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Sex Differences in the Incidence of Skin and Skin-Related Diseases in Olmsted County, Minnesota, United States, and a Comparison With Other Rates Published Worldwide

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Abstract

Many skin and skin-related diseases affect the sexes unequally, with attendant implications for public health and resource allocation. To better evaluate the incidence of skin and skin-related diseases affecting males versus females, we reviewed published population-based epidemiology studies of skin disorders performed utilizing Rochester Epidemiology Project (REP) data. Females had a higher incidence of the following diseases: connective tissue diseases (scleroderma, morphea, dermatomyositis, primary Sjögren syndrome, systemic lupus erythematosus [not in all studies]), pityriasis rosea, herpes progenitalis, condyloma acuminatum, hidradenitis suppurativa, herpes zoster (except in children), erythromelalgia, venous stasis syndrome, and venous ulcers. Males had a higher incidence of psoriasis and psoriatic arthritis, basal cell carcinoma (exception, females aged 40 years), squamous cell carcinoma, and lentigo maligna. Incidence rates were equal in males and females for cutaneous malignant melanoma (exception, higher in females aged 18–39 years), lower-extremity cellulitis, cutaneous nontuberculous mycobacterial infection, Behçet disease, delusional infestation, alopecia areata, and bullous pemphigoid. Many of the population-based sex-specific incidence rates of skin and skin-related diseases derived from the Rochester Epidemiology Project are strikingly different from those estimated elsewhere. In general, females are more commonly affected by skin and skin-related diseases. The reasons for this imbalance remain to be determined and are likely multifactorial.

Keywords

diseases of women; epidemiology; medical statistics; skin diseases

Introduction

Over the decades, interest is growing regarding sex differences in disease with respect to epidemiology, pathogenesis, clinical presentation, and response to treatment. Certain skin and skin-related diseases show striking differences between sexes in incidence patterns (a measure of new cases in a population over a given period). For example, females have a

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higher incidence of connective tissue disease such as primary Sjögren syndrome (pSS) and scleroderma, whereas males more commonly are affected by nonmelanoma skin cancer. The reasons underlying sex-based disparity in the development of skin and skin-related diseases remain largely unknown but are likely multifactorial. Factors that may be considered include differences in skin layers and physiology, sex hormones, genetics, age, ethnicity/race, lifestyle, occupation, and others.^{1–3}

In Olmsted County, Minnesota, United States, population-based incidence studies can be performed using the Rochester Epidemiology Project (REP). The REP is a unique records linkage research infrastructure system that has captured health care data on almost all residents of Olmsted County since 1966 (described in detail elsewhere).^{4,5} In Olmsted County, the majority of the population is white (ie, less racially diverse than the United States in general), and the number of residents is relatively small (146,000 persons).

In a previous manuscript, we summarized all incidence studies of skin and skin-related diseases derived from REP.⁶ The aim of this study is to outline sex disparities in the incidence of the select skin and skin-related diseases in Olmsted County, Minnesota, and compare them with other reported overall sex-specific incidence rates (IRs) worldwide.

Methods

We abstracted a complete list of published REP studies from 1966 (when the REP was established) through April 2014. We reviewed each article and identified those that described IRs of skin and skin-related diseases in Olmsted County. We included incidence studies in which overall sex-specific IRs either were reported or could be calculated (using data from the original publications). Studies reporting 10 or fewer cases (females and males combined) were excluded.

We abstracted the following data from the REP studies: study period, population defined by age, overall IR, overall sex-specific IRs, and *P* values with corresponding 95% CIs, when available.

We also reviewed the worldwide English-language literature to identify additional reports of overall sex-specific IRs for the entire study period using PubMed. We searched PubMed for incidence studies within the same period as the REP studies (1966–2014). Studies reporting 10 or fewer cases (men and women combined) were again excluded. In a few reports, the overall sex-specific IR was calculated only for one sex; we included these studies in our analysis. Search terms were as follows: *basal cell carcinoma* OR *squamous cell carcinoma* OR *lentigo maligna* OR *cutaneous malignant melanoma* OR *cutaneous LE* OR *systemic LE* OR *scleroderma (or systemic sclerosis)* OR *dermatomyositis* OR *primary Sjögren syndrome* OR *psoriasis* OR *psoriatic arthritis* OR *pityriasis rosea* OR *lower-extremity cellulitis* OR *herpes zoster* OR *herpes progenitalis* OR *condyloma acuminatum* OR *cutaneous nontuberculous mycobacterial infection* OR *hidradenitis suppurativa* OR *Behçet disease* OR *delusional infestation* OR *erythromelalgia* OR *alopecia areata* OR *venous stasis syndrome* OR *venous ulcer* OR *bullous pemphigoid* AND *incidence* AND *sex-specific incidence*. For each of these articles, we abstracted the following data: study period,

geographic areas, method, population defined by age, total number of incidents, crude or standardized rates, overall IR, overall sex-specific IRs, and *P* values with corresponding 95% CIs, when available. If multiple non-REP studies on overall sex-specific IRs were available, a maximum of 5 references for each disease were included; however, for some diseases, only 1 additional study was identified. We did not identify any non-REP incidence studies that met our inclusion criteria for lentigo maligna, pityriasis rosea, lower-extremity cellulitis, herpes progenitalis, cutaneous nontuberculous mycobacterial infection, hidradenitis suppurativa, delusional infestation, erythromelalgia, and alopecia areata; specifically, overall sex-specific IRs for the entire study period were either not reported in the studies that we did find, or they could not be calculated because of insufficient data in the original articles.

