Airborne pollen survey in Bangkok, Thailand: A 35-year update

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Summary

Background: **Pollen allergy is a growing global health issue. While airborne pollen counts are reported daily in several countries, such information is lacking in Thailand.**

Objective: **This study aimed to survey airborne pollens at five sites in Bangkok, comparing data with the previous study performed 35 years ago in 1980.**

Methods: **Sample collection was done using the ROTOROD® sampler by exposing the rods for one hour each day twice a week from May 2012–April 2013.**

Results: **Overall, we found that the average pollen count was relatively high throughout the year, at an average of 242 grains/m^3. The highest peak was found in September (700 grains/m^3). Interestingly, we found that the pollen count was noticeably lower in 2012–2013 when compared to the 1980 study. We also observed the approximate shift of pollen peaks about one to two months earlier in the 2012–2013 study. However, the major groups of airborne pollens did not change significantly. Grass, sedge, amaranthus pollens and fern spores still dominated. The unidentified pollen group was the only group with a higher pollen count when compared to the previous study.** ***(Asian Pac J Allergy Immunol 2015;33:253-62)***

Keywords: *airborne pollen, allergy, Bangkok, meteorological data, climate change*

Introduction

Outdoor aeroallergens are a significant cause of allergic diseases of both the upper and lower airways. These outdoor allergens consist of airborne pollens and mould spores, which are usually unique to each geographical area. Therefore, a survey of common pollens and moulds in each area is recommended because it can provide useful information for selection of appropriate pollens in the management of allergic patients in that area.

Previously, there had been several reports about airborne pollens and/or mould spores surveyed in Bangkok, the capital city of Thailand,[1–3] including our previous reports.[4,5] Aeroallergen patterns differ from those in western countries. The differences are not only among the types and amounts of aeroallergens, but also the seasonal conditions affected by meteorological factors. Unfortunately, Bangkok's previous wide-coverage aeroallergen survey was done nearly 35 years ago.[4] Another study, published in 1983, was a 10-year surveillance of aeroallergens at one site in Bangkok, which did not reveal any significant change.[6]

Bangkok has undergone tremendous change in the past 35 years into a large metropolitan area with a higher population density, a rise in personal automobiles, and increasing industrial production. Because of this transformation, a change of aeroallergen pattern is possible. Therefore, we performed another aeroallergen survey to provide the current data and investigate whether there has been any change concerning the type, amount, and seasonal patterns of airborne allergens in Bangkok when compared to the previous data. Only airborne pollens will be reported in this paper.

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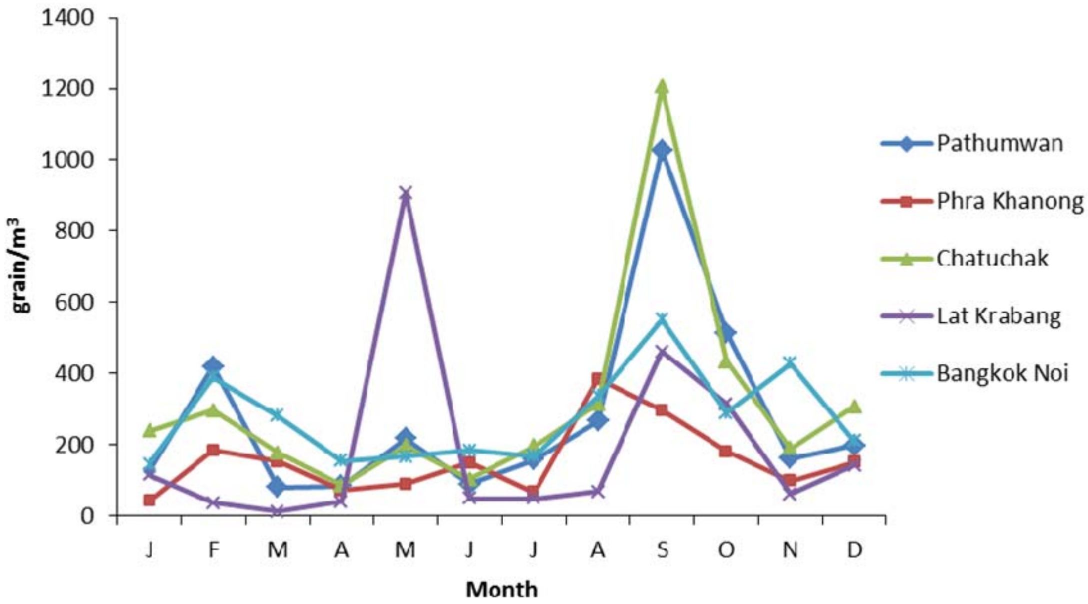

