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Regional differences and seasonal variation of the burden of skin diseases in southern Germany: a retrospective analysis of internet data

Background: Skin diseases are associated with a considerable burden for patients and their relatives. Not every affected individual, however, seeks medical health care and their families are often forgotten, which makes it challenging to identify all unmet needs. **Objectives:** This study aimed to identify regional differences and seasonal variations related to dermatology via an internet search and further investigate whether regional factors influence search behaviour. **Materials & Methods:** A retrospective longitudinal study using Google Ads Keyword Planner was carried out to identify skin disease-related terms throughout Bavaria, southern Germany, from June 2015 to May 2019. Terms were categorized and assessed for regional and seasonal differences. **Results:** From 976 human skin-related terms, with a total search volume of 9,928,630 queries, 7,988,220 referred to “human skin disease”, with a higher search volume in rural compared to urban areas ($p = 0.012$). Search queries for “allergy” and “human skin diseases” displayed significant seasonality ($p > 0.001$ and $p = 0.002$, respectively). **Conclusion:** Future monitoring and assessment of this type of Google data for predefined regional areas could identify specific medical needs and provide timed and target-group-oriented medical care and information. These could be beneficial for affected people, their family members, physicians, and public health officials

Key words: skin disease, Google, web search data, rural, urban, seasonal variation

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Dermatological diseases are the fourth most common of all human diseases, affecting 30-70% of individuals worldwide at any time [1]. Over 3,000 skin or skin-related illnesses are known [2], varying in severity and symptoms, from benign tumours and self-limiting infections to malignant neoplasms and chronic inflammatory diseases [3].

Skin and subcutaneous diseases accounted for 57.4 million “disability adjusted life-years” globally in 2016 [4]; mainly a function of “years lost due to disability” (YLD) than due to mortality [4]. In 2017, skin and subcutaneous diseases caused 41.6 million YLD; for comparison, diabetes mellitus and migraine caused 38.5 million and 38.1 million YLD, respectively [5]. Despite the variety of skin and subcutaneous diseases, the burden of YLD is dominated by only a few skin conditions, including acne vulgaris, dermatitis (including atopic, seborrheic, and contact dermatitis), urticaria, psoriasis, viral skin diseases, fungal skin diseases, and scabies (each causing 1.7-9.3 million YLD) [6]. Nevertheless, the burden of skin diseases is a multidimensional concept, not only affecting the patients themselves but also their family members [7], whose needs so far have received very limited attention [8]. Additionally, many people

suffering from skin diseases do not seek professional medical healthcare, but rely on inadequate self-treatment instead [9, 10]; thus, it is challenging to examine people’s overall dermatological needs using conventional approaches, such as secondary health insurance data.

A rather unconventional method to assess the populations’ interest in different aspects of skin diseases is to analyse internet search volumes for “skin disease,” as the internet is a very frequently used source of health information [11]. Moreover, patients search the internet for issues and unmet medical needs which they do not typically want to discuss with their physician [12]. In Germany, over 90% of people use the internet [13], of whom 57% have searched for health information at least once [14]. The vast majority of Germans (89% to 95%) use Google as their primary search engine [15]. Previously, Google analysis was shown to provide broad insight into people’s interest in different medical subjects [16, 17]. Furthermore, Google data analysis has been valuable in revealing seasonal trends and allowing forecasts related to different diseases, including cancer and influenza [16, 17], and even showing regional differences, such as for skin cancer and pruritus-related search behaviour between large cities throughout Germany