Statistical Analysis

IRs with corresponding 95% CIs and *P* values are presented as they were reported in the original publications, when available. Otherwise, for REP studies, we performed additional calculations using age- and sex-specific counts and IRs from the publications, assuming that the number of cases followed a Poisson distribution. For consistency, all IRs from REP studies were standardized to the 2000 US white population. For non-REP studies, the quantities were calculated as follows using the Person-Time module of Open Epi.⁷ If the 95% CI for an IR was not reported but the observed number of cases and the IR were reported, then the 95% CI was calculated using the normal approximation to the Poisson distribution if ($N \geq 10$) or using the Mid-P exact test if ($N < 10$) for either males or females. If the *P* value for the comparison of the IRs between males and females was not reported but both *N* and IR were reported, then the *P* value was calculated using the z-score test if both ($N \geq 10$) or using the Mid-P exact test if ($N < 10$) for either males or females.

Results

The skin and skin-related diseases were grouped as follows for both REP studies and non-REP studies: 1) skin cancer; 2) connective tissue diseases; 3) papulosquamous diseases (including psoriatic arthritis [PsA]); 4) skin infections; and 5) other skin diseases.

Table 1 summarizes data abstracted from each REP study. Females in Olmsted County were more affected by connective tissue diseases such as scleroderma, morphea, dermatomyositis (DM), pSS, systemic lupus erythematosus (SLE; not in all studies), pityriasis rosea, herpes progenitalis, condyloma acuminatum, hidradenitis suppurativa, herpes zoster (except in children), erythromelalgia, venous stasis syndrome, and venous ulcers. Males were slightly more affected by psoriasis and PsA. Males were more commonly affected by basal cell carcinoma (except for females aged ≥ 40 years), squamous cell carcinoma, and lentigo maligna. Males and females were equally affected by cutaneous malignant melanoma (CMM), except for a significantly higher incidence among females aged 18 to 39 years. Differences by sexes were not statistically significant for lower-extremity cellulitis, cutaneous nontuberculous mycobacterial infection, Behçet disease, delusional infestation, alopecia areata, or bullous pemphigoid (BP).

Table 2 summarizes data abstracted from each of the included non-REP studies. In general, females worldwide also were more affected by connective tissue diseases such as SLE,

cutaneous LE, scleroderma (or systemic sclerosis), pSS and DM (DM was not in all studies), venous leg ulcers (only 1 study found), and herpes zoster (except for a US study in which males were slightly more affected). Males worldwide seemed to be more commonly affected by basal cell carcinoma and squamous cell carcinoma. For cutaneous malignant melanoma, PsA, and condyloma acuminatum, the overall sex-specific IR varied by geographic area (one sex was not predominant in all areas). Differences by sex were not statistically significant for Behçet disease and bullous pemphigoid worldwide (except for one German study, which reported male predominance with bullous pemphigoid).

Discussion

We describe the results of multiple population-based epidemiologic studies performed in Olmsted County, Minnesota, examining sex-based differences in disease IRs. Intriguingly, most of the skin and skin-related diseases studied in Olmsted County were more common in females than males (Figure). Others have also noted sex-based disparities in the overall IRs of skin and skin-related diseases worldwide (Table 2). The reasons underlying sex-based disparities in the incidence of skin and skin-related diseases remain largely unknown but are likely multifactorial. Factors that ought to be considered include 1) sex differences in the structure and function of skin; 2) genetic predisposition; 3) effects of sex hormones; 4) race/ethnicity; 5) sociocultural behavior; and 6) environmental or geographic factors.

A direct comparison of the overall sex-specific IR data derived from the REP with data from other sources could, however, be complicated by several factors such as type of study (eg, population-based, survey), differences in the methods of disease ascertainment (eg, diagnostic classification criteria vs self-reported), whether the sex-specific IR was crude or standardized, or the age groups studied (eg, all ages, adults only, children only).

Skin Cancer

The incidence of basal cell carcinoma was higher in males than females in Olmsted County, except for females 40 years or younger^{8,9}; the same was true for squamous cell carcinoma in Olmsted County.^{9,10} Other studies have shown that, compared with females, males had significantly greater risk of acquiring basal cell carcinoma or squamous cell carcinoma,^{46–50} with the highest IRs reported among Australian males.⁴⁷

The incidence of lentigo maligna, a rare form of malignant melanoma in situ, is higher in males than females in Olmsted County. The incidence increased significantly with age and was higher for males (particularly age ≥ 50 years and highest between age 70–79 years) compared with females throughout the entire study period.¹¹

In Olmsted County, females aged 18 to 39 years had a significantly higher incidence of cutaneous malignant melanoma than males,¹⁴ but when considering all ages combined, as well as patients aged 40 to 60 years, males and females were equally affected by cutaneous malignant melanoma.^{12,13,15} In Europe, females had a significantly greater risk of acquiring cutaneous malignant melanoma compared with males.^{46,51} In Australia and New Zealand, the incidence of cutaneous malignant melanoma was much higher in both males and

females.^{53,54} In Iran, the reported IRs of cutaneous malignant melanoma were lowest for both sexes.⁵²

Connective Tissue Diseases

The incidence of lupus was higher in females than males in Olmsted County,^{16,21,22} although this difference was not statistically significant for combined SLE and discoid SLE. Other studies have also shown that females had a significantly greater risk than males of acquiring SLE^{55–58} and cutaneous LE.⁵⁹ In Olmsted County, for example, females had a 5- to 6-fold higher risk than males.²¹ In a US study (Baltimore, Maryland), the IR of SLE was highest among black females and lowest among white males.⁵⁸ In the United Kingdom, Afro-Caribbeans had the highest female IR, followed by Asian and white females, suggesting a racial disparity.⁵⁶

The incidence of scleroderma in Olmsted County is higher in females than in males for both localized scleroderma (morphea) and diffuse scleroderma (systemic sclerosis).^{17,24} Other studies have also found that females had a significantly greater risk of acquiring scleroderma compared with males, showing that estradiol concentrations may have a role in the pathogenesis.^{60–64}

