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INVESTIGATIVE REPORT

Prevalence of Atopic Dermatitis, Allergic Rhinitis and Asthma in Taiwan: A National Study 2000 to 2007

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To study the prevalence of atopic dermatitis, allergic rhinitis, and asthma in Taiwan, we analysed the claims data of a nationally representative cohort of 997,729 enrolees from the National Health Insurance register from 2000 to 2007. Overall, 66,446 patients were diagnosed with atopic dermatitis, and 49.8% of them had concomitant allergic rhinitis and/or asthma. The overall 8-year prevalences of atopic dermatitis, allergic rhinitis, and asthma were 6.7%, 26.3% and 11.9%, respectively. Children and adolescents had significantly higher prevalences of these atopic diseases. The prevalence of atopic dermatitis in females was lower than that in males before the age of 8 years, but became higher after that. Patients with atopic dermatitis were more likely to have allergic rhinitis and asthma. Those having both atopic dermatitis and allergic rhinitis possessed an even higher risk for asthma (odds ratio 9.04). The numbers of visits for atopic dermatitis were highest in late spring to mid-summer. These data suggest that atopic diseases are common in Taiwan. ***Key words: allergic rhinitis; asthma; atopic dermatitis; epidemiology.***

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Atopic dermatitis (AD) is a chronic dermatitis mainly affecting infants and children (1). It is characterized by pruritus, chronic or relapsing course, typical distribution, and a personal/family history of atopic disease such as allergic rhinitis (AR) and asthma (2). It has been hypothesized that these three atopic diseases share a common aetiological factor resulting in epithelial barrier dysfunction (3, 4). The investigation of filaggrin gene defect has further supported this hypothesis (5).

There are many published reports describing the prevalence of AD, and these report widely varying figures, which may be due to several factors such as the age and community of the subjects and the study methodology (6–12). Most of these studies were based mainly on questionnaires or clinical diagnosis, and the study subjects were mainly preschool or schoolchildren. However, there is little data regarding the prevalence of AD in the general population. Moreover, nationwide claims-based studies of the prevalence of AD are limited (13–15).

In Taiwan, the National Health Insurance (NHI) programme covers most of the population, and most medical institutions (91%) are contracted to the Bureau of NHI. The National Health Insurance Research Database (NHIRD), one of the largest insurance databases in the world, includes all the claims from ambulatory care and inpatient care and provides valuable information for many epidemiological studies (16–19). The aims of our study were to determine the overall prevalence of AD, AR and asthma in the general population, and to determine the relationships between these atopic diseases.

PATIENTS AND METHODS

Data source

The Taiwan NHIRD is a claims database maintained by the Department of Health and the National Health Research Institutes of Taiwan. The NHI programme was launched in Taiwan on 1 March 1995. It covered 96.2% of the total population in 2000 (20). By the end of 2007, 22.60 million of Taiwan's 22.96 million population had been enrolled in the program. People not registered in the NHIRD included citizens living abroad, prisoners, and those with economic difficulties. In 1999, the Bureau of NHI began to release all claims data in electronic format to the public under the NHIRD project. The database provides scrambled patient identification number, patient birthday, gender, diagnostic codes in the format of the International Classification of Disease, Revision 9, Clinical Modification (ICD-9-CM), prescription drugs dispensed, medical cost, medical care facilities and their specialties. In the present study, a total of 1,000,000 persons (approximately 5% of Taiwan's population), were randomly selected from the Taiwan NHIRD. After excluding persons with questionably basic data, such as conflicting gender or uncertain birthday, a total of 997,729 enrolees were included in this study and their claims data from 2000 to 2007 were analysed. Among these 997,729 enrolees, those who did not have the specific atopic diseases were used as the control group when calculating odds ratios (OR).

Diagnostic criteria

In the present study, to be designated as having a certain disease, the patient had to have a corresponding ICD-9-CM code in the

diagnosis field. The ICD-9-CM codes used for AD in our study were 691 and 691.8. The ICD-9-CM codes used for AR in our study were 477.0, 477.1, 477.2, 477.8, and 477.9. The ICD-9-CM code used for asthma in our study was 493.

Statistical analysis

Microsoft Office Excel 2003 (Microsoft Corporation, Redmond, WA, USA) was used to perform the statistical analysis. A χ^2 test was used to calculate the difference between groups. OR, 95% confidence interval (CI), and significance values for the prevalence of the three atopic diseases were calculated using the SPSS statistics analysis package (SPSS for Windows, version 17.0, Chicago, IL, USA). A p-value < 0.05 was considered statistically significant.

