Original Article

Disparities in Accessibility to Evidence-Based Breast Cancer Care Facilities by Rural and Urban Areas in Bavaria, Germany

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BACKGROUND: Breast cancer (BC), which is most common in elderly women, requires a multidisciplinary and continuous approach to care. With demographic changes, the number of patients with chronic diseases such as BC will increase. This trend will especially hit rural areas, where the majority of the elderly live, in terms of comprehensive health care. **METHODS:** Accessibility to several cancer facilities in Bavaria, Germany, was analyzed with a geographic information system. Facilities were identified from the national BC guideline and from 31 participants in a proof-of-concept study from the Breast Cancer Care for Patients With Metastatic Disease registry. The timeframe for accessibility was defined as 30 or 60 minutes for all population points. The collection of address information was performed with different sources (eg, a physician registry). Routine data from the German Census 2011 and the population-based Cancer Registry of Bavaria were linked at the district level. **RESULTS:** Females from urban areas (n = 2,938,991 [ie, total of females living in urban areas]) had a higher chance for predefined accessibility to the majority of analyzed facilities in comparison with females from rural areas (n = 3,385,813 [ie, total number of females living in rural areas]) with an odds ratio (OR) of 9.0 for cancer information counselling, an OR of 17.2 for a university hospital, and an OR of 7.2 for a psycho-oncologist. For (inpatient) rehabilitation centers (OR, 0.2) and genetic counselling (OR, 0.3), women from urban areas had lower odds of accessibility within 30 or 60 minutes. **CONCLUSIONS:** Disparities in accessibility between rural and urban areas exist in Bavaria. The identification of underserved areas can help to inform policymakers about disparities in comprehensive health care. Future strategies are needed to deliver high-quality health care to all inhabitants, regardless of residence. ***Cancer* 2021;127:2319-2332**.

KEYWORDS: accessibility, breast cancer, evidence-based medicine, geographic information science, health care service research.

INTRODUCTION

Breast cancer (BC) is one of the most common malignant neoplasia in women in Germany: approximately 70,000 incident cases occurred in 2016 with a mean age of 64 years at first diagnosis.[1-3] For treatment, an evidence- and consensus-based clinical guideline exists.[4,5] The guideline was developed by a multidisciplinary board representing the different disciplines involved in BC care (eg, gynecology and physiotherapy) throughout the different stages of care. In Germany, health care delivery is split into different sectors: inpatient care, rehabilitation, and outpatient care. This leads to substantial challenges in the continuous provision of high-quality care.[6] To overcome these challenges, initiatives such as disease management programs for chronically ill patients and the definition of health care priorities by national acts have been initiated.[7,8] Nennecke et al[9] investigated survival with the 10 most frequent cancer types between rural and urban areas in Germany. For their analysis, they used data from 11 cancer registries including 165,565 BC cases. The authors found that patients with BC who were 65 years old or older had better survival when they were living in urban areas versus rural areas.

With the development of the National Cancer Act, 13 priority goals were defined for guiding cancer care.[7] Goal 4 determines that high-quality care has to be offered to all patients with cancer, regardless of age, sex, ancestry, residence, or health insurance status. Identifying regional differences in the provision of adequate (ie, evidence- and consensus-based) cancer care can guide the delivery of health care for the entire population. Geographic information system (GIS) analysis

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is an effective tool for visualizing and analyzing health data combined with spatial information.[10] GIS analysis allows depicting travel times by foot, car, or public transportation to or from facilities of interest. Results may serve as an indicator on accessibility and help in identifying underserved regions. Through the linkage of routinely collected data (RCD), population subgroups with hampered access to health care facilities may be identified. Thus, policymakers can use this information to reallocate resources and to ensure equal access to health care for all residents. However, comprehensive data including these aspects are lacking for Germany. Because of demographic changes, including the aging of German society, BC cases will increase by 22% (per 100,000; crude rate) until 2050 (vs 2007).[11] This trend might especially be challenging for rural areas because of their higher proportion of elderly people. Moreover, a physician shortage might further aggravate the challenges of comprehensive care.[12,13]

The aim of our study was to identify areas with restricted access to nearest BC care facilities by using GIS-based (road) travel times linked with RCD from a statewide cancer registry and the German census. Bavaria was used as a model region for Germany because of its mainly rural character.

MATERIALS AND METHODS

Study Region and Model Disease

Bavaria lies in the southeast of Germany and is the largest territorial state. Bavaria comprises 96 districts, which can be categorized as rural or urban according to the Federal Office for Building and Regional Planning. The definition is based on population density and settlement structure characteristics (Supporting Data 1). Approximately 12.5 million inhabitants were registered in Bavaria (by May 9, 2011), with more than half (n = 6,687,938 [54%]) living in rural areas (Supporting Table 1). Females living in urban areas comprise n = 2,938,991 compared to those living in urban parts n = 3,385,813. With stratification by age groups, an advantage for rural areas versus urban ones can be seen in the <18-year age group (1,174,773 in rural areas [55%]) and in the 50- to 65-year age group (1,376,548 in rural areas [56%]). However, lower percentages of the 18- to 29-year age group (897,726 in rural areas [51%]) and the 30- to 49-year age group (1,907,852 in rural areas [52%]) live in rural regions (vs the rate of 54% based on all inhabitants). Moreover, 54% of all males and females are from rural areas.

Recommended Evidence-Based Breast Care Facilities

We searched the national guideline "Screening, Diagnosis, Therapy and Follow-Up Care for Breast Cancer" for recommended facilities.[4,5] Results from the proof-of-concept study of the Breast Cancer Care for Patients With Metastatic Disease (BRE-4-MED) registry were used to identify additional facilities for BC care. Results of the 3-month proof-of-concept study are described elsewhere.[14] Shortly, for the current analysis, we used information from 31 BRE-4-MED participants surveyed about their individual situation regarding access to several health care services ("no problem," "no access possible," or "not necessary"). In addition, patients could state facilities not mentioned in the BRE-4-MED questionnaire as free text. Finally, facilities from the guideline and those reported by patients were merged to identify overlaps (Fig. 1). A few recommendations, such as nutrition counselling, sports, integrative/complementary medicine, and contact person, were dropped because no standardized or accredited delivery of these services was stated in the guideline. Household aid was excluded from the analysis because this service demands availability more than accessibility (from a patient's point of view), and social services have been mandatory by law for all hospitals since October 2017. Nevertheless, services such as psychotherapy (not specialized for cancer) and geriatric assessment were also not further considered because these services are more essential for a non-BC population or can be delivered by any physician using a standardized screening instrument. Primary care was excluded because gynecologists in particular represent the major contact persons for BC evidence-based aftercare with respect to palpation examinations, sonography, and mammography.

Overall, 15 facilities were identified that covered all stages of care: prevention, acute care, rehabilitation/aftercare, and palliative care (Table 1).

Collection of Address Information

Address details were obtained from different sources such as the homepages of providers and contacts of scientific societies or professional associations. Data were extracted in an automated way if possible. More details on data extraction are given in the supporting material (Supporting Data 2). The whole process of data collection took place from 2018 to 2019.