The incidence of DM is higher in females than males in Olmsted County.¹⁸ The tendency toward female predominance in DM was also noted in a Taiwanese study,⁶⁶ although others have reported similar IRs for DM in females and males in Taiwan.⁶⁴ In the United States, white females and males were equally affected by DM, whereas black females had a higher incidence than black males (DM was absent in black males).⁶⁵

The incidence of pSS was higher in females than males. In Olmsted County, white females were 13 times more affected by pSS than males.¹⁹ In Taiwan, females had a 10-fold higher risk of acquiring pSS than males.⁶⁷ In Greece, females were 20 times more affected by pSS compared with males,⁶⁸ again showing that estradiol concentrations may affect the pathogenesis of pSS.^{63,64}

Papulosquamous Diseases

The incidence of psoriasis was similar between males and females in Olmsted County,^{25,27} but from 1970 to 2000, males had a higher incidence of psoriasis, except for during the sixth decade of life.²⁶ In another US study, the incidence of psoriasis among females aged 25 to 42 years was similar to that observed in Olmsted County among females aged 18 years or older.⁶⁹

The incidence of PsA was higher in males than females in Olmsted County,²⁸ except from 1982 to 1991, when females and males were equally affected.²⁹ The male predominance in PsA was also noted in Argentina.⁷⁰ In Norway, one study also reported that males had greater risk of acquiring PsA compared with females,⁷³ but another Norwegian study showed that females were more commonly affected by PsA than males.⁷⁴ In Sweden and Finland, female preponderance was reported among patients with PsA.^{71,72} In Olmsted County, the incidence of pityriasis rosea was also studied and showed a female predominance.³⁰

Skin Infections

The incidence of lower-extremity cellulitis in Olmsted County showed that females were slightly more affected compared with males.³¹ The incidence of herpes zoster also showed that females older than 22 years had a higher risk compared with males in Olmsted County.³³ Among children in Olmsted County, boys had a higher risk of acquiring herpes zoster than girls.³² Other studies have also showed that females have greater risk of acquiring herpes zoster compared with males,^{75,76,78,79} although others have found that females and males were equally affected.⁷⁷ The incidence of herpes progenitalis was higher in females than males in Olmsted County, with the highest IR for both sexes in those aged 20 to 24 years.³⁴ The incidence of condyloma acuminatum was higher in females than males in Olmsted County.³⁵ Others have reported that females and males are similarly affected in the United States.⁸⁰ In China, Spain, and England, males had a significantly higher incidence of condyloma acuminatum compared to females with highest IR among Chinese males.^{81–83} The incidence of condyloma acuminatum among females in Germany were found more similar as the one reported in Olmsted County.⁸⁴ The incidence of cutaneous nontuberculous mycobacterial infection was approximately equal between the sexes in Olmsted County.³⁶ In Olmsted County, the incidence of hidradenitis suppurativa was higher in females than males, with a sharp decline after the fifth decade of life in females.³⁷

Other Skin Diseases

The incidence of Behçet disease was approximately equal between the sexes in Olmsted County.³⁸ The same was true in Italy and Sweden.^{85,86} In Taiwan, females had nonsignificantly greater risk than males of acquiring Behçet disease.^{63,64} The incidence of venous stasis syndrome and venous ulcerations was higher in females than males in Olmsted County.⁴³ In the United Kingdom, females also had a higher incidence of venous ulcerations, except for those aged 86 to 95 years (when males were more likely to have venous ulceration).⁸⁷

In Olmsted County, the incidence of delusional infestation was higher in females than males, although this difference was not statistically significant.³⁹ Erythromelalgia was also more common among females in Olmsted County.⁴⁰ The incidence of alopecia areata was approximately equal between females and males in Olmsted County for more than 4 decades.^{41,42} In Olmsted County, the incidence of BP was slightly higher in males compared with females.⁴⁴ In 1 German study, males were twice as often affected by BP compared with females⁸⁸; however, another German study noted that females were slightly more affected by BP than males.⁸⁹ In Scotland and Switzerland, females had a slightly higher risk of getting BP compared with males.^{90,91}

Strengths and Limitations

The strengths of studies using REP data are the availability of complete medical records since 1966 (the date the REP started) and the ability to examine trends in the incidence of diseases using consistent eligibility criteria. We acknowledge, however, that each of the included REP studies had potential limitations (described in detail in the original publications). A direct comparison of REP vs non-REP studies was complicated by differences in the types of studies performed (population-based, survey, etc). Other

limitations could be due to differences in sample sizes and age distributions. Some studies did not provide standardized rates but considered crude rates only. It is unclear whether the results would have been the same if all studies were assessed using standardized rates or crude rates and same methods.

Conclusion

We describe the results of multiple population-based epidemiologic studies performed in Olmsted County, Minnesota, particularly examining sex-based differences in the incidence of skin and skin-related diseases. We observed notable differences between sexes in incidence patterns. Despite methodologic limitations, we showed that females were more commonly affected by skin and skin-related diseases in Olmsted County and worldwide. To further elucidate the global sex disparities in incidence of skin and skin-related diseases, more studies are needed, particularly from regions not represented well in the dermatology literature such as Latin America and Africa. A better insight into sex-based disparities may also facilitate better development for diagnosis, therapy, and prevention of these diseases in the future.

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Abbreviations

BP	bullous pemphigoid
DM	dermatomyositis
IR	incidence rate
LE	lupus erythematosus
PsA	psoriatic arthritis
pSS	primary Sjögren syndrome
REP	Rochester Epidemiology Project
SLE	systemic lupus erythematosus

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Figure.