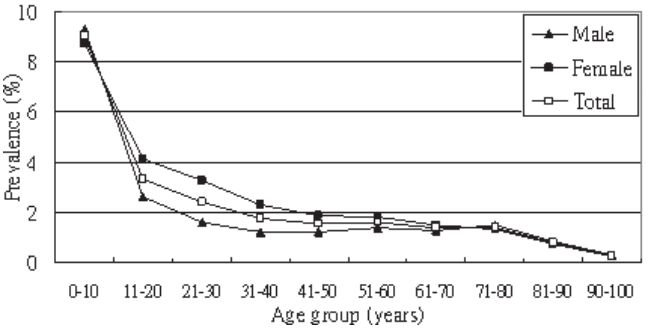

Fig. 1. Overall 8-year prevalence of atopic dermatitis in the whole study group.

RESULTS

Atopic dermatitis in the whole study group

Among the 997,729 study subjects in the study, 512,722 were males and 485,007 were females. The mean ± standard deviation (SD) of age was 33.78 ± 20.70 years. A total of 277,934 enrolees, consisting of 144,538 males and 133,396 females, were less than 20 years old. The age was defined by the age in year 2000, which was the time of enrolment.

In this study group, there were 66,446 patients (30,062 males and 36,384 females) with claim of primary diagnosis as AD during the 8-year study period. The mean one-year prevalence was 1.2%, and the overall 8-year prevalence was 6.7%. The prevalence in females was significantly higher than that in males (7.5% vs. 5.9%, $p < 0.001$) (Table I). Among these patients with AD, 50.2% had "pure AD" (AD alone, without respiratory allergies such as AR and asthma). The other 49.8% of the patients with AD who had concomitant respiratory allergies (AR and/or asthma) were designated "mixed-type AD": 43.4% had AR, 22.9% had asthma, and 16.5% of them had both AR and asthma. There was a higher proportion of "pure AD" in females. The prevalences in different age groups showed a trend of decreasing with age (Fig. 1).

Atopic dermatitis in children and adolescents

Among these patients with AD, 26,576 (40%) were less than 20 years old (Table I). The mean one-year prevalence in children and adolescents was 2%, and the overall 8-year prevalence of AD was 9.6%. It was highest in the age group less than one year old (22.4%) and decreased with age, reaching 6.1% in 14-year-olds (Fig. 2). The overall prevalence in girls was higher than that in boys (10% vs. 9.2%, $p < 0.001$) (Table I). In fact, the prevalence of AD in girls was lower than that in boys before the age of 8 years, but became higher after that. Among these patients, 38.8% had "pure AD". The other 61.2% had "mixed-type AD": 56.5% had AR, 31.2% had asthma, and 26.5% had both AR and asthma. There was a higher proportion of "pure AD" in girls (43.2% vs. 34.4%, $p < 0.001$).

Allergic rhinitis and asthma in the whole study group

The mean one-year prevalence of AR in the whole study group was 11.3%, whereas the overall 8-year prevalence was 26.3% (Table I). The prevalence in females was higher than in males (27.7% vs. 25.1%, $p < 0.001$).

The mean one-year and the overall 8-year prevalences of asthma in the whole study group were 2.9% and 11.9%, respectively. The prevalence in females was higher than that in males (12.2% vs. 11.7%, $p < 0.001$).

Allergic rhinitis and asthma in children and adolescents

The mean one-year and the overall 8-year prevalences of AR in children and adolescents were 11.3% and 37.8%, respectively (Table I). The prevalence in boys was higher than that in girls (39.7% vs. 35.8%, $p < 0.001$).

The mean one-year and the overall 8-year prevalences of asthma in children and adolescents were 4.4% and

Table I. *Overall 8-year prevalences of atopic dermatitis (AD), allergic rhinitis (AR), and asthma in Taiwan*

	Whole study group			Age < 20 years		
	Total % (*n*)	Male % (*n*)	Female % (*n*)	Total % (*n*)	Male % (*n*)	Female % (*n*)
AD	6.7 (66,446)	5.9 (30,062)	7.5 (36,384)	9. 6 (26,576)	9.2 (13,250)	10 (13,326)
AR	26.3 (262,665)	25.1 (128,524)	27.7 (134,141)	37.8 (105,160)	39.7 (57,419)	35.8 (47,741)
Asthma	11.9 (118,849)	11.7 (59,794)	12.2 (59,055)	15.7 (43,707)	17.3 (25,039)	14 (18,668)

