https://doi.org/10.4082/kjfm.24.0124 • Korean J Fam Med 2025;46(6):426-434

KJFM
Korean Journal of Family Medicine

eISSN: 2092-6715

■ Original Article

Investigation of the prevalence and treatment of atopic dermatitis in South Korea using a large national dataset

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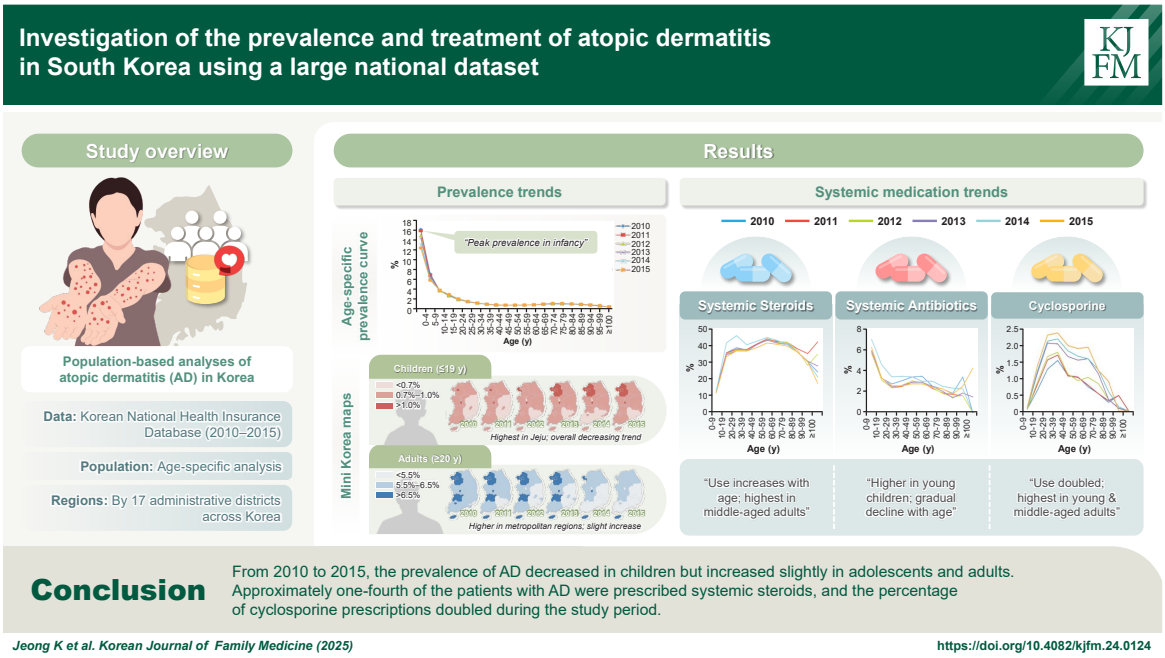

Received: May 31, 2024, Revised: August 9, 2024, Accepted: August 30, 2024, Published online: November 14, 2024
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ABSTRACT

Background: Updated reports on the population-based analysis of atopic dermatitis (AD) in Korea are rare. This study aimed to investigate the nationwide prevalence and systemic medication prescription trends of AD in Korea.

Methods: Based on the Korean National Health Insurance database, the prevalence of AD and systemic medication prescription trends in patients with AD were analyzed according to age groups and regional districts from 2010 to 2015.

Results: The prevalence of AD was the highest among patients aged 0–1 year (18.6%–24.5%), decreasing rapidly with increasing age (<2% in patients aged ≥20 years). From 2010 to 2015, the prevalence of AD decreased in children but increased slightly in adolescents and adults. In 2015, the proportion of systemic steroid prescriptions increased from 11.2% in the 0–9 years age group to 41.1% in the 50–59 years age group, while that of systemic antibiotic prescriptions gradually decreased from 6.2% in the 0–9 years age group to 1.8% in the 80–89 years age group. The proportion of systemic steroid prescriptions by region remained consistently high in Gyeongbuk (34.2%–34.9%) and low in Daejeon (20.2%–22.5%). The annual proportion of systemic cyclosporine prescriptions increased significantly from 0.6% in 2010 to 1.2% in 2015, with the highest rates observed in patients in their 30s (1.5%–2.4%), followed by those in their 20s (1.3%–2.3%) and 40s (1.1%–2.0%).

Conclusion: From 2010 to 2015, the prevalence of AD decreased in children but increased slightly in adolescents and adults. Approximately one-fourth of the patients with AD were prescribed systemic steroids, and the percentage of cyclosporine prescriptions doubled during the study period.