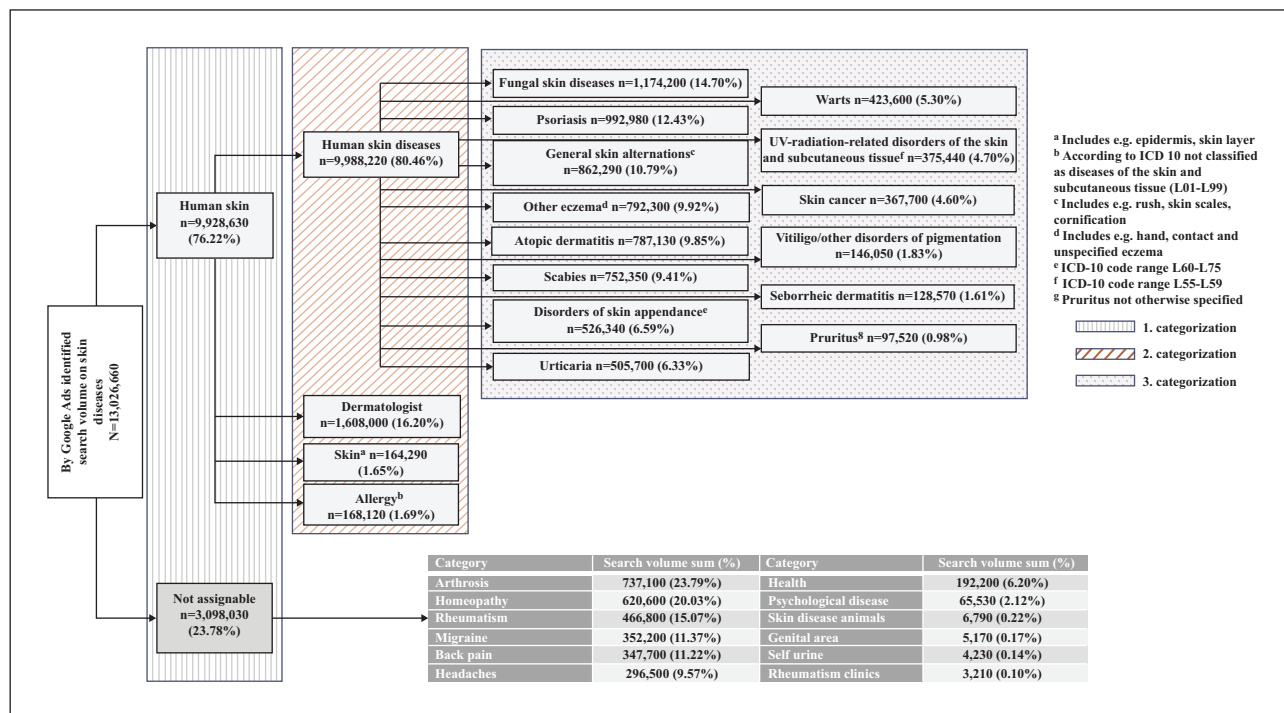


Figure 1. Categorization of the skin disease-related Google search volume queries for Bavaria, southern Germany, from June 2015 to May 2019 ($n = 13,026,660$).

[16]. However, dermatological diseases and their medical treatment also show differences on a smaller regional scale. For example, atopic dermatitis (AD) is diagnosed more often in urban than rural areas [18] and relevant data for skin cancer shows that increased distance from a place of diagnosis and living in rural areas result in a higher burden [19, 20]. According to the Association of Statutory Health Insurance Physicians of Bavaria, medical supplies are more available in urban than rural areas across Bavaria (Germany's geographically largest federal state, located in southern Germany) [21]. Therefore, to identify dermatological regional differences and seasonal variations as well as investigate whether regional factors influence search behaviour, this study examined Google search volume data in Bavaria in order to develop strategies to improve provision of adequate dermatological healthcare.

Materials and methods

Study design

A retrospective longitudinal study using Google Ads Keyword Planner (until 2018 named Google AdWords Keyword Planner) was conducted to identify search volumes of key words related to the German word for skin disease ("Hauterkrankungen") between June 2015 and May 2019 throughout Bavaria.

Although Google Ads is used primarily to detect key words for optimizing Google marketing campaigns, it can also be used for scientific purposes [16, 22]. Google Ads provides monthly search volume data, as estimated by Google. The search volume represents the total number of searches for

each key word identified based on the key word topic (herein "skin disease") [23].

Categorization

The authors screened and categorized all identified key words for Bavaria as a whole and for two regional groups (urban and rural areas; for details see *Regional comparison* below) in three steps (figure 1). Initially, two categories were formed based on the terms "human skin" and "not assignable"; terms not clearly related to human skin diseases were excluded from the analysis (e.g., "headaches" and "homeopathy"). Key words associated with "human skin" were subcategorized into "dermatologist" (e.g., "skin specialist"), "skin" (e.g., "epidermis"), "allergy" (according to ICD10, not classified as "diseases of the skin and subcutaneous tissue" [3], e.g., "hay fever"), and "human skin diseases" (Category 1). "Human skin diseases" was then subdivided into "psoriasis", "AD", "other eczema" (including hand, contact, and unspecified eczema), "fungal skin diseases", and 10 additional categories (Category 2) (figure 1).

Regional comparison

Fifty-three cities throughout Bavaria were chosen that were defined as a metropolis, regional centre, or upper centre to assess regional search behaviour (see *supplementary material*) [24].

Four so called "upper centres" (Dillingen an der Donau, Lauingen [Donau], Marktredwitz, and Wunsiedel) were excluded from the analyses as they lacked Google search volume data. According to the Bavarian Ministry of Economy, State Development and Energy (StMWi), the

remaining 49 cities were categorized as urban (21 cities) or rural areas (28 cities) (online Appendix) [24]. Urban areas included communities with percentage levels above the national average for: (1) population/employee density, (2) proportion of settlement and transport area of the community area in 2010, and/or (3) settlement and transport area development from 2000–2010. Neighbouring communities that also met the above criteria comprised >100,000 inhabitants. Rural areas included communities that did not fulfil these criteria [24].

Influencing factors

The degree of healthcare provision data (*i.e.*, ratio of target to actual number of physicians with respect to population) from the Association of Statutory Health Insurance Physicians of Bavaria [25] was used to determine whether there were correlations between the number of search queries and the number of dermatologists or general practitioners (GPs). In addition, correlations between searches and inhabitants' mean age, as well as sex, both taken from the Bavarian State Office for Statistics [26], were examined.

Seasonal variation

The monthly Google search volume data were summarized into seasons to assess seasonality (years under review: 2015 to 2019, each year from June to May). Seasons were defined according to conventional meteorological analysis for Central Europe, with winter encompassing December–February, spring March–May, summer June–August, and autumn September–November [1].

Statistical analysis

Descriptive data were generated for the identified key words for Bavaria and each of the regional groups. To assess differences in search behaviour between regional groups (search volume queries per 1,000 inhabitants) and seasons, the student's *t*-test and one-way analyses of variance (ANOVA) were used, respectively. The Pearson's correlation coefficient was used to assess relationships between the search queries and the above-mentioned influencing factors. A *p* value <0.05 was considered to be statistically significant. IBM SPSS (Version 26, IBM Corporation, Armonk, NY, USA) and Excel (Version 16.16.12) were used for statistical analyses.

