ORIGINAL ARTICLE

European Journal of Cancer Care WILEY

Access to paediatric oncology centres in Switzerland: Disparities across rural–urban and Swiss-foreigners cohorts

Sebastian Rauch[1] | Milenko Rakic[2] | Heinz Hengartner[3] | Bernice Elger[2] | Michael Rost[2] 🔗

[1]Institute of Geography and Geology, University of Würzburg, Würzburg, Germany

[2]Institute for Biomedical Ethics, University of Basel, Basel, Switzerland

[3]Children's Hospital of Eastern Switzerland, St. Gallen, Switzerland

Correspondence
Michael Rost, Institute for Biomedical Ethics, University of Basel, 4056, Bernoullistr. 28, 4056 Basel, Switzerland.
Email: michael.rost@unibas.ch

Abstract

Objective: In face of disparities in access to cancer care, it has been proposed to measure accessibility and to explore policy strategies for mitigating inequality of access. We aimed to determine the accessibility of Swiss paediatric oncology centres.

Methods: We employed spatial accessibility analysis, calculating driving time to nearest facility. Four data types were used: disaggregated population data, administrative data, street network data and addresses of centres. Besides analysing general accessibility, we compared access of urban versus rural areas and of Swiss citizens versus foreign residents and evaluated designating a new centre to improve accessibility.

Results: Overall, 97.4% could reach the nearest centre within 120 min (95.0% < 90 min, 86.5% < 60 min, 48.5% < 30 min). Accessibility could most effectively be improved by a new centre in Sion (city in the southwest of Switzerland). Access in urban areas was better than in rural areas. In urban areas, access of European Union/European Free Trade Association (EU/EFTA) and non-European residents was better than access of Swiss citizens and residents from non-EU European countries.

Conclusion: Access is satisfactory. However, our study presents high-resolution insights which could serve as points of leverage for policymakers to mitigate inequalities by designating a new centre and to evaluate potential benefits of centralisation.

KEYWORDS
accessibility, health disparities, location-allocation, paediatric oncology

1 | INTRODUCTION

Cancer is the leading disease-related cause of death in children in the World Health Organization European region (Kyu et al., 2018). In 2020, in the European Union age-standardised incidence rates of childhood cancer were 17.9 per 100,000 persons for boys and 16.5 for girls (European Commission, 2022). Besides disease burden, affected families continuously experience burden of treatment, for example, the disruptive effects of cancer treatment on their daily lives, working lives and social lives (Rost, Wangmo, et al., 2018). Burden of treatment is greater for families who live far from the specialised paediatric cancer centre (PCC), which are typically located in urban areas (Fluchel et al., 2014; Rost, Wangmo, et al., 2018), since given the many trips to the hospital longer travel times accumulate to a significantly higher

overall expenditure of time. In a Swiss sample of 193 children who died of cancer, almost one in three had a disease duration of at least 4 years, one in four spent at least 5 months in the hospital and one in five had more than 20 inpatient stays (Rost, Wangmo, et al., 2018). This circumstance points to the need to consider the relationship between place of residence and burden of treatment.

Similarly, a US-study revealed that nearly one in 10 parents of children with cancer had changed residence since diagnosis and that parents who lived rurally missed more days of work during the first month after diagnosis (Fluchel et al., 2014). Furthermore, in the United Kingdom's South West, where travel time to the nearest principal paediatric cancer treatment centre is more than 2 h, much of inpatient chemotherapy has been devolved to local hospitals (Pritchard-Jones et al., 2011). Lastly, hospital waiting time was a potent predictor of families' satisfaction with paediatric oncology care, highlighting the importance of time for overall satisfaction, including travel times (Davis et al., 2017). Evidence on challenges faced by families of children with cancer in rural areas revealed longer travel times to PCCs, longer time spent in community hospitals to receive emergent care, cancer care disparities, but no differences in survival rates (Bhatia et al., 2022; Delavar et al., 2019; Lemieux-Sarrasin et al., 2021; Walling et al., 2019).