Because the quality of the information was heterogeneous, we applied a statement to assess the risk of bias based on the following criteria: 1) the level of address information (street level vs postal code level) and 2) the comprehensiveness of the providers (missing data due to the extraction or source of information [eg, just 1 association screened] likely).

Accessibility

Criteria for the accessibility model were defined. The potential travel speed was calculated on the basis of the

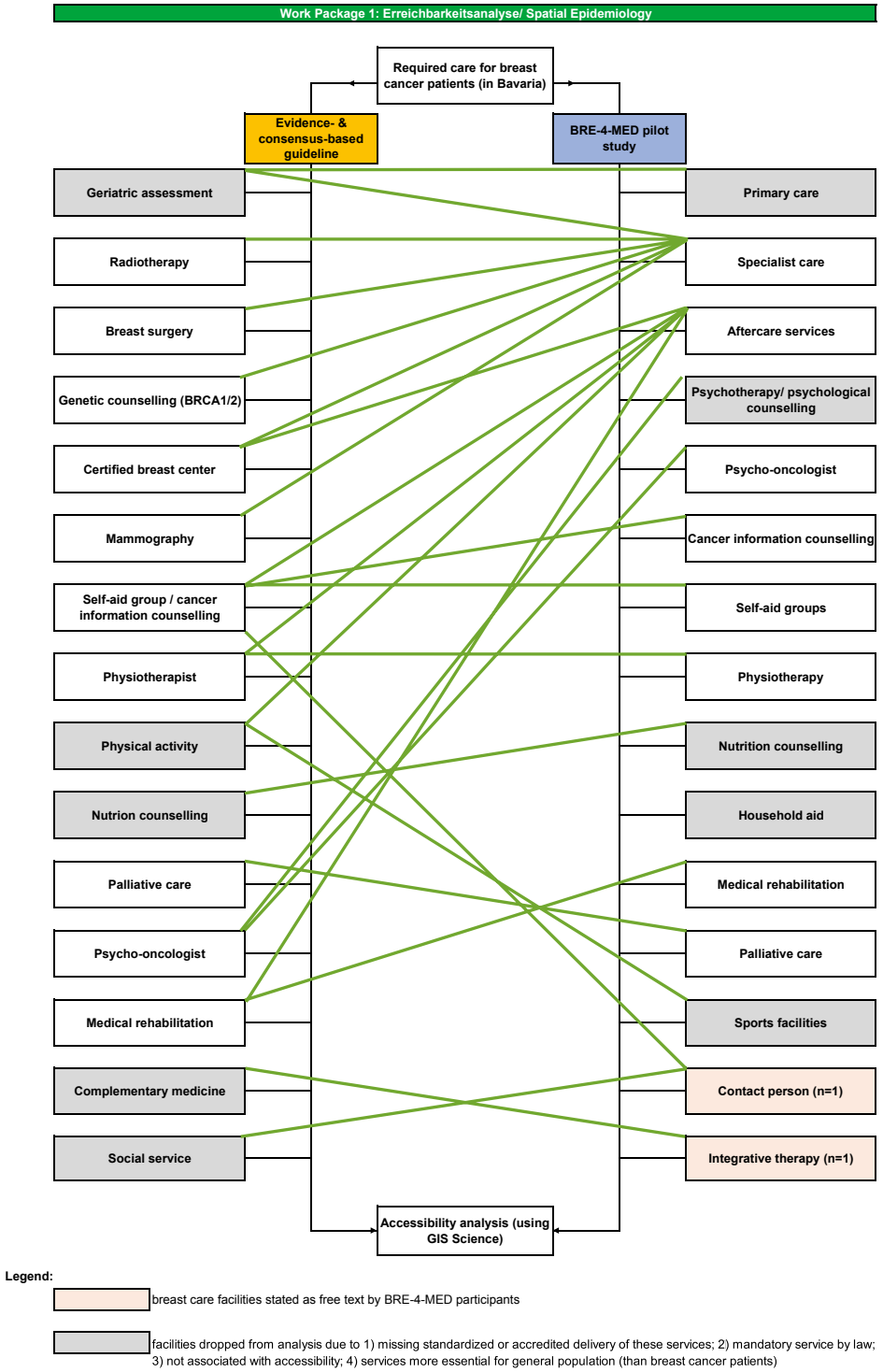

Figure 1. Comparison of health care facilities identified by the evidence-based guideline and facilities reported by participants of the BRE-4-MED registry. BRE-4-MED indicates Breast Cancer Care for Patients With Metastatic Disease; GIS, geographic information system.

street type (eg, motorway), speed limit, and surrounding population density as classified by the Federal Office for Building and Regional Planning.[15] For travel modality, only individual transportation was considered in our current study because patients with BC can get a prescription for taxi/shuttle service rides to medically

TABLE 1. Evidence-Based and Patient-Reported Health Care Facilities for Breast Cancer Care and Predefined Accessibility (in Minutes)

Accessibility	Health Care Facilities for Breast Cancer Care	Source of Information for Addresses	Health Care Sector	Information Bias[a]
Within 30 min	Certified breast care centers	Homepage: German Cancer Society (OncoMap), statutory health insurance	Prevention, acute, aftercare, palliative	Mild
	Cancer information counselling	German Cancer Society	Acute, aftercare	Mild
	Self-aid groups	Homepages of self-aid groups plus contact via newsletter of Bavarian Cancer Society	Acute, aftercare	Moderate
	(Inpatient) rehabilitation centers (with an indication for oncology)	Federal Office of Statistics	Rehabilitation	Mild
	Palliative care	Bavarian Ministry for Health and Care	Palliative	Mild
	University hospitals	Homepage	Prevention, acute, aftercare, palliative	Mild
	Radiotherapist	Statutory Health Physicians of Bavaria	Prevention, acute, aftercare	Moderate
	Urologist or andrologist	Statutory Health Physicians of Bavaria	Acute, aftercare	Moderate
	Psycho-oncologist	Homepage of the Cancer Information Service	Acute, aftercare	Moderate
	Physiotherapy	German Association of Physiotherapists	Acute, rehabilitation	Moderate
	Mammography screening	Homepage of central unit	Prevention	Moderate
	(Aftercare) mammography	Statutory Health Physicians of Bavaria	Acute, aftercare	Moderate
	Diagnostic assessment unit	Statutory Health Physicians of Bavaria	Acute, aftercare	Moderate
Within 60 min	Genetic counselling center	Statutory Health Physicians of Bavaria	Acute	Moderate
	Fertility and reproduction center	Homepages/professional societies	Acute, aftercare	Severe

[a]The risk of bias was estimated on the basis of extraction/collection challenges regarding missing data and the aggregation of addresses.

necessary treatments. Address information on single providers was obtained. Nevertheless, a short comparison of travel times (in minutes) between rural and urban areas with individual and public transportation is given in the supporting information (Supporting Table 3, Supporting Data 4, and Supporting Figs. 1 and 2).

