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MEDICAL CONSULTATION RATE OF ALLERGIC RHINITIS AND POLLINOSIS SURVEILLANCE IN AICHI, JAPAN

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ABSTRACT

The medical consultation rate of allergic rhinitis (AR) was analysed using Japan National Health Insurance records of Aichi Prefecture for May 1989. Data collected from 88 cities, towns and villages were tabulated and divided into five-year age groups. The standardized medical consultation rate (SMCR) of AR in each municipality was then calculated. It was found that SMCR of AR did not correlate well with the pollen count for Japanese cedars, Japanese cypresses or gramineae, respectively, but a weak correlation with the mean yearly levels of nitrogen dioxide was suggested by the data. There was a significant positive correlation between SMCR of AR and the mean yearly levels of suspended particulate matter, the major element of which is diesel exhaust particulate.

Key Words: Air pollution, Allergic rhinitis, Diesel exhaust particulate, Japanese cedar pollinosis, Pollen, Medical consultation rate.

INTRODUCTION

In Japan, seasonal allergic rhinitis (AR) caused by Japanese cedar pollen (JCP) has recently been on the rise,[1] with the medical consultation rate (MCR) of AR rising three times in the ten years from 1981 to 1990.[2] Although Japanese cedar pollinosis was originally reported by Horiguchi and Saito[3] in 1964, it did not receive widespread attention until the 1980s.

There are many arguments and much speculation as to why Japanese cedar pollinosis has risen so rapidly in recent years.[4] Firstly, a large number of Japanese cedars have been planted in mountain areas in the last 40 years.[5] We note here that Japanese cypress pollen has the same antigen as Japanese cedar pollen[6,7] and that the season of the Japanese cedar, *cryptomeria japonica*, is from February to April, and that of the Japanese cypress, *cupressaceae*, is from April to May. At present, Japanese cedars occupy, by area, 45 per cent of the coniferous forests planted artificially in Japan. Additionally, Japanese cypress trees occupy 23 per cent of that land. In total, this is a not inconsiderable two thirds of the total land set aside for coniferous forests. It is not until Japanese cedars are 30 years of age, that they release their greatest amount of pollen.

Secondly, air pollution levels, related to the large rise in the use of diesel-engined vehicles, have been thought to be a causative factor in Japanese cedar pollinosis. In Japan, from 1985 to 1988, the overall car population rose from 49 million to 55 million vehicles, a 12% increase. Diesel-engined vehicles rose from 6.3 million to 8.3 million units, or 32%.[8]

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Additionally, the level of house dust in homes has increased with the change in type of house structures in Japan.[9] Traditional wooden quarters have now been replaced with the ubiquitous concrete high-rise, causing house dust to be more easily trapped than before.

Various causative factors of Japanese cedar pollinosis are suspected, but few papers that analyse their overall effects have been written to date. For the present study, data were collected from each city and town in Aichi Prefecture, and the average counts of JCP dispersion, gramineae dispersion and various air pollutant levels, including sulfur dioxide (SO_2), nitrogen dioxide (NO_2) and suspended particulate matter (SPM) were tabulated. This paper aims to analyze statistically and compare the suspected causative factors of Japanese cedar pollinosis and to try to determine the relative significance of each.

MATERIALS AND METHODS

Japanese cedar pollinosis surveillance has recently been introduced on a widespread scale. There are several pollinosis surveillance centers, including some in Aichi Prefecture, that measure the seasonal JCP count.[10,11] Generally, most of the pollinosis surveillance is focused on the trends in causative pollen dispersion, while some are aimed at analyzing the number of patients with allergic rhinitis in otorhinolaryngology clinics or with allergic conjunctivitis, as fixed-point observations.

The pollen count is recorded for Japanese cedars and cypresses everyday from February 1 until April 30 every year, and for the gramineae pollen counts, from May 1 until October 31. For the purpose of this study, only May's figures for the gramineae were used, while for the Japanese cedars and cypresses, both their total and peak counts were used. The dispersed pollen count was collected from 18 monitoring sites using IS Rotary Pollen Traps,[12] which were all well distributed within Aichi Prefecture (Fig. 1.). It should be noted that the IS Rotary Pollen Trap collects approximately five times as much pollen as the Durham's Pollen Trap, which is the more widely used.