Figure 1. Average pollen count from each site (May 2012-April 2013)

Methods

Aeroallergen sampling

The aeroallergen survey was performed at five sites to cover the total area of Bangkok, which is 1,568.737 km^2. The sites were located in five districts of Bangkok, namely the Pathumwan, Phra Khanong, Chatuchak, Lat Krabang and Bangkok Noi districts. The ROTOROD SAMPLER® Model 20 with fixed sampling head (Multidata LLC, MN 55416, U.S.A.) was used for the survey, and it was situated on the unobstructed balcony of two-storey buildings (about four metres aboveground), except for the Bangkok Noi site, which was located on the rooftop of a seven-storey building at about 22 metres aboveground. Two silicone greased rods were attached to the sampling heads at a time and the motor speed was set at 2,400 RPM according to the standard operating condition.[7] The sampling device was turned on for one hour (approximately during 10:00 AM to 11:00 AM) twice a week throughout the 12-month period of the study (May 2012–April 2013). After exposure, the exposed rods were stored in a plastic box and were randomly distributed to the designated readers for pollen identification and counting.

Pollen identification and counting

Altogether, five readers were trained to identify various types of pollens and moulds found on the rods. Their readings were tested and standardised. The exposed rods were stained with Calberla's solution, composed of glycerol, ethyl alcohol, water and basic fuchsin. Pollen grains were stained pink and the pollen types were identified based on their physical characteristics seen under the light microscope with 400x magnification.

Of the two rods exposed at the same time, only the rod with more pollen grains was counted. The number of pollen grains on the surface of the rod was counted only within the area imposed by the 22x22 mm cover glass. The pollen count was then related to the amount of air sampled by the collector rod, expressed as pollen grains per cubic metre of air according to the ROTOROD SAMPLER® operating instructions.[7]

Meteorological data

Meteorological data of Bangkok were obtained from the Thai Meteorological Department http://www.tmd.go.th/climate/climate.php.[8] Data were averaged from two weather stations: Klong Toey (station code 455201) and Bang Na (station code 455301).

Results

Airborne pollen

Altogether, 1,040 rods were collected from five sampling sites in Bangkok from May 2012 to April 2013. Pollens were found on all exposed rods. The pollen count from each rod was calculated to obtain the number of pollen grains per cubic metre of air