In the context of regional planning, which is used by governments for strategic development for regions, the concept of central places is applied to organizing and promoting places.[16] Shortly, places are categorized as basic, middle, or regional centers on the basis of their minimum infrastructure, the minimum amount of inhabitants in their catchment area, and the reasonable accessibility of these centers from peripheral sites. For our GIS analysis, we transferred this concept to BC care. Facilities representing basic BC care should be accessible within 30 minutes. These facilities might also be needed by patients on a regular basis (eg, psycho-oncology); therefore, good accessibility should be mandatory in particular. For facilities mostly needed by a minority of patients with BC, a timeframe of 60 minutes was applied. All facilities with defined time frames and health care sectors are presented in Table 1.

Geographic Information System

The accessibility of health care facilities is a central instrument for an evaluation of the health care system. For our analysis, we used a street network from the free OpenStreetMap. The usage of OpenStreetMap has been demonstrated in similar research.[17,18] This type of analysis, using ESRI's ArcGIS, provides an evaluation of the temporal accessibility of each population point in the study. Visualization of the spatial conditions helps us to better understand the overall care situation. Although this is not always reality, we assumed that patients would choose the facility closest to their residential location.[17-20]

Data Linkage

RCD are raised for administrative or public health purposes and do not serve a priori research questions.[21] For our analysis, we used RCD from the German Census 2011 and the Bavarian Cancer Registry (BC incidence and prevalence), and we linked this information to GIS-based travel times.

German Census 2011

Information on population size, sex, and age strata were obtained from published aggregated data from the 2011 national census.[22] More information on the census is provided in the supporting material (Supporting Data 3). All census data were derived for our spatial analysis on a 100 m × 100 m level. Bavaria is split into 581,539 squares of 100 m × 100 m, which were used for our analysis. Because of data protection, squares with fewer than 3 inhabitants were rounded up to 3. Because of aggregation, no linkage between several variables was possible (eg, the number of females in each age group).

Bavarian Cancer Registry

Data on BC cases were drawn from the Bavarian Cancer Registry. This mandatory registry provides information on

a population-based level. Information on incidence and prevalence was derived at the district level. The latest data were available for the reference date: December 31, 2015. The completeness of cancer registration in Germany is assessed externally by the federal Robert Koch Institute. For women with BC in Bavaria, the completeness in 2015 has been estimated to be 96% with a death certificate only rate of 4% (cases registered by death certificate only).

Ethics Committee and Data Protection Approval

For the BRE-4-MED registry, ethical approval was obtained from the ethics committee of the University of Würzburg (245/17), the University of Heidelberg (S-223/2018), and the Physicians' Chamber of Baden-Württemberg (B-F-2018-034). Participants gave written informed consent. From the Bavarian Cancer Registry, only aggregated data were used. Thus, no formal ethics committee review or data protection approval was required. A declaration of no objection waiver by the ethics committee of the University Würzburg is available (No. 2019042402).

Statistical Analysis

A variable travel time by car, calculated with ArcGIS, was available in seconds for each 100 m × 100 m square and was transformed into minutes. Medians, minimums, and maximum times from residences to nearest facilities were calculated. We dichotomized the travel time for each facility by using the cutoffs for accessibility (yes or no: ≤30 vs >30 minutes or ≤60 vs >60 minutes; Table 1). Demographic information on the accessibility of every 100 m × 100 m square was aggregated at the district level. In case districts had both (accessible and nonaccessible parts), we calculated the percentage of females for each part and multiplied it by the number of BC cases (Supporting Table 1). To quantify and compare associations between the area of living (urban vs rural) and the accessibility of facilities, we calculated the odds ratios (ORs). ORs were restricted to females except for urologists/andrologists (restricted to males). The absolute difference in females (or males) with no accessibility between rural and urban areas was calculated ($n_{rural} - n_{urban}$). No statistical testing was performed because the high number of observations (n = 581,539) factually constituted the entire population, not only a random sample. Analyses were performed with SAS 9.4 for Windows.

RESULTS

Accessibility of Nearest Facility

The median travel times to BC facilities for urban and rural areas were in most cases within the predefined time frame (see Table 2). Only for rehabilitation (both types of areas) and university hospitals (rural areas) did the travel time exceed the 30-minute cutoff by 10 to 20 minutes.

The majority of females with access within 30 minutes were living in urban areas. The urban-rural gap (within 30 minutes) was especially pronounced for distances to university hospitals (2,120,419 in urban areas [34%] vs 443,468 in rural areas [7%]), cancer information counselling centers (CICCs; 2,705,842 in urban areas [43%] vs 1,906,698 in rural areas [30%]), and psycho-oncologists (2,751,319 in urban areas [44%] vs 2,276,230 in rural areas [36%]; Supporting Table 1). Odds for access to a CICC (within 30 minutes) were 9 times higher for females from urban regions versus those from rural parts of Bavaria (Table 2). Furthermore, access within 30 minutes to the nearest psycho-oncologist (OR, 7.2), university hospital (OR, 17.2), palliative care (OR, 16.7), mammography screening (OR, 26.6), and (aftercare) mammography (OR, 145.2) was also more likely for females living in urban areas versus rural areas. Absolute differences between females from rural and urban areas without accessibility quantifies this gap for the 3 services with the biggest discrepancies: university hospitals (2,123,773), CICCs (1,245,966), and psycho-oncology (921,911).

A reversing trend between urban and rural areas was found for rehabilitation (218,219 in urban areas [3%] vs 1,093,691 in rural areas [17%]) and genetic counselling (2,778,311 in urban areas [44%] vs 3,325,796 in rural areas [53%]) in favor of rural areas. Females living in urban areas had 70% decreased odds (OR for genetic counselling, 0.3) and 80% decreased odds (OR for rehabilitation, 0.2) for accessibility in comparison with females living in rural areas (Table 2).

Furthermore, no major differences in accessibility between areas were revealed for urologists/andrologists, physiotherapy, and fertility/reproduction centers. Five percent of all females (140,432 in urban areas [2%] and 167,282 in rural areas [3%]) were over the 60-minute cutoff for fertility/reproduction facilities (OR, 1.0). Even fewer females (<1%; or males [urologist]) had travel times over 30 minutes to the nearest urologist/andrologist or physiotherapist. Nevertheless, all of those were inhabitants of rural areas (the OR was not available because of a cell count of 0). Similar patterns were observed when we compared relative numbers estimated from the census as well as numbers of incident or prevalent BC patients from cancer registry data.