Results

Google Ads Keyword Planner identified 999 key words for the German word for “skin diseases” in Bavaria, resulting in an overall search volume of 13,026,660 queries from June 2015 to May 2019. Of these, 23 key words were excluded from the final analysis as they were not assignable (*e.g.*, “homeopathy” and “animal skin diseases”) (*figure 1*). The remaining 976 key words were associated with an overall search volume of 9,928,630 queries (76.22%) and were subcategorized as follows: 1,6080,000 (16.20%) referred to “dermatologist”, 164,290 (1.65%) to “skin”, 168,120 (1.96%) to “allergy”, and 7,988,220 (80.46%) to “human

Table 1. Top 10 key words.

| Key word | Urban area ^a | Rural area ^a |
|----------------------------|-------------------------|-------------------------|
| Dermatologist ^b | 179 | 113 |
| Scabies | 90 | 91 |
| AD | 74 | 70 |
| Nail fungus | 67 | 65 |
| Urticaria | 60 | 60 |
| Foot fungus | 55 | 54 |
| Psoriasis ^c | 50 | 50 |
| Dermatologist ^d | 45 | |
| Skin cancer | 44 | 44 |
| Warts | 34 | |
| Psoriasis ^e | | 37 |
| Sun allergy | | 33 |

^aUrban areas include communities with percentage levels above the national average for: (1) population/employee density; (2) proportion of settlement and transport area within the community area in 2010; and/or (3) settlement and transport area development from 2000–2010. Neighbouring communities that also met the above criteria comprised >100,000 inhabitants. Rural areas include communities which do not fulfil these criteria.^bTranslated from the German word “hautarzt”^cTranslated from the German word “schuppenflechte”^dTranslated from the German word “dermatologist”^eTranslated from the German word “psoriasis”

skin disease”. The latter category was subdivided into 14 groups, including “psoriasis” (*n* = 992,980, 12.43%), “AD” (*n* = 787,130, 9.85%), and “fungal skin diseases” (*n* = 1,174,200, 14.70%) (*figure 1*).

Over the four years, the total search volume increased (*F* = 18.69; *p* < 0.001). Pairwise comparisons showed a significant annual increase in the mean number of search queries from the first to second and from the second to third year, but not from the third to fourth year.

The most commonly searched key words throughout Bavaria were “dermatologist” (*n* = 1,313,500), “scabies” (*n* = 750,400), “neurodermatitis” (*n* = 590,700), “nail fungus” (*n* = 554,900), and “urticaria” (*n* = 505,700) (*table 1*).

Regional comparison

As expected, the highest overall search volume was observed in the Bavarian urban area (*n* = 4,970,080), as this is the larger Bavarian regional group by population (urban: 3,473,272; rural: 1,005,679). However, the number of search queries per 1,000 inhabitants from June 2015 to May 2019 was higher in rural areas than urban areas (1,699 and 1,431 queries per 1,000 inhabitants, respectively), with significant differences in Years 2 and 4 (366.60 vs. 442.37, *p* = 0.026; 375.60 vs. 534.85, *p* = 0.005) (*figure 2*).

While a significant increase in search volume over the years was observed for rural areas (*F* = 21.64; *p* < 0.001), urban areas showed an increasing trend but no significant annual changes (*F* = 2.69; *p* = 0.058).

There were regional differences in searches between urban and rural areas for “human skin disease” (1204.70 vs. 1594.96, respectively; *p* = 0.012), “skin” (27.50 vs. 45.96, respectively; *p* < 0.001), and “allergy” (21.80 vs. 33.04, respectively; *p* < 0.001) (*table 2*). In contrast, “dermatologist” showed significantly more queries in urban compared to rural areas (171.70 vs. 137.33, respectively; *p* = 0.045).