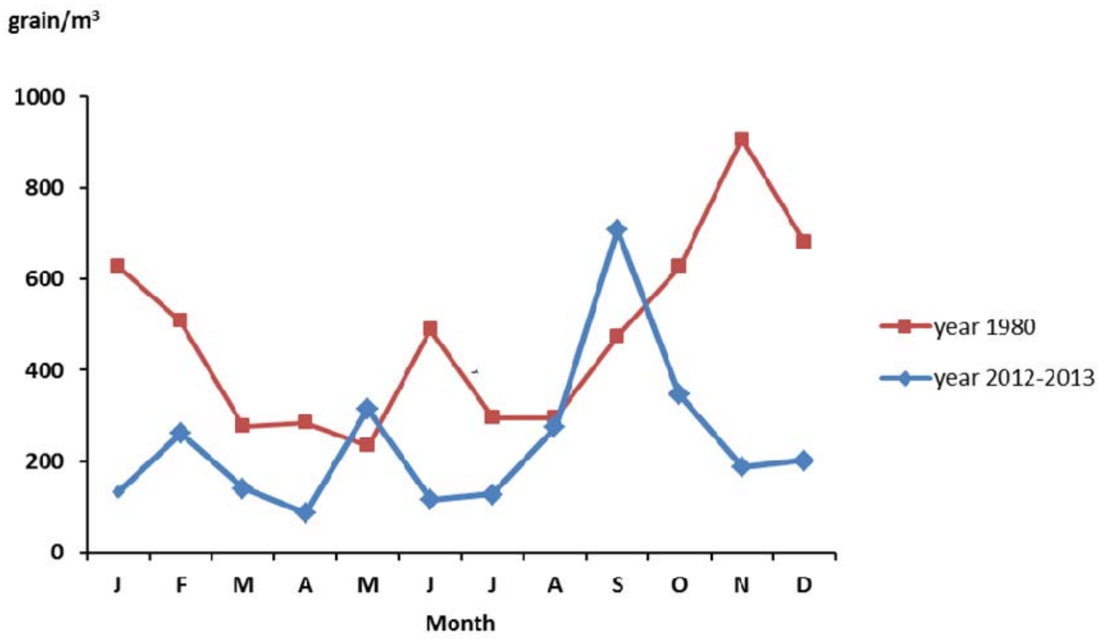

Figure 2. Comparison between average pollen counts from the 1980 and 2012-2013 studies

per hour. Data from all rods in each month were then averaged, as shown in Figure 1. In order to compare our current findings with the similar survey performed by our group in 1980 (published in 1986),[4] the data were rearranged as January to December (and thus, out of chronological order). The average pollen count from all sites was about 242 grains/m^3 year-round. Pollens peaked in September with approximately 700 grains/m^3. During this month, the pollen count was especially high (above 1,000 grains/m^3) in Pathumwan and Chatuchak. The months with the lowest pollen count (less than 150 grains/m^3) were April, June, July, January, and March, respectively.

Pollen type

In this survey, pollens were classified into 14 groups based on morphological characters visible at 400x magnification under light microscopy. Because all grass pollens are similar and cannot be classified beyond the family level (Poaceae), we reported the grass pollens according to their sizes, i.e. < 40 µm and > 40 µm. Pollens that could not be identified were grouped together in the "unidentified" group. Of note, even though fern spores are developmentally significantly different from pollens, they have also been demonstrated to be allergenic,[9] and thus, the fern spore count is also reported.

Change of aeroallergen prevalence after 35 years

Total pollen counts from the two periods of the study were compared and are shown in Figure 2. The comparison revealed that pollens were present in the Bangkok atmosphere all year round in both studies. Importantly, the prevalence of airborne pollen was lower in the recent study. During the low season, the pollen count was mostly below 150 grains/m^3 in the 2012 study, but was almost at 300 grains/m^3 in the 1980 study. Similarly, the peak concentration was about 700 grains/m^3 in the 2012 study, and more than 800 grains/m^3 in the 1980 study. Remarkably, the patterns of airborne pollen in 2012 and 1980 were almost the same, with two major peaks, except that the peaks were shifted 1–2 months earlier in the more recent study. The peaks in the 1980 study were during October to February and again in June, while in the 2012–2013 study, the peaks were during August to October and again in February and May.

Change of aeroallergen composition after 35 years

The types of pollens identifiable from the exposed rods in the two studies were compared in Table 1, listed in decreasing order of frequency percentage. The most striking change was that the unidentified pollen increased in prevalence from 10.04% to 43.13%, while the sedge pollen decreased from 23.34% to 3.48% from 1980 to 2012. Although the ranking of common pollens found in the two

Table 1. Comparison of pollen types found in the 1980 and 2012-2013 studies, listed in decreasing order of prevalence. Concentration of each type of pollen found in 2012-2013 is shown in parenthesis.

