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Prevalence of Onychomycosis in Korea: A Nationwide Population-based Study

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Background: Onychomycosis is a common fungal infection of the toenails and fingernails. Although onychomycosis is a common health concern, there is a lack of nationwide studies of this condition in Korea.

Objective: We aimed to investigate the prevalence of onychomycosis according to age, month of hospital visit, and residence using national statistics provided by the National Health Insurance Service (NHIS) of South Korea in 2015.

Methods: We utilized data from the NHIS database that was procured between January and December, 2015. Statistical analyses were performed using the SAS version 9.4 (SAS Institute, Cary, NC, USA).

Results: The prevalence of onychomycosis was 3.49%. Its prevalence among individuals in their 60s (OR 5.148, 95%CI of 5.113~5.183) and 70s (OR 5.466, 95%CI of 5.427~5.505) was significantly higher than that of those in their 20s (reference age group). The highest prevalence of onychomycosis was observed in summer. The age-standardized prevalence ranged from 3.24% to 4.29% based on the place of residence, with the highest prevalence observed in provinces and large cities at lower latitudes, including Jeollanam-do, Gyeongsangnam-do, Ulsan, and Jeju-do.

Conclusion: This is the first nationwide study exploring the prevalence of onychomycosis in Korea according to the place of residence. The prevalence of onychomycosis primarily depends on age and region.

Key Words: Epidemiology, Korea, National health insurance, Onychomycosis

INTRODUCTION

Onychomycosis is a common fungal infection of the nail, representing up to 50% of all nail diseases[1]. This infection may be caused by dermatophytes, yeast, or non-dermatophyte molds. However, *Trichophyton rubrum* is the primary causative pathogen[2]. Fungal cutaneous infection is a major skin disease, causing troublesome health problems[3]. Risk factors include old age, immunocompromized condition, diabetes mellitus, polyneuropathy, peripheral arterial disease, chronic venous in-

sufficiency, tinea pedis, and trauma[4]. Hyperhidrosis, occlusive shoes, and participation in sports may also be the predisposing factors[5]. Onychomycosis may result in severe complications in patients with diabetes[6].

Previous studies have demonstrated all-type fungal infections, total cutaneous fungal infections, or subtypes of fungal species in patients with onychomycosis. Cutaneous fungal infections account for 10~20% of all dermatologic outpatient cases reported in Korea[7]. In 2010, the prevalence of cutaneous fungal infection was 6.51% for dermatophytosis and 0.31% for other superficial mycoses[8]. Yoon et al. reported that the prevalence of all-type fungal infections among the Korean population was approximately 7.1%[9].

Currently, there is a lack of nationwide studies exploring the prevalence of onychomycosis in Korea. Thus, in this population-based study, we have analyzed the prevalence of onychomycosis using data obtained from the Korean National Health Insurance Service (NHIS) in 2015.

MATERIALS AND METHODS

1. Data source

We utilized data from the NHIS database obtained between January and December, 2015. The Korean NHIS monitors all medical services in Korea; 100% of the Korean population is covered under the NHIS. This computerized database includes all claim data, such as patient demographics, dates of hospital visits, residence, socioeconomic status, and claimed treatment details based on the International Classification of Disease (ICD)-10 codes[10].

2. Study sample

We analyzed data for patients who visited clinics or hospitals with a diagnostic code (ICD-10) of onychomycosis (*Tinea ungium*) (B351) more than once between January and December, 2015. Patients with other types of dermatophytosis, including *Tinea pedis* and those with missing data, were excluded from the analysis. This study was approved by the institutional review boards of the Korean National Institute for Bioethics Policy (NHIS-2017-1-002), the Korea Centers for Disease Control and Prevention, and the Catholic University of Korea (No. KC16EISE0923).