Female:Male Incidence Ratio and 95 % CIs of Studies From the Rochester Epidemiology Project, Presented on a Log Scale. A, Skin cancer. B, Connective tissue diseases. C, Papulosquamous diseases (including psoriatic arthritis). D, Skin infections. E, Other skin diseases. AA indicates alopecia areata; BCC, basal cell carcinoma; BD, Behçet disease; BP, bullous pemphigoid; CA, condyloma acuminatum; CLE, cutaneous lupus erythematosus; DI, delusional infestation; DM, dermatomyositis (and its subtypes); HP, herpes progenitalis; HS, hidradenitis suppurativa; HZ, herpes zoster; LE-cellulitis, lower-extremity cellulitis; LM, lentigo maligna; MM, malignant melanoma; NMI, nontuberculous mycobacterial infection; PR, pityriasis rosea; PsA, psoriatic arthritis; pSS, primary Sjögren syndrome; SCC, squamous cell carcinoma; SLE, systemic lupus erythematosus; VSS, venous stasis syndrome; VU, venous ulcer.

Studies of Sex-Specific Incidence of Skin and Skin-Related Disease in Olmsted County, Minnesota

Table 1

Age- and Sex-Adjusted Incidence Rate Per 100,000 Person-Years (95% CI) ^a								
Source	Study Period	Skin Disease	Age, y	No. of Cases	Overall	Female	Male	P Value ^b
Skin Cancer								
Chuang et al ⁸	1976–1984	Basal cell carcinoma	All	657	171.2 (157.8–184.5)	146.1 (130.6–161.6)	203.6 (179.7–227.4)	<.001
Christenson et al ⁹	1976–2003	Basal cell carcinoma	40	417	23.4 (21.1–25.6)	25.9 (22.6–29.2)	20.9 (17.8–23.9)	.03
Chuang et al ⁸	1976–1984	Squamous cell carcinoma	All	169	47.9 (40.6–55.3)	27.7 (20.9–34.4)	77.0 (61.5–92.5)	<.001
Christenson et al ⁹	1976–2003	Squamous cell carcinoma	40	68	3.9 (3.0–4.8)	3.5 (2.3–4.7)	4.3 (2.9–5.7)	.40
Gray et al ¹⁰	1984–1992	Squamous cell carcinoma	All	511	114.6 (104.5–124.7)	77.2 (67.0–87.4)	166.2 (146.2–186.1)	<.001
Mirzoyev et al ¹¹	1970–2007	Lentigo maligna	18	145	6.3 (5.3–7.4)	3.8 (2.9–5.1)	9.9 (7.9–11.9)	<.001
Resseguie et al ¹²	1950–1974	Cutaneous malignant melanoma	All	42	4.9 (3.4–6.5)	4.5 (2.6–6.4)	5.7 (3.1–8.3)	.47
Popescu et al ¹³	1950–1985	Cutaneous malignant melanoma	All	107	8.2 (6.6–9.8)	7.6 (5.7–9.6)	9.2 (6.4–12.0)	.34
Reed et al ¹⁴	1970–2009	Cutaneous malignant melanoma	18–39	256	16.9 (14.8–19.0)	23.2 (19.7–26.6)	10.8 (8.4–13.3)	<.001
Lowe et al ¹⁵	1970–2009	Cutaneous malignant melanoma	40–60	383	37.1 (33.4–40.8)	34.5 (29.5–39.5)	39.8 (34.3–45.3)	.16
Connective Tissue Diseases								
Durosaro et al ¹⁶	1965–2005	Cutaneous LE	All	156	4.3 (3.6–5.0)	5.2 (4.2–6.3)	3.3 (2.4–4.2)	.006
Peterson et al ¹⁷	1960–1993	Morphea	All	82	2.7 (2.1–3.3)	3.8 (2.8–4.8)	1.7 (0.9–2.5)	<.001
Bendewald et al ¹⁸	1976–2007	Dermatomyositis and its subtypes	All	29	1.0 (0.6–1.3)	1.4 (0.8–2.0)	0.5 (0.1–0.8)	.007
Pillemer et al ¹⁹	1976–1992	Primary Sjögren syndrome	All	53	4.1 (2.9–5.2)	7.2 (5.2–9.3)	0.6 (0.0–1.4)	<.001
Nannini et al ²⁰	1976–2005	Primary Sjögren syndrome	18	105	5.1 (4.1–6.1)	8.7 (6.9–10.4)	1.1 (0.4–1.9)	<.001
Uramoto et al ²¹	1980–1992	SLE	All	48	6.4 (4.5–8.2)	10.1 (7.0–13.3)	2.2 (0.4–4.0)	<.001
Kurland et al ²²	1951–1967	SLE	All	29	5.6 (3.5–7.6)	7.3 (4.1–10.4)	3.5 (1.1–6.0)	.07
Nobrega et al ²³	1950–1965	Combined SLE	All	25	3.3 (2.0–4.6)	4.0 (2.1–5.9)	2.5 (0.8–4.2)	.27
Michet et al ²⁴	1950–1979	SLE	All	25	2.3 (1.4–3.2)	3.0 (1.7–4.4)	1.5 (0.3–2.7)	.12
Michet et al ²⁴	1950–1979	Suspected SLE	All	21	1.9 (1.1–2.7)	3.5 (2.0–5.0)	0	Not calculated ^c
Michet et al ²⁴	1950–1979	Discoid LE	All	24	2.3 (1.4–3.3)	2.5 (1.2–3.8)	2.2 (0.8–3.6)	.77
Michet et al ²⁴	1950–1979	Scleroderma	All	13	1.2 (0.5–1.8)	2.0 (0.9–3.2)	0.3 (0.0–0.9)	.03
Papulosquamous Diseases (Including Psoriatic Arthritis)								