	Year 1980		Year 2012-2013	
1	Cyperaceae (Sedge)	23.34%	Unidentified pollen	43.13%
2	Wild grasses (Grass <40 µm)	19.56%	Grass <40 µm	31.45%
3	Fern	17.08%	Typhaceae	6.14%
4	Cultivated grasses (Grass >40 µm)	11.08%	Fern	6.05%
5	Unidentified pollen	10.04%	Sedge	3.48%
6	Amaranthaceae	8.08%	Grass >40 µm	3.32%
7	Myrtaceae	2.35%	Amaranthaceae	2.78%
8	Fabaceae	2.22%	Myrtaceae	1.26%
9	Urticaceae	2.09%	Mimosa	0.65%
10	Palm	1.56%	Palm	0.57%
11	Lythraceae	0.91%	Compositae	0.48%
12	Casuarinaceae	0.78%	Acrostichum	0.32%
13	Pine	0.39%	Acacia	0.25%
14	Wattle (Acacia)	0.39%	Urticaceae	0.08%
15	Compositae	0.13%	Pine	0.04%

studies was not exactly the same, the top five pollen types remained similar, with grasses and sedge as the commonly found pollen types in both studies. It should be noted that Typhaceae was not identified in the previous study. We postulated that it was included in the group of grass pollens smaller than 40 µm.

Change in seasonal variation of each pollen type

The seasonal incidence of common pollen types was compared between the two study periods, as shown in Figure 3. It can be seen that, apart from the lower amount of pollens in the recent study, the seasonal incidence of each type of pollens was also changed considerably during the 35-year period, except for sedge. Grass (< 40 and > 40 µm), sedge, and Amaranthaceae pollens all had a high pollen count at roughly the same time, contributing to the high pollen season during September–February in the 1980 study (highest in November). On the other hand, high pollen counts in August–October and in February and May of 2012–2013 (highest in September) were mostly the result of unidentified pollen production.

Because weather can significantly influence pollen production, we also compared the meteorological data of Bangkok during the years 1980 and 2012–2013.[8] The weather of Bangkok differed markedly during the two studies (Table 2 and Figure 4). While the minimum temperature was slightly lower (from 21.3°C to 20.7°C), the maximum temperature was significantly higher (from 35.8°C to 39.5°C) in 2012–2013 compared to 1980. Wind velocity and relative humidity both increased. The largest difference during these two periods was the amount of rainfall, which was extremely low in the year 1980. These factors may affect pollen prevalence in the Bangkok atmosphere. When the meteorological data and total pollen count from the two surveys were compared, we noticed that the highest peak in the pollen count in the 2012–2013 study occurred during September, corresponding to the highest amount of rainfall (Figure 4).

Discussion

The amounts and types of outdoor allergens have been repeatedly shown to affect allergic symptoms, asthma attacks, and quality of life of patients in several countries.[10–18] However, aeroallergen surveys in Asia, particularly in Southeast Asia, are less frequently reported, although the incidence of allergy is no less than the world's average. In Thailand, the prevalence of allergic rhinitis increased nearly three-fold (17.9%–44.2%) from 1990 to 2002.[19] However, the last reported aeroallergen survey in Bangkok was performed in the 1980s. This study provides a much-needed update on the status of airborne pollen in Bangkok.

We surveyed aeroallergens within the Bangkok area and compared the results with the survey performed 35 years ago. The Rotorod sampler was chosen for this study because it was already shown to have equivalent efficiency to the Burkard sampler for airborne pollen counts (collecting 95% of 20µm particles, e.g. most pollen types) and was more convenient to use.[10,20] The same technique was also used in our previous study, allowing for a direct comparison.[4,5] The survey was performed at five sites, with the maximum distance between sites around 32 km. These five sites should give a reasonable estimate of aeroallergens in Bangkok (total area ~1,500 km^2), as previously suggested by Katelaris et al., where one sampling site can represent approximately 30 km.[21]

