

## Monitoring of airborne Japanese cedar and Japanese cypress pollen in Nagasaki prefecture. -A clinical review of a 30-year data series-

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**Objective:** To describe the situation of Japanese cedar (JC) and Japanese cypress pollens in Nagasaki prefecture based on a 30-year data series ranging from 1990 to 2019.

**Methods:** The data of JC and Japanese cypress pollens at eight measurement sites in Nagasaki prefecture was retrospectively studied. A one-way analysis of variance was used to determine annual differences among the eight sites. Simple regression analyses were used to detect annual increasing or decreasing trends in the scattering of JC and Japanese cypress pollens at each of the eight sites.

**Results:** JC pollen scattering began in early to mid-February and ended between late March and mid-April, while Japanese cypress pollen scattering began in mid-March to early April and ended in mid- to late April. Positive correlations between the total counts of JC pollens and year were observed in four measurement sites, while a positive correlation between the total count of Japanese cypress pollens and year was found in Goto city. Regional differences were statistically observed in the annual mean JC pollen values.

**Conclusions:** Because these data are extremely meaningful, the work of Nagasaki Association of Medical Technologists and Nagasaki Medical Association is necessary for the future treatment of patients with JC and/or Japanese cypress pollinosis.

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**Key words:** seasonal allergic rhinitis; Japanese cedar pollen; Japanese cypress pollen; Nagasaki prefecture; 30-year data series;

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### Introduction

Japanese cedar (JC) pollinosis is a seasonal allergic rhinitis (SAR) that was first reported in 1963 (1). This condition is unique to Japan, where a recent epidemiological survey reported average national JC pollinosis morbidity rates of 26.5% and 15.2% nationwide and in Nagasaki prefecture, respectively, during 2008 (2). Therefore, JC pollinosis is now considered a national affliction in Japan. The prevalence of JC pollinosis is further complicated by cross-reactivity between JC and several components of Japanese cypress

pollen. Accordingly, 70% of patients with JC pollinosis also experience SAR caused by Japanese cypress pollen (3).

Avoidance of the allergen is the most effective means of decreasing an allergic inflammatory reaction (4). For example, patient with SAR in response to JC and Japanese cypress pollens rely strongly on data regarding the distribution of these allergens. In Nagasaki prefecture, JC and Japanese cypress pollen levels are measured by the Nagasaki Association of Medical Technologists which, together with the Nagasaki Medical Association, has provided relevant information to residents of Nagasaki prefecture since 1990. The present

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study aims to describe the situation of JC and Japanese cypress pollens in Nagasaki prefecture based on a 30-year data series ranging from 1990 to 2019.

## Materials and Methods

### 1. Measurement sites in Nagasaki prefecture (Figure 1)

Since 1990, the distributions of JC and Japanese cypress pollens were initially measured at four sites; Nagasaki University Hospital in Nagasaki city, Sasebo Kyosai Hospital in Sasebo city (urban area), Isahaya General Hospital in Isahaya city, and Nagasaki Prefecture Tsushima Hospital in Tsushima city. Subsequent measurements began at Nagasaki Prefecture Shimabara Hospital in Shimabara city and at Hokusyo Central Hospital in Emukae town (suburb area in Sasebo city) in 1991, at Nagasaki Goto Chuoh Hospital in Goto city in 1997, and at Omura City Hospital in Omura city in 1998.

The measurement sites at Nagasaki University Hospital in Nagasaki city, Isahaya General Hospital in Isahaya city, Nagasaki Prefecture Shimabara Hospital in Shimabara city and Hokusyo Central Hospital in Emukae town have remained the same over time. However, three sites were changed due to relocation of Nagasaki Goto Chuoh Hospital in Goto city in 2002, Nagasaki Prefecture Tsushima Hospital in Tsushima city in 2015, and Omura City hospital in Omura city in 2017. In 2017, the site in Sasebo city changed from Sasebo Kyosai Hospital to Sasebo Chuo Hospital. Although four sites have been relocated, we thought that there will be little impact on the data due to the proximity of the replacement site.

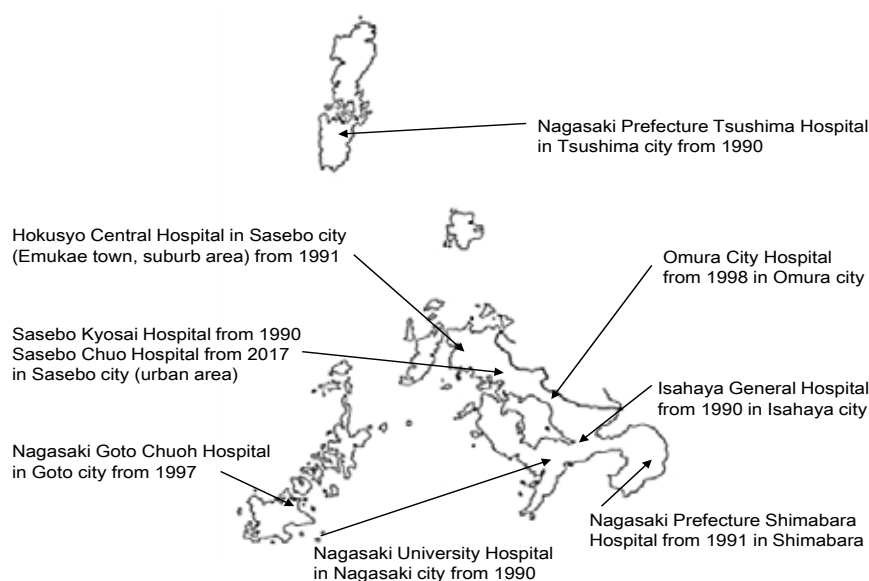
### 2. Measurement method and period

Scattering pollens were collected by adherence to petroleum jelly coated glass slides and fixed in a Durham sampler (5). The coated glass slides were exchanged every morning, as a rule. Subsequently, the samples were stained with saturated basic fuchsin (Carberla's stain) and covered with a 3.24 cm<sup>2</sup> coverglass. The pollen grains were identified at 400× magnification and counted at 100× magnification. Pollen counts were standardized and expressed as numbers of pollen grains per 1 cm<sup>2</sup> and per 1 day.

From 1990 to 2007, pollen grains were identified on all weekdays from February 1 to April 30, excluding national holidays. After 2008, pollen grains were similarly identified from December 1 of the previous year to April 30.