Keywords: Atopic Dermatitis; Eczema; Korea; Prevalence

Introduction

Atopic dermatitis (AD) is a major public health problem worldwide and one of the most common chronic skin diseases [1]. The lifetime prevalence of AD has increased worldwide over the past 30 years. According to the International Study of Asthma and Allergies in Childhood (ISAAC), the prevalence of AD in children is 10%–20% in developed countries; although low in many developing countries, it is showing an upward trend [2,3]. The prevalence of AD in adults is approximately 1%–3%; however, some studies have suggested that it is close to 7% [4]. In Asia, the prevalence of childhood AD is 12%–13% in mainland Japan, 10.7% in Taipei, and 12.94% in China [5-7]. Although the prevalence of AD has been decreasing in some developed countries, such as New Zealand and the United Kingdom, an increasing trend is still observed in many developing countries in Asia and Africa [8].

In Korea, the first nationwide questionnaire survey to assess the prevalence of AD using the ISAAC protocol was conducted in 1995, reporting a prevalence of 7.3% in 6–12-year-olds and 3.9% in 12–15-year-olds [9]. The second and third nationwide surveys were conducted in 2000 and 2010, respectively. The prevalence of "itchy eczema in the last 12 months" increased from 13.4% in 2000 to 20.6% in 2010 in children aged 6–7 years and from 6.7% in 2000 to 13.1% in 2010 in children aged 12–13 years [10,11]. However, based on the data from the Korean National Health Insurance Service database from 2009 to 2014, the prevalence of AD in Korean children aged ≤18 years appears to be decreasing, especially in infants [12].

Various treatments have been used for AD, with topical or systemic steroids being a common treatment option. However, in patients with moderate to severe AD, systemic immunosuppressants such as cyclosporine can be used for long-term treatment, considering the various complications associated with systemic steroids [13]. Microbes, such as *Staphylococcus aureus*, are a well-known cause of skin infection in patients with AD. As antibiotics are important for treating bacterial skin infections in AD, the prevalence of methicillin-resistant *S. aureus* is a concern [14]. A recent report indicated that the empirical use of antibiotics may be inappropriate to treat patients with AD exacerbation [15].

This study investigated the nationwide prevalence and medication prescription trends for AD in South Korea using a large national dataset. Evaluating the latest AD prevalence and investigating the nationwide trends in drug use, which have not been well studied, will provide useful information for establishing treatment policies for patients with AD.

Methods

Data collection and assessment of prevalence

We utilized data from the Korean National Health Insurance database, which covers 97.9% of the Korean population [16], to obtain the diagnostic codes of the Korean Classification of Diseases, sixth Edition (KCD-6), a modified version of the 10th revision of International Classification of Diseases (ICD-10). We extracted data with the first three digits of "L20" in the KCD-6, which corresponds to the ICD-10 code. The number of patients with AD in each year was determined by identifying those who visited medical facilities for AD management at least once a year. To estimate the prevalence and incidence of AD, we also collected data on the total annual population and the population grouped by age and sex from the Korean Statistical Information Service, a website-based service operated by Statistics Korea. This study was exempt from Institutional Review Board (IRB) review according to the IRB regulations, as it is a national big data research project (IRB ap-

proval no., AJIRB-MED-EXP-16-125). Descriptive statistics have been used to describe the numbers and percentages of prescriptions. Data were preprocessed and analyzed using SAS ver. 9.4 software (SAS Institute Inc.).

Clinically, there are cases where another skin condition is the primary diagnosis; however, AD is recorded as the primary diagnostic code to prescribe specific medications, with the actual clinical primary condition listed as the secondary diagnosis. Hence, we initially analyzed the entire dataset with the primary diagnosis code "L20," and then compared this with the dataset where the primary diagnosis code was L20 without other specific skin conditions (psoriasis, rosacea, seborrheic dermatitis, vitiligo, or lichen planus) included as the secondary diagnosis. As there were no significant differences in prevalence between these two datasets, the entire dataset with the primary diagnosis code L20 was used as the study population.

Age-specific prevalence analysis

For age-specific prevalence, age groups were categorized into 5-year intervals, and patients up to 19 years of age were considered as the children and adolescent group. When determining the prevalence of AD in the different childhood life cycle stages, the age groups were categorized as 0–1 year (infants), 2–6 years (preschool children), 7–12 years (elementary school), 13–15 years (junior high school), and 16–18 years (high school), instead of the typical 5-year intervals, to analyze the epidemiological pattern according to the developmental stages in Korean children.

Regional prevalence analysis

The regional prevalence of AD in Korea was analyzed separately for children (aged ≤19 years) and adult (aged ≥20 years) groups. We analyzed the prevalence in each of the 17 regions of South Korea from 2010 to 2015. The regional prevalence in children was classified into the following three categories: <5.5%, 5.5%–6.5%, and >6.5%. In adults, the regional prevalence was classified into the following three groups: <0.7%, 0.7%–1.0%, and >1.0%.