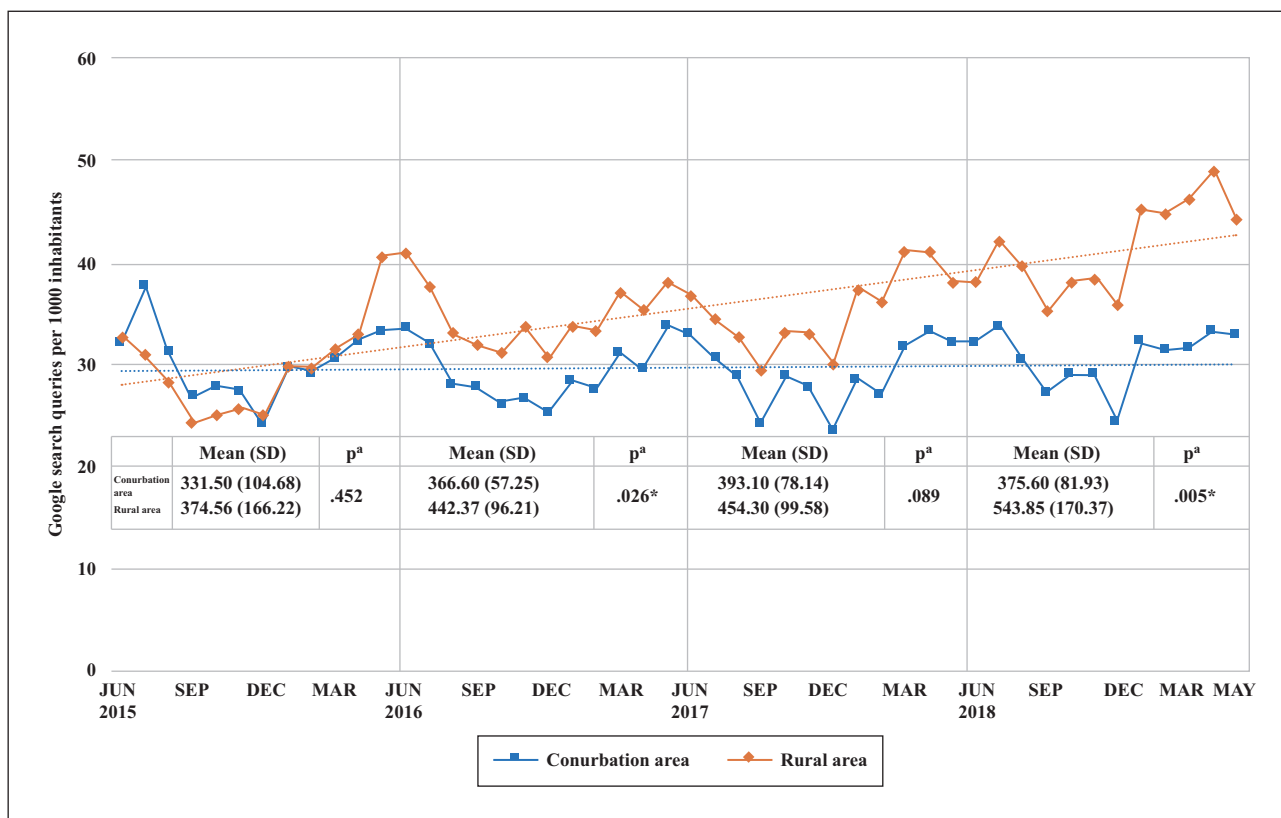


Figure 2. Trends in the number of Google search queries per 1,000 inhabitants based on human skin-related key words in urban and rural areas of Bavaria, southern Germany, from June 2015 to May 2019. Urban areas include communities with percentage levels above the national average for: (1) population/employee density; (2) proportion of settlement and transport area within the community area in 2010; and/or (3) settlement and transport area development from 2000–2010. Neighbouring communities that also met the above criteria comprised >100,000 inhabitants. Rural areas include communities which do not fulfil these criteria. SD: standard deviation

^aP values were determined using the student's t-test to assess differences in yearly search volume queries between urban and rural areas

*Significance at alpha 0.05.

There were significant differences in the six “human skin disease” subcategories. Overall, more queries per 1,000 inhabitants were seen in rural areas than urban areas for “atopic dermatitis” (128.50 vs. 175.22, respectively; $p=0.005$), “other eczema” (249.90 vs. 349.33, respectively; $p=0.003$), “psoriasis” (161.70 vs. 200.44, respectively; $p=0.036$), “UV-radiation-related disorders” (45.80 vs. 61.30, respectively; $p=0.009$), “pruritus” (16.60 vs. 33.33, respectively; $p<0.001$), and “vitiligo” (20.60 vs. 42.19, respectively; $p<0.001$) (see table 2).

Influencing factors

The inhabitants' mean age correlated negatively with the number of search queries per 1,000 inhabitants for “dermatologist” ($r=-0.366$; $p=0.026$), but positively with “allergy”, “skin”, and “human skin disease” ($r=0.467$; $p=0.004$, $r=0.394$; $p=0.015$, and $r=0.305$; $p=0.066$, respectively). However, there were weak, non-significant positive correlations between being female and each of the four categories. Provision of GPs and dermatologists negatively correlated with the number of search queries per 1,000 for “human skin disease” (GP: $r=-0.122$, dermatologist: $r=-0.214$), “allergy” (GP: $r=-0.129$, dermatologist:

$r=-0.246$), and “skin” (GP: $r=-0.060$, dermatologist: $r=-0.246$). The number of search queries per 1,000 for “dermatologist” correlated negatively with the number of GPs ($r=-0.245$), but positively with the number of dermatologists ($r=0.004$), both with weak, non-significant effects.

Seasonal variation

Overall search queries for “allergy” and “human skin diseases” revealed significant seasonality ($F=18.18$; $p<0.001$ and $F=5.98$; $p=0.002$, respectively), as did all individual disease categories (figure 3). The categories, “dermatologist” and “skin”, did not demonstrate any statistically significant seasonal variation ($F=1.02$; $p=0.392$ and $F=2.41$; $p=0.080$, respectively). As figure 3 shows, the overall category “human skin diseases” showed a search peak during spring (total search volume for spring from 2015–2019: $n=2,146,960$), as did “psoriasis” ($n=272,420$), “general skin alterations” ($n=244,400$), “atopic dermatitis” ($n=231,810$), “other eczema” ($n=215,200$), and “urticaria” ($n=140,000$). A search peak in winter was observed for “scabies” ($n=215,800$), “seborrheic dermatitis” ($n=34,650$), and “pruritus” ($n=25,450$), and in summer for “fungal

Table 2. Comparison of rural and urban areas across Bavaria, southern Germany, from June 2015 to May 2019, showing the most frequently searched key words and differences in human skin-related search behaviour per 1,000 inhabitants.

| Category | Key word | Area | Mean (SD) | <i>p</i> ^a |
|----------|----------------------------------|-------|------------------|-----------------------|
| 1 | Allergy | Urban | 21.80 (3.80) | <0.001* |
| | | Rural | 33.04 (10.23) | |
| | Dermatologist | Urban | 171.70 (70.25) | 0.045* |
| | | Rural | 137.33 (31.31) | |
| | Human skin disease | Urban | 1204.70 (255.74) | 0.012* |
| | | Rural | 1594.96 (434.28) | |
| 2 | Skin | Urban | 27.50 (6.31) | <0.001* |
| | | Rural | 45.96 (17.11) | |
| | AD | Urban | 128.50 (28.56) | 0.005* |
| | | Rural | 175.22 (46.15) | |
| | Eczema | Urban | 249.90 (69.99) | 0.003* |
| | | Rural | 349.33 (90.46) | |
| | Psoriasis | Urban | 161.70 (31.66) | 0.036* |
| | | Rural | 200.44 (52.48) | |
| | Scabies | Urban | 89.00 (22.41) | 0.873 |
| | | Rural | 90.78 (31.99) | |
| | Seborrheic dermatitis | Urban | 34.00 (32.45) | 0.303 |
| | | Rural | 26.93 (9.21) | |
| | Pruritus | Urban | 16.60 (4.86) | <0.001* |
| | | Rural | 33.33 (10.63) | |
| | Warts | Urban | 47.70 (11.18) | 0.442 |
| | | Rural | 51.22 (12.59) | |
| | UV-radiation-related disorders | Urban | 45.80 (8.73) | 0.009* |
| | | Rural | 61.30 (16.91) | |
| | Disorders of the skin appendages | Urban | 66.30 (14.48) | 0.216 |
| | | Rural | 75.93 (22.36) | |
| | Skin cancer | Urban | 42.90 (8.48) | 0.928 |
| | | Rural | 43.26 (11.38) | |
| | Urticaria | Urban | 59.60 (11.26) | 0.705 |
| | | Rural | 57.70 (14.12) | |
| | Fungal skin disease | Urban | 132.80 (33.47) | 0.654 |
| | | Rural | 138.70 (35.86) | |
| | Vitiligo | Urban | 20.60 (4.70) | <0.001* |
| | | Rural | 42.19 (16.51) | |