3. Study variables

NHIS data were interpreted to calculate the national pre-

valence of onychomycosis in each city or province of Korea. Patients were classified into nine age groups as follows: 0~9, 10~19, 20~29, 30~39, 40~49, 50~59, 60~69, 70~79, and >80 years. The region of residence for each patient was defined as urban (Seoul, Busan, Daegu, Incheon, Gwangju, Daejeon, Ulsan, Sejong, and Gyeonggi-do) or rural (Gangwon-do, Chungcheongbuk-do, Chungcheongnam-do, Jeollabuk-do, Jeollanam-do, Gyeongsangbuk-do, Gyeongsangnam-do, and Jeju-do)[11]. Further, assessment of the influence of the month of hospital visit on the prevalence of onychomycosis was also performed.

4. Statistical analysis

Statistical analyses were performed using the SAS version 9.4 (SAS Institute, Cary, NC, USA) statistical software. Age-specific rates of prevalence of onychomycosis were calculated by dividing the number of patients with onychomycosis by the total Korean population according to the 2010 Population and Housing Census. p-values < 0.05 were considered statistically significant.

RESULTS

1. Characteristics of patients with onychomycosis

In 2015, total 1,917,588 patients with onychomycosis were covered under the NHIS and the prevalence of onychomycosis was 3.49%. The prevalence of onychomycosis tended to increase with age (Table 1). The prevalence of onychomycosis among patients aged 60~69 years [odds ratio (OR) 5.148, 95% confidence interval (CI) 5.113~5.183)] and 70~79 years (OR 5.466, 95% CI 5.427~5.505) were significantly higher than that reported in patients aged 20~29 years (reference age group). In addition, the prevalence of onychomycosis was higher in females than in males across all age groups. The prevalence was 3.59% for males and 3.84% for females. Females aged 70~79 years had the highest prevalence of onychomycosis (OR 6.597, 95% CI 6.527~6.668). However, the prevalence of onychomycosis among patients aged 0~9 and 10~19 years was 0.088 (0.086~0.090) and 0.405 (0.401~0.410), respectively, which is lower than that reported in the reference group.

2. Monthly prevalence

The highest prevalence of onychomycosis was observed in

Table 1. Prevalence of onychomycosis according to age in 2015

| Age group (yrs)	Total			Male			Female		
	Reference population	Onychomycosis	OR (95% CI)	Reference population	Onychomycosis	OR (95% CI)	Reference population	Onychomycosis	OR (95% CI)
0~9	4,605,930	6,761	0.088 (0.086~0.090)	2,370,685	368	0.083 (0.081~0.086)	2,235,245	2,993	0.095 (0.092~0.099)
10~19	5,980,471	40,217	0.405 (0.401~0.410)	3,126,473	23,667	0.400 (0.394~0.406)	2,853,998	16,550	0.414 (0.407~0.422)
20~29	6,821,889	112,087	-ref-	3,602,702	67,410	-ref-	3,219,187	44,677	-ref-
30~39	7,945,906	211,874	1.640 (1.628~1.652)	4,074,241	120,676	1.601 (1.586~1.616)	3,871,665	91,198	1.714 (1.695~1.734)
40~49	8,934,467	358,249	2.501 (2.484~2.518)	4,535,856	176,283	2.121 (2.102~2.140)	4,398,611	181,966	3.066 (3.034~3.099)
50~59	8,210,181	488,090	3.784 (3.759~3.809)	4,121,285	227,600	3.066 (3.039~3.092)	4,088,896	260,490	4.835 (4.786~4.884)
60~69	4,691,566	371,495	5.148 (5.113~5.183)	2,276,167	174,038	4.342 (4.303~4.381)	2,415,399	197,457	6.326 (6.260~6.392)
70~79	3,124,667	261,451	5.466 (5.427~5.505)	1,327,943	108,812	4.681 (4.635~4.727)	1,796,724	152,639	6.597 (6.527~6.668)
≥80	1,258,967	64,047	3.209 (3.177~3.241)	378,167	23,941	3.545 (3.491~3.599)	880,800	40,106	3.390 (3.344~3.436)
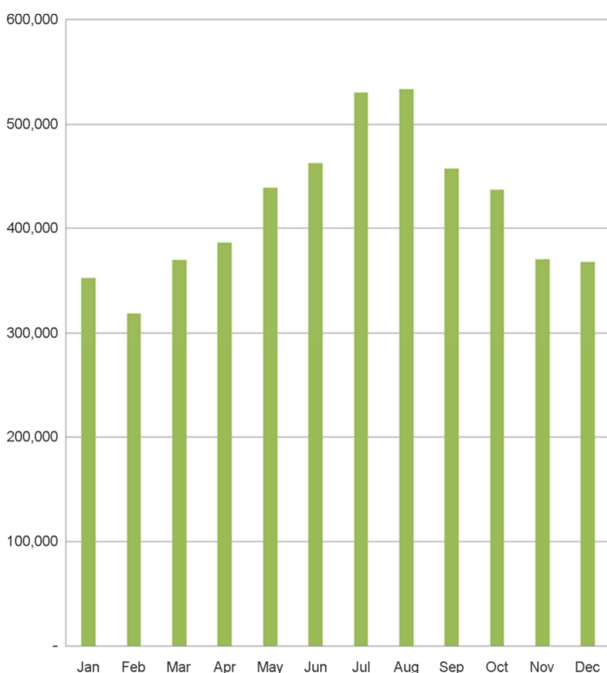
Fig. 1. Monthly prevalence of onychomycosis in 2015

