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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;

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 fuchsine (Carberla's stain) and covered with a 3.24 cm^2 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^2 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^2 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.

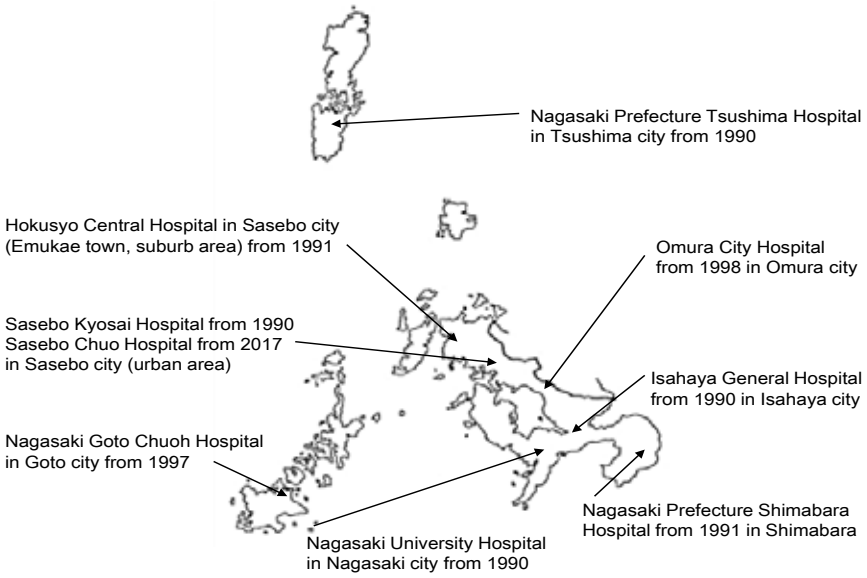

Figure 1 Locations of 8 measurement sites in Nagasaki prefecture

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^2 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.

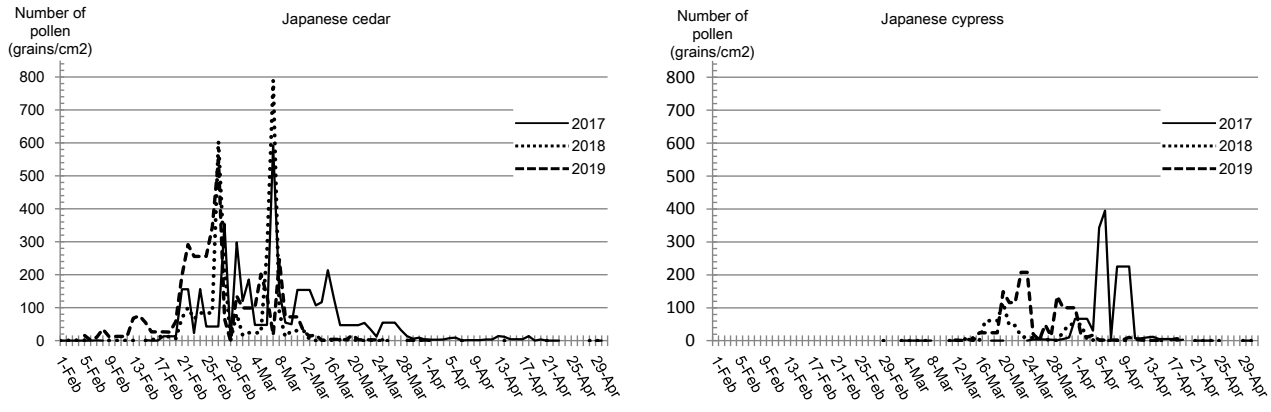

Figure 2 A and B
Typical patterns of Japanese cedar (A) and Japanese cypress (B) pollen at Nagasaki University Hospital in 2017, 2018, and 2019.