In this study, the starting day of pollen dispersion was defined as the first day on which more than 1 grain per cm<sup>2</sup> per day was sampled on 2 consecutive days between February 1 and April 30 (6). The peak day of pollen dispersion was defined as the day on which the highest number of pollen grains was detected. The end day of dispersion was defined as the first day on which no pollen grains were observed for 3 consecutive days (6).

A one-way analysis of variance was used to determine annual differences among the eight JC and Japanese cypress pollen measurement sites. Simple regression analyses were used to detect annual increasing or decreasing trends in the scattering of JC and Japanese cypress pollens at each of the eight sites. Significance was defined as a p value <0.05.



**Figure 1** Locations of 8 measurement sites in Nagasaki prefecture

### 3. Comparison of JC and Japanese cypress pollen date obtained using the automatic pollen counter KH-3000 and the Durham sampler in Nagasaki city.

In 2003, the Ministry of the Environment began to install automatic pollen counters (KH-3000) on the roofs of buildings. These devices automatically collect JC and Japanese cypress pollens and display the resulting data on the Internet (<http://kafun.taiki.go.jp>). KH-3000 pollen counters were installed in Nagasaki city and Isahaya city in 2007 and in Sasebo city in 2015. In this study, we compared the total JC and Japanese cypress pollen counts obtained using a conventional Durham sampler with those obtained using the automatic pollen counter (KH-3000) in Nagasaki city in 2018.

## Results

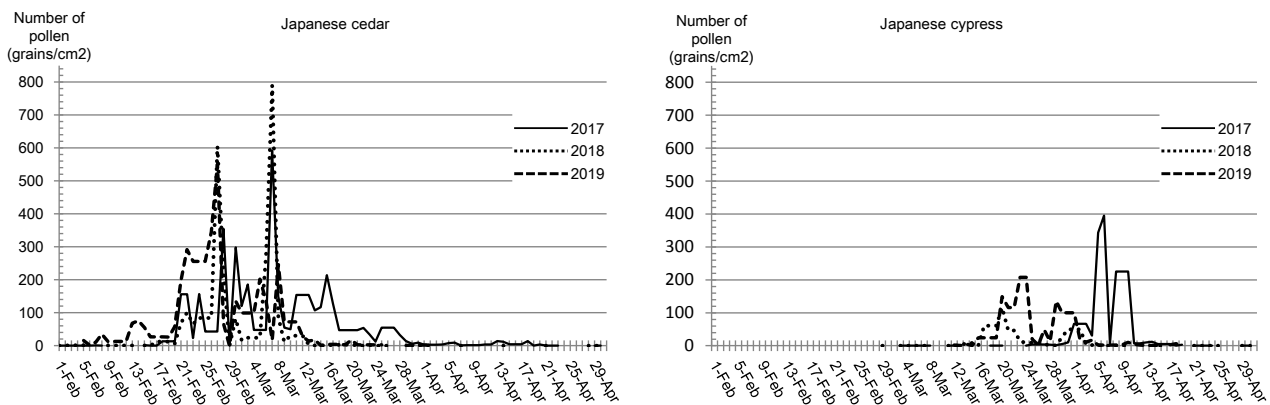
Table 1 A and B list the starting, peak and end days of JC and Japanese cypress pollen scattering at the eight measurement sites over a 30-year period. Figures 2 A and B depict typical patterns of the number of JC and Japanese cypress pollen grains seen per cm<sup>2</sup> during a 3-year period (2017-2019) at Nagasaki University Hospital. In Nagasaki prefecture, JC pollen scattering began in early to mid-February and ended between late March and mid-April, while Japanese cypress pollen scattering began in mid-March to early April and ended in mid- to late April.

Figure 3 A-H presents the annual total JC pollen counts at

the eight measurement sites, while Figure 4 A-H presents the annual total Japanese cypress pollen counts at the same sites. Notably, positive correlations between the total counts of JC pollens and year were observed in Nagasaki city, Sasebo city, Omura city, and Emukae town (Table 2-A), while a positive correlation between the total count of Japanese cypress pollens and year was found in Goto city (Table 2-B). Figure 5 A and B present the annual mean JC and Japanese cypress pollen counts at the eight measurement sites during the 30-year data collection period. Statistically, regional differences were observed in the annual mean JC pollen values (Table 3 A). However, no such differences were observed in the annual mean Japanese cypress pollen values (Table 3 B).

Table 4 further summarizes the JC pollen counts from December 1 of the previous year to January 31 at the eight measurement sites. Notably, in multiple years, JC pollen grains were identified on approximately half of the days between December 1 of the previous year and January 31: in Nagasaki city in 2011, 2012 and 2018; Isahaya city in 2011 and 2018; Tsushima city in 2011; Emukae town in 2011, 2013, 2015, 2016 and 2018; and Goto city in 2018.

Figure 6 presents the correlations between the results derived using Durham’s sampling method and those obtained from the KH-3000 at Nagasaki University Hospital in 2018. Notably, an apparently high coefficient of correlation between these data was observed from late February to early April. However, the KH-3000 dataset included some missing data points in early/ mid-February and mid/late April.



**Figure 2 A and B**  
Typical patterns of Japanese cedar (A) and Japanese cypress (B) pollen at Nagasaki University Hospital in 2017, 2018, and 2019.