^a*P* values determined using the students *t*-test to assess differences in search volume queries per 1,000 inhabitants between urban and rural areas (**p*≤0.05).

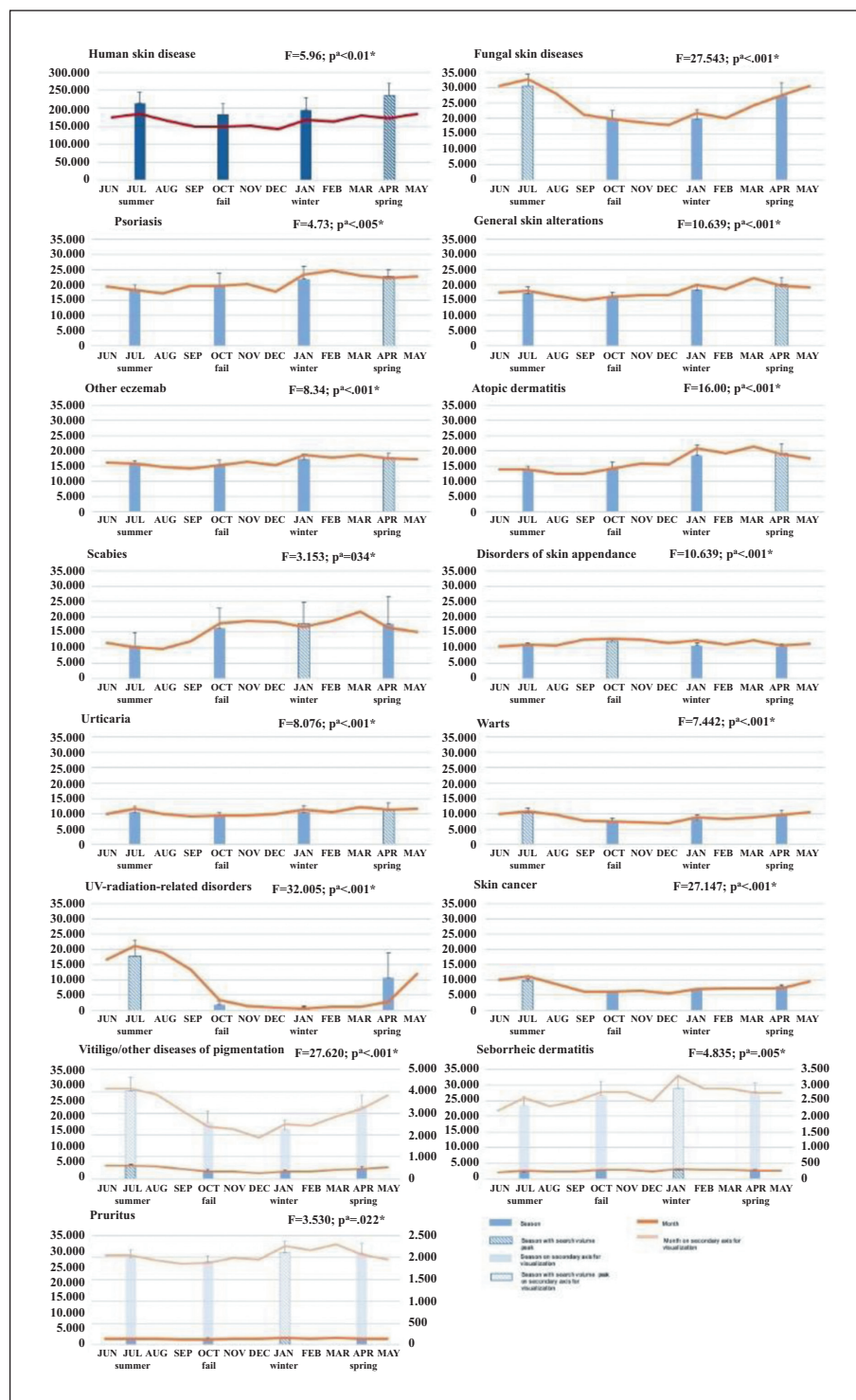


Figure 3. Mean number of Google search queries in each season and month for human skin disease categories in Bavaria, southern Germany across four years, from June 2015 to May 2019. European seasons were defined as winter (December to February), spring (March to May), summer (June to August), and autumn (September to November).

^aP values were determined using one-way analysis of variance (ANOVA) to assess differences in seasonal search volume queries

*Significance at alpha 0.05.

