



ORIGINAL ARTICLE

# Epidemiological Characterization of Skin Fungal Infections Between the Years 2006 and 2010 in Korea

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**Abstract**

**Objectives:** The purpose of this study was to build and provide a basic database of skin fungal infections for the effective management of skin fungal infections in the future.

**Methods:** We collected health insurance data between the years 2006 and 2010 from the Health Insurance Corporation (Seoul, Korea) and analyzed the data to determine the prevalence and treatment management of skin fungal infections.

**Results:** Skin fungal infections were divided into two groups: namely dermatophytosis and other superficial mycoses. Dermatophytosis showed a higher prevalence (16,035,399 cases) than the other superficial mycoses (794,847 cases) within the study period. The prevalence rate decreased consecutively by 0.01% to 0.19% every year. The prevalence according to region showed that Jeolla-do had a high prevalence distribution. The prevalences in men and women were similar (7.01% vs. 6.26%). It is interesting to note that adults from the 50–79-year age group showed a higher prevalence than children and young adults. The average convalescence time (days) of dermatophytosis was longer than that of other superficial mycoses. The total medical expenses were also much higher in dermatophytosis than in the other superficial mycoses.

**Conclusion:** This study provides useful data for study trends of skin fungal infections.

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## 1. Introduction

Fungal infections of the skin, hair, and nails are a common public health problem worldwide. However, a population-based survey reported that they are rarely managed [1]. The prevalence of skin fungal infections is expected to reach 20–25% of the world's population, and its incidence continues to increase [2,3] and accounts for 10–20% of all dermatologic outpatients in South Korea [4]. This increase may be a result of usage of antibiotics and immunosuppressive drugs [5].

Skin fungal infections are caused mainly by dermatophytes such as *Trichophyton*, *Microsporum*, and *Epidermophyton* that can invade the stratum corneum and keratinized tissues [6,7]. Skin fungal infections are less frequently caused by nondermatophyte fungi (e.g., *Malassezia in tinea versicolor*) [7].

Dermatophytoses are referred to as tinea infections and can be classified according to the body site involved [8]. These infections are typically acquired directly from contact with infected humans or animals or indirectly from exposure to contaminated soil or fomites.

The lipophilic yeast *Malassezia* is a normal microflora of the human skin that may be pathogenic under certain conditions. *Malassezia* species cause the most human skin infections, and is the most common cause of dandruff, seborrhoeic dermatitis, folliculitis, papillomatosis, and tinea (pityriasis) versicolor [9–13]. However, the exact species implicated still remains unclear [14].

The prevalence of skin fungal infection differs by social, geographic, economical status, and life environment. According to Korean research studies on skin fungal infections (trichophytosis), 5.2% of total outpatients had trichophytosis in the survey of Yonsei University Severance Hospital, Seoul, Korea from 1937 to 1946 [15]. Skin infections are known to spread not only in the patient but also to the patient's family members.

Skin fungal infections induced by fungal agents may have side effects caused by antifungal reagents and increases medical fees and social costs if not treated quickly in the early stage. However, research on the nationwide developmental distribution and epidemiological characteristics of skin fungal infections is rare. Therefore, this study aimed to build a basic database for effective fungal infection control by examining age, sex, year, distribution, and prevalence by region, medical care institution, and treatment costs over 5 years, from 2006 to 2010, by using the database of the Health Insurance Corporation (Seoul, Korea) to research the epidemiological characteristics of skin fungal infections.

## 2. Materials and methods

### 2.1. Data collection and study design

The individuals of the research were health insurance recipients over 5 years, from January 1, 2006 to

December 30, 2010. The only information on skin fungal infection was extracted from all cases of fungal infections and collected data, and was divided into dermatophytosis (Korea International Classification of Diseases: B35) and other superficial mycoses (B36).

