 and PM2.5 levels is in the passenger cars.[4] An interior ventilation system helps improve the air circulation inside trains. To attenuate the onset frequency and severity of AR among train attendants, it is critical to improve labor protections and optimize the working environment.

The present study shows that train crewmembers who are affected by AR also have comorbidities, including sinusitis, eczema, and allergic dermatitis. Prolonged severe AR has also been reported to be associated with physical and psychological symptoms, including anxiety,[8] depression, and sleep disorders.[3,9,23]

Table II. Baseline Characteristics of AR Subjects (*N* = 494).

VARIABLE	MEAN ± SD.	NO. (%)
Demographic		
Sex		
Male		279 (56.48)
Female		215 (43.52)
Age (yr) (missing = 4)	33.15 ± 8.20	
Position (missing = 14)		
Engineering		2 (0.40)
Logistics		7 (1.42)
Vehicle service		14 (2.83)
Passenger services		425 (86.03)
Maintenance		32 (6.48)
Seniority (yr) (missing = 13)	11.74 ± 7.93	
Work time (d/wk) (missing = 46)	3.64 ± 0.55	
Most serious symptoms (missing = 59)		
Sneezing		107 (24.43)
Rhinorrhea		59 (13.47)
Nasal itching		101 (23.06)
Nasal congestion		171 (39.04)
AR duration (yr) (missing = 124)	6.32 ± 5.52	
Feeling worse on trains (missing = 59)		281 (64.60)
AR related to work hours on trains (missing = 62)		291 (67.36)
History of sinus surgery (missing = 58)		20 (4.59)
Frequency of allergic rhinitis (missing = 98)		
Perennial		159 (40.15)
Seasonal		237 (59.85)
Symptom times (missing = 121)		
Symptoms 4 d/wk and 4 > consecutive weeks		188 (50.40)
Symptoms 4 < d/wk or 4 < consecutive weeks		185 (49.60)
Effect on quality of life (missing = 99)		279 (70.63)
Allergen		
Dust mite		248 (50.20)
Dog hair		24 (4.86)
Cat hair		25 (5.06)
Pollen		116 (23.48)
Cosmetics		32 (6.48)
Cold air		256 (51.82)
Unknown things on the train cars		270 (54.66)
Allergic diseases		
Asthma		22 (4.45)
Eczema		93 (18.83)
Dermatitis		63 (12.75)
Nasal polyps		31 (6.28)
Sinusitis		99 (20.04)
Without allergic diseases		237 (47.98)
Allergy history		
Parents		13 (2.63)
Father		37 (7.49)
Mother		31 (6.28)
Siblings		25 (5.06)
Child		26 (5.26)
TNSS (missing = 117)	10.20 ± 3.16	
Nasal congestion (missing = 105)	2.71 ± 0.94	
Rhinorrhea (missing = 107)	2.45 ± 1.04	
Nasal itching (missing = 96)	2.50 ± 0.97	
Sneezing (missing = 97)	2.54 ± 0.99	
RQLQ (missing = 156)	94.5 ± 40.88	
Activity limitation (missing = 116)	9.68 ± 3.94	
On train (missing = 101)	3.57 ± 1.59	
Indoors (missing = 111)	3.07 ± 1.42	
Outdoors (missing = 115)	3.10 ± 1.52	
Sleep problems (missing = 117)	10.21 ± 5.02	
Difficulty falling asleep (missing = 110)	3.40 ± 1.74	
Waking up at night (missing = 112)	3.29 ± 1.73	
Poor night sleep (missing = 111)	3.54 ± 1.82	
Performance (missing = 121)	24.25 ± 11.39	
Lack of energy (missing = 109)	3.52 ± 1.78	
Thirsty (missing = 115)	3.29 ± 1.71	
Decreased ability to work (missing = 111)	3.39 ± 1.79	
Tired (missing = 108)	3.68 ± 1.76	
Difficulty concentrating (missing = 111)	3.39 ± 1.76	
Headache (missing = 111)	3.44 ± 1.76	
Exhausted (missing = 109)	3.56 ± 1.81	
Practical problems (missing = 119)	11.22 ± 5.2	
Inconvenience of having to bring tissues (missing = 115)	3.66 ± 1.84	
Need to rub nose/eyes (missing = 113)	3.81 ± 1.77	
Need to blow your nose repeatedly (missing = 114)	3.75 ± 1.85	
Nasal symptoms (missing = 124)	14.35 ± 6.37	
Nasal congestion/stuffy nose (missing = 110)	3.97 ± 1.80	
Runny nose (missing = 118)	3.62 ± 1.81	
Sneezing (missing = 116)	3.55 ± 1.72	
Runny nose drains down throat (missing = 121)	3.27 ± 1.82	
Eye symptoms (missing = 125)	12.8 ± 6.58	
Itchy eyes (missing = 117)	3.46 ± 1.87	
Weeping (missing = 120)	3.24 ± 1.77	
Eye pain (missing = 123)	3.12 ± 1.72	
Swollen eyes (missing = 124)	3.01 ± 1.72	
Emotions (missing = 124)	13.06 ± 7.03	
Frustrated (missing = 116)	3.07 ± 1.81	
Impatient or restless (missing = 115)	3.33 ± 1.83	
Irritable (missing = 118)	3.37 ± 1.91	
Embarrassed by symptoms (missing = 119)	3.31 ± 1.84	

(continued)

AR: allergic rhinitis; TNSS: Total Nasal Symptoms Scores; RQLQ: Rhino-Conjunctivitis Quality of Life Questionnaire.