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

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

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

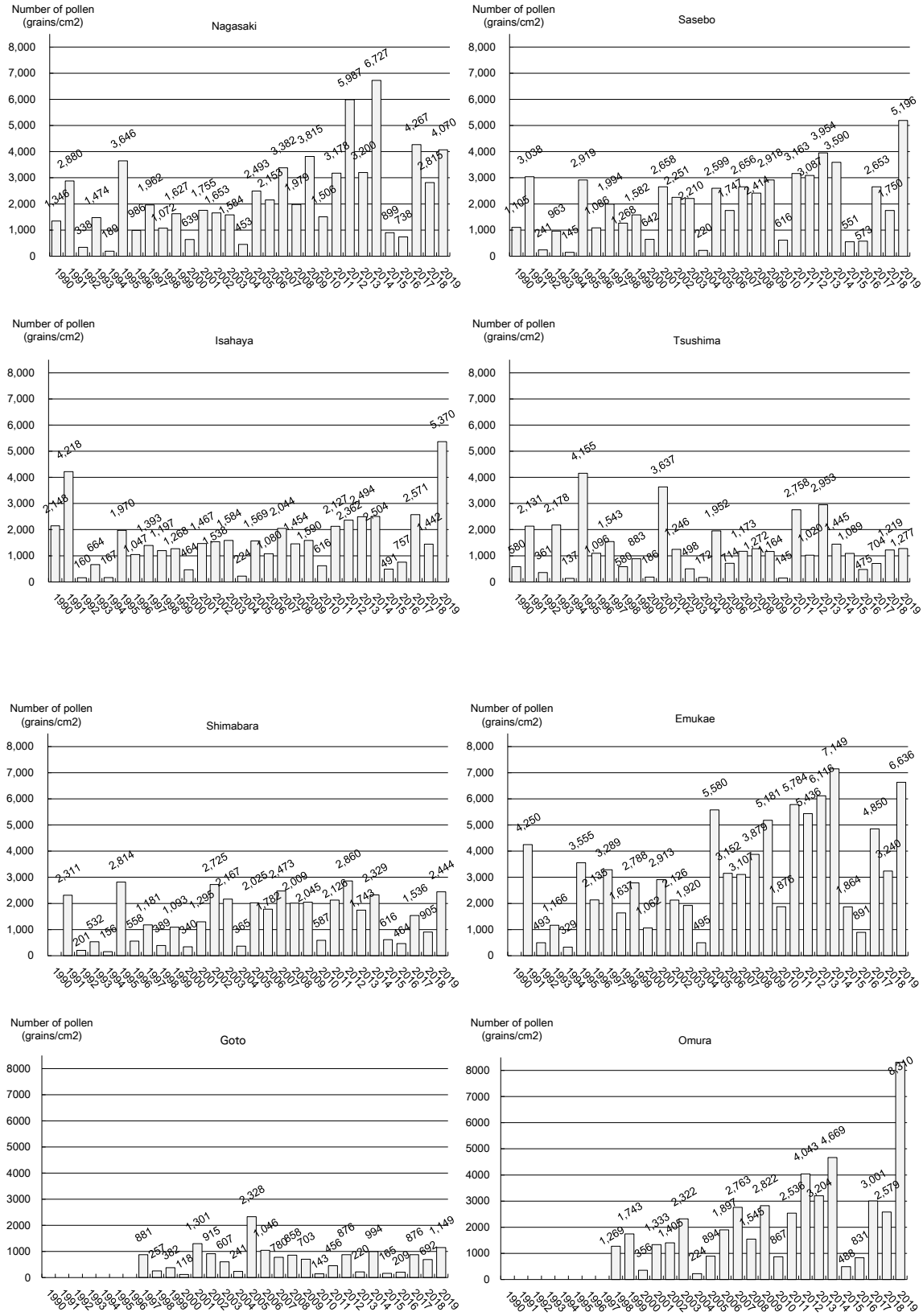

Figure 3 A-H
Annual total Japanese cedar pollen counts in eight sites. A: Nagasaki city, B: Sasebo city, C: Isahaya city, D: Tsushima city, E: Shimabara city, F: Emukae town, G: Goto city, H: Omura City