Medication prescription analysis

The medication prescription trends for patients with AD were extracted using the generic name codes for oral steroids, antibiotics, and immunosuppressants. The drugs included in the systemic steroid analysis were betamethasone, dexamethasone, methylprednisolone, and prednisolone, classified under the Ministry of Health and Welfare's therapeutic category code 245 (adrenal hormones), excluding epinephrine and norepinephrine. For antibiotics, the analysis included drugs categorized under codes 611 (primarily acting on Gram-positive bacteria), 612 (primarily acting on Gram-negative bacteria), 614 (acting on Gram-positive bacteria, rickettsia, and viruses), 615 (acting on Gram-positive and Gram-negative bacteria, rickettsia, and viruses), 618 (acting on Gram-positive and Gram-negative bacteria), 619 (other antibiotic preparations), and 621 (sulfa drugs among chemotherapeutic agents). For immunosuppressant agents, we only used the data on cyclosporine, which is accepted for therapeutic use in Korea. We analyzed the medication prescription patterns according to age and region. The age groups used in the medication prescription analysis were identical to those used in the age-specific prevalence analysis. The regional medication prescription patterns were analyzed separately for the children (aged ≤19 years) and adult (aged ≥20 years) groups.

Results

Prevalence

Over the study period, the age-specific prevalence of AD showed a rapid decrease with increasing age in children and adolescents, and the decreasing trend continued until approximately 50 years of age. The prevalence increased slightly from 50 to 75 years of age but finally showed a declining trend toward older ages. The annual prevalence of AD decreased from 2010 to 2015 in young children (aged 0–9 years)

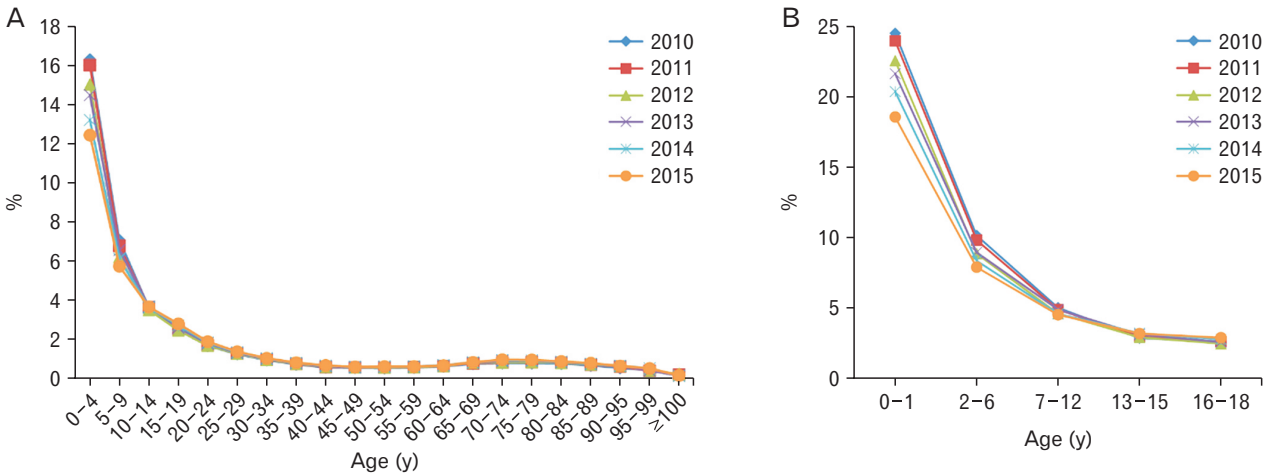

Figure 1. (A) The prevalence of atopic dermatitis by age from 2010 to 2015. (B) The prevalence of atopic dermatitis by childhood life cycle stage from 2010 to 2015.

Table 1. Prevalence of atopic dermatitis in men and women by age from 2010 to 2015 (%)