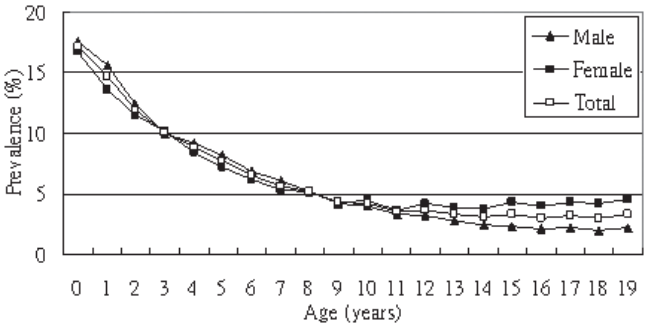

Fig. 2. Overall 8-year prevalence of atopic dermatitis in children and adolescents.

15.7%, respectively (Table I). The prevalence in boys was higher than that in girls (17.3% vs. 14%, $p < 0.001$).

Relationships between atopic dermatitis, allergic rhinitis, and asthma

Patients with AD were more likely to have AR and asthma, with ORs of 2.28 (95% CI: 2.25–2.32) and 2.38 (95% CI: 2.33–2.42), respectively. Patients with AR had an increased risk for asthma, with an OR of 5.09 (95% CI: 5.03–5.16). Patients with both AD and AR had an even higher risk for asthma, with an OR of 9.04 (95% CI: 8.81–9.27).

Seasonal variation

There were a total of 213,893 visits for AD in the present study group. The number of medical visit per day was calculated to represent the disease activity. The seasons were defined as follows: spring: March, April and May; summer: June, July and August; autumn: September, October and November; winter: December, January and February. In the AD group, there were more visits in late spring to mid-summer (Fig. 3). In the AR and asthma groups, the numbers of visits were higher in autumn and winter. These seasonal variations were observed in both the whole study group (not shown) and in the children/adolescents.

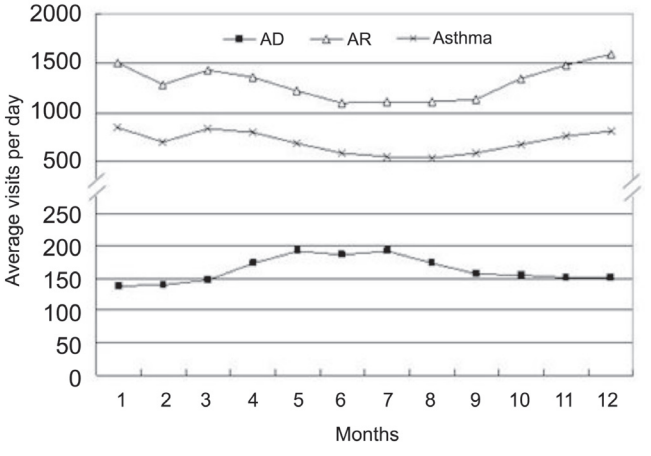

Fig. 3. Seasonal variation of disease activities (average medical visits per day) of atopic dermatitis (AD), allergic rhinitis (AR), and asthma in children and adolescents.

Hospitalization of patients with atopic dermatitis

Among the 66,446 patients with AD, 120 (0.18%) had been hospitalized during 2000 to 2007, and 84 (70%) of those inpatients were less than 20 years old. The hospitalization rate in males was higher than that in females (0.24% vs. 0.13%, $p = 0.001$). The most frequently associated diagnoses on admission included asthma (18.3%), cellulitis (17.5%), pneumonia (10%), and eczema herpeticum (3.3%). As shown in Fig. 4, the months with the lowest admission numbers were January and December.

DISCUSSION

There have been many studies on the prevalence of AD, and the diagnoses of AD in most of these studies were based on clinical diagnosis and/or questionnaires. Clinical diagnosis by board-certified doctors offers higher validity, but is more time-consuming, and it only provides point prevalence (6). Studies utilizing questionnaires have the advantage of being easier to perform and acquire a large amount of data in large areas, and questionnaires have been used in large international studies, such as the International Study of Asthma and Allergies in Childhood (ISAAC) (10). However, the validity of diagnosis may be questioned, as misinterpretation could occur in different populations, and recall bias may exist. Moreover, the current questionnaire instrument does not perform well in the identification of adult patients with AD (21). In our study, we used a claims database as the study material. Research using a claims database has the advantages of low cost and ease of acquiring a large sample size with long-term follow-up. Furthermore, because there is no selection bias, the data from a claims database could be generalized to the whole population.