In cases of skin fungal infection, in order to avoid duplication, a new case was defined when new treatment was administered for 2 months after the last treatment date (Figure 1). The collected data were analyzed by using the SPSS version 20.0 software (SPSS Inc., Chicago, IL, USA) after entering into an Excel sheet with encoding.

### 2.2. Epidemiological investigations

In order to determine the significance of skin fungal infections that cause diseases, we performed an epidemiological analysis of variables such as seasonal and regional prevalences and age- and gender-specific patterns of the prevalences of dermatophytosis and other superficial mycoses.

### 2.3. Calculation of convalescence days and medical treatments for therapy

The convalescence days of the in- and outpatients for skin fungal infections and superficial mycosis were calculated for the previous 5 years. Medical care costs were calculated by classifying into personal and insurance charges from the insurance items in the Health Insurance Corporation database. No insurance charge items were excluded from the medical care costs.

## 3. Results

Among the skin fungal infections, dermatophytosis showed a higher prevalence (16,035,399 cases) than the other superficial mycoses (794,847 cases) between the years 2006 and 2010. Here, we describe the epidemiological characterization of and medical treatments for patients infected with skin fungal infections during the past 5 years in South Korea.

### 3.1. Epidemiological characterization of skin fungal infections

As shown in Table 1, the prevalence rate of dermatophytosis, according to resident population, consecutively decreased by 0.01% to 0.19% from the years 2006 to 2010. The regional prevalence was highest in Jeollanam-do at 7.98% and the lowest in Incheon at 5.96%.

The prevalences of the other superficial mycoses also decreased gradually every year. The yearly prevalence based on registered population information showed a 0.01% decrease in prevalence rate, the rate being 0.35% by resident population in 2006 and 0.31% in 2010. The regional prevalence showed that Jeonbuk (0.41%) had the highest prevalence and Jeju (0.26%) had the lowest prevalence (Table 1).

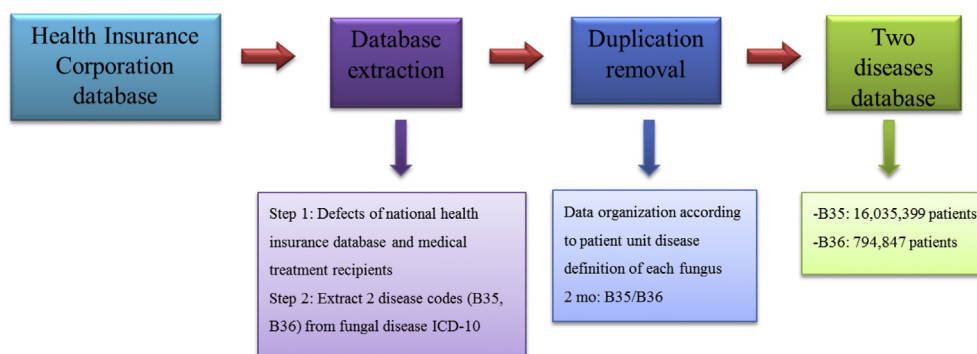


Figure 1. National Health Insurance database algorithm.

Table 1. Prevalence rate of skin fungal infections by year and regions.