Age (y)	2010			2011			2012			2013			2014			2015		
	Total	M	F	Total	M	F	Total	M	F	Total	M	F	Total	M	F	Total	M	F
0–4	16.314	16.654	15.952	16.027	16.416	15.613	15.041	15.398	14.663	14.493	14.895	14.067	13.225	13.598	12.832	12.450	12.873	12.003
5–9	7.092	6.903	7.296	6.806	6.651	6.973	6.225	6.111	6.347	6.586	6.485	6.694	6.131	5.975	6.296	5.760	5.631	5.898
10–14	3.637	3.300	4.007	3.663	3.343	4.012	3.524	3.221	3.855	3.707	3.434	4.005	3.664	3.403	3.947	3.680	3.443	3.937
15–19	2.498	2.044	3.011	2.563	2.099	3.089	2.476	2.029	2.977	2.615	2.163	3.118	2.747	2.304	3.234	2.824	2.436	3.249
20–24	1.696	1.266	2.172	1.724	1.294	2.201	1.703	1.274	2.182	1.826	1.377	2.332	1.878	1.431	2.383	1.920	1.486	2.410
25–29	1.264	0.929	1.619	1.308	0.973	1.664	1.302	0.985	1.640	1.334	1.034	1.656	1.375	1.087	1.686	1.398	1.116	1.706
30–34	0.958	0.709	1.218	0.990	0.745	1.245	0.992	0.754	1.242	1.032	0.796	1.278	1.063	0.839	1.299	1.069	0.850	1.300
35–39	0.743	0.554	0.939	0.779	0.576	0.991	0.783	0.597	0.974	0.808	0.619	1.004	0.824	0.636	1.020	0.836	0.650	1.029
40–44	0.585	0.428	0.748	0.608	0.455	0.766	0.635	0.478	0.799	0.661	0.495	0.834	0.691	0.524	0.864	0.697	0.531	0.870
45–49	0.569	0.429	0.716	0.595	0.443	0.755	0.598	0.454	0.749	0.601	0.451	0.756	0.625	0.470	0.784	0.623	0.471	0.780
50–54	0.558	0.445	0.674	0.585	0.479	0.694	0.601	0.487	0.717	0.634	0.510	0.761	0.641	0.514	0.771	0.640	0.508	0.777
55–59	0.575	0.514	0.634	0.608	0.551	0.664	0.622	0.561	0.683	0.634	0.556	0.712	0.654	0.573	0.736	0.635	0.551	0.718
60–64	0.636	0.622	0.650	0.673	0.669	0.678	0.673	0.667	0.678	0.701	0.678	0.722	0.709	0.682	0.735	0.688	0.659	0.716
65–69	0.778	0.808	0.753	0.802	0.837	0.771	0.833	0.884	0.789	0.837	0.880	0.798	0.857	0.909	0.810	0.854	0.894	0.818
70–74	0.809	0.876	0.758	0.842	0.923	0.780	0.845	0.914	0.791	0.925	1.004	0.863	0.969	1.066	0.891	0.994	1.111	0.899
75–79	0.807	0.953	0.720	0.861	1.018	0.762	0.869	1.021	0.771	0.927	1.075	0.830	0.955	1.121	0.843	0.986	1.152	0.871
80–84	0.782	1.002	0.683	0.841	1.068	0.738	0.825	1.080	0.707	0.857	1.111	0.734	0.887	1.147	0.757	0.896	1.112	0.783
85–89	0.687	0.943	0.591	0.738	1.057	0.619	0.755	1.066	0.640	0.780	1.075	0.672	0.790	1.130	0.666	0.815	1.137	0.697
90–95	0.562	0.753	0.501	0.639	0.884	0.563	0.680	0.960	0.593	0.684	0.936	0.605	0.679	1.025	0.569	0.672	1.027	0.563
95–99	0.442	0.502	0.426	0.422	0.447	0.416	0.452	0.564	0.423	0.435	0.662	0.377	0.552	0.613	0.535	0.548	0.706	0.503
≥100	0.162	0.294	0.119	0.232	0.264	0.223	0.261	0.378	0.226	0.167	0.157	0.170	0.173	0.143	0.183	0.185	0.317	0.145

The number of patients in each age group is as follows: 377,994 for 0–4 y, 175,749 for 5–9 y, 120,854 for 10–14 y, 91,647 for 15–19 y, 54,982 for 20–24 y, 48,887 for 25–29 y, 39,382 for 30–34 y, 34,285 for 35–39 y, 27,590 for 40–44 y, 25,966 for 45–49 y, 24,039 for 50–54 y, 17,829 for 55–59 y, 15,428 for 60–64 y, 15,652 for 65–69 y, 13,203 for 70–74 y, 8,851 for 75–79 y, 4,719 for 80–84 y, 1,936 for 85–89 y, 514 for 90–95 y, 103 for 95–99 y, and 19 for 100 y and above.
M, male; F, female.

https://doi.org/10.4082/kjfm.24.0124

but increased slightly in adults. The prevalence of AD in the 0–4 years age group decreased from 16.3% in 2010 to 12.5% in 2015, while that in the 20–24 years age group rose from 1.7% in 2010 to 1.9% in 2015 (Figure 1A).

Regarding the prevalence of AD in the different childhood life cycle stages, the highest prevalence was reported in the youngest age group (0–1 years, 18.6%–24.5%), which decreased rapidly with increasing age but gradually declined over the years from 24.5% in 2010 to 18.6% in 2015. However, after 13 years of age, the annual prevalence increased slightly, similar to that in the adult age groups (Figure 1B).

A comparison of the prevalence of AD between males and females showed similar overall tendencies. However, at ages 0–4 years, the prevalence of AD was slightly higher in males (12.9%–16.7%) than in females (12.0%–15.9%). In those aged >50 years, an upward curve was observed in males but not in females (Table 1).