Source	Study Period	Skin Disease	Age, y	No. of Cases	Age- and Sex-Adjusted Incidence Rate Per 100,000 Person-Years (95% CI) ^a			P Value ^b
					Overall	Female	Male	
Tollefson et al ²⁵	1970–1999	Psoriasis	18	357	40.8 (36.6–45.0)	43.9 (37.6–50.2)	37.9 (32.2–43.6)	.17
Icen et al ²⁶	1970–2000	Psoriasis	18	1,633	78.9 (75.0–82.9)	73.2 (68.0–78.4)	85.5 (79.5–91.6)	.002
Bell et al ²⁷	1980–1983	Psoriasis	All	132	61.2 (50.2–72.1)	63.8 (48.8–78.9)	60.0 (43.2–76.8)	.72
Wilson et al ²⁸	1970–1999	Psoriatic arthritis	18	147	7.2 (6.0–8.4)	5.4 (4.0–6.9)	9.1 (7.1–11.0)	.002
Shibeeb et al ²⁹	1982–1991	Psoriatic arthritis	18	66	9.3 (7.0–11.6)	9.3 (6.0–12.5)	9.3 (6.0–12.7)	.97
Chuang et al ³⁰	1969–1978	Pityriasis rosea	All	939	140.7 (131.1–150.3)	165.3 (151.1–179.4)	117.0 (103.9–130.0)	<.001
Infections								
McNamara et al ³¹	1999	Lower-extremity cellulitis	18	176	213.0 (181.2–244.9)	193.6 (153.1–234.1)	226.1 (181.5–245.2)	.30
Guess et al ³²	1960–1981	Herpes zoster	20	173	48.6 (41.3–55.9)	42.6 (33.5–51.6)	48.2 (38.1–58.4)	.41
Yawn et al ³³	1996–2001	Herpes zoster	22	1,669	374.0 (355.8–392.2)	407.4 (382.0–432.9)	336.6 (310.2–363.1)	<.001
Chuang et al ³⁴	1965–1979	Herpes progenitalis	All	392	49.8 (44.7–54.9)	48.9 (42.5–55.3)	33.2 (27.2–39.2)	<.001
Chuang et al ³⁵	1950–1978	Condyloma acuminatum	All	746	48.7 (44.9–52.5)	56.5 (51.2–61.8)	41.2 (35.9–46.6)	<.001
Wentworth et al ³⁶	1980–2009	Cutaneous nontuberculous mycobacterial infection	All	40	1.3 (0.9–1.7)	1.4 (0.8–2.0)	1.0 (0.5–1.6)	.50
Vazquez et al ³⁷	1968–2008	Hidradenitis suppurativa	All	268	6.1 (5.4–6.9)	7.9 (6.8–9.1)	3.8 (3.0–4.7)	<.001
Other Skin Diseases								
Calamia et al ³⁸	1960–2005	Behçet disease	18	13	0.4 (0.2–0.5)	0.5 (0.2–0.8)	0.2 (0.0–0.5)	.26
Bailey et al ³⁹	1976–2010	Delusional Infestation	All	64	1.9 (1.5–2.4)	2.3 (1.6–3.0)	1.7 (1.0–2.4)	.16
Reed and Davis ⁴⁰	1976–2005	Erythromelalgia	All	33	1.3 (0.8–1.7)	2.0 (1.2–2.7)	0.6 (0.1–1.1)	.004
Safavi et al ⁴¹	1975–1989	Alopecia areata	All	292	19.9 (17.6–22.3)	20.0 (16.7–23.4)	19.7 (16.3–23.1)	.88
Mirzoyev et al ⁴²	1990–2009	Alopecia areata	All	530	20.9 (19.1–22.6)	21.3 (18.8–23.9)	20.2 (17.7–22.6)	.77
Heit et al ⁴³	1966–1990	Venous stasis syndrome	15	1,131	87.0 (81.8–92.1)	96.5 (89.3–103.6)	76.2 (68.4–83.9)	<.001
Heit et al ⁴³	1966–1990	Venous ulcer	15	263	23.0 (18.4–23.5)	24.2 (20.6–27.7)	16.7 (13.0–20.4)	.004
Brick et al ⁴⁴	1960–2009	Bullous pemphigoid	All	87	2.4 (1.9–2.9)	2.2 (1.6–2.8)	2.8 (1.8–3.7)	.25

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Studies of Sex-specific Incidence Rates of Skin and Skin-related Disease Worldwide

Table 2

Skin Disease	Source	Study Period	Method	Geographic Area	Age, y	Total Incidents, No. ^a	Crude or Standardized Rates	Incidence Rate per 100,000 Person Years (95% CI)			P Value ^b			
								Overall	Female	Male				
Basal cell carcinoma	Bath-Hextall et al ⁴⁵	1996–2003	Cases of persons registered with a general practitioner, with data maintained in The Health Improvement Network database	United Kingdom	18	11,113	World population	60.0 (58.9–61.1) ^c	53.0 (51.6–54.4) ^c	69.0 (67.2–70.8) ^c	<.001 ^d			
												Skin Cancer		
	Osterlind et al ⁴⁶	1973–1982	Cases reported to the Danish Cancer Registry	Denmark	All	10,846	World population	Not reported	23.7 (23.1–24.3) ^c	30.4 (29.6–31.2) ^c	<.001 ^d			
	Green et al ⁴⁷	1986–1992	Clinical examination and postal survey of a random sample of residents	Nambour, Queensland	All	250	World population	Not reported	1,579.0 ^e	2,074.0 ^e	Not possible to calculate			
	English et al ⁴⁸	1987–1992	Clinical examination and postal survey of residents; medical record review of persons reporting any treatment	Geraldton, Australia	45–64	717	Crude	Not reported	3,379 (2,813–4,059)	7,067 (6,015–8,304)	<.001 ^d			
Squamous cell carcinoma	Staples et al ⁴⁹	2002	Face-to-face interviews to identify persons previously treated for skin cancer using a stratified sampling of households	Australia	All	612	World population	884 (816–957)	745 (662–839)	1,041 (936–1,158)	Not possible to calculate			
	Osterlind et al ⁴⁶	1978–1982	Cases reported to the Danish Cancer Registry	Denmark	All	2,005	World population	Not reported	2.5 (2.3–2.7) ^c	6.7 (6.3–7.1) ^c	<.001 ^d			
	Serrano et al ⁵⁰	June 1979–May 1980	Survey sent to health professionals to identify cases among state residents; details	New Hampshire and Vermont, United States	All	277	US population	Not reported	8.0 (6.2–9.8) ^c	32.0 (27.6–36.4) ^c	<.001 ^d			