July and August. The lowest prevalence of onychomycosis was noted in January and February (Fig. 1).

3. Place of residence

When the age-standardized prevalence was calculated using the 2010 Census Korean population, Jeollanam-do (4.29%), Gyeongsangnam-do (3.99%), Ulsan (3.89%), and Jeju-do (3.88%) showed a much higher prevalence of onychomycosis than other areas. Conversely, the age-standardized prevalence in Seoul (3.24%) and Gyeonggi-do (3.31%) was relatively low (Fig. 2).

DISCUSSION

This was the first large-scale population-based study, evaluating the epidemiology of onychomycosis in Korea. The prevalence of onychomycosis was shown to be dependent on age and region.

The impact of age on the prevalence of onychomycosis in a population is very important. There is a positive correlation
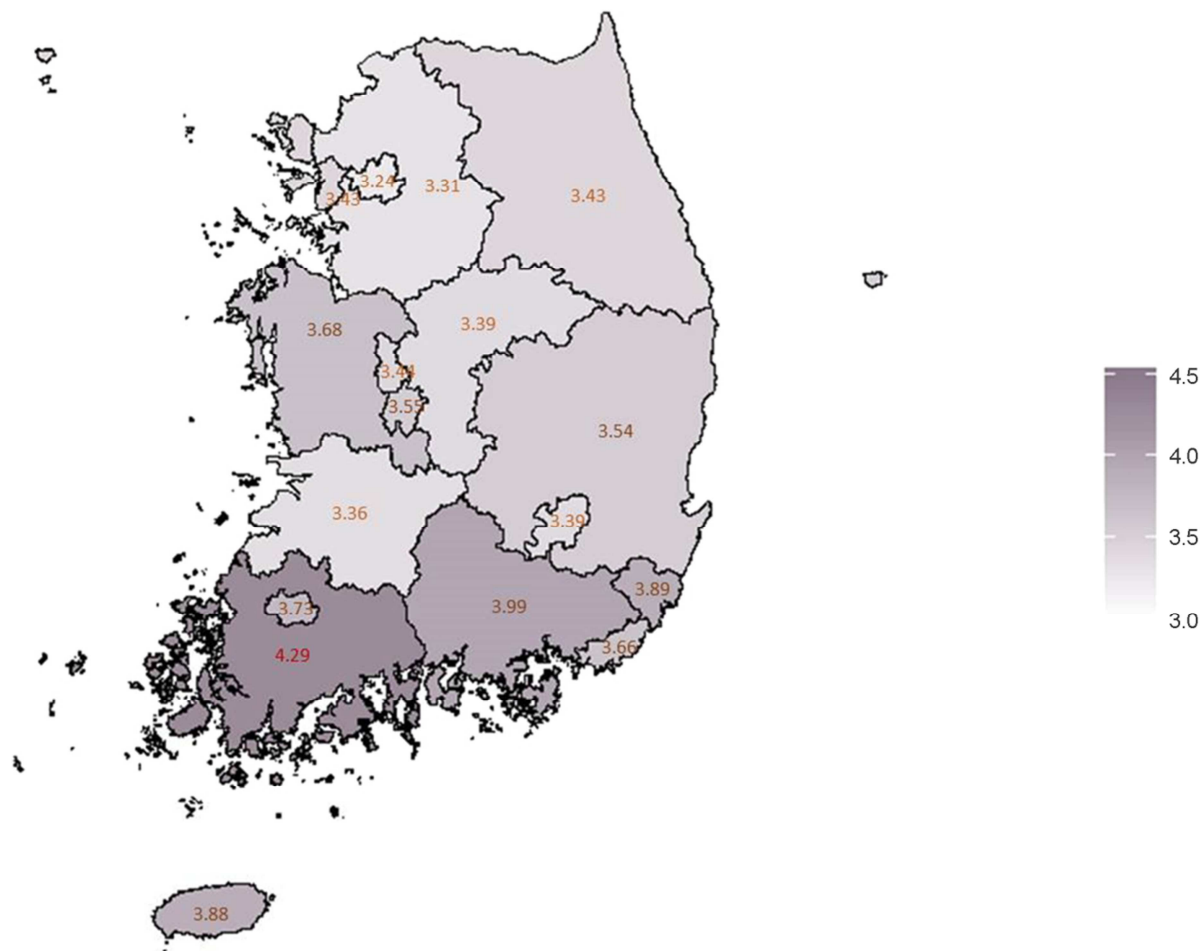
Fig. 2. Regional prevalence of onychomycosis in Korea The prevalence for each region was based on diagnostic codes.