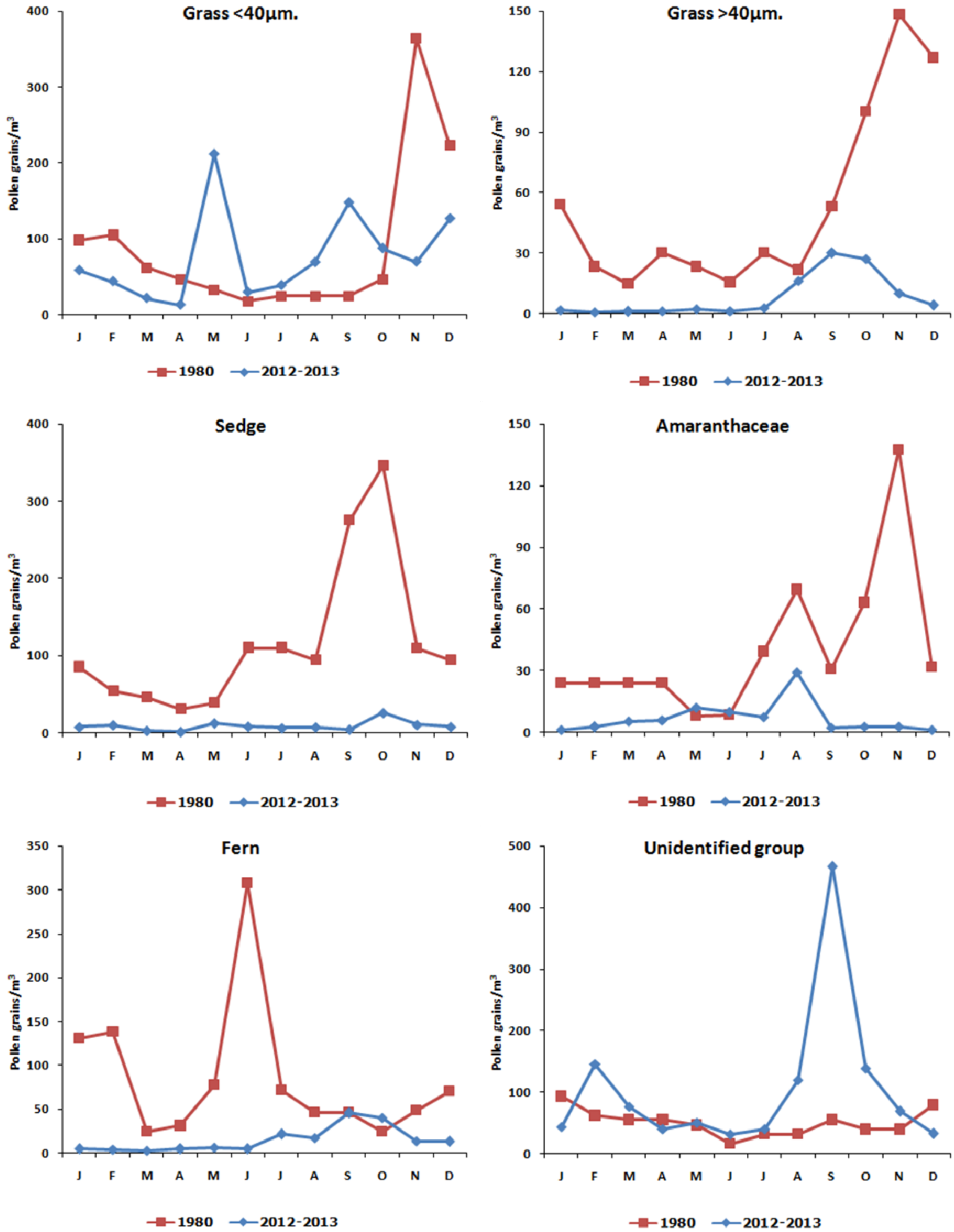

Figure 3. Seasonal incidence of common pollens found in the years 1980 and 2012-2013 studies

Table 2. Meteorological data of Bangkok in January – December 1980 and May 2012- April 2013