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Skin Disease	Source	Study Period	Method	Geographic Area	Age, y	Total Incidents, No. ^a	Crude or Standardized Rates	Incidence Rate per 100,000 Person Years (95% CI)			P Value ^b
								Overall	Female	Male	
Cutaneous malignant melanoma	Green et al ⁴⁷	1986–1992	abstracted by study staff Clinical examination and postal survey of a random sample of residents	Nambour, Queensland	18	94	World population	Not reported	472.0	1035.0	Not possible to calculate
	English et al ⁴⁸	1987–1992	Clinical examination and postal survey of residents; medical record review of persons reporting any treatment	Geraldton, Australia	45–64	88	Crude	Not reported	501 (334–668)	775 (567–984)	.04 ^d
	Staples et al ⁴⁹	2002	Face-to-face interviews to identify persons previously treated for skin cancer using a stratified sampling of households	Australia	All	286	World population	387.0 (344.0–434.0)	291.0 (242.0–349.0)	499.0 (430.0–580.0)	Not possible to calculate
	Osterlind et al ⁴⁶	1978–1982	Cases reported to the Danish Cancer Registry	Denmark	All	2,376	World population	Not reported	8.4 (8.0–8.8) ^c	6.1 (5.7–6.5) ^c	<.001 ^d
	MacKie et al ⁵¹	1979–1994	Cases reported by pathologists to the Scottish Melanoma Group	Scotland	All	6,288	World population	Not reported	6.7 (6.5–6.9) ^c	4.5 (4.3–4.7) ^c	<.001 ^d
	Noorbala et al ⁵²	1988–2008	Cancer registry of cases among persons referred to public health centers in the province	Province of Yazd, Iran	All	71	Crude	Not reported	0.27 (0.17–0.37) ^c	0.40 (0.28–0.52) ^c	.11 ^d
	Jell's et al ⁵³	1989	Cases captured by all state or territory cancer registries	Australia	All	5,494	World population	Not reported	23.9 (23.0–24.8) ^c	30.2 (29.1–31.3) ^c	<.001 ^d
	Jones et al ⁵⁴	1995	Cases from the Auckland region reported to the New Zealand Cancer Registry or collected by	Auckland region, New Zealand	All	525	World population	56.2	55.2 (NA)	58.0 (NA)	Not possible to calculate

Skin Disease	Source	Study Period	Method	Geographic Area	Age, y	Total Incidents, No. ^a	Crude or Standardized Rates	Incidence Rate per 100,000 Person Years (95% CI)			P Value ^b
								Overall	Female	Male	
Connective Tissue Diseases											
Systemic lupus erythematosus	Johnson et al ⁵⁵	1991	the Auckland melanoma unit	Metropolitan districts of Birmingham and Solihull, England	18	33	West Midlands population	3.8 (2.5–5.1)	6.8 (4.4–9.2)	0.5 (0.1–1.7)	<.001 ^d
	Somers et al ⁵⁶	1990–1999	Cases captured in the General Practice Research Database, covering 5% of persons served by the National Health Service	United Kingdom	All	1,638	European population	4.71 (4.48–4.94)	7.89 (7.46–8.31)	1.53 (1.34–1.71)	<.001 ^d
	Nossent ⁵⁷	1978–1996	Cases captured by inpatient and outpatient registries; medical record review	Counties of Finnmark and Troms, Norway	16	83	Crude	2.6 (2.1–3.2)	4.6 (3.6–5.8)	0.6 (0.3–1.3)	<.001 ^d
Cutaneous lupus erythematosus	Hochberg ⁵⁸	1970–1977	Cases with a hospital discharge diagnosis	City of Baltimore, Maryland	All	W: 73 B: 233	Baltimore population	Not reported	W: 3.93 (3.0–4.8) ^c B: 11.4 (9.8–13.0) ^c	W: 0.42 (0.11–0.73) ^c B: 2.50 (1.7–3.4) ^c	<.001 for W and B ^d
	Deligny et al ⁵⁹	1995–1999	Cases captured by dermatologists in public and private practice, all rheumatology and internal medicine in public and private practice	French Guiana	All	20	Crude	2.0 (1.1–3.2)	3.4 (1.8–5.8)	0.5 (0.1–1.9)	.06
Scleroderma	Silman et al ⁶⁰	1980–1985	Cases captured by 7 separate sources. 1)	The West Midlands Region, United Kingdom	All	156	Crude	0.37 (NA)	0.62 (NA)	0.11 (NA)	Not possible to calculate

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Skin Disease	Source	Study Period	Method	Geographic Area	Age, y	Total Incidents, No. ^a	Crude or Standardized Rates	Incidence Rate per 100,000 Person Years (95% CI)			P Value ^b
								Overall	Female	Male	
Consultants (vascular surgeons, general physicians, dermatologists, rheumatologists, renal physicians, chest physicians); 2) relevant regional physicians; 3) 2 rheumatology units in the area; 4) the Regional Health Authority; 5) the Royal College of General Practitioners Research Unit; 6) the Raynaud's Association; and 7) consultants of the United Kingdom Scleroderma Study Group	Herrick et al ⁶¹	2005–2007	Cases captured by members of 5 specialist medical associations (including pediatricians, dermatologists, and rheumatologists)	United Kingdom and Ireland	<16	94	Crude	0.34 (0.27–0.41)	0.44 (0.33–0.58)	0.24 (0.17–0.35)	.005 ^c
Cases identified by the Department of Medicine of the Hospital Xeral-Calde of Lugo	Arias-Nunez et al ⁶²	1988–2006		Spain	15	78	European population	2.3 (1.6–2.5)	3.5 (2.3–3.9)	1.0 (0.5–1.4)	.001
Cases registered with the Taiwan National Health Insurance Database containing records of	Yu et al ⁶³	2000–2008		Taiwan	All	118	Crude	1.5 (1.2–1.7)	2.5 (2.1–3.0)	0.4 (0.2–0.6)	<.001 ^d