**Table 1A and B**

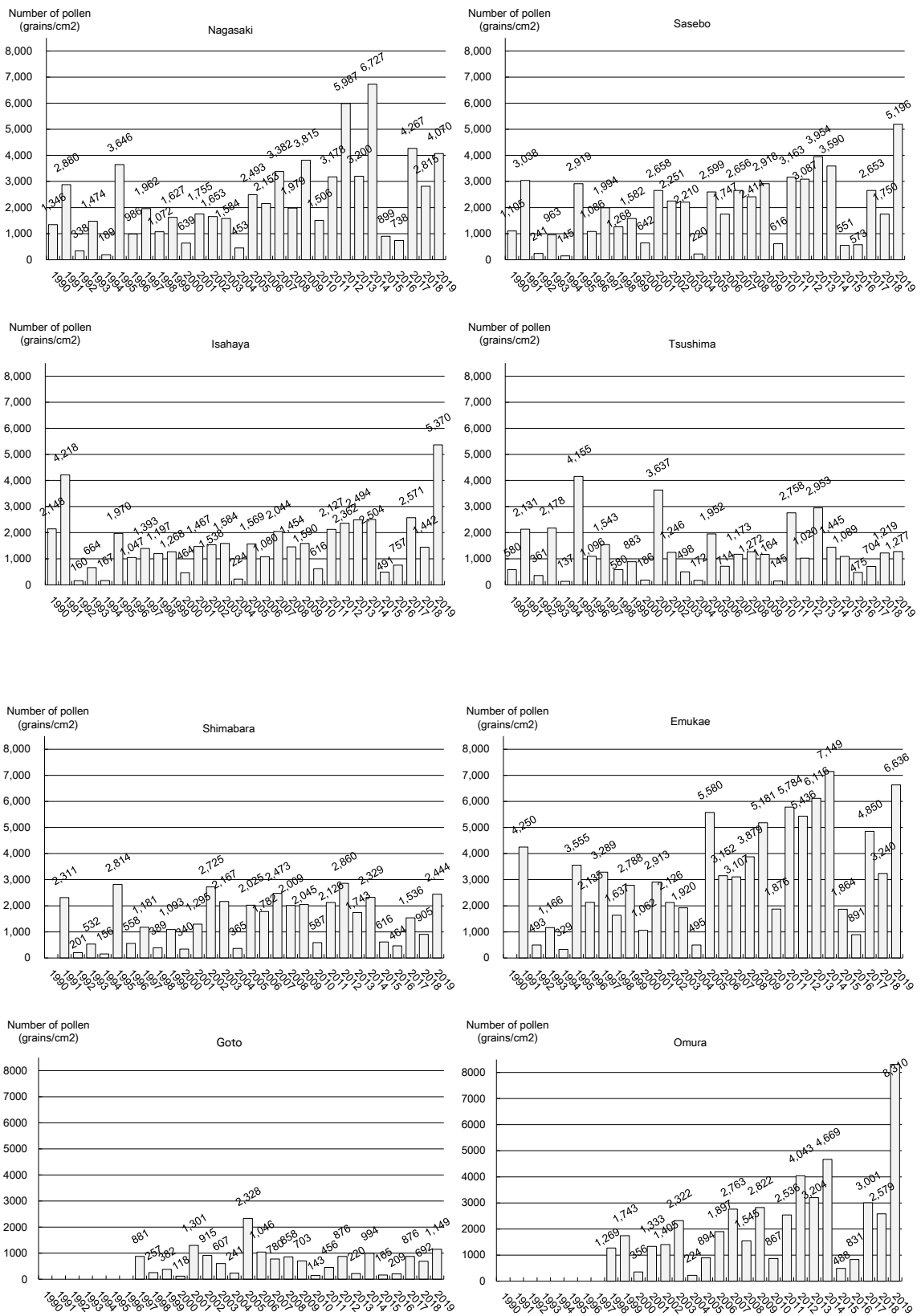
A: Starting, peak and end days of Japanese cedar pollen scattering at eight measurement sites over a 30-year period. The number means the year as a decimal number without a century.

	Starting Day								Peak Day		
	Nagasaki	Sasebo	Isahaya	Tsushima	Shimabara	Emukae	Goto	Omura	Nagasaki	Sasebo	Isahaya
31-Jan or before	10,14	96,06,09,14	14	91,93,14	91,14	97,06,09,13,14,15	14	14	31-Jan or before		
1-Feb	90,02,06,13	02,13	06	02,06,13,15	02,06	02		02,06	1-Feb		
2-Feb	99,18			92		03			2-Feb		
3-Feb	94,15	91,15	91,13		13	91,08,19	15	09	3-Feb		
4-Feb	92,93,97,09,19	90,93,94,19	90,92,93,97,09,15	96	92	92,93,94,96,07	13	13,19	4-Feb		
5-Feb	95	97	96	90,95,97,09	95	10		97,09	5-Feb		
6-Feb	91,05	92,98,00	94,02,07,19	94,07,19	94,09			19	6-Feb		
7-Feb	03	95,01,03,07	03,12		93,03				7-Feb		
8-Feb	96,07,08	08	08	99,08		98,99		02	8-Feb		
9-Feb	01			03	97,07	95,01,18		03	9-Feb		
10-Feb	00	10,16	99,00,10		10,15	00,16		98,06,10	10-Feb		
11-Feb	16			10,	08,19			98	11-Feb		
12-Feb			95,16	98,16					12-Feb		
13-Feb	98	17	98,01,17	01	96,98,00	04,17		98	13-Feb		
14-Feb				18				07,18	14-Feb		
15-Feb	04,12		18	12	16	12		01,12	15-Feb		
16-Feb		12,18			99	05,11		17	16-Feb	09	09
17-Feb	17	99,04,05	05	04,17				00,05	17-Feb	06	09
18-Feb	11	11	11	00,11	01,05,11			11	18-Feb	15	
19-Feb								20	19-Feb		96,10
20-Feb			04		04,17,18			04	20-Feb	94,13	06
21-Feb									21-Feb	93	94,13
22-Feb				05				08	22-Feb	98,04,15	98
23-Feb									23-Feb	03	
24-Feb					12				24-Feb	02	02
25-Feb									25-Feb	96,01,07	01,07
26-Feb									26-Feb	06,19	95,97,18,19
27-Feb									27-Feb	90,97,03,11	90,03,07,11
28-Feb									28-Feb	90,11,13	16
29-Feb									29-Feb	99	99
1-Mar									1-Mar	04	
2-Mar									2-Mar	92,	
3-Mar									3-Mar	92,00,14	97,08
4-Mar									4-Mar	91	92,14
5-Mar									5-Mar	12	
6-Mar									6-Mar	00	91,17,18
7-Mar									7-Mar	16	93,00
8-Mar									8-Mar	91,99,12	
9-Mar									9-Mar	95	
10-Mar									10-Mar		
11-Mar									11-Mar		12
12-Mar									12-Mar	08	
13-Mar									13-Mar	05,17	05
14-Mar									14-Mar	10	
15-Mar									15-Mar		
16-Mar									16-Mar	08	
17-Mar									17-Mar		
18-Mar									18-Mar		
19-Mar									19-Mar		
20-Mar									20-Mar		
21-Mar									21-Mar		
22-Mar									22-Mar		
23-Mar									23-Mar		
24-Mar									24-Mar		
25-Mar									25-Mar		
26-Mar									26-Mar		
27-Mar									27-Mar		
28-Mar									28-Mar		
29-Mar									29-Mar		
30-Mar									30-Mar		
31-Mar									31-Mar		
1-Apr									1-Apr		
2-Apr									2-Apr	05	
3-Apr									3-Apr		
4-Apr									4-Apr		
5-Apr									5-Apr		
6-Apr									6-Apr		
7-Apr									7-Apr		
8-Apr									8-Apr		
9-Apr									9-Apr		
10-Apr									10-Apr		
11-Apr									11-Apr		
12-Apr									12-Apr		
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14-Apr									14-Apr		
15-Apr									15-Apr		
16-Apr									16-Apr		
17-Apr									17-Apr		
18-Apr									18-Apr		
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22-Apr									22-Apr		
23-Apr									23-Apr		
24-Apr									24-Apr		
25-Apr									25-Apr		
26-Apr									26-Apr		
27-Apr									27-Apr		
28-Apr									28-Apr		
29-Apr or later									29-Apr or later		
30-Apr or later									30-Apr or later		