Table III. Differences in Symptoms from the TNSS (*N* = 353).

SYMPTOM GROUP	MEAN RANK	SDCF VALUE	*P*-VALUE*
A–B	193.41–210.22	1.500	0.714
A–C	193.41–166.29	2.306	0.362
A–D	193.41–161.30	3.345	0.084
B–C	210.22–166.29	3.220	0.103
B–D	210.22–161.30	4.182	**0.016**
C–D	166.29–161.30	0.397	0.992

TNSS: Total Nasal Symptoms Scores.
A: sneezing (*N* = 82); B: rhinorrhea (*N* = 52); C: nasal itching (*N* = 73); D: nasal congestion (*N* = 146); SDCF: Steel-Dwass-Critchlow-Fligner.
The overall *P*-value for comparison of TNSS levels between the symptom groups was 0.007. *P*-values < 0.05 are shown in bold.
*The Kruskal-Wallis test and Steel-Dwass-Critchlow-Fligner pairwise ranking nonparametric method was performed for the post hoc multiple comparison of the Kruskal-Wallis test.

Table IV. The Spearman's Correlation Coefficient Between Seven Sections of the RQLQ Scale.

	A	B	C	D	E	F	G
A	1						
B	0.691	1					
C	0.729	0.874	1				
D	0.746	0.753	0.824	1			
E	0.749	0.765	0.839	0.891	1		
F	0.657	0.733	0.784	0.715	0.733	1	
G	0.705	0.777	0.900	0.819	0.831	0.776	1

RQLQ: Rhino-Conjunctivitis Quality of Life Questionnaire.
A: Activity limitation ($N = 378$); B: Sleep problems ($N = 377$); C: Performance ($N = 373$); D: Practical problems ($N = 375$); E: Nasal symptoms ($N = 370$); F: Eye symptoms ($N = 369$); G: Emotions ($N = 370$).
All P-values < 0.001.

RQLQ scores in the present study also showed that problems affecting the working efficiency of train crew with AR included problems with work performance, practical problems, and sleep problems. All of these problems reduced patients' quality of life. Therefore, it is important to care for the symptoms and progress of crewmembers with AR. For example, nasal congestion caused by AR correlated positively with sleep disturbance; therefore, effective treatment for AR may improve patients' sleep quality.[23] The relationship between AR and other allergic diseases also deserves more attention, since treating one condition may also benefit the others.

AR is an allergic disease that involves a combination of genetic,[5] epigenetic, and environmental factors.[10,11,14] In the present study, ~27% of the train crew with AR had a family history of allergic disease. The prevalence of AR is comparable whether the subject's parents, siblings, or children are affected (Table II, 5–7.5%), suggesting that genetic factors play a role in AR pathogenesis. In addition, only 4.59% of the crewmembers with AR had a history of nasal surgery.

Mainland China has a vast land area, a large population, and strong population aggregation. The distance between gathering places is relatively concentrated and natural resources are unevenly distributed, so the railway has become a widely used mode of transportation in mainland China and plays a very important role in the development of the national economy.[6] The occupational safety and health of railway-related personnel has also become an important issue.

The present questionnaire survey study is limited by the relatively small sample size in Beijing city. We plan to investigate train crews of the China National Railway over the whole country and compare the prevalence of AR in different geographic areas in the future.

Table V. Spearman's Correlation Coefficient Between TNSS and RQLQ with Seniority and Worktime.

GROUP	r_p	*P*-VALUE
Total TNSS score ($N = 377$)		
Seniority ($N = 366$)	0.103	**0.049**
Worktime ($N = 345$)	−0.009	0.868
Total RQLQ score ($N = 338$)		
Seniority ($N = 329$)	0.113	**0.041**
Worktime ($N = 309$)	0.008	0.892

TNSS: Total Nasal Symptoms Scores; RQLQ: Rhino-Conjunctivitis Quality of Life Questionnaire.
P-values < 0.05 are shown in bold.

In conclusion, this is the first study focusing on the prevalence and symptoms of self-reported AR among Chinese train crew. Train attendants working in passenger cars have a high prevalence of AR, which is related to the working environment and seniority. Long-term AR also affects the mood and work performance of train crew with seniority. Through this study, we have gained a preliminary understanding of the current status and complications of AR among Chinese train crew, which may help to correct interventions to control AR in this occupational population.

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