Fig. 1. Observation sites of atmospheric pollen count using the *IS Rotary Pollen Trap*™ in Aichi Prefecture.

The MCR of AR for 88 municipalities, towns and cities in Aichi Prefecture was analyzed using Japan National Health Insurance records for May 1989, and these records were classified for each municipality into five-year age groups. Since the National Health Insurance scheme has the self-employed (e.g., farmers) and their families as its largest insurants, there may be some slight deviations in occupations and age distributions from municipality to municipality, with rural districts differing from city areas.

However, National Health Insurance is the only system that classifies its data into the 88 municipalities used for this study. Gender differences have not been found to have discernible effects on the MCR of AR,[13] and the present data were not tabulated according to gender. It should be noted that the records are kept only for the diagnosis, prescription and subsequent treatment of the primary illness diagnosed and treated.

The Japanese Environment Agency collects data from more than 50 municipalities in Aichi[14] and of those, 51 municipalities record SO_2 measurements and 50 record both NO_2 and SPM. For the present study, the level of pollutants from April 1988 to March 1989 were tabulated and a yearly average was determined. For municipalities that recorded more than one measurement of a certain pollutant in their area, an average value was calculated and used as representative of that municipality. Among the 88 municipalities, over 50 measure levels of air pollutants, 18 measure pollen counts and 15 measure both.

Rate$_r$ was defined as the number of AR sufferers divided by the total number of *records* of any ailment. In this study, rate$_r$ is favoured over rate$_i$ (number of AR sufferers divided by the total number of *insurants*) in the assessment of AR due to a variety of reasons. Access to clinics determines the number of claims that are made, and in rural areas, this access may be difficult, clinics may be too far away or people are reluctant to seek medical attention for what they consider to be only minor ailments. By considering records of disorders only, rate$_r$ may be deemed a more suitable parameter.

Using the rate$_r$ of AR, the standardized medical consultation rate$_r$ (SMCR) was computed and adjusted for age distribution by indirect methods (SMCR: all of Aichi = 1.0). Firstly, the rate$_r$ of AR for each of the five-year age groups was determined for all of Aichi prefecture. Next, for each city, the expected number of patients was calculated by multiplying the total number of patients by the rate$_r$ for all of Aichi, for each age group. The individual age groups' figures were then totaled and the resulting figure was the expected number of records of AR in each city. The number of observed records was divided by the expected number of records to determine the SMCR of AR for each city. Using this figure and the major suspected causative factors, a correlation coefficient matrix was calculated and used as the basis for the present study.

RESULTS

Table 1 shows the MCR$_i$ of AR outpatients by age groups tabulated from National Health Insurance records in May 1989. From this table, it can be seen that the MCR$_i$ of AR is 0.746% of the insured population of all of Aichi Prefecture. There are two recognizable peaks, one in the age groups from 5 to 14 years and the other in the 30 to 39 years age groups. We note too, that rate$_r$ displays similar trends.

Table 2 shows the total Japanese cedar and cypress pollen counts and the gramineae pollen count in 1989 and the SMCR of AR from the 18 pollen monitoring sites, divided into four districts. For Japanese cedars and cypresses, the minimum pollen count was recorded in East Owari, and the maximum in East Mikawa. The gramineae pollen count recorded a minimum in East Mikawa and a maximum in East Owari. The calculated SMCR had a minimum in West

Owari and a maximum in West Mikawa. West Mikawa recorded the highest SMCR of AR, 1.2819%, while West Owari recorded 0.9104%.

Table 3 shows the five highest pollution levels for centers that recorded such levels. The mean level of SO_2 (in 51 recording municipalities) was 0.008 ppm, the minimum being 0.004 ppm and the maximum, 0.014 ppm. The mean value of NO_2 in the prefecture (50 municipalities) was 0.019 ppm, the minimum, 0.008 ppm and the maximum, 0.031 ppm. The mean value of SPM (50 municipalities) was 0.044 mg/m^3, the minimum, 0.028 mg/m^3 and the maximum, 0.061 mg/m^3.