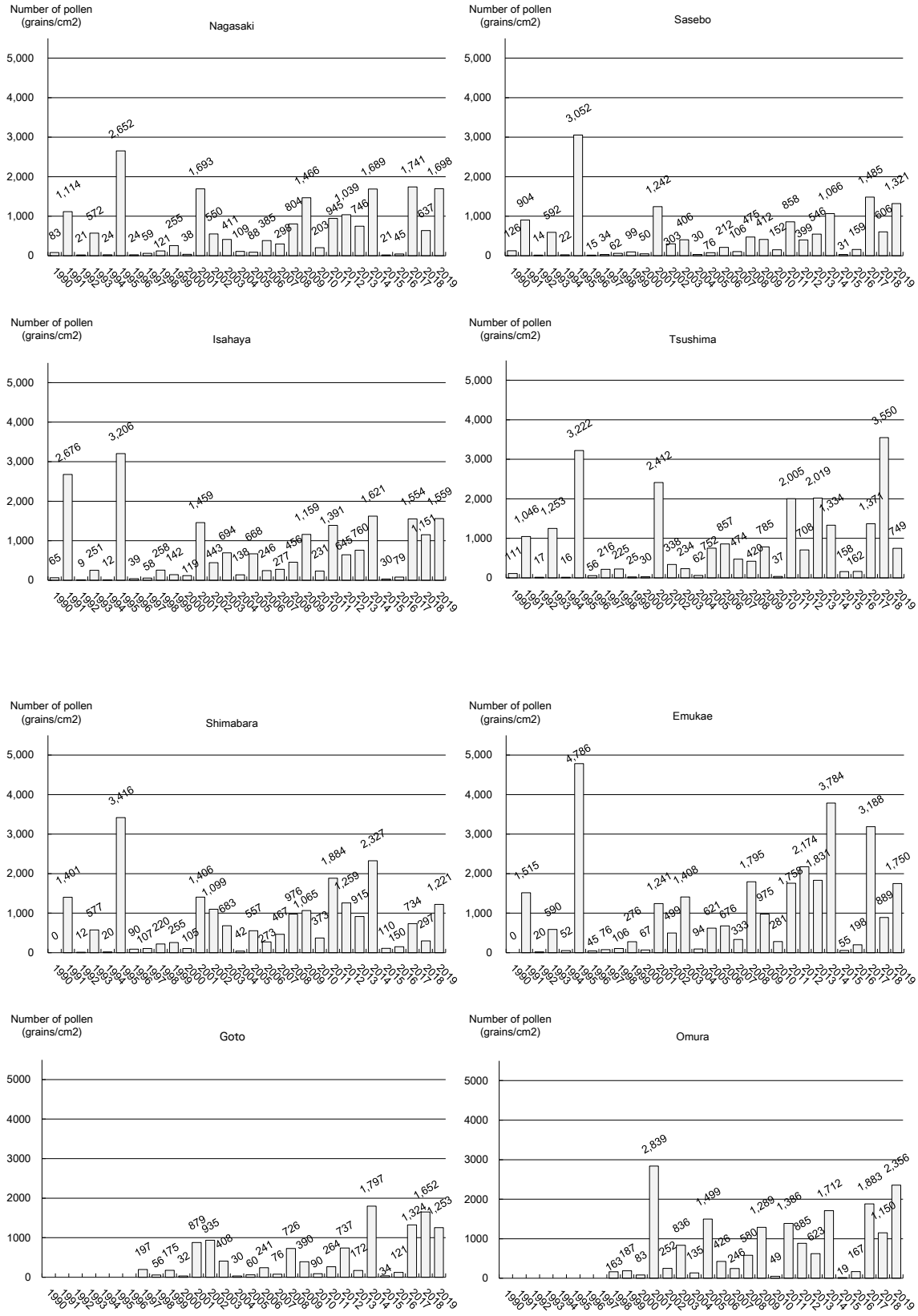

Figure 4 A-H
Annual total Japanese cypress pollen counts in eight sites. A: Nagasaki city, B: Sasebo city, C: Isahaya city, D: Tsushima city, E: Shimabara city, F: Emukae town, G: Goto city, H: Omura City

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

Nagasaki

Source	df	SS	Mean square	F pvalue	p value	R^2
Trials	1	17672390	17672390	8.7931	0.006	0.21181
Error	28	56274415	2009800.6			
Total	29	73946805				

Sasebo

Source	df	SS	Mean square	F pvalue	p value	R^2
Trials	1	7370917	7370917	5.4945	0.026	0.13419
Error	28	37562044	1341502			
Total	29	44932961				

Isahaya

Source	df	SS	Mean square	F pvalue	p value	R^2
Trials	1	2648605	2648605	2.1479	0.154	0.03808
Error	28	34526876	1233103			
Total	29	37175481				

Tsushima

Source	df	SS	Mean square	F pvalue	p value	R^2
Trials	1	88917	88917	0.0833	0.775	-0.0326
Error	28	29871049	1066823			
Total	29	29959965				

Shimabara

Source	df	SS	Mean square	F pvalue	p value	R^2
Trials	1	1358586	1358586	1.7321	0.199	0.02548
Error	27	21177063	784336			
Total	28	22535650				

Emukae

Source	df	SS	Mean square	F pvalue	p value	R^2
Trials	1	27982760	27982760	9.3617	0.005	0.22996
Error	27	80704959	2989072.6			
Total	28	108687719				