Figures 2 to 7 provide an overview of Bavaria-wide accessibility of all settlements for selected facilities. In

TABLE 2. Travel Times to Nearest Health Care Facilities (in Minutes) and Odds Ratios Regarding the Chance of Accessibility Within a Predefined Timeframe

Health Care Facilities for Breast Cancer Care	Travel Time, Median (Range), minutes		Odds Ratio[a]	Absolute Difference Between Females[b] From Rural and Urban Areas With No Accessibility ($n_{rural} - n_{urban}$)
	Urban	Rural		
Certified breast cancer centers	14 (0-54)	21 (0-81)	3.4	441,910
Cancer information counselling	17 (0-69)	29 (0-106)	9.0	1,245,966
Self-aid groups	11 (0-57)	15 (0-75)	3.9	168,512
(Inpatient) rehabilitation centers	51 (0-114)	40 (0-96)	0.2	–428,650
Palliative care (inpatient and outpatient)	10 (0-39)	14 (0-62)	16.7	75,898
University hospitals	27 (0-122)	54 (0-143)	17.2	2,123,773
Radiotherapist	13 (0-73)	21 (0-79)	3.7	494,047
Urologist or andrologist[b]	7 (0-29)	10 (0-43)	NA	10,888
Psycho-oncologist	14 (0-57)	25 (0-99)	7.2	921,911
Physiotherapy	3 (0-22)	6 (0-41)	NA	8
Mammography screening	11 (0-35)	14 (0-80)	26.6	120,180
(Aftercare) mammography	9 (0-32)	14 (0-60)	145.2	41,235
Diagnostical assessment unit	14 (0-54)	20 (0-81)	2.7	332,262
Genetic counselling center	17 (0-80)	27 (0-82)	0.3	–100,663
Fertility and reproduction center	21 (0-78)	35 (0-92)	1.0	26,850

Abbreviation: NA, not available (no observations in the denominator).
A minimum travel time of 0 minutes is given when the distance to the nearest (public) street (with driveways and so forth also considered as ways to the street) is identical for the facility of interest and the place of living (patient).
[a]Chance for accessibility (within a predefined time frame) for females living in urban areas versus females from rural areas (urologists/andrologists were calculated for males).
[b]Males: urologists/andrologists.

particular, accessibility to certified BC centers, university hospitals, CICCs, and psycho-oncologists in Bavaria was over 30 minutes in regions close to international and also national borders. This trend was strongly pronounced for university hospitals, which were located in cities far from international borders. In addition, CICCs were not accessible within 30 minutes for some regions close to the border. For certified BC centers, similar patterns could be seen. Nevertheless, some central regions also showed travel times above the predefined timeframe. Psycho-oncologists, as identified within our search, were accessible, especially within rural regions close to the Czech border. Still, regions in the south of Bavaria, close to the Austrian border, and in the north, close to Hesse and Thuringia, had long travel times to the nearest psycho-oncologist in Bavaria. The accessibility of inpatient rehabilitation centers (specialized for cancer) showed an inverse trend. In particular, more central regions had no access within 30 minutes. Mammography screening showed an almost Bavaria-wide coverage. Only a few settlements near Hesse or the Czech Republic had hampered access. Further information on key differences between Figures 2 to 7 is provided in Supporting Table 2.

DISCUSSION

To the best of our knowledge, this is the first comprehensive GIS analysis of the accessibility of various health care facilities in Germany using the largest territorial state, Bavaria, as a model region.

In the majority of the investigated evidence-based health care facilities for adequate BC care, we found a disadvantage for women living in rural regions versus urban regions; this was especially pronounced for psycho-oncologists and CICCs. The rural-urban gap in access to BC facilities was strongly pronounced for areas close to the border.

Demographic changes will shift the disease spectrum.[23] In particular, chronic diseases in the elderly requiring long-term care will increase.[11] Thus, strategic planning and the development of environments with comprehensive access to health care services are of major importance. Our analyses have revealed that rural regions, where the majority of the elderly live, are already facing challenges in accessibility (eg, psycho-oncologists).

A few earlier studies of distances to health care investigated an association between travel times and factors such as a later stage at diagnosis and found a relationship with worse outcomes, especially for people living in rural areas.[24-27] A GIS analysis based on data from the Study of Health in Pomerania population-based cohort found no statistically significant association between the spatial accessibility of family practitioners or gynecologists and the number of consultations for any reason by females surveyed.[28] However, the authors stated as a limitation that severe conditions (eg, chronic diseases), which might influence adherence and the number of consultations, were not assessed.

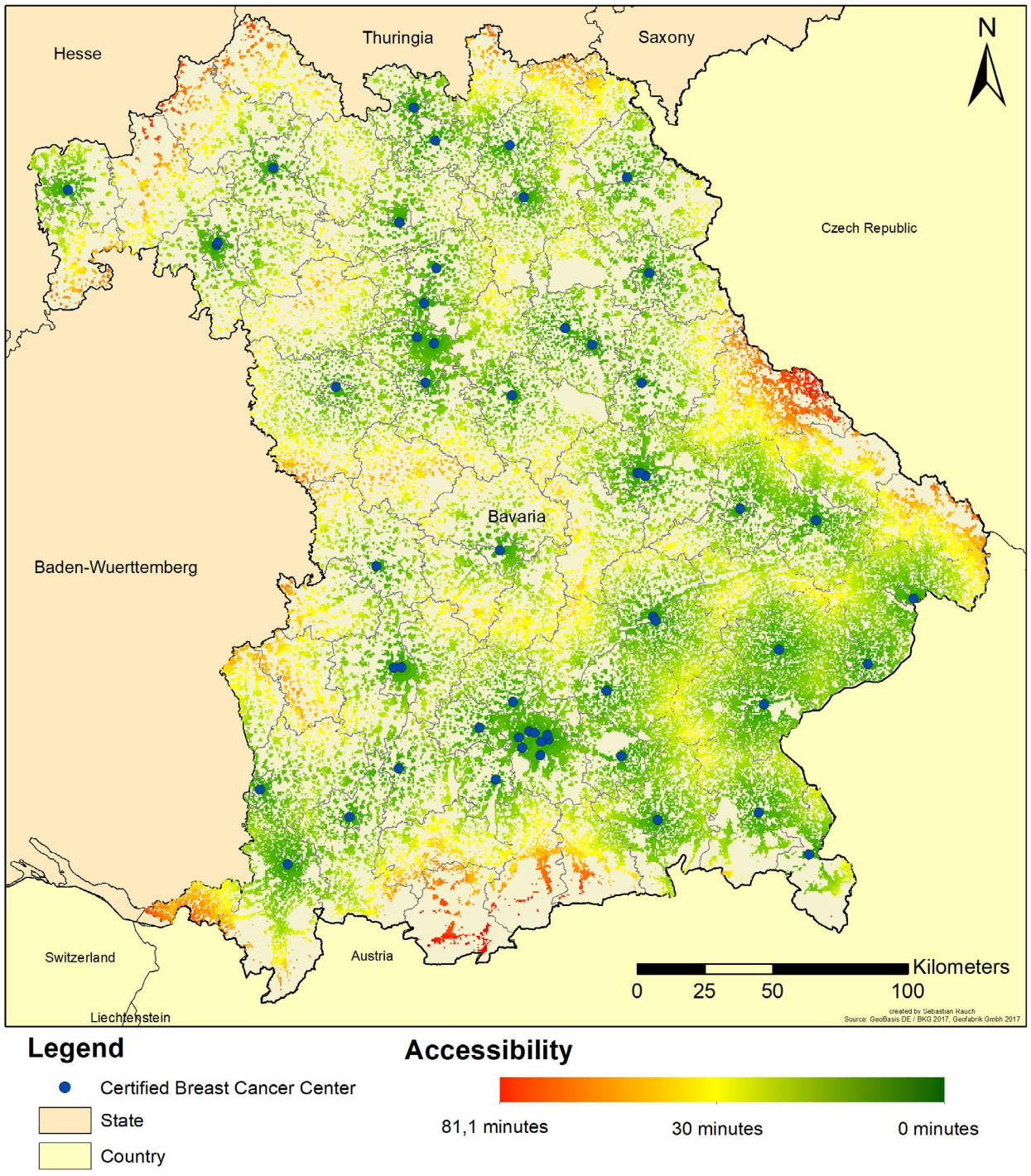

Figure 2. Accessibility of certified breast cancer centers in Bavaria, Germany.