From Table 4, the correlation coefficients among the various suspected causative factors can be seen. These include the various pollen counts and the air pollutant levels. There is a highly significant correlation between the seasonal count and the maximum count of the Japanese cedars and cypresses, as expected. Similarly, the pollutants have significant correlations among themselves.

Table 5 shows that all the pollen counts used in this analysis have little discernible correlation with SMCR of AR. However, for the air pollutant NO_2, an insignificant but possible correlation is suggested. SPM has a significant correlation with SMCR of AR.

Table 1. Medical Consultation (MC) Rates of Allergic Rhinitis Outpatients by Age. (Japan National Health Insurance Data in Aichi Prefecture, May 1989)

Age	Number of allergic rhinitis patients (A)	Number of insured in Aichi prefecture (B)	Total number of patients (C)	MC for all insured (rate$_i$: %) (A/B)	MC for all patients (rate$_r$: %) (A/C)
0- 4	594	69822	68239	0.851	0.871
5- 9	1882	85986	62710	2.189	3.001
10-14	2179	112103	49977	1.944	4.360
15-19	1113	142023	39641	0.784	2.808
20-24	470	92983	28020	0.506	1.677
25-29	541	77674	30387	0.697	1.780
30-34	770	78438	30607	0.982	2.516
35-39	1018	107329	40691	0.949	2.502
40-44	1160	137635	53745	0.843	2.158
45-49	931	139186	61695	0.669	1.509
50-54	676	126735	68523	0.533	0.987
55-59	639	137204	92732	0.466	0.689
60-64	775	173069	141118	0.448	0.549
65-69	519	143726	142361	0.361	0.365
70-74	382	102072	130488	0.374	0.293
75-79	213	79812	99917	0.267	0.213
80-	95	65436	74330	0.145	0.128
Total	13957	1871233	1215181	0.746	1.149

Table 2. Medical Consultation Rate$_r$ of Allergic Rhinitis (Standardized Medical Consultation Rate$_r$: SMCR) with Dispersed Pollen in Aichi Prefecture (1989)

Area / Municipality	Japanese cedar and Japanese cypress: Total pollen count from Feb. to Apr., '89 (pollen/cm^2)	Gramineae pollen count in May, '89 (pollen/cm^2)	SMCR of allergic rhinitis
West-Owari			
1 Konan	1015	253	0.7857
2 Ichinomiya	1815	151	0.9781
3 Tsushima	703	30	0.4389
	Average 1178	Average 145	Average 0.9104
East-Owari			
4 Kasugai	1373	177	1.2665
5 Nagoya	1179	154	0.9789
6 Seto	1096	70	0.4821
7 Chita	889	237	0.6253
8 Handa	685	250	1.3612
	Average 1044	Average 178	Average 1.0174
West-Mikawa			
9 Asuke	897	27	0.1158
10 Toyota	1926	143	0.8865
11 Kariya	1432	56	1.7522
12 Okazaki	901	22	1.4537
13 Nishio	1325	32	0.9451
	Average 1296	Average 56	Average 1.2819
East-Mikawa			
14 Shitara	3075	43	0.5700
15 Shinshiro	4356	31	0.9843
16 Toyokawa	1727	102	0.8427
17 Toyohashi	2623	25	1.1602
18 Tahara	1389	45	0.7218
	Average 2634	Average 49	Average 1.0632

Table 3. Highest Levels of Air Pollution in the Cities and Towns of Aichi Prefecture (April, 1988–March, 1989)

Sulfur dioxide (SO_2)

mean value of the year = 0.008 ppm (n=51)

(min. 0.004 ppm - max. 0.014 ppm)

1.	Ichinomiya	(West-Owari)	0.014 ppm
2.	Bisai	(West-Owari)	0.013 ppm
3.	Inazawa	(West-Owari)	0.012 ppm
4.	Tokai	(East-Owari)	0.010 ppm
5.	Okazaki	(West-Mikawa)	0.010 ppm

Nitrogen dioxide (NO_2)

mean value of the year = 0.019 ppm (n=50)