Goto

Source	df	SS	Mean square	F pvalue	p value	R^2
Trials	1	3567.2	3567	0.0134	0.909	-0.047
Error	21	5570654.7	265269			
Total	22	5574221.9				

Omura

Source	df	SS	Mean square	F pvalue	p value	R^2
Trials	1	19487119	19487119	8.0338	0.01	0.2509
Error	20	48512846	2425642.3			
Total	21	67999965				

df:degree of freedom, R^2:coefficient of determination, SS:sums of squares

Analysis of variance summary table for year and Japanese cypress pollen

Nagasaki

Source	df	SS	Mean square	F pvalue	p value	R^2
Trials	1	878301	878301	1.858	0.184	0.06223
Error	28	13236132	472719			
Total	29	14114433				

Sasebo

Source	df	SS	Mean square	F pvalue	p value	R^2
Trials	1	157937	157937	0.3698	0.548	0.01304
Error	28	11956947	427034			
Total	29	12114884				

Isahaya

Source	df	SS	Mean square	F pvalue	p value	R^2
Trials	1	220748	220748	0.3274	0.572	0.01156
Error	28	18879405	674264			
Total	29	19100153				

Tsushima

Source	df	SS	Mean square	F pvalue	p value	R^2
Trials	1	1658061	1658061	1.8542	0.184	0.06211
Error	28	25038698	894239			
Total	29	26696759				

Shimabara

Source	df	SS	Mean square	F pvalue	p value	R^2
Trials	1	103414	103414	0.1616	0.691	0.00595
Error	27	17274779	639807			
Total	28	17378193				

Emukae

Source	df	SS	Mean square	F pvalue	p value	R^2
Trials	1	2657153	2657153	1.8775	0.182	0.06502
Error	27	38211107	1415226			
Total	28	40868260				

Goto

Source	df	SS	Mean square	F pvalue	p value	R^2
Trials	1	1593542.5	1593542	6.5764	0.018	0.23848
Error	21	5088593.3	242314			
Total	22	6682135.7				

Omura

Source	df	SS	Mean square	F pvalue	p value	R^2
Trials	1	1248105	1248105	1.9788	0.175	0.09003
Error	20	12614960	630748			
Total	21	13863065				