Year	Temp. (°C) (min - max)	Wind (knots) (min - max)	Rainfall (mm.) (min - max)	Relative humidity (%) (min - max)
1980	21.3 – 35.8	2.3 – 6.5	0 – 10.5	65.9 – 77.8
2012-2013	20.7 – 39.5	11.5 – 19.0	4.2 – 528.0	68.0 – 83.0

Although most aerobiological sampling sites are situated 10–30 metres aboveground, a study from Finland revealed that grass and weed pollen counts were higher at ground level than at 15 metres aboveground.[22] We chose a sampling height of about four metres aboveground because it is the height of most residential housing in the city, and thus, is the most applicable height for patient exposure without disturbing obstacles at the ground level. Data from the Bangkok Noi site, which was collected 22 metres aboveground, did not show significant difference from data collected at other sites.

We found that the month with the lowest total pollen count in this study (April) had an average count of 87.5 grains/m^3, which would still be considered as a medium or high pollen count. All of the other months had pollen counts greater than 100 pollen grains/m^3, with the annual average of about 242 grains/m^3, which would be considered high pollen counts by most standards.[21] It can be said that Bangkokians are continuously exposed to a high level of pollens. This observation is correlated with our allergic rhinitis patients, 71% of which were reported to have persistent symptoms according to the new classification in the ARIA guidelines.[19]

In this study, airborne pollens were classified into 14 different groups based on morphological characteristics seen under light microscopy. Because of the high diversity of flora in Thailand, it is impossible to use traditional groupings of airborne pollens into grasses, weeds, and trees. For example, pollens that are classified as mimosa can come from the sensitive plant (weed) or the rain tree, or any of more than 50 members in the Leguminosae–Mimosoidae subfamily found in Thailand. The classification also might not be all-inclusive. For example, the Acrostichum spore is significantly different from other fern spores, and is grouped separately, even though Acrostichum is generally considered to belong to a group of ferns. Also because of the high diversity, it has been difficult to pinpoint the exact source of allergenic pollens, especially among grasses, because their pollens are morphologically highly similar. Moreover, in the 2012–2013 survey, as much as 43.13% of all counted pollen grains were in the unidentified group, requiring more investigation of local flora and their pollens. A field survey can provide helpful information and should accompany the aeroallergen survey, but is often neglected due to a lack of funding or botanical expertise.

Comparing the pattern of distribution for each type of pollen, it can be said that the most highly prevalent pollens remained largely unchanged over the 35-year period, consisting of pollens from grass, sedge, Amaranthaceae, fern, and unidentified sources. All of these pollens, except for sedge, had different peak periods in the 1980 and 2012–2013 studies. Nonetheless, most peaks occurred between August and November, corresponding to the end of the rainy season and the beginning of winter in Bangkok.

When we compared the 2012–2013 study to the 1980 study, it was found that the amount of airborne pollens strikingly decreased for almost all types of pollen. Grass >40 µm, sedge, and Amaranthaceae pollens were found to be lower than 30 grains/m^3 for most of the year in the recent study, which could be considered a low pollen count. It is possible that these types of pollens might play a less significant role in eliciting allergic symptoms than before. On the other hand, grass pollen < 40 µm remained high above 50 grains/m^3 for about eight months of the year. It was reported that at this concentration, all grass-allergic patients would have allergic symptoms.[23] The reduction of airborne pollens could be due to the expansion of the metropolitan area, turning agricultural areas and wasteland into high-rise buildings, condominium, and developed office and housing projects. In addition, climate change has been shown to affect the distribution and amount of outdoor allergens.[24,25] It is possible that low levels of precipitation in 1980 led to a high level of pollen production or longer suspension time in the air, since rainfalls usually bring airborne particles down