Our findings indicate substantial disparities between rural and urban regions, especially for services such as psycho-oncology, university hospitals, palliative care, and CICCs. These facilities represent vital parts of the medical treatment and psychosocial well-being of patients with BC.[4,5,29] An undersupply of information or psychosocial services might lead to an increase in mental health issues when patients are not able to cope with their diagnosis.[30] A lack of expertise from university hospitals in terms of cutting-edge therapies might be

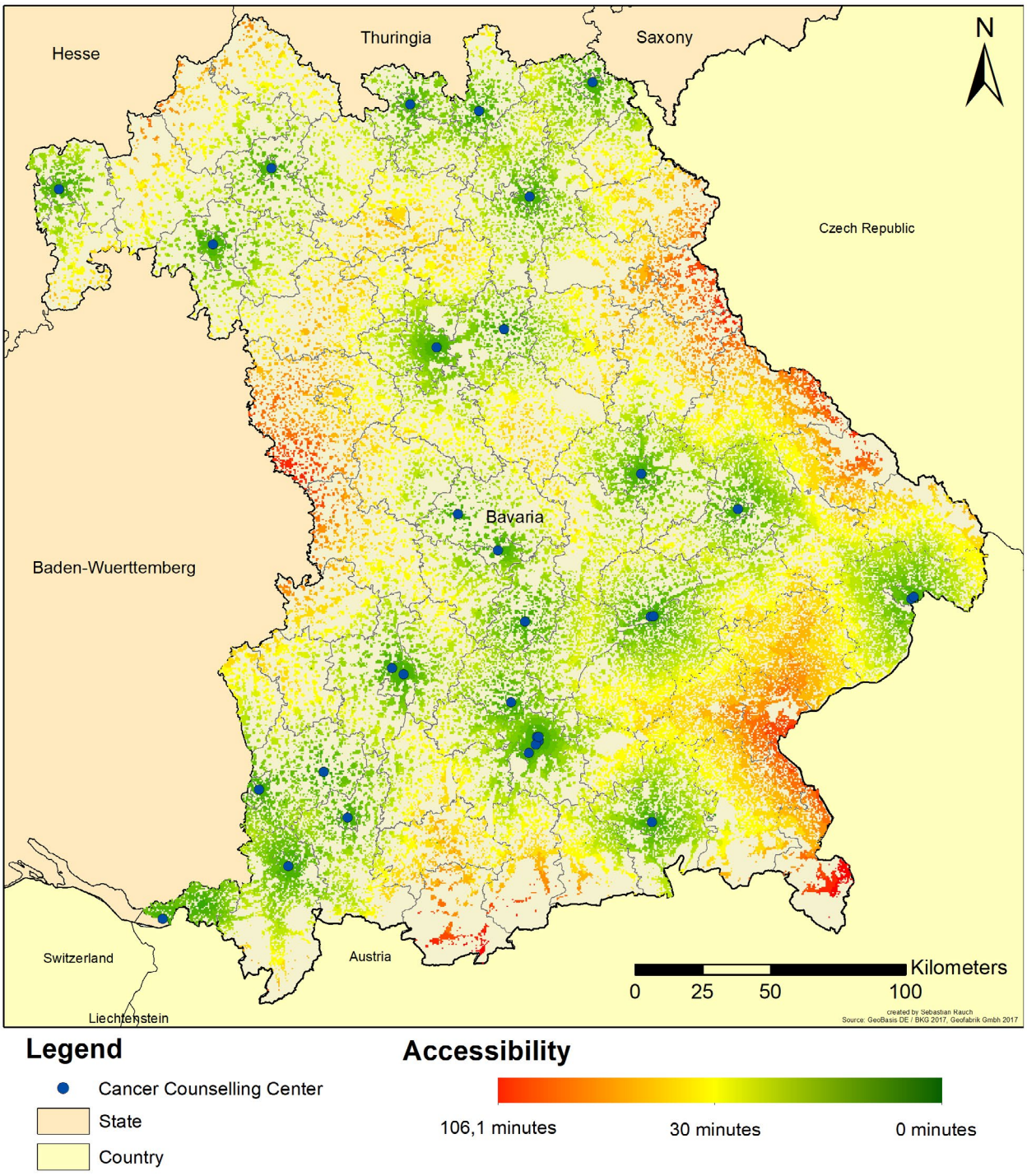

Figure 3. Accessibility of certified cancer information counselling in Bavaria, Germany.

associated with inadequate care. Furthermore, rehabilitation is often provided by inpatient centers, especially in rural areas. Nevertheless, providing rehabilitation in a community-based and integrated manner might help to overcome this sectoral and geographic separation. As mammography screening shows, a comprehensive distribution can be successfully organized on the basis of governmental requirements. Moreover, accessibility to CICCs might not represent a major public health issue because counselling is possible via phone or the internet.