In addition to the differences in access to healthcare between rural and urban areas, specific barriers to accessing healthcare were described for migrant populations in Switzerland. The latter exhibit higher rates of health problems and migrant children have distinct health needs (Jaeger et al., 2012; Swiss Federal Office of Public Health, 2013). In Switzerland, the proportion of permanent residents with foreign nationality has reached 26% in 2019 (Swiss Federal Statistical Office, 2020a). While the majority comes from European Union/European Free Trade Association (EU/EFTA) countries (65.9%; e.g., Italy 14.8%, Germany 14.1%), a significant minority comes from other continents (17.1%; e.g., Asia and Oceania 8.0%, Africa 6.4%) and non-EU European countries (17.0%; e.g., Kosovo 5.2%, Northern Macedonia 3.1%) (Swiss Federal Statistical Office, 2020a). For minor permanent residents, 27% of children younger than 15 years of age have a foreign nationality with a significant minority from the Balkans and a majority from EU countries (Swiss Federal Statistical Office, 2017b, 2018). The causes for specific barriers to healthcare access for some parts of the migrant population are attributed to migration-related factors (e.g., traumatic experiences), socio-economic situation (e.g., lower level of income and education), lack of knowledge and poor health literacy (e.g., limited knowledge of healthcare system) and the structuring of healthcare system (e.g., insufficient migrant orientation) (Gehri et al., 2016; Swiss Federal Office of Public Health, 2013). Lastly, it is known that asylum seekers and refugees face numerous practical barriers to access healthcare in Europe, including Switzerland (e.g., language, avoiding contact with authorities and lack of awareness of healthcare system), becoming even more complicated when expensive or long-term care is necessary (Human Network—Health for Undocumented Migrants and Asylum Seekers, 2009; Swiss Confederation—Federal Office of Public Health, 2011).

Regarding cancer care, a German study found lower utilisation of early cancer detection among migrants and concluded that this is not only due to socio-economic status and existing language barriers but also due to formal access barriers, such as travel distances (Klein & von dem Knesebeck, 2018). Similarly, a US-study demonstrated that the likelihood of referral to a paediatric oncology centre is influenced by distance to the centre, and a Swiss study showed that one in six children with cancer were not treated in a PCC (Adam et al., 2010; Albritton et al., 2007). Given the rarity and complexity of paediatric cancer, all countries are in need of PCCs, but at the same time face the challenge to centralise (i.e., high level care at specialised centres) and share care (i.e., specialist centres cooperate with local hospitals) to facilitate reasonable accessibility of care (Pritchard-Jones et al., 2011; van Goudoever, 2015). The extent of centralisation and devolution of care depends on, among others, geography and resulting travel times (Pritchard-Jones et al., 2011). In face of disparities in access to cancer care, it has been proposed to (1) measure accessibility of cancer care; (2) examine associations of accessibility, utilisation, and cancer outcomes; and (3) explore policy strategies for mitigating inequality of access across both geographic areas and racialised populations (Wang & Onega, 2015). Thus, by employing spatial accessibility analysis (SAA), we aim to determine the accessibility of PCCs in Switzerland, to compare access of urban versus rural areas and of Swiss citizens versus foreign residents and asylum seekers (i.e., people who have filed an asylum application in Switzerland), and to evaluate designating a new PCC to improve accessibility.

2 | METHODS

2.1 | Accessibility of healthcare

Accessibility to healthcare describes how well care can be accessed and has spatial (i.e., spatial separation between supply and demand) and non-spatial dimensions (i.e., demographic and socio-economic variables) (Khan, 1992). One measure of spatial accessibility of healthcare is distance or travel time to nearest care provider, usually from a patient's residence or a spatial raster-cell centroid (Guagliardo, 2004). Although numerous deeper methods provide useful approaches that go beyond a simple static, one-dimensional view (e.g., 2SFCA approaches), analysis of spatial resistance (time and distance) proves to be an efficient evaluation tool for spatial care (Neutens, 2015). Typically, the statistic-based strategies model the spatial separation between places (e.g., PCCs) and people (e.g., families of children with cancer) analysing distance or time. The aim is to improve accessibility of healthcare and to mitigate inequalities (Wang & Onega, 2015).

2.2 | Swiss paediatric oncology setting

In Switzerland, there are 10 PCCs (Map 1), nine as part of the Swiss Paediatric Oncology Group (Aarau, Basel, Bellinzona, Bern, Geneva, Lausanne, Lucerne, St. Gallen, Zurich) and one additional (Chur). All

PCCs provide care along the entire cancer trajectory (e.g., diagnosis, chemotherapy, radiotherapy, cancer surgery, palliative care and follow-up care). Between 2009 and 2018, 3.505 children were diagnosed with cancer (351/year; leukaemias: 31.8%, lymphomas: 11.6%, CNS: 21.4%), of whom 10.7% had foreign nationalities; age-standardised incidence was 17.3 per 100,000 person-years (Swiss Childhood Cancer Registry, 2019). In principle, cancer care is covered by the obligatory basic health-insurance.