	Population	No. (%) of patients	
		Dermatophytosis <i>N</i> = 16,035,399	Other superficial mycoses <i>N</i> = 794,847
<b>Y</b>			
2006	48,039,415	3,284,276 (6.84)	170,434 (0.35)
2007	48,138,077	3,192,487 (6.63)	165,531 (0.34)
2008	48,297,184	3,197,343 (6.62)	157,502 (0.33)
2009	48,456,369	3,196,877 (6.6)	153,120 (0.32)
2010	48,606,787	3,164,416 (6.51)	148,260 (0.31)
<b>Region</b>			
Seoul	51,095,550	3,098,254 (6.06)	153,371 (0.3)
Busan	17,874,948	1,268,433 (7.1)	53,858 (0.3)
Daegu	12,483,557	816,304 (6.54)	42,985 (0.34)
Incheon	13,450,538	801,208 (5.96)	46,130 (0.34)
Gwangju	7,132,220	495,330 (6.94)	27,857 (0.39)
Daejeon	7,410,556	495,254 (6.68)	21,734 (0.29)
Ulsan	5,546,060	410,413 (7.4)	18,754 (0.34)
Gyeonggi	56,551,740	3,403,427 (6.02)	178,798 (0.32)
Gangwon	7,560,489	460,330 (6.09)	20,153 (0.27)
Chungbuk	7,597,760	475,145 (6.25)	21,956 (0.29)
Chungnam	10,101,597	684,849 (6.78)	40,543 (0.4)
Jeonbuk	9,309,885	640,377 (6.88)	37,764 (0.41)
Jeonnam	9,623,250	768,344 (7.98)	30,628 (0.32)
Gyeongbuk	13,403,668	865,560 (6.46)	47,412 (0.35)
Gyeongnam	16,135,777	1,145,585 (7.1)	45,553 (0.28)
Jeju	2,812,290	206,586 (7.35)	7,351 (0.26)

As shown in Table 2, the prevalences in men and women were similar; although in men it was slightly higher than that in women (7.01% vs. 6.26%). Age-specific patterns were observed in the occurrence of skin fungal infections, with a high prevalence rate in older adults, especially in people from the 50–79-years age group, but a low prevalence rate in children and young adults (Table 2).

### 3.2. Medical treatments of patients by skin fungal infections

The average convalescence time (days) of dermatophytosis was longer than that of other superficial mycoses. The average convalescence time of dermatophytosis

was 26.9 days for inpatients and 2.51 days for outpatients. The average convalescence time of the other superficial mycoses was 19.9 days for inpatients and 1.80 days for outpatients (Table 3).

The total medical costs of dermatophytosis were higher than those of the other superficial mycoses. The total medical cost for inpatients and outpatients was 5,332 hundred million won, 441 hundred million won for hospitalization, and 4,891 hundred million won for outpatient medical costs. Of the total medical costs for the other superficial mycoses, 9 hundred million won was for inpatients and 175 hundred million won was for outpatients (Table 3).

**Table 2.** Prevalence rate of skin fungal infections by age and sex.

	Population	No. (%) of patients <i>N</i> = 16,035,399
Sex		
Men	121,384,162	8,509,986 (7.01)
Women	120,153,670	7,52,5413 (6.26)
Age (y)		
0–9	27,724,299	313,939 (1.13)
20–29	33,060,697	796,600 (2.4)
20–29	37,329,397	1,788,201 (4.79)
30–39	42,264,128	2,903,591 (6.87)
40–49	41,286,367	3,634,778 (8.8)
50–59	27,180,185	2,993,946 (11.01)
60–69	18,404,769	2,131,719 (11.58)
70–79	10,654,688	1,206,261 (11.32)
80–89	3,260,919	249,196 (7.64)
>90	435,853	171,68 (3.93)

#### 4. Discussion

Skin fungal infections occur because of fungal agents invading the skin [6], causing superficial lesions with fungus parasitic on the stratum corneum of the skin, hair, nails, and toenails, and skin candidiasis. Skin fungal infection is a common disease in South Korea, affecting 10–20% of dermatology outpatients [16,17]. The World Health Organization estimates the global prevalence of dermatophytoses to be approaching 20% [18].

Dermatophytes are the only fungal agents that have evolved a dependency on human or animal infection for survival. The infection may spread from person to person (anthropophilic), animal to person (zoophilic), or soil to person (geophilic) [19].

The distribution of skin fungal infections and their causative agents vividly differ between geographical, climatic factor, and cultural requirements, and also show differences in changes in lifestyle, habit, sanitary thought, and socioeconomic status, as well as frequent interchange, trade, and human immigration [3,20,21].