df:degree of freedom, R^2:coefficient of determination, SS:sums of squares

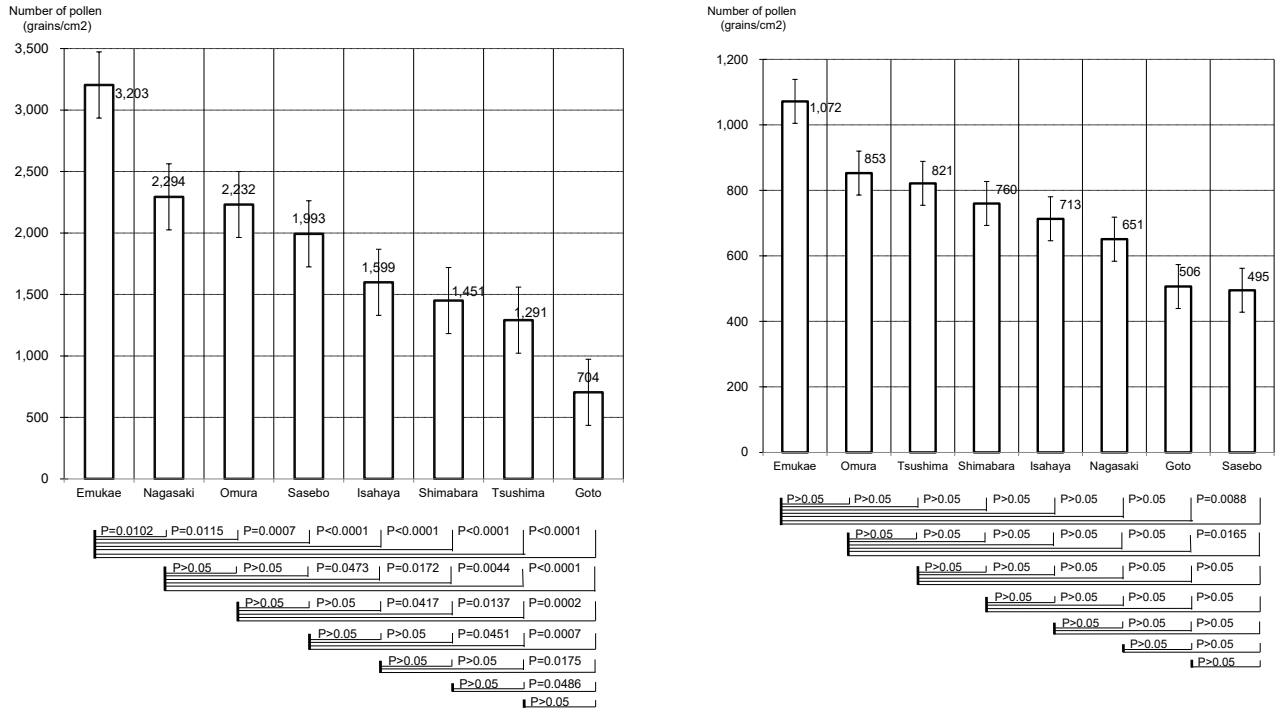

Figure 5 A and B
A: the annual mean Japanese cedar pollen counts at the eight sites during the 30-year data collection period.
B: the annual mean Japanese cypress pollen counts at the eight sites during the 30-year data collection period.

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^2
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^2
Trials	7	6991158	998737	1.4238	0.197	0.0443
Error	215	150817883	701479			
Total	222	157809041				

df:degree of freedom, R^2 :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^2 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 cm2 per 1 day

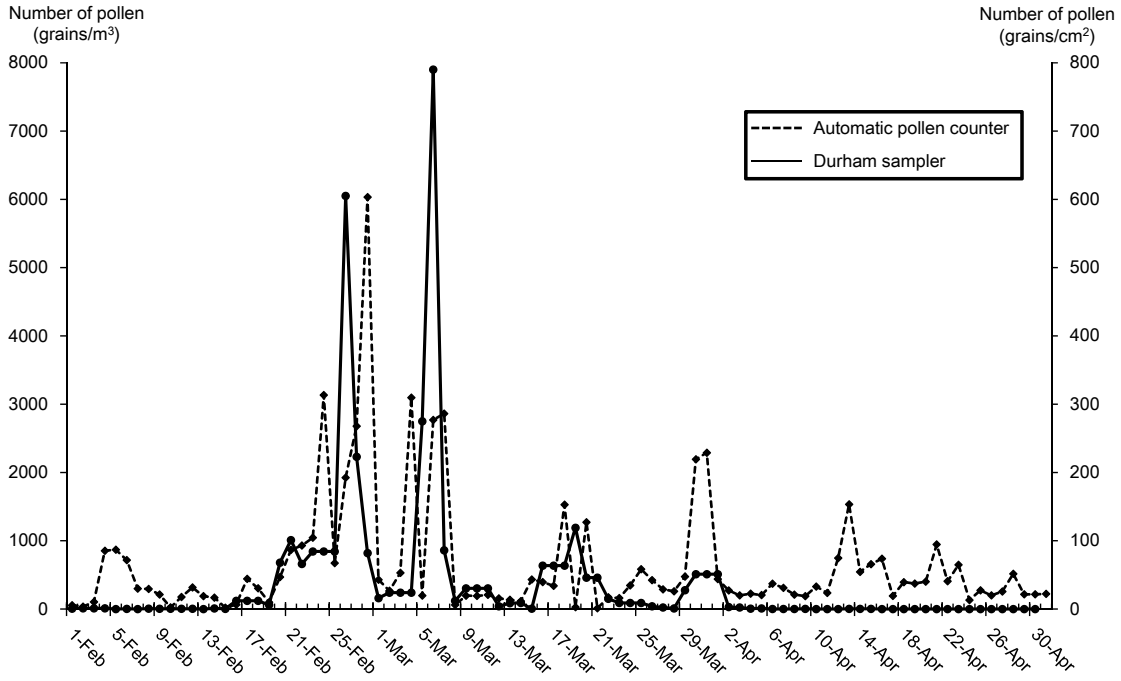

Figure 6
The correlations between the results derived using Durham's sampling method and those obtained from the KH-3000 at Nagasaki University Hospital in 2018.

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 suppresses 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 patients 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.

Acknowledgement

The data used in this study were provided through steady work by Nagasaki Association of Medical Technologists and Nagasaki Medical Association. We appreciate all medical technologists of the Nagasaki Association of Medical Technologists and all doctors and staff of the Nagasaki Medical Association who support this project. We also thank all doctors in Department of Otolaryngology – Head and Neck Surgery Nagasaki University Graduate School of Biomedical Sciences, for there helpful advice.

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