(min. 0.008 ppm - max. 0.031 ppm)

1.	Komaki	(West-Owari)	0.031 ppm
2.	Inazawa	(West-Owari)	0.026 ppm
3.	Obu	(West-Mikawa)	0.025 ppm
4.	Iwakura	(West-Owari)	0.024 ppm
5.	Chiryu	(West-Mikawa)	0.024 ppm

Suspended particulate matter (SPM)

mean value of the year = 0.044 mg/m^3 (n=50)

(min. 0.028 mg/m^3 - max. 0.061 mg/m^3)

1.	Obu	(West-Mikawa)	0.061 mg/m^3
2.	Inazawa	(West-Owari)	0.059 mg/m^3
3.	Higashiura	(East-Owari)	0.058 mg/m^3
4.	Chiryu	(West-Mikawa)	0.055 mg/m^3
5.	Takahana	(West-Mikawa)	0.054 mg/m^3

Table 4. Correlation Coefficient Matrix of Suspected Causative Factors for Allergic Rhinitis

Factor	Jap. Cedar & Jap. Cypress seasonal pollen count (No./cm^2) (A)	Jap. Cedar & Jap. Cypress pollen count / maximum day (B)	Gramineae pollen count in May (No./cm^2) (C)	Mean Sulfur dioxide: SO_2 (ppm) for 4/88-3/89 (D)	Mean Nitrogen dioxide: NO_2 (ppm) for 4/88-3/89 (E)	Mean Suspended particulate matter: SPM (mg/m^3) for 4/88-3/89 (F)
(B)	0.925**	--				
(C)	-0.350	-0.221	--			
(D)	-0.155	0.043	0.084	--		
(E)	0.089	0.212	-0.037	0.513**	--	
(F)	-0.237	0.091	0.196	0.438**	0.557**	--

*: $p < 0.05$, **: $p < 0.01$

Table 5. The Correlation Coefficients Between Standardized Medical Consultation Rate, (SMCR) of Allergic Rhinitis and Various Factors
(Japan National Health Insurance Data in Aichi prefecture, May, 1989)

Factor	Correlation coefficient between factor and SMCR of allergic rhinitis	
Jap. Cedar & Jap. Cypress pollen count (2/89-4/89)	0.065 (n=18)	NS
Jap. Cedar & Jap. Cypress pollen count max/day (2/89-4/89)	-0.041 (n=18)	NS
Jap. Cedar & Jap. Cypress pollen count/month (4/89)	-0.154 (n=18)	NS
Gramineae pollen count/month (5/89)	0.126 (n=18)	NS
Mean sulfur dioxide (ppm) (4/88-3/89)	0.031 (n=51)	NS
Mean nitrogen dioxide (ppm) (4/88-3/89)	0.249 (n=50)	NS
Mean suspended particulate matter (4/88-3/89)	0.390 (n=50)	**

**: $p < 0.01$, NS: not significant

DISCUSSION

Pollinosis patient surveillance was monitored by the Aichi Prefectural Government from 18 otorhinolaryngologist surveillance sites. These sites coincide with those of the pollen monitoring sites and they report similarities between the level of Japanese cedar and Japanese cypress pollen dispersion, and the number of AR patients. The correlation of AR and pollen dispersion is very high in all municipalities when several consecutive months are analysed and this has been shown by many studies.[4,5,15,16] In this present study, we have used a cross-sectional method with many sample locations and we have found little correlation between AR and pollen dispersion in those cities.