According to the retrospective analysis from 2005 to 2010 of Vena et al [22], the most prevalent clinical form was tinea unguium (39.2% of the total dermatophytoses) and *Trichophyton rubrum* was the most prevalent causative agent, implicated in 64% of the total cases. Epidemiological data showed gradual decreases in the prevalences of tinea cruris, tinea corporis, and tinea capitis infections over time. However, the prevalence rates of tinea pedis and tinea unguium have significantly increased.

In South Korea, many lifestyle changes have occurred since the social changes after the liberation occurred in the past 60 years, which took 100–150 years in Europe and the United States [23]. The prevalences of many diseases have changed along with the lifestyle changes in South Korea. In particular, the isolation frequency of fungal species that cause skin fungal infection has largely changed. New fungal species have been transmitted from foreign countries, or the number of fungal species with high isolation frequency were reduced [4,16,17,23,24]. However, no nationwide epidemiological research on skin fungal infections have been conducted that involve clinical mycological observation and causative organism identification in patients with skin fungal infection patients [25,26].

The aim of this study was to analyze the epidemiological characteristics of skin fungal infections that occurred between 2006 and 2010. We collected data from the Health Insurance Corporation and analyzed two groups, namely the dermatophytosis and other superficial mycosis groups, according to similarity of fungal infection pattern. The prevalence rate of dermatophytosis decreased slightly every year between the years 2006 and 2010, whereas the prevalence rate of the other superficial mycoses was 0.3% from 2006 to 2010. This decrease in the prevalence rate of dermatophytosis is thought to be caused by the change in the hygiene concern of people.

Of the total medical care cost, the medical care cost for skin fungal infections was the highest at 918 hundred million won. The individual medical care cost in 2010 was 159,480 won. About 6.8% of the average population

**Table 3.** Convalescence days and medical costs for skin fungal infections.

Origin	Patient	Frequency	Average convalescenced	Persons cost of care	Total cost	Self-cost	Insurance cost
		<i>N</i>		(Korean won)	(100 million)	(100 million)	(100 million)
Dermatophytosis	Inpatient	31,714	26.9220	1,390,722	441	92	349
	Outpatient	15,841,190	2.5130	30,842	4,891	1,387	3,504
	Total	15,872,904		1,421,564	5,332	1,479	3,853
Other superficial mycoses	Inpatient	636	19.9860	1,376,977	9	2	7
	Outpatient	786,375	1.8050	22,308	175	53	122
	Total	787,011		1,399,285	184	55	129

receives treatment of skin fungal infection. In particular, 0.8 in 10 people of the Korean population receives treatment for fungal infections every year, which indicates a high prevalence rate.

For the prevalence rate according to age, the 60–70-years age group showed the highest prevalence rate, as the rate increased with age. Although data in relation to age and dermatophytosis have not yet been reported, with an aging society, epidemiological studies on chemotherapy and the increase in the incidence of metabolic diseases such as diabetes are needed. By contrast, superficial mycosis was shown to have the highest prevalence among the 20–30-years age group, with the tendency to decrease with age. Tattoo, nail art, nail care, degree of skin exposure, skin care, and so on, were thought to be influenced by the changes in socio-cultural, economic, and living customs.

The data collected from the database may not coincide 100% with clinical diagnoses for dermatophytoses and other superficial mycoses, but are greatly useful in judging changes in the prevalence of fungal infections. Yearly prevalence rates are analyzed according to socioeconomic changes. A retrospective research using data from the Health Insurance Corporation database has advantages of solving the limitation of space-time or cost, but long-term tracking observation of individual patients is difficult.

Therefore, continuous surveillance of changes in prevalence, region of infectious disease, and epidemiological pattern over different periods is possible for pathogens of fungal infections occurring in high prevalences in South Korea. Accurate prediction of prevalence is also possible using this data collection.

## Conflicts of interest

All authors have no conflicts of interest to declare.

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