					End Day							
Tsushima	Shimabara	Emukae	Goto	Omura	Nagasaki	Sasebo	Isahaya	Tsushima	Shimabara	Emukae	Goto	Omura
					31-Jan or before							
		14			1-Feb							
					2-Feb							
					3-Feb							
					4-Feb							
					5-Feb							
					6-Feb							
					7-Feb							
					8-Feb							
					9-Feb							
					10-Feb							
					11-Feb							
					12-Feb							
					13-Feb							
					14-Feb							
09		98	15		15-Feb							
02	15	94		98	16-Feb							
93,03					17-Feb							
					18-Feb							
94,07					19-Feb							
06	94,07	07	07	07	20-Feb							
		15	98		21-Feb							
90	04	06,09,12	09	06,09	22-Feb							
10,19	10	02,10,19	10,19	10,15	23-Feb							
04	01,19	04	13		24-Feb							
15		97		19	25-Feb							
13	97,03,06	03,11	97,03	03,11	26-Feb							
		92	16		27-Feb		98					
	13,16	13,18	99,12,18	04,13,17	28-Feb							
92,98,11,17,18,	98,09,	17,	17,	01,	29-Feb							
97,08	11	00,08			1-Mar							
96	92,99,02,14	96,99	14	02,14	2-Mar							
01					3-Mar							
14	96			00	4-Mar							
91,00,12,16	91,00,17,18	16	00,02	18	5-Mar							
95,99	95	91,93	99	99	6-Mar							
	93,12	95	06	12,16	7-Mar							
				05	8-Mar							
					9-Mar							
					10-Mar							
					11-Mar							
	08,		08,	08,	12-Mar							
05					13-Mar							
		01			14-Mar							
					15-Mar							
					16-Mar							
					17-Mar							10
					18-Mar							
					19-Mar	10						
					20-Mar		10			10	10	
					21-Mar							98
					22-Mar							
					23-Mar	98	94			94		
					24-Mar			10	92	98		
					25-Mar			04	92	97	98,99,15	
					26-Mar		14		04		93	
					27-Mar		02		98	98	92,02	09
					28-Mar		98,06	13	07	15		19
	05		05		29-Mar							18
					30-Mar	02,06,16	07	06,14			06,07	
					31-Mar			02			06	06
					1-Apr		91,15		06,09,16	02,10	06	06
					2-Apr		92,97		97,03,19	06	91	16
					3-Apr	97	90,99,04	99,09	15		16	02
					4-Apr	90,04	09,12,13,18,19	96,12,15,18	96		97,13,18	13
					5-Apr	13,19	96	97,00	02	96,03	09	07,18
					6-Apr	07,18		91,19	08	00,12,14	08	00,14
					7-Apr	96,99	93,16	90,95,07	91	04,16	95,00	04
					8-Apr	92,93,12,15	00,17	16	90,94,95	07,18	04	12
					9-Apr	03,14	95,08	03,05,17	14	95,19	99,05,14,19	03
					10-Apr	91		93	05,13	91,99,09	03	
					11-Apr	08,10			12,18	08		07,08
					12-Apr	00					12,15	12
					13-Apr	94		94,08	00,17	13	17	08,11
					14-Apr	95,01	05,11	11	11	93	11	17
					15-Apr	09,11	01			01,11		11
					16-Apr	05						05
					17-Apr		03					05
					18-Apr			01				01
					19-Apr							97
					20-Apr					05		
					21-Apr					17		
					22-Apr	17			99			
					23-Apr							
					24-Apr							
					25-Apr							
					26-Apr							
					27-Apr							
					28-Apr							
					29-Apr or later							
					30-Apr or later							