The regional prevalence in adults increased slightly in metropolitan areas, especially in Gyeonggi, from 0.9% in 2010 to >1.0% in 2015 (Figure 2A, Supplement 1). In contrast, the regional prevalence in children tended to decrease annually throughout the region, especially in the metropolitan areas. The prevalence in Seoul and Gyeonggi, the metropolitan areas of Korea, decreased from 7.1% in 2010 to 6.2% in 2015 (Figure 2B, Supplement 2). Regarding the regional prevalence in 2015, the highest prevalence in children was reported in Jeju, whereas the highest prevalence in adults was reported in Seoul, followed by Gyeonggi, Incheon, and Daejeon (Figure 2A, B).

Medications

In 2015, the proportion of patients with AD receiving systemic steroids and systemic antibiotics was 27.2% and 4.0%, respectively. The percentage of systemic cyclosporine prescriptions increased from 0.6%

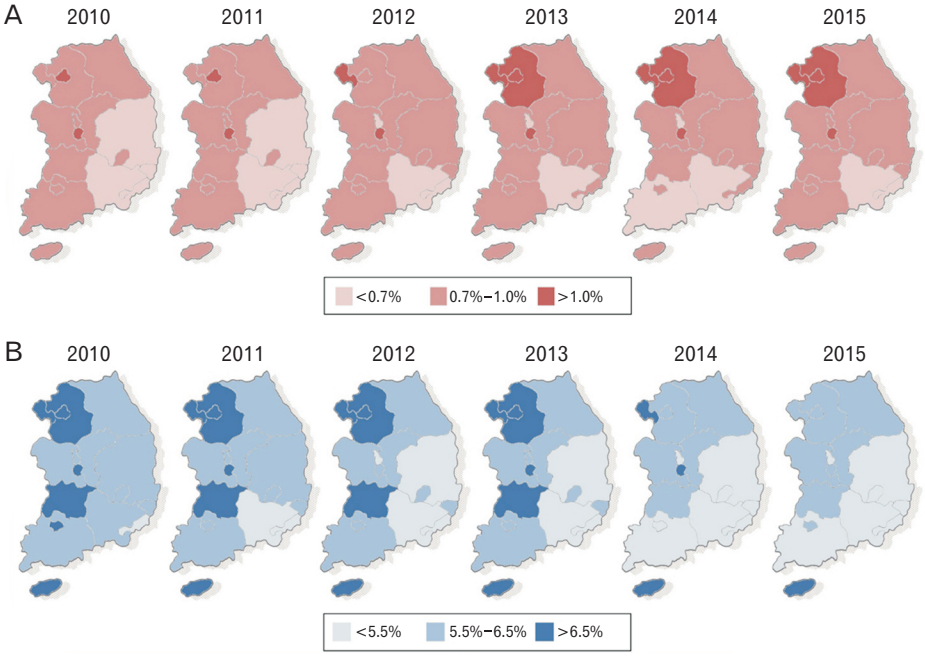

Figure 2. (A) The prevalence of atopic dermatitis by region from 2010 to 2015 in adults. (B) The prevalence of atopic dermatitis by region from 2010 to 2015 in children and adolescents.

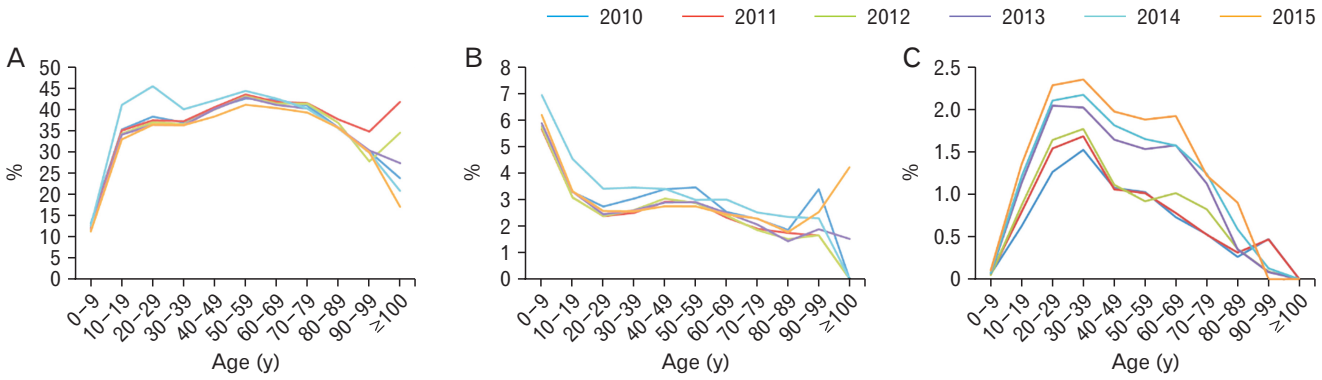

Figure 3. (A) The proportion of systemic steroid prescriptions by age in the total number of prescriptions for patients with atopic dermatitis from 2010 to 2015. (B) The proportion of systemic antibiotic prescriptions by age in the total number of prescriptions for patients with atopic dermatitis from 2010 to 2015. (C) The proportion of cyclosporine prescriptions by age in the total number of prescriptions for patients with atopic dermatitis from 2010 to 2015.