^bIncluding hand, contact, and non-specified eczema.

skin diseases" ($n = 366,400$), "UV-radiation-related disorders" ($n = 213,400$), "warts" ($n = 122,000$), "skin cancer" ($n = 117,800$), and "vitiligo" ($n = 48,480$). "Disorders of skin appearance" ($n = 145,580$) showed a search peak during autumn.

Discussion

From July 2015 to May 2019, 13,026,660 Google searches were performed for skin diseases throughout Bavaria, southern Germany, which provides substantial insight into the dermatological interest of the Bavarian population. The results appear to indicate a higher unmet dermatological demand in rural than urban areas. These findings are particularly important in order to provide adequate healthcare and gain useful population-based health information.

Among the 7,988,220 human skin disease-related search queries, fungal skin diseases, psoriasis, AD, and scabies were the most frequently searched specific diseases throughout the urban and rural areas. Thus, the data are in line with secondary data, as psoriasis, AD, and fungal skin diseases are among the most relevant dermatologist-diagnosed skin diseases throughout Germany [27, 28]. Moreover, there was an increase in diagnosis of scabies cases over recent years in Germany [29], which was also observed by Wu *et al.* who assessed scabies-related Google search volumes [30]. One explanation might be an increase in information-seeking behaviour because of a shortage of medical information, which could be due to a lack of GPs or dermatologists. However, further studies are necessary to evaluate whether a shortage of physicians in ambulatory care or other factors, such as low confidence in GPs' abilities [31], a lack of information due to a shorter length of consultation [12, 31, 32], or the role of "shared decision-making" [12], are responsible for the relevant Google search behaviour.

It is important to note that rural populations sought more allergy, skin, and human skin disease-related information on the internet compared to people living in urban areas in the present study. However, apart from vitiligo [33], these differences cannot be traced back to prevalence because these diseases are more prevalent in urban areas [18, 34, 35]. Although observed negative correlations between search volume and GPs or dermatologists were less evident, one can assume that the rural population sought more information on the internet because of lower GP and dermatologist density [25]. This is strengthened by reported dissatisfaction with hospital and specialist supply [36], reduced or delayed use of medical services such as skin cancer screening [19], and a higher proportion of people aged 65 years or older who suffer with more skin diseases [37] in rural areas throughout Germany. However, using the methodological options in Google Ads Keyword Planner, "rural area" in this study also included smaller cities located in areas defined as rural by the StMWi [24]. It is conceivable that when examining rural areas without cities, correlations and differences might be more significant because of even lower physician density and probably more search queries. Alternatively, effects might be similar or even weaker because of fewer search queries across rural areas resulting from a higher proportion of people aged 65 years or older (rural: 20.8%; urban: 19.6%) [37] and the existing digital divide

[38]. A decrease in the digital divide that has been achieved in recent years in Germany can, however, explain why the scale of search queries in rural and urban areas was similar during the first year considered, with increasing differences from 2016 (figure 2) [38].

As expected, considering previous findings [16, 22], the present analysis clearly shows that scientifically confirmed seasonal occurrence and diagnosis of skin disease [39, 40] are directly linked to relevant interest in a population, *e.g.*, as observed for UV radiation-related disorders (figure 3). For example, a marked observation was that every significant increase in scabies Google search volume was linked with a scabies onset in the corresponding area, such as in Aschaffenburg [41] and Cham [42]. This supports the notion that ongoing monitoring of specific Google search volume for infection, but also non-infectious (skin) diseases such as scabies [30] or melanoma [43], can be employed in the analysis, detection, and prediction of diseases and epidemics as well as the prediction of human behaviour with respect to certain health topics [44, 45].

The fact that key words were excluded from the analysis because they were not assignable to the topic of skin disease cannot simply be dismissed as an error by Google Ads Keyword Planner, but rather hint at the public's interest and needs. For example, skin diseases are reported to be treated homeopathically [46] and several human skin disease-related key words were merged with "homeopathy" as alternative therapies in the present analysis. Furthermore, skin alterations are widely recognized as side effects of migraine or headache medications [47].

Study limitations

It is plausible that several limitations may have influenced the reported results. The overall increase in search queries must be considered bearing in mind the increased Google market share (about 89% to 95%) [15] and the percentage of people using the internet to seek medical information [12], as well as the change in number of inhabitants from 2015 to 2019 [26]. However, this may not have affected regional differences, as no city included in the regional comparison was later allocated to another area during the time under review (*e.g.*, from rural to urban area due to population growth) [24]. Additionally, this might have no relevant effect on seasonal variation.

Even though 90% of the German population use the internet [13] and 89% to 95% of these users rely on Google as a search engine [15], younger age groups use the internet even more frequently [13].

Furthermore, it is not possible to fully assess the accuracy of the data, as monthly search volumes were based on estimates from Google algorithms, with no detailed information. Finally, people's search behaviour might be biased by automatic addition of search terms suggested by Google. Frequently searched terms might be more readily searched, while less frequently searched terms are neglected.