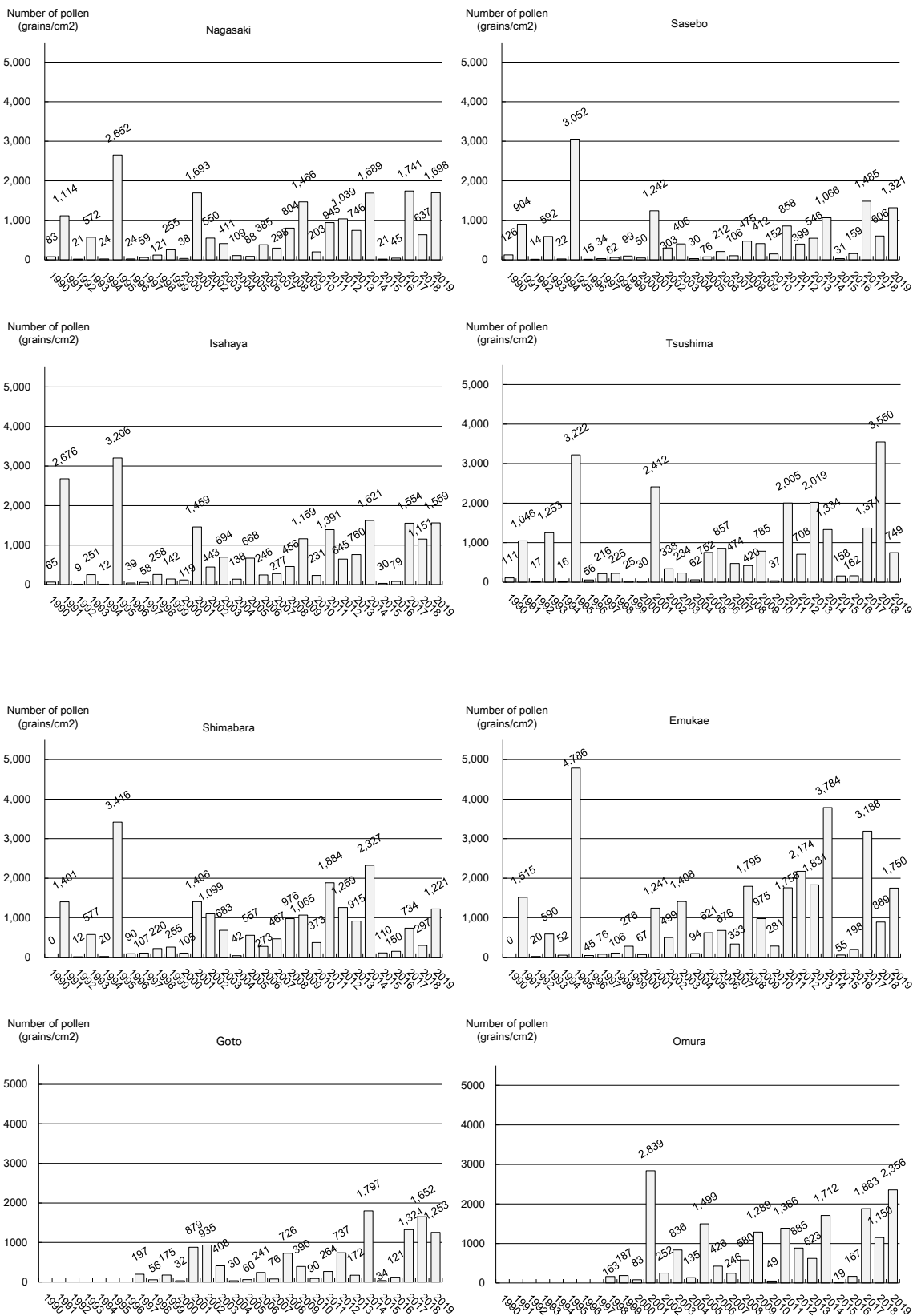


					End Day									
Izuhara	Shimabara	Emukae	Goto	Omura		Nagasaki	Sasebo	Isahaya	Izuhara	Shimabara	Emukae	Goto	Omura	
					31-Jan or before									
					1-Feb									
					2-Feb									
					3-Feb									
					4-Feb									
					5-Feb									
					6-Feb									
					7-Feb									
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					11-Mar									
					12-Mar									
		02		14,18	13-Mar									
	10	10			14-Mar									
					15-Mar									
			02		16-Mar									
02	02	99,18	14,18		17-Mar									
		13			18-Mar									
					19-Mar									
					20-Mar									
					21-Mar									
			15		22-Mar									
	97,09		04	06,09	23-Mar									
04	04	96,14			24-Mar									
	13		13	01,13	25-Mar									
03,07,19		03,06,07		07	26-Mar									
97,06,14,18	06	01,19	97,06,19	02	27-Mar									
13	99		01,07,12,16	19	28-Mar									
12,15,16	07,12,18	04,12,16	11	04,12	29-Mar									
90,98	98,19	98,00	98	08,15	30-Mar									
93,99,09,11	91,08	99,15		98	31-Mar									
96,08,10	14	97	99	99	1-Apr									
01	95	08	00,03,08,17	03	2-Apr									
05	00,03			00,05	3-Apr									
91,95	01,11	91,93,17		11,16	4-Apr									
94,00,17	92,17	94		17	5-Apr				02					
		92,95,05,11	10	10	6-Apr									
92	05		05		7-Apr			92						
	15				8-Apr		15							
	96		09		9-Apr	98								
					10-Apr		02	13	92	92	02		98	
					11-Apr			18	06	98		98,02		
	16				12-Apr	00	00						02	
					13-Apr		90,99					18,	00,13,18	
					14-Apr	92	94,98	15	90		92,94,15	15	15	
	93				15-Apr			94,97,04,16			98	00	10	
					16-Apr		16		94,98	04		13,16		
	94				17-Apr	90,02,04,18	92,96,04,18	90,98	97,04,07,15	03		99,04	99,07	
					18-Apr	15	03,06,07	06		97,02	18	06	03	
					19-Apr	16,19	14	96,02	00,03,16	94,06	16	05		
					20-Apr	94			99	10			04,06	
					21-Apr		05		10,17	00,01	06,07,09	11		
					22-Apr	95,97		00	05	15	97,04,14	03,09	09	
					23-Apr	96,10	11,13				13			
					24-Apr	03	01,09,19	99,03,12,19	96,12,18	07,18	03,10,12	12,15	12,19	
					25-Apr	91,01	91,95,12	07,08,09	01,19	91	00,19			
					26-Apr	05,11,12,13		11	95	96,13,19	05,11	97,19	17	
					27-Apr	17		91,93,01,10,17	05	91,01	91,01	01,10	01,11,16	
					28-Apr	93,06	17	05	91,93,11	09		07	05	
					29-Apr or later	99,14	97,08	95,14	08	99,08,11,16	93,95	08,14	08,14	
					30-Apr or later	97,98,99	93,10		09,13,14	93,95,12,14,17	96,99,08,17	17		



**Figure 3 A-H**  
 Annual total Japanese cedar pollen counts in eight sites. A: Nagasaki city, B: Sasebo city, C: Isahaya city, D: Tsushima city, E: Shimabara city, F: Emukae town, G: Goto city, H: Omura City





**Figure 4 A-H**  
 Annual total Japanese cypress pollen counts in eight sites. A: Nagasaki city, B: Sasebo city, C: Isahaya city, D: Tsushima city, E: Shimabara city, F: Emukae town, G: Goto city, H: Omura City