between onychomycosis prevalence and age[12]. In the current study, the prevalence of onychomycosis increased with age, i.e., the highest prevalence was observed in patients aged 60~69 and 70~79 years. Advanced age is considered a risk factor of onychomycosis owing to diminished blood circulation, longer exposure to fungi, slower growth of nails and nail thickening, and increased susceptibility to infection.

We observed a female predominance in the prevalence of onychomycosis. This finding was consistent with that of a previous study in Spain showing that the prevalence of onychomycosis among females was higher than that reported in males (1.8% vs. 0.8%, respectively)[13]. However, other studies have demonstrated that onychomycosis is more prevalent in males than in males[14-17]. In the United Kingdom, a population survey showed a prevalence of dermatophyte nail infection of 2.8% in males and 2.6% in females[14]. In Finland, the prevalence of onychomycosis identified as dermatophyte culture-

positive cases was 13% in males and 4.3% in females[15]. In Iceland, based on photograph evaluations by patients, 195 males (17.5%) and 187 females (13.7%) identified themselves as having onychomycotic nails[16]. In another study in Spain, the prevalence of onychomycosis was 3.1% (CI 95% 2.12~4.38), 4.4% (CI 95% 2.7~6.7), and 1.9% (CI 95% 0.9~3.4), in total, males, and females, respectively[17]. The discrepancies among the results of studies may be explained by the finding that Korean females are more likely to seek medical attention than Korean males. Another possible explanation is that susceptibility to such infections varies between ethnic groups.

Moreover, the results of the current study suggest that the prevalence of onychomycosis in Korea is related to environmental factors. Firstly, we observed seasonal differences in the month of hospital visit among the studied groups. Secondly, we observed regional differences in the prevalence of onycho-

mycosis, with higher prevalence reported in lower latitudes, such as Jeollanam-do, Gyeongsangnam-do, Ulsan, and Jeju-do. Although the reason for this regional difference remains unclear, we hypothesize that environmental factors such as high temperature and humidity may play key roles. These factors may increase sweating and provoke the development of onychomycosis.

The limitations of this study must be acknowledged. Firstly, access to medical care differs from region to region. Secondly, we did not make mycologic diagnoses using potassium hydroxide or fungus culture. Despite these limitations, this was the first nationally representative, population-based study, evaluating patients with onychomycosis in Korea.

The results of the current study suggest that onychomycosis is most prevalent in elderly patients living at lower latitudes. This high prevalence may be because of the hot, humid weather in such provinces in South Korea.

ACKNOWLEDGMENTS

CONFLICT OF INTEREST

In relation to this article, I declare that there is no conflict of interest.

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