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Skin Disease	Source	Study Period	Method	Geographic Area	Age, y	Total Incidents, No. ^a	Crude or Standardized Rates	Incidence Rate per 100,000 Person Years (95% CI)			P Value ^b
								Overall	Female	Male	
Dermatomyositis	See et al ⁶⁴	2005–2009	1,000,000 beneficiaries	Taiwan	All	54	Crude	1.1 (0.8–1.4)	1.6 (1.1–2.1)	0.6 (0.3–0.9)	<.001 ^d
			Cases registered with the Taiwan National Health Insurance Database containing records of 1,000,000 beneficiaries								
	Oddis et al ⁶⁵	1963–1982	Cases with a hospital discharge disease (35 hospitals)	Allegheny County, Pennsylvania, United States	All	W: 22 B: 5	US population	Not reported	W: 0.8 (0.01–1.6) ^e B: 2.8 (0.1–5.5) ^e	W: 0.7 (0–1.4) ^e B: 0	W: .758 ^d B: Not calculated ^f
	See et al ⁶⁴	2005–2009	Cases registered with the Taiwan National Health Insurance Database containing records of 1,000,000 beneficiaries	Taiwan	All	36	Crude	0.7 (0.5–1.0)	0.8 (0.5–1.2)	0.6 (0.3–0.9)	.40 ^d
Primary Sjögren syndrome	Kuo et al ⁶⁶	2003–2007	Cases registered with the Taiwan National Health Insurance Research Dataset and the National Death Registry of Taiwan. Coverage rate, >99%, of Taiwanese citizens	Taiwan	All	803	Crude	7.1 (6.6–7.6)	10.0 (9.2–10.9)	4.3 (3.8–4.9)	<.001
	See et al ⁶⁴	2005–2009	Cases registered with the Taiwan National Health Insurance Database containing records of 1,000,000 beneficiaries	Taiwan	All	583	Crude	11.8 (10.8–12.7)	20.1 (18.3–21.8)	3.3 (2.6–4.1)	<.001 ^d
	Yu et al ⁶³	2000–2008	Cases registered with the Taiwan National Health Insurance	Taiwan	All	855	Crude	10.6 (9.9–11.4)	18.5 (17.2–19.9)	2.9 (2.4–3.5)	<.001 ^d

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	Weng et al ⁶⁷	2005–2007	Database containing records of 1,000,000 beneficiaries	Taiwan	15	3,352	Taiwan population	6.0 (5.8–6.2)	11.0 (10.6–11.4)	1.1 (1.0–1.2)	<.001 ^d
	Alamanos et al ⁶⁸	1982–2003	Cases captured by inpatients and outpatients referred to rheumatology clinics of the Ioannina University Hospital and the Ioannina General Hospital; patients referred to private rheumatologists practicing in the study area	Ioannina, Greece	All	422	Greek population	5.3 (4.8–5.8) ^c	10.1 (9.2–11.1) ^c	0.5 (0.3–0.7) ^c	<.001 ^d
Papulosquamous Diseases, Including Psoriatic Arthritis											
Psoriasis	Setty et al ⁶⁹	1991–2005	Cases captured by the Nurses' Health Study II	United States (15 States)	25–42	892	Crude	Not studied	82 (77–89)	Not studied	Not calculated ^f
Psoriatic arthritis	Soriano et al ⁷⁰	2000–2006	Cases captured by the membership of the Hospital Italiano Medical Care Program (2 main hospitals and 24 medical office buildings to around 140,000 members)	Buenos Aires, Argentina	>18	35	Crude	6.26 (4.2–8.3)	3.64 (1.6–5.7)	10.02 (5.9–14.1)	.005 ^d
	Soderlin et al ⁷¹	1999–2000	Cases captured by rheumatology department or to	Växjö, Sweden	16	11	Crude	8 (4–15)	12 (5–24)	5 (1–13)	.20 ^d

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Herpes zoster	Savolainen et al ⁷²	2000	the 1 private rheumatologist	Kuopio, Finland	All	16	Crude	23.1 (13.2–37.5)	27.2 (13.1–50.0)	18.4 (6.8–40.1)	.45 ^d
			Cases captured by all physicians practicing in the Kuopio Health Centre, private clinics, and occupational health services or in various departments of the Kuopio University Hospital								
	Nossent and Gran ⁷³	1978–1996	Cases captured by departments of the University Hospital	Norway	16	232	Crude	6.9 (4.3–9.8)	5.2 (3.8–6.7)	7.9 (5.2–10.9)	.002 ^d
			Cases registered in the Nord-Trøndelag Health Study 3	Norway ^d	20	188	Crude	41.3 (35.8–47.6)	43.4 (36.0–52.5)	38.7 (31.10–48.20)	.44 ^d
	Opstelten et al ⁷⁵	2001	Infections	The Netherlands	All	1,080	Crude	320.0 (300.9–339.1) ^c	389.0 (359.2–418.8) ^c	254.0 (229.8–278.2) ^c	<.001 ^d
	Toyama and Shiraki ⁷⁶	1997–2006	Cases captured from primary care physicians	Miyazaki, Japan	All	43,388	Crude	415.0 (411.3–418.7) ^c	458.0 (452.7–463.3) ^c	367.0 (361.9–372.1) ^c	<.001
			Cases identified by 39 dermatology clinics and the departments of 7 general hospitals associated with the Miyazaki Dermatologic Society								
	Donahue et al ⁷⁷	1990–1992	Cases captured from the Harvard Community Health Plan	Boston, Mass, United States	All	1,075	Crude	215.0 (202.2–227.9)	211.0 (193.7–228.4)	219.0 (199.9–238.1)	.54 ^d
			Cases captured from the Health care claims database (Medstat								
	Insinga et al ⁷⁸	2000–2001		United States	All	9,152	US population	320.0 (313.4–326.6) ^c	380.0 (370.0–390.0) ^c	260.0 (251.5–268.5) ^c	<.001