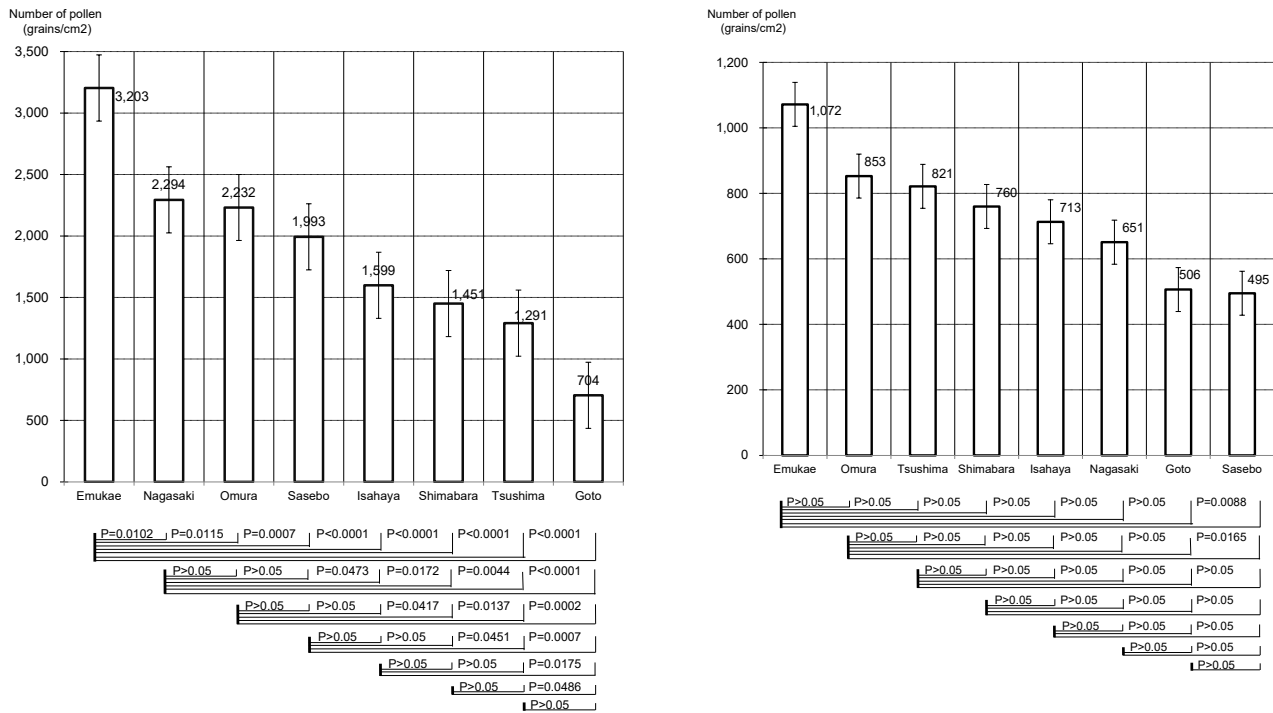
**Table 2 A and B**

A: Summary of simple regression analyses for year and Japanese cedar pollen in eight measurement sites.

B: Summary of simple regression analyses for year and Japanese cypress pollen in eight measurement sites.

Analysis of variance summary table for year and Japanese cedar pollen							Analysis of variance summary table for year and Japanese cypress pollen						
Nagasaki							Nagasaki						
Source	df	SS	Mean square	F pvalue	p value	R <sup>2</sup>	Source	df	SS	Mean square	F pvalue	p value	R <sup>2</sup>
Trials	1	17672390	17672390	8.7931	0.006	0.21181	Trials	1	878301	878301	1.858	0.184	0.06223
Error	28	56274415	2009800.6				Error	28	13236132	472719			
Total	29	73946805					Total	29	14114433				
Sasebo							Sasebo						
Source	df	SS	Mean square	F pvalue	p value	R <sup>2</sup>	Source	df	SS	Mean square	F pvalue	p value	R <sup>2</sup>
Trials	1	7370917	7370917	5.4945	0.026	0.13419	Trials	1	157937	157937	0.3698	0.548	0.01304
Error	28	37562044	1341502				Error	28	11956947	427034			
Total	29	44932961					Total	29	12114884				
Isahaya							Isahaya						
Source	df	SS	Mean square	F pvalue	p value	R <sup>2</sup>	Source	df	SS	Mean square	F pvalue	p value	R <sup>2</sup>
Trials	1	2648605	2648605	2.1479	0.154	0.03808	Trials	1	220748	220748	0.3274	0.572	0.01156
Error	28	34526876	1233103				Error	28	18879405	674264			
Total	29	37175481					Total	29	19100153				
Tsushima							Tsushima						
Source	df	SS	Mean square	F pvalue	p value	R <sup>2</sup>	Source	df	SS	Mean square	F pvalue	p value	R <sup>2</sup>
Trials	1	88917	88917	0.0833	0.775	-0.0326	Trials	1	1658061	1658061	1.8542	0.184	0.06211
Error	28	29871049	1066823				Error	28	25038698	894239			
Total	29	29959965					Total	29	26696759				
Shimabara							Shimabara						
Source	df	SS	Mean square	F pvalue	p value	R <sup>2</sup>	Source	df	SS	Mean square	F pvalue	p value	R <sup>2</sup>
Trials	1	1358586	1358586	1.7321	0.199	0.02548	Trials	1	103414	103414	0.1616	0.691	0.00595
Error	27	21177063	784336				Error	27	17274779	639807			
Total	28	22535650					Total	28	17378193				
Emukae							Emukae						
Source	df	SS	Mean square	F pvalue	p value	R <sup>2</sup>	Source	df	SS	Mean square	F pvalue	p value	R <sup>2</sup>
Trials	1	27982760	27982760	9.3617	0.005	0.22996	Trials	1	2657153	2657153	1.8775	0.182	0.06502
Error	27	80704959	2989072.6				Error	27	38211107	1415226			
Total	28	108687719					Total	28	40868260				
Goto							Goto						
Source	df	SS	Mean square	F pvalue	p value	R <sup>2</sup>	Source	df	SS	Mean square	F pvalue	p value	R <sup>2</sup>
Trials	1	3567.2	3567	0.0134	0.909	-0.047	Trials	1	1593542.5	1593542	6.5764	0.018	0.23848
Error	21	5570654.7	265269				Error	21	5088593.3	242314			
Total	22	5574221.9					Total	22	6682135.7				
Omura							Omura						
Source	df	SS	Mean square	F pvalue	p value	R <sup>2</sup>	Source	df	SS	Mean square	F pvalue	p value	R <sup>2</sup>
Trials	1	19487119	19487119	8.0338	0.01	0.2509	Trials	1	1248105	1248105	1.9788	0.175	0.09003
Error	20	48512846	2425642.3				Error	20	12614960	630748			
Total	21	67999965					Total	21	13863065				

df: degree of freedom, R<sup>2</sup>: coefficient of determination, SS: sums of squares



**Figure 5 A and B**  
 A: the annual mean Japanese cedar pollen counts at the eight sites during the 30-year data collection period.  
 B: the annual mean Japanese cypress pollen counts at the eight sites during the 30-year data collection period.