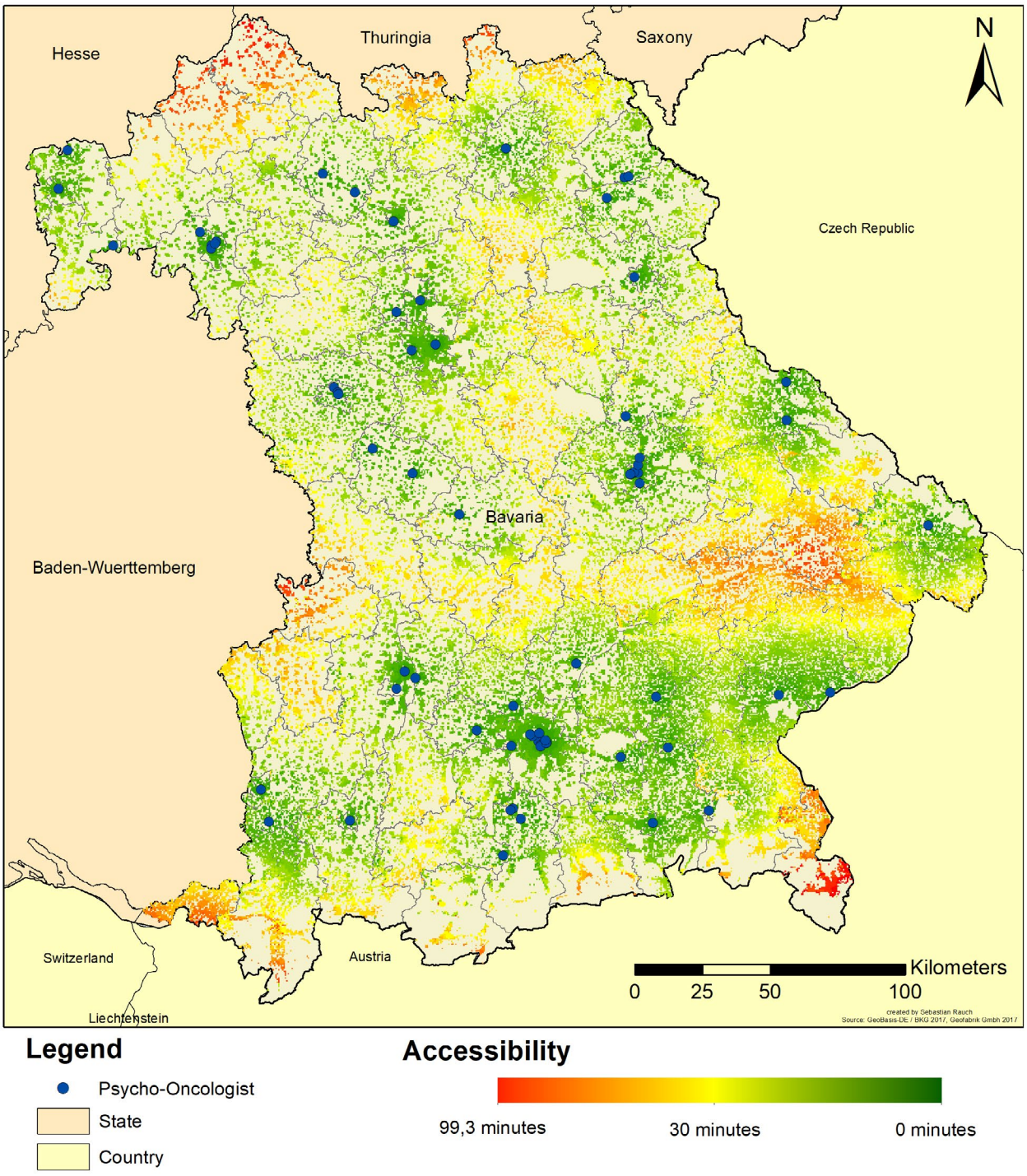

Figure 4. Accessibility of psycho-oncologists in Bavaria, Germany.

However, web-based information needs to be provided in an evidence-based and validated way.

We identified underserved areas mainly in rural regions close to the border. Initiatives to guarantee free movement in terms of health care between countries of the European Union have already been addressed: With directive 2011/24/EU of the European Parliament, a legal basis for patients seeking cross-border health care, including refunding of costs, was established.[31] Since then, several cooperatives in terms of shared health

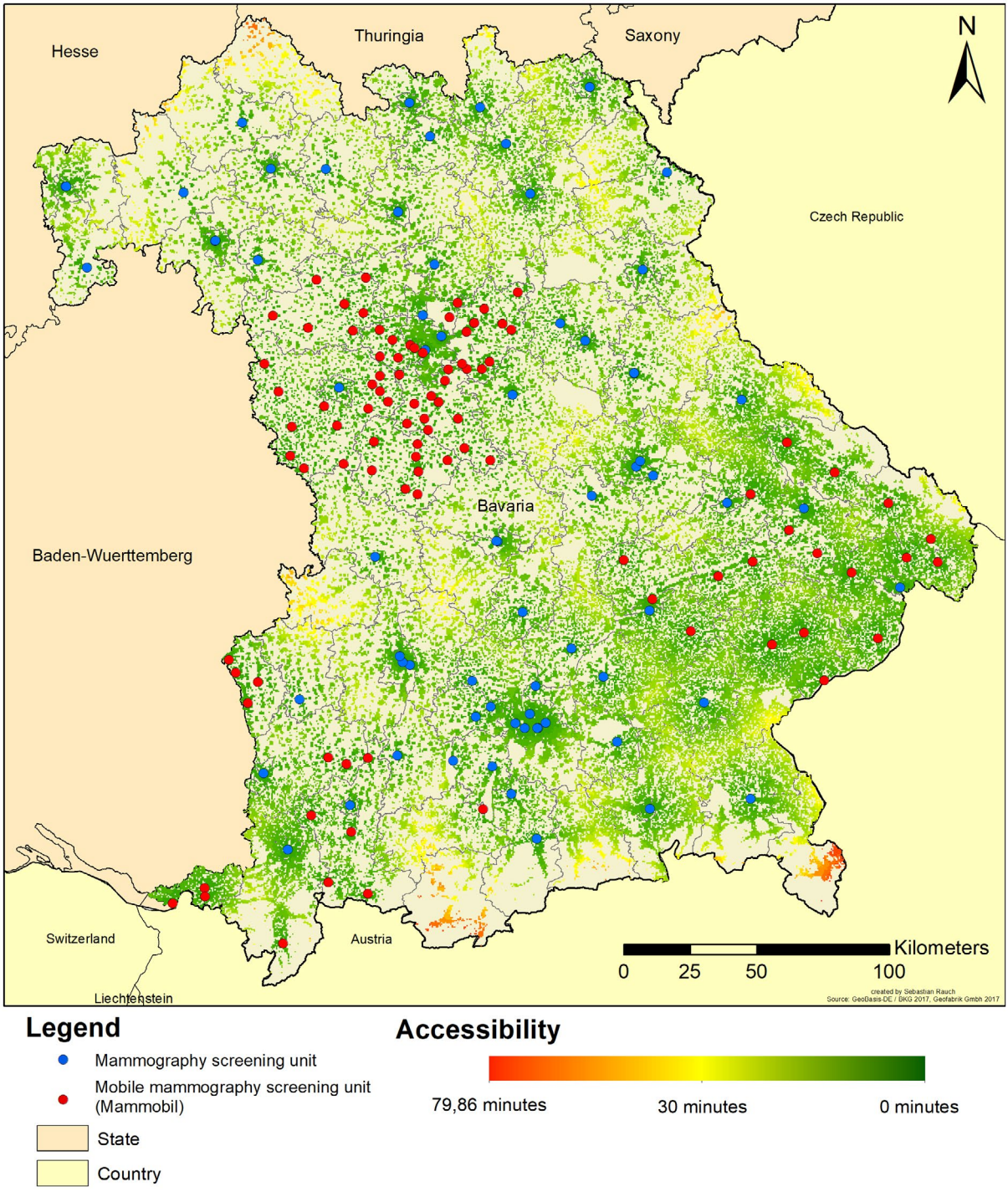

Figure 5. Accessibility of mammography screening units in Bavaria, Germany.