Conclusion

Google search term analysis was extremely useful in obtaining a broad overview of the Bavarian population's interest

in skin diseases. The present study allows reliable conclusions on seasonal and regional differences, showing more allergy and skin-related search queries per 1,000 inhabitants in rural than urban areas. The rural population may therefore have a higher demand for specific dermatological care. Moreover, the population's interest increased with seasonal and sudden occurrence of certain diseases, such as psoriasis and scabies. It is important to correctly place professional and reliable websites and online portals that provide information adjusted for both seasonal and regional differences, including information on regional medical healthcare providers, so that they acquire their target group at the right time, avoiding information overload. For this purpose, and to provide timed and target-group oriented medical care, the highly relevant interest in specific skin diseases reported here should be more closely investigated in future studies. ■

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References

- Hay RJ, Johns NE, Williams HC, *et al.* The global burden of skin disease in 2010: an analysis of the prevalence and impact of skin conditions. *J Invest Dermatol* 2014; 134: 1527-34.
- Segre JA. Epidermal barrier formation and recovery in skin disorders. *J Clin Invest* 2006; 116: 1150-8.
- ICD-10-GM Version 2019, Systematisches Verzeichnis, Internationale statistische Klassifikation der Krankheiten und verwandter Gesundheitsprobleme, 10. Revision, Stand: 21. September 2018. Deutsches Institut für Medizinische Dokumentation und Information (DIMDI) im Auftrag des Bundesministeriums für Gesundheit (BMG) unter Beteiligung der Arbeitsgruppe ICD des Kuratoriums für Fragen der Klassifikation im Gesundheitswesen (KKG), 2018.
- Hay SI, Abajobir AA, Abate KH, *et al.* Global, regional, and national disability-adjusted life-years (DALYs) for 333 diseases and injuries and healthy life expectancy (HALE) for 195 countries and territories, 1990-2016: a systematic analysis for the Global Burden of Disease Study 2016. *Lancet* 2017; 390: 1260-344.
- James SL, Abate D, Abate KH, *et al.* Global, regional, and national incidence, prevalence, and years lived with disability for 354 diseases and injuries for 195 countries and territories, 1990-2017: a systematic analysis for the Global Burden of Disease Study 2017. *Lancet* 2018; 392: 1789-858.
- Karimkhani C, Dellavalle RP, Coffeng LE, *et al.* Global skin disease morbidity and mortality: an update from the global burden of disease study 2013. *JAMA dermatology* 2017; 153: 406-12.
- Chren MM, Weinstock MA. Conceptual issues in measuring the burden of skin diseases. *J Invest Dermatol Symp Proc* 2004; 9: 97-100.
- Sampogna F, Finlay AY, Salek SS, *et al.* Measuring the impact of dermatological conditions on family and caregivers: a review of dermatology-specific instruments. *J Eur Acad Dermatol Venereol* 2017; 31: 1429-39.
- Tizek L, Schielein MC, Seifert F, Biedermann T, Bohner A, Zink A. Skin diseases are more common than we think: screening results of an unreferral population at the Munich Oktoberfest. *J Eur Acad Dermatol Venereol* 2019; 33: 1421-8.
- Basra MK, Shahruck M. Burden of skin diseases. *Expert Rev Pharmacoecon Outcomes Res* 2009; 9: 271-83.
- Amante DJ, Hogan TP, Pagoto SL, English TM, Lapane KL. Access to care and use of the Internet to search for health information: results from the US National Health Interview Survey. *J Med Internet Res* 2015; 17: e106.
- Haschke C, Grote Westrick M, Schwenk U. *Gesundheitsinfos Wer sucht, der findet - Patienten mit Dr. Google zufrieden. Daten, Analysen, Perspektiven*, 2018.
- Frees B, Koch W. ARD/ZDF-Onlinestudie 2018: Zuwachs bei medialer Internetnutzung und Kommunikation. *Media Perspektiven* 2018: 398-413.
- European Commission. *European citizens' digital health literacy*. Brussel, Belgium: European Union, 2015.
- Rabe L. *Marktanteil von Suchmaschinen bei der Desktop-Suche und bei der mobilen Suche in Deutschland Juli 2019*. Statista, 2019. Available at: <https://de.statista.com/statistik/daten/studie/301012/umfrage/marktanteile-der-suchmaschinen-und-marktanteile-mobile-suche/> (assessed on 12/03/2022).
- Ziehfreund S, Tizek L, Zink A. Web search data as health data?: Geographic differences, temporal trends, and topics of interest from internet search engine analyses in Germany. *Hautarzt* 2022; 73: 53-60.
- Mavragani A, Ochoa G, Tsagarakis KP. Assessing the methods, tools, and statistical approaches in google trends research: systematic review. *J Med Internet Res* 2018; 20: e270.
- Kowalska-Oledzka E, Czarnecka M, Baran A. Epidemiology of atopic dermatitis in Europe. *J Drug Assess* 2019; 8: 126-8.
- Stitzenberg KB, Thomas NE, Dalton K, *et al.* Distance to diagnosing provider as a measure of access for patients with melanoma. *Arch Dermatol* 2007; 143: 991-8.
- Tizek L, Schielein MC, Berger U, *et al.* Regional differences in medical needs and care for skin cancer across Bavaria: confronting the gap. *Eur J Dermatol* 2020.
- Kassenärztliche Vereinigung Bayern (KVB). *Versorgungsatlas - Analyse aus erster Hand*. Available from: <https://www.kvb.de/ueber-uns/versorgungsatlas/> (assessed on 12/03/2022).
- Wongvibulsin S, Khanna R, Kwatra SG. Anatomic localization and quantitative analysis of the burden of itch in the United States. *J Am Acad Dermatol* 2020; 82: 234-6.
- Google Ads Help. *What you need to know about online marketing - Using Google Ads for online marketing*. Available at: <https://support.google.com/google-ads/answer/6227565?hl=en> (assessed 09 Mar 2022).
- Bayerisches Staatsministerium für Wirtschaft Landesentwicklung und Energie. *Landesentwicklungsplan Bayern (LEP)*. 2018. Available from: https://www.landesentwicklung-bayern.de/fileadmin/user_upload/landesentwicklung/Dokumente/Instrumente/Landesentwicklungsprogramm/Verordnung_ueber_die_LEP-Teilfortschreibung_2018/180220_Verordnung.pdf (assessed on 12/12/2021).
- Gesundheitsdaten. Kassenärztliche Bundesvereinigung. *Versorgungsgrade in den Planungsbereichen Berlin, Germany*. Available from: <http://gesundheitsdaten.kbv.de/cms/html/17016.php>. (assessed on 09/12/2021).
- Bayerisches Landesamt für Statistik. *Einwohnerzahlen der Gemeinden, Kreise und Regierungsbezirke, Basis: Zensus 2011 2019*. Available from: https://www.statistik.bayern.de/statistik/gebiet_bevoelkerung/bevoelkerungsstand/index.html#link_2 (assessed 08/12/2021).
- Svensson A, Ofenloch RF, Bruze M, *et al.* Prevalence of skin disease in a population-based sample of adults from five European countries. *Br J Dermatol* 2018; 178: 1111-8.
- Ruhnke M, Groll AH, Mayser P, *et al.* Estimated burden of fungal infections in Germany. *Mycoses* 2015; 58(Suppl 5): 22-8.