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Condyloma acuminatum	Jih et al ⁷⁹	2000–2006	MarketScan) of individuals from all states Cases registered in the National Health Insurance program; covering 96% of the population (2000)	Taiwan	All	34,280	Crude	489.0 (483.8–494.2) ^c	509.0 (501.6–516.5) ^c	471.0 (463.8–478.2) ^c	<.001 ^d
	Hoy et al ⁸⁰	2004	Cases registered in the HealthCore Integrated Research Database	United States	All	4,264	US population	120.0 ^e	120.0 ^e	110.0 ^e	Not possible to calculate
	Lin et al ⁸¹	January 5–18, 2009	Cases recorded in 170 private doctors and all doctors working in the 5 local Social Hygiene Clinics	Hong Kong, China	18	73	Crude	203.7 (157.0–250.4) ^c	124.9 (61.7–188.1) ^c	292.2 (217.0–367.4) ^c	.003 ^d
	Castellsague et al ⁸²	2005	Cases identified by gynecologists, dermatologists, and urologists in 6 geographic regions; covering 68% of the total population	The regions of Spain (Andalucia, Catalonia, Valencia, Galicia, Madrid, Pais Vasco)	14–64	36,565	Spain population	117.9 (116.7–119.1) ^c	99.6 (98.0–101.2) ^c	136.6 (134.8–138.4) ^c	<.001 ^d
	Desai et al ⁸³	2006–2008	Cases recorded in the UK General Practice Research Database (Genitourinary Medicine Clinic activity dataset); covering 6% of persons registered with general practitioners	United Kingdom	All	80,531	England population	156.5 (155.4–157.6) ^c	142.0 (140.6–143.4) ^c	167.7 (166.1–169.3) ^c	<.001 ^d
	Hillemanns et al ⁸⁴	2005 2 month	Cases identified by 130 gynecologists, 50 dermatologists, and 20 urologists from 8	Germany	All	303	Crude	Not studied	76.0 (72.6–79.4)	Not studied	Not calculated ^f

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								Overall	Female	Male		
Other Skin Diseases												
Behçet disease	Mohammad et al ⁸⁵	1997–2010	geographic regions	Skåne, southern Sweden	15	20	Crude	0.2 (0.1–0.3)	0.1 (0.0–0.2)	0.3 (0.1–0.4)	.14	
								0.24 (0.14–0.38)	0.24 (0.11–0.45)	0.25 (0.11–0.47)	.93 ^d	
								0.8 (0.6–1.0)	1.0 (0.7–1.3)	0.6 (0.4–0.8)	.048 ^d	
Venous leg ulcer	Yu et al ⁶³	2000–2008	Cases captured from 3 health care districts (covering 1.2% of the total area of Sweden)	Taiwan	All	64	Crude	0.9 (0.6–1.1)	1.1 (0.7–1.5)	0.6 (0.3–0.9)	.06 ^d	
								Cases identified from physicians at Reggio Emilia Hospital, medical practitioners, and community–based specialists				
								Cases registered with the Taiwan National Health Insurance Database containing records of 1,000,000 beneficiaries				
Bullous pemphigoid	See et al ⁶⁴	2005–2009	Cases registered in the General Practice Research Database, covering 6% of persons registered with general practitioners	Taiwan	All	42	Crude	Not reported	1,420.0 (1,350.0–1,480.0)	760.0 (711.0–830.0)	Not possible to calculate	
								Cases recorded in the General Practice Research Database, covering 6% of persons registered with general practitioners				
								Cases identified in the Departments of Dermatology				
Bullous pemphigoid	Jung et al ⁸⁸	1988–1996	Cases identified in the Departments of Dermatology	United Kingdom	65–95	>2,000	Crude	0.61 (0.49–0.73) ^c	0.49 (0.35–0.63) ^c	0.87 (0.62–1.12) ^c	.005	
								Mannheim and Würzburg, Germany				
								German population				

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								Overall	Female	Male	
	Bertram et al ⁸⁹	2001–2002	Cases identified in the Department of Dermatology at the University of Würzburg	Würzburg, Germany	21	27	Crude	1.34 (0.83–1.85) ^c	1.46 (0.72–2.20) ^c	1.22 (0.53–1.91) ^c	.64
	Gudi et al ⁹⁰	1991–2001	Cases registered by the Pathology Department, Aberdeen Royal Infirmary	Grampian Region of northeast Scotland	All	83	Crude	1.4 (1.1–1.7) ^c	1.7 (1.2–2.2) ^c	1.1 (0.7–1.5) ^c	.05 ^d
	Marazza et al ⁹¹	2001–2002	Study protocol was distributed to all dermatology clinics, immunopathology laboratories, and practicing dermatologists	Switzerland	All	140	Crude	1.2 (1.0–1.4) ^c	1.33(1.0–1.6) ^c	1.1 (0.8–1.3) ^c	.19 ^d

Abbreviations: B, black; NA, not available; W, white.

^aBoth sexes.

^bWomen vs men.

^cConfidence interval calculated.

^d*P* value calculated.

^eIncidence rate is reported per million.

^f*P* value was not calculated because the incidence was 0 in the male group.