care facilities have been established. Studies on these projects indicate the success of international care but also a demand for close access to health care facilities.[32] A successful example of cross-border BC care was the German-Danish radiotherapy collaboration from 1998 to 2016.[33] With a trend to few but high-volume treatment centers in Denmark, distances to the next cancer care hospital increased for Danish patients. Through the initiative of a Danish patient with cancer living and working close to the German border, the first step for

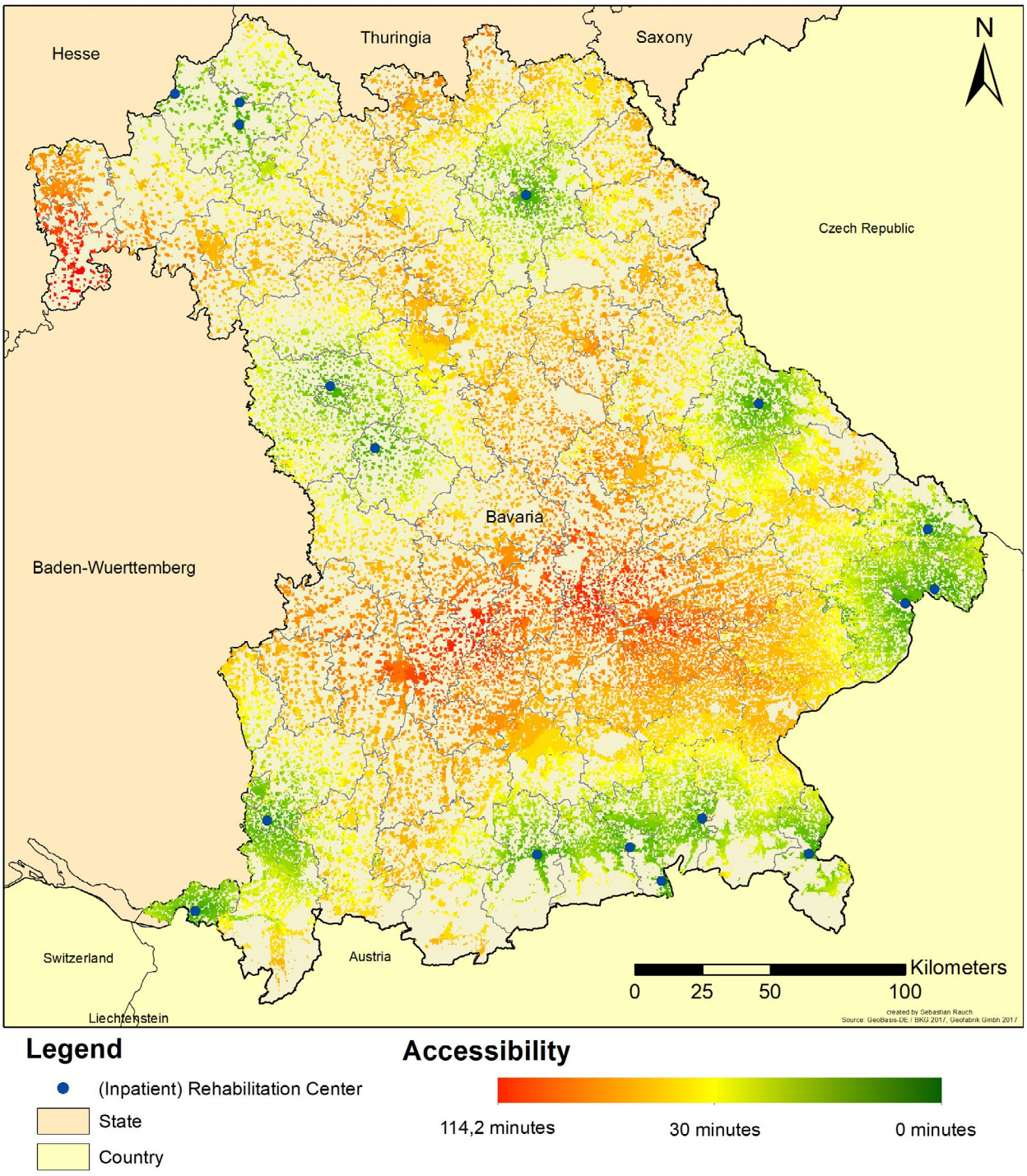

Figure 6. Accessibility of inpatient rehabilitation centers in Bavaria, Germany.

cross-border health care was taken. Since then, many Danish patients have chosen Flensburg for radiation. This example proves that sustainable collaborations depend on incentives and a legal framework provided by policymakers to overcome initial economic hurdles.

Another project on international and cross-border cancer treatment and research is Innovative High Technology Cancer Treatment Denmark-Germany (InnoCan) within the Interreg Deutschland-Denmark funded by the European Union.[34] This project shows