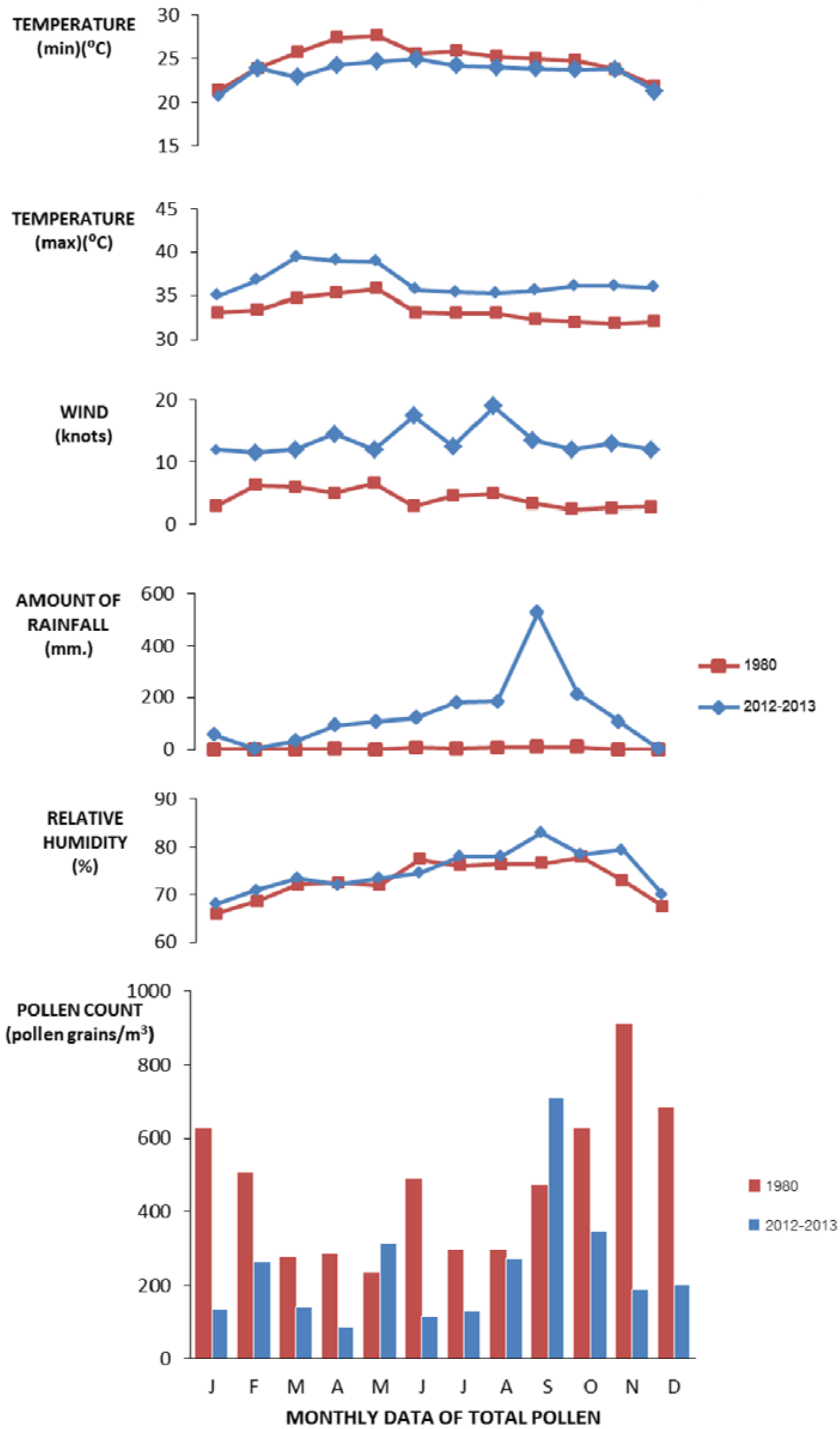

Figure 4. Comparison between meteorological data and total pollen count in Bangkok in the 1980 and 2012-2013 studies

to the ground. The correlation between airborne pollen and meteorological parameters had been previously reported from several countries.[26–28] However, our data of annual pollen counts, performed 35 years apart, were insufficient to draw a conclusion about the correlation between the amount and type of airborne pollens and meteorological parameters.