In the area of air pollution studies, National Health Insurance records have been used by the Japanese Environment Agency in Japan,[17] but there are various arguments concerning their reliability and comparability. These records are compiled from clinics, and hence only patients that visit clinics will have their ailments recorded, i.e., there are accessibility problems. In this study, rater is a relatively unbiased parameter because it utilized not the entire population of insurants, but only those records of patients. Consequently, the factor of accessibility may be ruled out. One may also claim that if the patient goes to two clinics, there will be two records. AR is not by any means a serious disease and as such, its sufferers rarely go and seek medical attention; therefore, the rate of visits is extremely low. It is estimated that approximately 10% of the adult population suffers from pollinosis,[18] and from our results, it was found that the MCR_i was only 0.746%. This figure indicates that however annoying the ailment is, its sufferers rarely go to the doctor, and perhaps even more rarely, to two different clinics. In the statistics of the National Health Insurance Annual Report, there are 99 clinical entities, of which AR is listed as the fifty-third. As doctors often diagnose diseases that vary from these classifications, one might suggest that AR is not listed as often as it should be (under-diagnoses). However, AR as a disease is easy to classify, and as such, varying diagnosis like nasal allergy, allergic nose and pollinosis are often correctly grouped together under the one heading of AR by the statistical staff of the National Health Insurance Organization. On the other hand, doctors might record "AR" when they prescribe anti-allergy drugs or laboratory testing for allergies for patients suspected of having similar but different allergic symptoms regardless of the actual disease (over-diagnoses). We did not confirm whether doctors performed the patch test or IgE RAST to diagnose AR. These are confounding factors when National Health Insurance records are used, with the former being of minor significance and the latter being more prominent, in the case of AR.

The month chosen for analysis of SMCR was May, but by this time, Japanese cedar and cypress pollen dispersion may have almost ceased. In choosing the month of May, the results may therefore not reflect the trends. However, both the Tokyo and Aichi Government Offices report that the peak MCR was in late March with the minimum rate being recorded around November.[10,11] In May, this rate was still maintained at the considerably high levels set in March and April and, hence, these data can still be considered as valid. Also, we should be aware that if the month analysed is not in the off-season, the above-mentioned confounding factors using National Health Insurance records will not be significant.

There are two possibilities as to why SMCR of AR had little discernible correlation with Japanese cedar and cypress, and gramineae pollen counts. Firstly, seasonal tendencies dictate that most cases of AR occur when the pollen dispersion is at its peak, i.e., before May. Also, in May there might be considerable numbers of "vasomotor rhinitis" cases. Secondly, if we consider that the majority of the analysed AR patients were suffering from Japanese cedar and cypress pollinosis because of seasonal conditions but there was little correlation with levels of pollen, then there must be other causative factors which contribute to the onset of pollinosis. To confirm these possibilities, accurate diagnoses of AR or pollinosis using the appropriate tests are required in further studies.

The relation between air pollutants and AR has been documented in epidemiological circles, albeit with fewer samples and hence less statistical analysis. Ishizaki et al.[13] reported on vehicle pollution accelerating the instances of AR while Saito[5] compared the incidence of Japanese cedar pollinosis between high pollen dispersion areas and high pollution areas. He found that low JCP count areas with high pollution had a higher instance of pollinosis than low pollution areas with a high pollen count. Suzuki[19] also reported that Tokorozawa, where there were higher levels of air pollution and a lower pollen count, had a higher prevalence of pollinosis than that of Yorii city, which had a high level of pollen dispersion but low pollution. In our study, the SMCR for East Mikawa, which had the highest level, by far, of Japanese cedar and cypress pollen count, was lower than that for West Mikawa, which recorded a much smaller figure for the pollen count.

In this paper, the link between the SMCR of AR and air pollutants has also been analysed and a significant correlation between the SMCR of AR and SPM was found. Suzuki[20] reported that the major element of SPM is diesel exhaust particulate (DEP) while Muranaka et al.[21] and Takafuji et al.[22] demonstrated the adjuvant activity of DEP for the production of IgE antibodies of JCP in mice. An increase in the likelihood of suffering pollinosis may stem from Japanese cedar pollen bound to DEP increasing production of antibodies against pollen.

CONCLUSION

This study simultaneously included all the major causative factors that may be associated with AR. Using a follow-up approach, when consecutive months were analysed, there existed a reasonable relationship between the incidence of AR and the JCP count. In our cross-sectional study, however, there was found to be a negligible dose-response relationship for JCP and AR. Of more importance, it was found that SPM levels had a significant correlation with the SMCR of AR. AR is induced by JCP, but the results suggest that pollen alone cannot account for this large increase in the MCR of AR. The element of pollution must not be discounted, especially SPM, and further study is necessary to investigate the true mechanisms behind this problem.

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