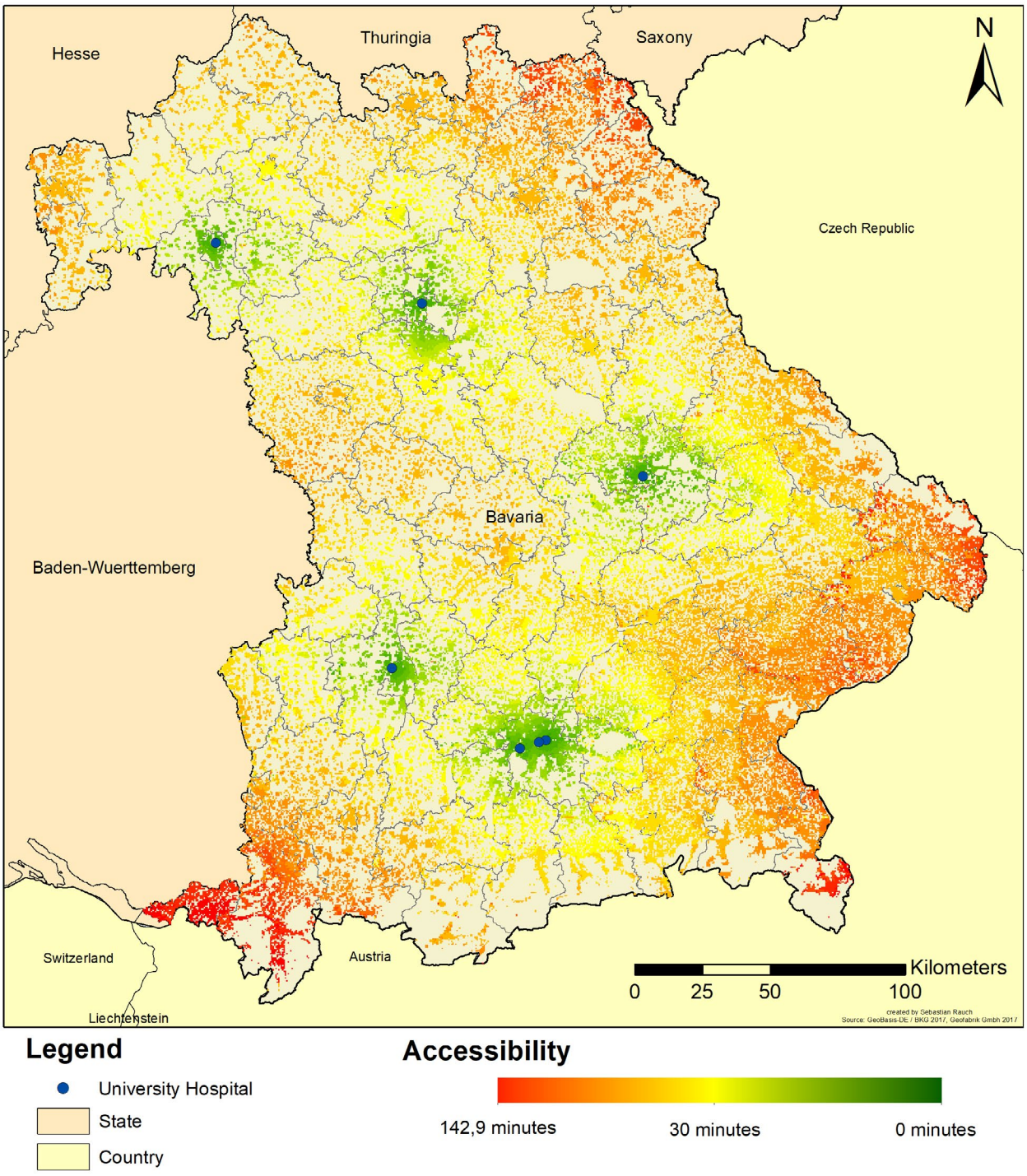

Figure 7. Accessibility of university hospitals in Bavaria, Germany.

how several facilities (eg, research, hospital, and cancer registry data) can be implemented and shared in a synergetic manner across international borders. In terms of Bavaria's border within Germany, we found regions in the northwest with hampered access. Because patients in all of Germany have a free choice of physician or therapist, this might not appear to be major problem if these facilities are provided in the neighboring state within a given travel time. This was not the aim of our study. Nevertheless, with an increase in patients with

BC and survivors, care should be delivered in an integrated and community-based manner to guarantee accessibility and coordinated long-term care, especially for complex BC cases.[35,36] Still, cross-border care could be provided in a collaborative and synergetic way between states with underserved regions close to the border.

Structural intervention is an effective tool for promoting a healthy environment by targeting the "context with which health is produced and reproduced."[37] We believe that if we address the accessibility of evidence-based and patient-reported facilities, underserved regions and populations can be identified, and the planning of interventions to overcome hurdles in accessibility for all citizens is possible. This takes into account the fact that, in terms of building healthy environments to bring adequate health care to the people (eg, via telemedicine or closer health facilities), place of living is a modifiable factor (by policymakers) in comparison with age, sex, and ancestry as addressed in the Nationaler Krebsplan (ie National Cancer Act).

An opportunity to overcome these regional discrepancies might be led by digitalization because connected hospitals can share expertise. Telemedical consultation might be especially beneficial for discussing complex BC cases or treatment options in case all evidence-based therapy lines are spent. Thus, knowledge from university hospitals is available quickly in all areas.

Strengths and Limitations

The main strengths of our study are that RCD were obtained from the German Census 2011 and the Bavarian Cancer Registry and that state-of-the-art GIS modeling was used. Thus, a valid quantification of people living in underserved areas, based on an estimated travel speed, was possible. Furthermore, the analysis was performed at a very detailed but also comprehensive spatial level, which allowed for customized travel times for each 100 m × 100 m square. This allowed drawing conclusions based on the whole area and population instead of a random sample.

However, there are also limitations. First, our study is limited by the fact that only aggregated data were available, and they also represented different years: 2011 and 2015. Thus, information on the number of females aged 65 years or older living in each square could not be directly extracted. Because of data protection, the number of people living in each square might also be overestimated slightly by rounding. Still, assuming that the sexes are distributed 50:50 in a population could help with the assessment of the female proportion of this age class. Because our analysis had less power for analyzing accessibility for several (BC-related) subgroups adequately, we put the focus on analyzing accessibility by place of living. This also takes into account that people moving might influence the current status quo. Furthermore, data from the cancer registries (or any other registry) might provide more information but at the cost of no fine spatial information (compared with census data available for each 100 m × 100 m unit). A restriction to adults (aged 18 years or older) is in general possible but only at the price of not being able to analyze females only. Because BC is especially frequent in women, we chose sex over age for calculating ORs. Second, address information was not always available (eg, mobile screening stations). Therefore, some travel times might not be representative for certain districts. Third, our study focused only on individual transportation. Further analyses concentrating on public transportation and surveying patients' mobility preferences are needed to draw a complete picture of accessibility to health care services. However, individual transportation might represent a best-case scenario because of lower travel times to the nearest health care facilities. Fourth, our analysis was based on information that was freely available via homepages or (online) documents. Some of those documents were very large (eg, a physician registry) and, therefore, automatically extracted. Other addresses were extractable only by a database query for single postal codes (eg, psycho-oncologists). Therefore, some facilities might have been missed. Moreover, some providers might not be registered within the searched databases. Nevertheless, patients depend on freely available information on the nearest health care facility, and our search might be representative of available knowledge. Fifth, some areas with hampered access might already have started initiatives to overcome these hurdles (eg, telemedical networks). Therefore, our analysis might underestimate accessibility for these regions.

In conclusion, our analysis has revealed that there is no statewide coverage in accessibility to several facilities and that disparities between rural and urban areas exist in a mainly rural federal state of southern Germany. Our findings can guide research focusing on underserved areas and inform policymakers about disparities at the district or state level regarding health care accessibility. Results can be used for developing and evaluating strategies to deliver high-quality health care to all inhabitants, regardless of residence (eg, by telemedicine or cross-border collaborations).

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CONFLICT OF INTEREST DISCLOSURES

Achim Wöckel reports membership in the certification commission for German breast cancer centers and is coordinator of the national guideline "Screening, Diagnosis, Therapy and Follow-Up Care of Breast Cancer" of the German Guideline Program in Oncology. The other authors made no disclosures.

AUTHOR CONTRIBUTIONS

Stephanie Stangl: Conception, analysis, interpretation of data, analysis of data, and drafting of the manuscript. **Sebastian Rauch:** Analysis, interpretation of data, and revision of the manuscript. **Jürgen Rauh:** Conception, interpretation of data, and revision of the manuscript. **Martin Meyer:** Interpretation of data and revision of the manuscript. **Jacqueline Müller-Nordhorn:** Interpretation of data and revision of the manuscript. **Manfred Wildner:** Interpretation of data and revision of the manuscript. **Achim Wöckel:** Conception, interpretation of data, and revision of the manuscript. **Peter U. Heuschmann:** Conception, interpretation of data, and revision of the manuscript. All authors read and approved the final version of the manuscript.

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