**Table 3 A and B**

A: Summary of a one-way analysis of variance for the annual differences among the eight Japanese cedar pollen measurement sites  
 B: Summary of a one-way analysis of variance for the annual differences among the eight Japanese cypress pollen measurement sites.

A: Statistical result of a regional difference in Japanese cedar pollen

Source	df	SS	Mean square	F pvalue	p value	R <sup>2</sup>
Trials	7	108870639	15552948	8.5562	<.0001	0.21788
Error	215	390812768	1817733.8			
Total	222	499683407				

B: Statistical result of a regional difference in Japanese cypress pollen

Source	df	SS	Mean square	F pvalue	p value	R <sup>2</sup>
Trials	7	6991158	998737	1.4238	0.197	0.0443
Error	215	150817883	701479			
Total	222	157809041				

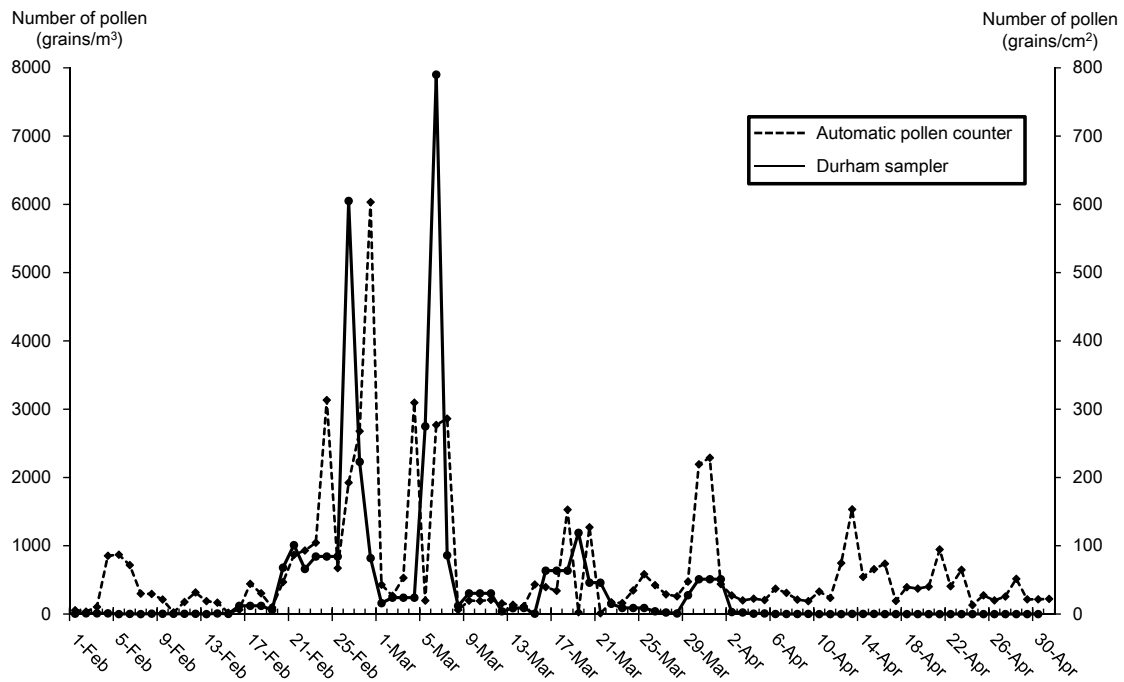
df:degree of freedom, R<sup>2</sup>:coefficient of determination, SS:sums squares

**Table 4**

Summary of days of Japanese cedar pollen counts and maximum number of pollen grains per 1 cm<sup>2</sup> per 1 day from December 1 of the previous year to January 31 in eight measurement sites.

		From Dec-08 to Jan-09	From Dec-09 to Jan-10	From Dec-10 to Jan-11	From Dec-11 to Jan-12	From Dec-12 to Jan-13	From Dec-13 to Jan-14	From Dec-14 to Jan-15	From Dec-15 to Jan-16	From Dec-16 to Jan-17	From Dec-17 to Jan-18	From Dec-18 to Jan-19
Nagasaki	Count Days	15 days	17 days	13 days	26 days	23 days	14 days	7 days	14 days	13 days	16 days	25 days
	Max. Number	1.9	1.9	1	15	0.9	1.2	1.2	1.2	5.7	1.6	3
Sasebo	Count Days	7 days	13 days	5 days	15 days	14 days	9 days	4 days	5 days	15 days	6 days	17 days
	Max. Number	1.5	1.2	0.6	4.9	1.2	4.6	1.2	0.9	3.8	1.3	2.2
Isahaya	Count Days	5 days	10 days	6 days	23 days	5 days	4 days	2 days	10 days	12 days	10 days	21 days
	Max. Number	2.1	1.5	1.2	11	0.6	0.3	0.3	3.9	3.9	3	5.4
Tsushima	Count Days	7 days	2 days	16 days	20 days	15 days	10 days	10 days	4 days	9 days	5 days	3 days
	Max. Number	0.9	0.3	1.5	4.5	0.6	3.9	0.9	2.1	2.4	2.7	0.6
Shimabara	Count Days	15 days	11 days	7 days	18 days	5 days	7 days	1 days	8 days	12 days	7 days	13 days
	Max. Number	0.9	1.2	0.3	8.6	0.3	0.6	0.3	0.6	1.2	0.3	0.7
Emukae	Count Days	15 days	19 days	15 days	25 days	16 days	26 days	17 days	20 days	26 days	14 days	24 days
	Max. Number	2.2	1.7	0.9	12	0.9	4.3	1.9	2.5	4.3	1.9	3.1
Goto	Count Days	2 days	6 days	6 days	15 days	2 days	10 days	7 days	8 days	16 days	11 days	20 days
	Max. Number	0.3	0.3	0.3	6	0.3	0.6	0.3	2.3	5.3	1	3.3
Omura	Count Days	4 days	3 days	5 days	19 days	2 days	9 days	4 days	9 days	11 days	6 days	17 days
	Max. Number	0.6	0.3	0.3	11	0.3	0.9	1.2	2.2	3.4	0.9	1.9

Max. Number : Maximum number of pollen grains per 1 cm<sup>2</sup> per 1 day



**Figure 6**

The correlations between the results derived using Durham’s sampling method and those obtained from the KH-3000 at Nagasaki University Hospital in 2018.