in 2010 to 1.2% in 2015. No significant trend was observed in the annual proportion of systemic steroid prescriptions. The proportion of systemic steroid prescriptions by age for patients with AD increased from 11.2% in the 0–9 years age group to 41.1% in the 50–59 years age group in 2015 (Figure 3A). Among the childhood life cycle stages, the proportion was the lowest at 0–1 year (3.7%–4.3%) of age and rapidly increased until 16–18 years (36.4%–46.5%) (Figure 4A). The regional proportion of systemic steroid prescriptions was consistently high in Gyeongbuk (34.2%–34.9%) but low in Daejeon (20.2%–22.5%). The annual proportion sharply decreased in Sejong from 29.5% in 2012 to 18.4% in 2015 but increased steadily in Gangwon and Jeonnam from 24.7% and 22.5% in 2010 to 28.5% and 26.9% in 2015, respectively (Figure 5A).

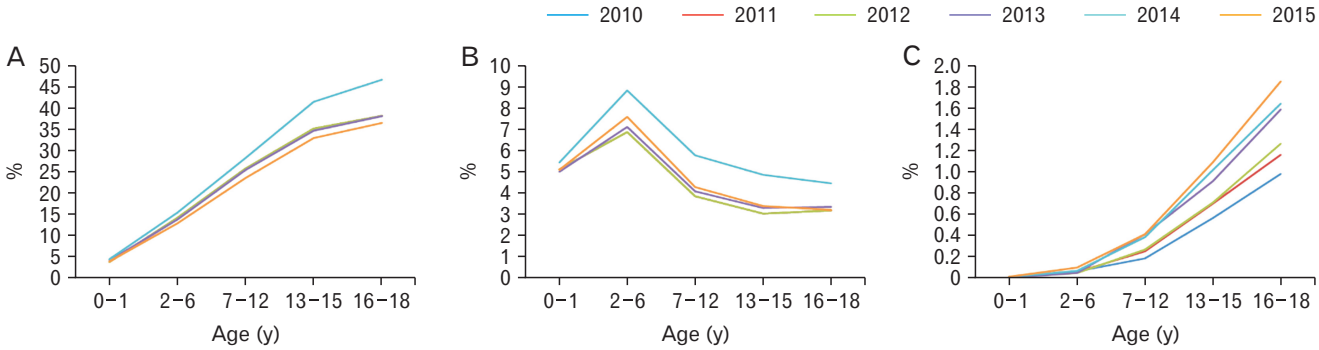

Figure 4. (A) The proportion of systemic steroid prescriptions by childhood life cycle stage in the total number of prescriptions for patients with atopic dermatitis from 2010 to 2015. (B) The proportion of systemic antibiotic prescriptions by childhood life cycle stage in the total number of prescriptions for patients with atopic dermatitis from 2010 to 2015. (C) The proportion of cyclosporine prescriptions by childhood life cycle stage in the total number of prescriptions for patients with atopic dermatitis from 2010 to 2015.