The prevalence of AD in different regions varied from as low as 0.8% in Iran to as high as 37.6% in Costa Rica

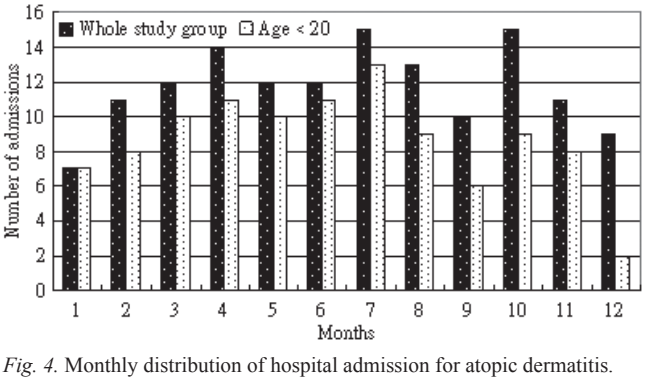

Fig. 4. Monthly distribution of hospital admission for atopic dermatitis.

(8–10, 22–24). Among these countries, Taiwan had a relatively lower prevalence of AD. There are some possible reasons for the variation of prevalence of AD. First, previous studies have demonstrated that the extent of urbanization, industrialization, life style, and latitude all affect the prevalence of atopic diseases (2, 10, 25–27). Secondly, since we observed a seasonal variation in the disease severity of atopic disease, when the study was performed also affects the prevalence. Other possible factors, such as socioeconomic status or ethnic group, may also contribute to the variation (8).

AD is a disease generally affecting infants and adolescents, and most cases occur before childhood (1, 2, 27). The prevalence usually decreases with increasing age (10, 11), but some patients are still affected by the disease in adulthood. In our study, the findings were consistent with those of previous studies. The prevalence of AD in children was 9.6%; in contrast, only 4% of adults were still affected by this disease.

The gender difference in AD has been variable among different studies. Some studies reported a higher prevalence in females, while others did not (3, 28–32). Most studies in Taiwan showed a male predominance, with various levels of statistical significance (30–32). In our study, the overall prevalence in girls was higher than that in boys. In fact, the prevalence of AD in females was lower than that in males before the age of 8 years, but became higher after that. A similar trend was also reported in previous study (8, 33). This crossover of prevalence was suggested to be related to the change of sex hormones (33).

In the present study, the disease activity of AD was assessed by visits to medical institute and was highest in late spring to mid-summer. In addition, the monthly distribution of hospital admission number also showed a decrease in winter. Previous studies had shown seasonal difference in the point prevalence of AD (34, 35). Krämer et al. (35) identified two seasonal patterns in children with eczema; those becoming more severe in the winter time ("winter type") showed a strong impact of the temperature, and those worsening in the summer time ("summer type") had an association with grass pollen. According to this classification, the patients with AD in Taiwan belonged to the "summer type". Other studies had shown that hot weather and humidity were exacerbating factors for AD (36, 37). In Taiwan, the average temperature is highest in summer, and the relative humidity is highest in spring (38). The monthly variation in average temperature and humidity both correlated with the disease activity of AD. It was likely that temperature and humidity were at least two of the causes of exacerbation of AD in Taiwan.

Previous studies in East Asia showed that the prevalence of AR ranged from 19.3% to 61.9% and the prevalence of asthma varied from 2.8% to 18.2% (22, 39–41). Most of the studies that compared sex difference of AR and asthma in children showed male predilection, which was consistent with our study (32, 39, 42–44). AD and AR often coincide with or precede the development of asthma (45). In our study, we found that 49.8% of the patients with AD had "mixed-type AD". The proportion was even higher in children, reaching 61.2%. Most of these "mixed-type AD" patients had both AD and AR, while approximately half of them were affected by AD and asthma. AR has not only been identified as risk factor for asthma (46), but also a predictor of the development of asthma in children with AD (47). The presence of concomitant AR and AD has also been identified as a risk factor for asthma (47). In our study, we found both AD and AR were risk factors for asthma, and patients with both AD and AR had an even higher risk for asthma (OR: 9.04).

There were some limitations in our study. First, our data was obtained from a claims database, which means only those who had visited a medical institution would be enrolled. Those with less severe symptoms would not seek medical advice. This could cause underestimation of prevalence. Secondly, this database did not document disease severity, duration of the disease, family history, lifestyle, or laboratory data. The lack of this valuable information made us unable to evaluate the influence of these factors.

In conclusion, atopic diseases are common in Taiwan. The prevalence of AD in females is lower than that in males before the age of 8 years, but subsequently becomes higher. Children and adolescents have significantly higher prevalences of atopic diseases. Patients with either AD or AR have increased risk for asthma, while patients with both AD and AR have an even higher risk.

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