29. Sunderkötter C, Aebischer A, Neufeld M, *et al.* Increase of scabies in Germany and development of resistant mites? Evidence and consequences. *J Dtsch Dermatol Ges* 2019; 17: 15-23.
30. Wu J, Tizek L, Rueth M, *et al.* The national burden of scabies in Germany: a population-based approach using Internet search engine data. *Infection* 2022; 50(4): 915-23.
31. Hansen H, Pohontsch NJ, Bole L, Schafer I, Scherer M. Regional variations of perceived problems in ambulatory care from the perspective of general practitioners and their patients - an exploratory focus group study in urban and rural regions of northern Germany. *BMC Fam Pract* 2017; 18: 68.
32. Irving G, Neves AL, Dambha-Miller H, *et al.* International variations in primary care physician consultation time: a systematic review of 67 countries. *BMJ Open* 2017; 7: e017902.
33. Kruger C, Schallreuter KU. A review of the worldwide prevalence of vitiligo in children/adolescents and adults. *Int J Dermatol* 2012; 51: 1206-12.
34. Schram ME, Tedja AM, Spijker R, Bos JD, Williams HC, Spuls PL. Is there a rural/urban gradient in the prevalence of eczema? A systematic review. *Br J Dermatol* 2010; 162: 964-73.
35. Von Ehrenstein OS, Von Mutius E, Illi S, Baumann L, Bohm O, von Kries R. Reduced risk of hay fever and asthma among children of farmers. *Clin Exp Allergy* 2000; 30: 187-93.
36. AOK Bundesverband. *Umfrage zeigt Relevanz der Gesundheit-sinfrastruktur. Stadt. Land. Gesund. Ergebnisse der forsa-Umfrage.* Available from: https://aok-bv.de/presse/pressemitteilungen/2019/index_21784.html (assessed on 15/02/2022).
37. Bayerisches Staatsministerium für Wirtschaft Landesentwicklung und Energie. *Landesentwicklung Bayern. Altersstruktur - aktuell (LEP-Gebiteskategorien, Regierungsbezirke, Regionen).* 2017. Available from: http://www.landentwicklung-bayern.de/fileadmin/user_upload/landesentwicklung/Dokumente_und_Cover/Raumbeobachtung/EE_Alterstruktur/Tab_1.4.1_Alterstruktur_der_BV_2017_nach_LEP-GK_RegBez_und_Reg_gde-scharf.pdf (assessed on 15/02/2022).
38. European Commission. *Index für die digitale Wirtschaft und Gesellschaft 2019 (DESI) - Länderbericht 2019 - Deutschland.* Available from: <https://ec.europa.eu/digital-single-market/en/scoreboard/germany> (assessed on 15/02/2022).
39. Alikhan A, Felsten LM, Daly M, Petronic-Rosic V. Vitiligo: a comprehensive overview Part I. Introduction, epidemiology, quality of life, diagnosis, differential diagnosis, associations, histopathology, etiology, and work-up. *J Am Acad Dermatol* 2011; 65: 473-91.
40. Hancox JG, Sheridan SC, Feldman SR, Fleischer AB Jr.. Seasonal variation of dermatologic disease in the USA: a study of office visits from 1990 to 1998. *Int J Dermatol* 2004; 43: 6-11.
41. Krätze: Zahlen steigen - So sieht es in unserer Region aus. 2018. Available from: <https://www.main-echo.de/ueberregional/politik/Kraetze-Zahlen-steigen-So-sieht-es-in-unserer-Region-aus;art4204,5503229> (assessed 15/02/2022).
42. Gesundheit. *Krätze-Fälle im Landkreis Cham.* Mittelbayerische. 2018. Available from: <https://www.mittelbayerische.de/aktuelles-nachrichten/kraetze-faelle-im-landkreis-cham-23669-art1609684.html> (assessed 15/02/2022).
43. Hopkins ZH, Secrest AM. Public health implications of google searches for sunscreen, sunburn, skin cancer, and melanoma in the United States. *Am J Health Promot* 2019; 33: 611-5.
44. Eysenbach G. Infodemiology and infoveillance: framework for an emerging set of public health informatics methods to analyze search, communication and publication behavior on the Internet. *J Med Internet Res* 2009; 11: e11.
45. Mavragani A. Infodemiology and infoveillance: scoping review. *J Med Internet Res* 2020; 22: e16206.
46. Rossi E, Picchi M, Bartoli P, Panozzo M, Cervino C, Nurra L. Homeopathic therapy in pediatric atopic diseases: short- and long-term results. *Homeopathy* 2016; 105: 217-24.
47. Wollenberg A, Howell MD, Guttman-Yassky E, *et al.* Treatment of atopic dermatitis with tralokinumab, an anti-IL-13 mAb. *J Allergy Clin Immunol* 2019; 143: 135-41.