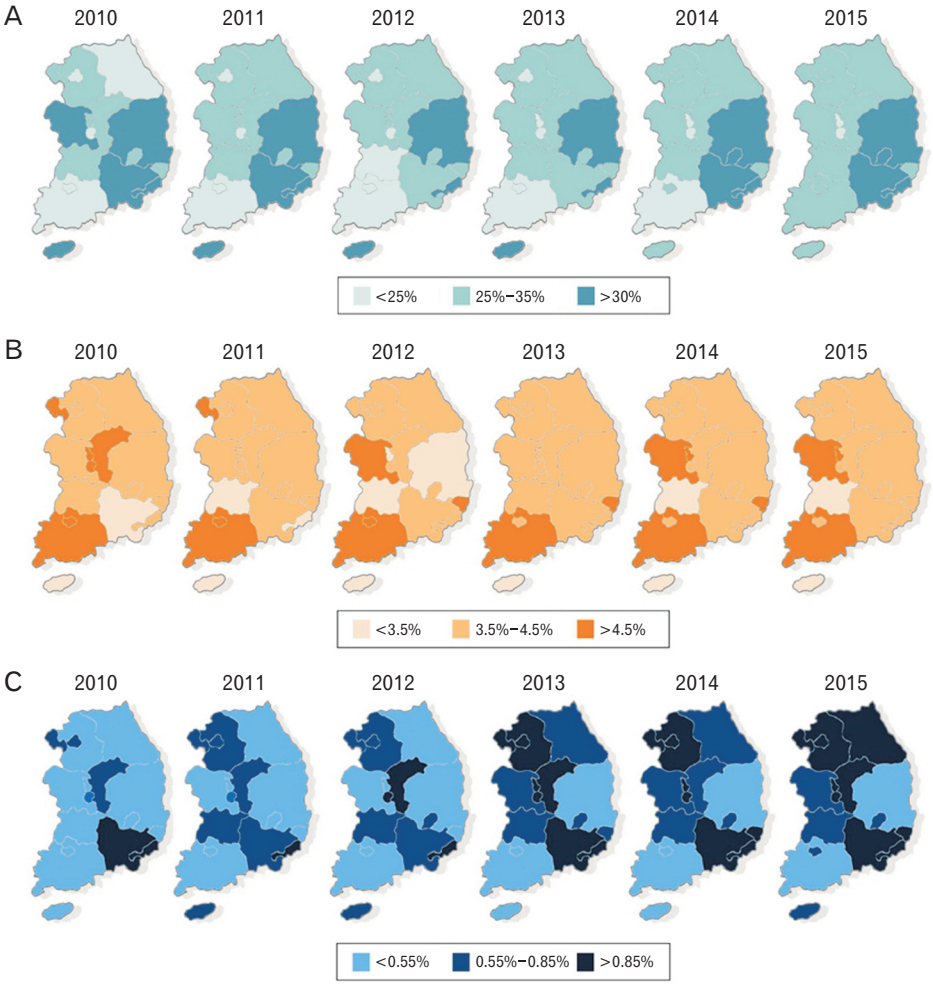

Figure 5. (A) The proportion of systemic steroid prescriptions by region in the total number of prescriptions for patients with atopic dermatitis from 2010 to 2015 in Korea. (B) The proportion of systemic antibiotic prescriptions by region in the total number of prescriptions for patients with atopic dermatitis from 2010 to 2015 in Korea. (C) The proportion of cyclosporine prescriptions by region in the total number of prescriptions for patients with atopic dermatitis from 2010 to 2015 in Korea.

https://doi.org/10.4082/kjfm.24.0124

No significant trends were observed in the annual proportion of systemic antibiotic prescriptions. The proportion of systemic antibiotic prescriptions by age in patients with AD gradually decreased from 6.2% in the 0–9 years age group to 1.8% in the 80–89 years age group and then increased slightly in older ages in 2015 (Figure 3B). Among the childhood life cycle stages, the proportion was the highest at 2–6 years (6.9%–8.8%) of age (Figure 4B). The regional proportion of systemic antibiotic prescriptions was higher in Jeonnam, Chungnam, and Sejong than in the other regions in 2015. In Sejong, the annual proportion increased from 2.9% in 2012 to 4.6% in 2015; however, in Chungbuk, it decreased from 5.2% in 2010 to 3.9% in 2015 (Figure 5B).

The annual proportion of systemic cyclosporine prescriptions increased significantly from 0.6% in 2010 to 1.2% in 2015. The proportion of systemic cyclosporine prescriptions by age in patients with AD was the highest among those in their 30s (1.5%–2.4%), followed by those in their 20s (1.3%–2.3%) and 40s (1.1%–2.0%) (Figure 3C). Among the childhood life cycle stages, the proportion was the lowest at 0–1 year (0%) of age and rapidly increased until 16–18 years (1.0%–1.8%) (Figure 4C). The regional proportion of cyclosporine prescriptions increased annually in almost all regions. In 2015, it was significantly higher in Seoul, Incheon, Daejeon, Gwangju, and Busan than in the other regions (Figure 5C).

Discussion

Numerous studies on the prevalence of AD have been conducted worldwide, and its prevalence in children and adolescents is universally known to be higher than that in adults [17]. Notably, the lifetime prevalence has shown a worldwide increase, especially in many developing countries [2,3,18]. Our nationwide study mainly shows that the recent annual prevalence of AD has been decreasing in children but increasing in adults. Lee et al. [12] suggested that the recent prevalence of AD in Korean children aged ≤18 years appears to be decreasing, particularly in infants, which corroborates our results.

One reason for the decreasing trend in the annual prevalence of AD in Korean children could be the increased awareness regarding AD [19]. Basic educational programs on AD, such as the importance of environmental controls and the use of moisturizers periodically, have recently become widespread in the country. Furthermore, public healthcare policies for early diagnosis, treatment, and prevention of AD are increasing, as well as national support networks such as environmental health centers. Reports indicate that the prevalence of AD has been increasing, particularly in Africa, Northern and Western Europe, and East Asia. However, most of these studies have focused on pediatric and adolescent populations, leading to a paucity of comparable data on the prevalence trends of adult AD [3]. An analysis of the Korean National Health Insurance Service–National Sample Cohort database revealed an increase in the prevalence of AD among individuals aged ≥20 years from 2002 to 2019, corroborating the findings of this study [20].