## Discussion

Although the Japanese population had little understanding of JC pollinosis prior to World War II, a subsequent report on hypersensitivity to JC pollen (1) led to the recognition of JC and Japanese cypress pollinosis as increasingly serious nationwide social issues. In Nagasaki prefecture, more than half of the existing JC and Japanese cypress trees were planted between the early 1950s and early 1970s (7). Today, forests cover approximately 242 thousand hectares (i.e., 59% of the total area) of Nagasaki prefecture of which approximately 29 thousand (7%) and 60 thousand (15%) hectares are covered by JC and Japanese cypress trees, respectively (8). These characteristics may have contributed the increased frequency of JC pollinosis in Nagasaki prefecture.

The 30-year data series used in this study revealed that the distributions of JC and Japanese cypress pollens did not generally decrease over time at any of the measurement sites. Moreover, the distributions of JC and Japanese cypress pollens tended to increase at four and one spot, respectively, over time. As both JC and Japanese cypress trees have lifespans of several decades, we do not expect future decreases in the distribution of pollen from these trees unless a large-scale deforestation event occurs. Therefore, the information presented in this study is becoming increasingly important for patients with JC and/or Japanese cypress pollinosis, who will need to take extra caution to the information to avoid JC and Japanese cypress pollens.

As noted previously, avoidance is the most effective means of decreasing inflammatory reactions to aeroallergens (4). Accordingly, some patients with JC and/or Japanese cypress pollinosis travel to places that are less affected (e.g., Okinawa prefecture) (9, 10) during the peak pollen scattering period. Within Nagasaki prefecture, higher JC and Japanese cypress pollen values were reported in Emukae town, while lower values were reported in Goto city (Figure 5). There might be few JC and Japanese cypress trees in Goto city as Okinawa prefecture. Such information about regional differences may help residents of Nagasaki prefecture who suffer from JC and/or Japanese cypress pollinosis to avoid these pollens within their own home regions.

In this study conducted in Nagasaki prefecture, we found that JC pollen scattering began in early to mid-February. According to the Japanese guideline for allergic rhinitis (2), primary therapy (initial treatment) is recommended for patients with pollinosis, because this type of treatment sup-

presses the allergic inflammation and nasal mucosal hypersensitivity that are aggravated by repeated exposure to small amounts of antigen. Currently, the initiation of pharmacotherapy is recommended when even mild symptoms develop simultaneously with or even before pollen dispersal. Our findings suggest that patients with pollinosis would benefit from treatment initiation as soon as early February.

Our clinical experience also confirms that some highly sensitive patients with JC pollinosis complain of symptoms as early as the starting day of pollen dispersion as defined by the Palynological Society of Japan (6). As JC pollens were detected, albeit at low number, in December and January at approximately half of the days, our data suggest that patients who exhibit symptoms JC pollinosis beginning in December should be treated carefully.

In this study, we compared data obtained via Durham sampling and the KH-3000 device mounted at Nagasaki University Hospital in 2018, as this was the only site where both form of measurement were available. Although we observed a high coefficient of correlation during the period when Durham sampling was used to measure pollens, KH-3000 were missing during other periods. Moreover, the KH-3000 is subject to the following drawbacks (11, 12): 1) it cannot distinguish JC pollen from Japanese cypress pollen and 2) it may be affected by other pollens and particles (e.g., yellow sand). Therefore, pollen data determined using the KH-3000 must be interpreted carefully.

As indicated in this report, these data are extremely meaningful. Therefore, we consider the work of Nagasaki Association of Medical Technologists and Nagasaki Medical Association to be necessary for the future treatment of patients with JC and/or Japanese cypress pollinosis.

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## References

1. Horiguchi S, Saito Y. The cases of Japanese cedar pollinosis in Nikko Tochigi prefecture [in Japanese]. *Jap J Allergol* 13: 16-8, 1964
2. Okubo K, Kurono Y, Fujieda S, et al. Japanese guideline for allergic rhinitis. *Allergol Int* 60: 171-89, 2011
3. Yamada T, Saito H, Fujieda S. Present state of Japanese cedar pollinosis: the national affliction. *J Allergy Clin Immunol* 133:632-9, 2014
4. Bousquet J, Schünemann HJ, Samolinski B, et al. Allergic Rhinitis and its Impact on Asthma (ARIA): achievements in 10 years and future needs. *J Allergy Clin Immunol* 130:1049-62, 2012
5. Durham OC. The volumetric incidence of atmospheric allergens IV. A proposed standard method of gravity sampling, counting, and volumetric interpolation of results. *J. Allergy* 39:79-86, 1946
6. Kishikawa R, Sahashi N, Saitou A, et al. Japanese Cedar Airborne Pollen Monitoring by Durham's and Burkard Samplers in Japan -Estimation of the Usefulness of Durham's Sampler on Japanese Cedar Pollinosis-. *Global Environmental Research* 13:55-62, 2009
7. A History of Forestry Administration in Nagasaki Prefecture [in Japanese]. Forestry Administration Division, Agriculture & Forestry Department, Nagasaki Prefectural Government 321pp, 1991
8. A Summary of Forestry and the Forests of Nagasaki Prefecture [in Japanese]. Forestry Administration Division, Agriculture & Forestry Department, Nagasaki Prefectural Government 24pp, 2018
9. Takasaki K, Terakado M, Takahashi H. Epidemiological Study of Japanese Cedar Pollinosis in Oshimamura, Hirado City [in Japanese]. *Jap. J. Rhinol* 49:112-5,2010
10. No problem for hay fever. Scientific guarantee. *Ryukyu Shimpo* Aug 1, 2008
11. Sano S, Dake Y, Sakoda T, et al. 2001 survey of pollen in Wakayama city with a real-time pollen counter. [in Japanese] *Nihon Jibiinkoka Gakkai Kaiho* 108:801-5,2005.
12. Watanabe T, Suzuki M. A comparative study between the automatic pollen counter KH-3000 and conventional Durham sampler measuring airborne pollen in the Oita University Faculty of Medicine complex [in Japanese]. *JJIAO* 35: 271-7, 2017