In contrast with the airborne pollen reduction, the number of patients suffering from allergic rhinitis has been increasing continuously in Thailand.[19] Data from Siriraj Hospital in Bangkok showed that the number of asthma patients admitted for intensive care because of severe asthmatic attacks per year has nearly doubled over the seven year period (from 465 cases in the year 2007 to 863 cases in the year 2013).[29] This suggests that the rising incidence is likely to be correlated with factors other than the amount of airborne pollens, such as the increasing allergenicity of pollens and the high levels of pollution.[25] Increased air pollution, including NO_2, volatile organic compounds (VOCs), particulate matter (PM) and ozone, is associated with a higher incidence of allergy and asthma.[15,25] Rising incidence of pollen allergies can also be related to increasing indoor allergies, such as dust mites or cockroaches, which is an interesting aspect for further investigation.

Significantly higher temperatures might also play a significant role. The maximum temperature of Bangkok rose approximately 4°C from 1980 to 2013, which could result from a combination of the urban heat island effect and global warming. Previous reports have shown that global warming can speed flower development, leading to earlier pollen seasons.[25] In agreement with this observation, our study also found that the pollen peaks shifted one to two months earlier in the 2012–2013 study compared to the 1980 study. Furthermore, higher temperatures could increase the allergenicity of pollen.[30] A study comparing ragweed in the rural and urban areas showed that 2°C higher temperature and 30% higher CO_2 levels in the urban area resulted in a higher biomass of plants, a seven-fold increase in pollen production, and a two-fold higher amount of Amb a 1 per microgram of pollen protein.[31] Although this type of information is highly useful for the management of allergic diseases, it is still lacking in the tropical zone, where the climate is drastically different. For example, the higher temperature might not lead to early flower bud breaking, but may lead to heat stress and a change in the allergenicity of pollens instead.

Similar to the survey in 1980, grass and sedge pollens still accounted for a large percentage of total airborne pollen in 2012–2013. This is well-correlated with the high percentage of patients visiting the ENT Allergy Clinic at Siriraj Hospital between 2002 and 2004 that had positive skin prick test (SPT) reactions to grass, sedge, and Amaranthus extracts (Bermuda grass = 52.3%, sedge = 45.9%, Amaranthus = 45.4%).[19] Nonetheless, because of the similarity of grass pollen morphology, it is still unknown which grass species produce the most prominent pollen and therefore, are more likely to be the primary sensitising species. Our preliminary data suggest that pollens from different species of grasses have a wide range of allergenicity. We are actively pursuing a research programme to determine immunogenicity and cross reactivity of grass species found in the area.

Interestingly, there was a significant rise in the unidentified pollen group. Even though there were a few changes to the grouping of pollen and to the Rotorod readers, it could not account for this difference. It is speculated that this is due to the change of land use. The replacement of agricultural areas and wasteland by developed housing projects and highways brought about new plant species in the form of ornamental plants and possibly new weeds that are more adapted to the new environment. The peak for pollen in the unidentified group was observed in September, corresponding to the highest amount of rainfall, suggesting that most of these pollens were released from flowers that bloom in the rainy season that were most likely produced from perennial weeds and trees rather than annual weeds and grasses. Because the source of these pollens has not yet been identified, it is not possible to assess allergenicity of these pollens. This suggests that there is an urgent need to increase the amount of research in this particular area.

In conclusion, this study reported the first airborne pollen survey in Bangkok in over three decades. It was found that the total number of pollens has decreased, but the types of airborne pollens remained relatively similar to the previous survey, with a noticeable rise of pollens in the unidentified group. The results of this work suggested that the rise of allergic rhinitis incidences caused by pollens in Bangkok was not simply correlated with the amount of airborne pollens. Ideally, aeroallergens should be constantly monitored to understand the correlation between airborne pollens and meteorological factors in the tropical areas, which can provide highly useful information to help alleviate this global health issue.

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Conflict of interest

None declared.

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