The regional prevalence in children was the highest in Jeju throughout the study period. Environmental exposure is considered more important than genetic variation in the occurrence of AD [21]. There has been a tendency for families with AD to be drawn to Jeju, preferring its cleaner air, abundant green spaces, and overall lower stress levels compared to urban settings. However, the findings by Lee et al. [22] underscore that the growing concentration of Japanese cedar pollen, potentially exacerbated by climate change, might pose a paradoxical risk factor, complicating the expected environmental benefits for AD patients.

According to our results, the proportion of systemic steroid prescriptions for children was significantly lower than that for adults. This could be because the symptoms of AD are more severe in adults than in children, and managing AD in adults is generally considered more difficult than in children [23]. Moreover, systemic steroid prescriptions for children have several limitations because of their association with critical side effects, such as the common occurrence of growth disorders and vulnerability to ocular problems [24,25]. An analysis of the Danish nationwide registry data revealed that the proportion of patients with a history of systemic corticosteroid use was 5% among children and 57.5% among adults, comparable with the findings of this study [26].

Systemic antibiotics are more commonly prescribed for children than for adults. One of the reasons for this is the high incidence of infectious diseases, such as impetigo and Kaposi's varicelliform eruption, in children [27]. The use of topical antibiotics in adult AD has been reported to range from 46% to 74% [28]. The Danish nationwide registry data indicated that the proportion of patients with a history of systemic antibiotic use was 36.7% in children and 62% in adults, which was significantly higher than the rates observed in this study. The use of systemic antibiotics for treating AD complications may have been partially underestimated in this study due to the L20 primary diagnosis code for AD being missed in clinical practice when systemic antibiotics were prescribed [26]. The higher proportion of cyclosporine prescriptions in adults compared to children could be attributed to the challenges of controlling adult AD with conventional treatments and the potential for significant side effects associated with long-term systemic steroid use [29]. The prescription rate of cyclosporine in this study was significantly higher in adults compared to children, which is consistent with the Danish nationwide registry data that reported a history of cyclosporine use in 0.4% of children and 5% of adults [26]. According to our study, the annual proportion of cyclosporine prescriptions increased significantly, suggesting that the number of adult patients with severe AD is increasing.

Our study has some limitations. First, our nationwide study only analyzed data from 2010 to 2015. Further studies analyzing more extensive data are warranted, including data obtained before 2010. This could potentially provide more meaningful insights if data from 2016 onwards were analyzed to examine the trends over a decade. Second, we analyzed the medication prescription trends only for systemic steroids, systemic antibiotics, and systemic immunosuppressants, especially cyclosporine. Further analysis of the prescription trends of other

drugs for AD, such as antimetabolites and biologics, is warranted. Lastly, we compared the two datasets and found no significant differences according to the presence of other skin conditions in the secondary diagnosis codes; however, we acknowledge that medication prescriptions for the treatment of other skin conditions may not have been entirely excluded, which is an inherent limitation in big data analysis studies.

In conclusion, from 2010 to 2015, the prevalence of AD decreased in children and adolescents but increased slightly in adults. Approximately 25% of the patients with AD received systemic steroids. As the prevalence of AD in adult patients has increased, the percentage of cyclosporine prescriptions has also increased.

Article Information

Conflict of interest

No potential conflict of interest relevant to this article was reported.

Funding

This study was supported by research funding from The Korean Atopic Dermatitis Association in 2016.

Data availability

The data supporting the findings of this study are available from the Korean National Health Insurance database.

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Conceptualization: KJ, SKK, SL, ESL. Data curation: KJ, SKK, DY, YC. Formal analysis: KJ, SKK, DY, YC. Funding acquisition: SKK, ESL. Investigation: KJ, SKK, SL, ESL. Methodology: KJ, SKK, SL, ESL. Project administration: SL, ESL. Resources: KJ, SKK, DY, YC. Software: DY, YC. Supervision: SL, ESL. Validation: KJ, SKK, DY, YC. Visualization: KJ, SKK, DY, YC. Writing–original draft: KJ, SKK. Writing–review & editing: KJ, SKK, SL, ESL. Final approval of the manuscript: all authors.

Supplementary materials

Supplementary materials can be found via https://doi.org/10.4082/kjfm.24.0124. Supplement 1. Prevalence of atopic dermatitis by region from 2010 to 2015 in adults. Supplement 2. Prevalence of atopic dermatitis by region from 2010 to 2015 in children and adolescents.

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