2.3 | Data sources and ethical considerations

We obtained the following data: (1) disaggregated population data (i.e., 100 × 100 m raster cells) from 2020 from the Swiss Federal Statistical Office containing information on age-group composition of the resident population to spatialise the researched population (Swiss Federal Statistical Office, 2020c); (2) administrative data from the Swiss Federal Office of Topography to spatialise rural (i.e., exclusively rural), intermediate (i.e., both urban and rural parts) and urban (i.e., exclusively urban) areas (Swiss Federal Statistical Office, 2017a, 2020b)[1]; (3) street network data from OpenStreetMap (2022) to which traffic-related car travel speeds were assigned (OpenStreetMap); and (4) addresses of PCCs (March 2022). Data suitability has been demonstrated in comparable research (Haesen et al., 2021; Rauch & Rauh, 2016; Stangl et al., 2021). Actual population of analysed areas (i.e., urban, intermediate, rural and entire Switzerland) broken down by nationalities (i.e., Swiss, EU/EFTA, non-EU Europe, non-European and total population) are presented in Table 1: 63% of Swiss population live in urban, 22% in intermediate and 15% in rural areas. Since we exclusively worked with anonymous and aggregated data, ethical approval was not needed.

2.4 | SAA

Using ArcGIS Pro, we analysed Swiss population's access to PCCs with the variable of interest being car travel time. We included all 100 × 100 m raster cells in which at least one child or adolescent (0–19 years) resides, resulting in 231,441 raster cells with 1.73 million children and adolescents. Analysis was limited to these raster cells,

since PCCs exclusively provide care for this age group, and to individual car transportation, since we knew from previous own and other research that families mostly use private cars (Fluchel et al., 2014; Rost, Acheson, et al., 2018; Rost et al., 2020). There are no administrative barriers to families' access to PCCs, that is, families can choose a PCC and also go to other cantons (federal states) to receive paediatric oncology care. Additionally, we performed two subanalyses. First, we compared access in rural, intermediate and urban areas, as categorised by the Swiss Federal Statistical Office (2014). Second, we compared Swiss citizens' versus foreign residents' access to PPCs.

To create the routable network, we used an approach for OpenStreetMap data, based on maximum speeds (V_{max}) and surrounding population density (Bundesinstitut für Bau- Stadt- und Raumforschung im Bundesamt für Bauwesen und Raumordnung, 2019; Rauch et al., 2021). OSM has large gaps in the presentation of V_{max} in Switzerland (approx. 89% of the max. speeds are unknown). To obtain a complete data set, we first divided all roads into their individual segments. In a second step, these fragments were additionally assigned the information of the location of a road with the help of Landcover data (CORINE). In a third step, administrative data were used to classify the roads into in-town and out-of-town. Finally, we checked which speed usually exists for the respective attribute combination and assigned it to unknown values. For each road segment, the following function (Fu1) was used.

(Fu1)

$$v = V_{max} * cfa * \left(1 - \frac{\text{Population density within a 1 km radius}}{k}\right)$$

k is either 5000 for highways and highway-like segments or 10,000 for all other types. The space-dependent constant parameter cfa is set at 0.85, as suggested for scenarios like in the used study area (Schwarze & Spiekermann, 2018).

Street network was combined with the 100 × 100 m population data (i.e., age), enabling us to analyse accessibility on a fine spatial resolution. We used two approaches to model accessibility, both resting on the nearest centre hypothesis (choosing the closest PCC) (Neumeier, 2016; Rauch & Rauh, 2016). First, based on streetmap data, we calculated time needed from each raster cell's centroid to the closest of the 10 PCCs, resulting in an overall accessibility matrix.

TABLE 1 Population statistics of analysed areas—absolute and relative numbers

	Urban	Intermediate	Rural	Switzerland
Total population	5.459.871 (63.0%)	1.892.586 (21.8%)	1.317.843 (15.2%)	8.670.300 (100%)
Swiss citizens	3.816.213 (44.0%)	1.555.119 (17.9%)	1.088.180 (12.6%)	6.459.512 (74.5%)
Foreign residents total	1.643.658 (19.0%)	337.467 (3.9%)	229.663 (2.6%)	2.210.788 (25.5%)
EU/EFTA	1.017.680 (11.7%)	239.168 (2.8%)	161.517 (1.9%)	1.418.365 (16.4%)
Non-EU Europe (incl. GB)	316.924 (3.7%)	54.820 (0.6%)	41.814 (0.5%)	413.558 (4.8%)
Non-European	309.054 (3.6%)	43.479 (0.5%)	26.332 (0.3%)	378.865 (4.4%)

Note: Rounded to first decimal and thus percentages can add up to more than 100%.
Abbreviations: EU/EFTA, European Union/European Free Trade Association; GB, Great Britain.

Second, isochronic values were set to determine areas in which a person could reach a PCC within the time thresholds of 30, 60, 90 and 120 min (Fluchel et al., 2014; Pritchard-Jones et al., 2011; van Goudoever, 2015). The resulting catchment areas indicate varying degrees of accessibility and allow to identify areas with (in)sufficient access. It has to be noted that acceptability and impact of various travel times depend, among others, on the point in the cancer trajectory (e.g., during inpatient stays families have to travel more frequently to the hospital to visit the child as compared to follow-up care). We did not perform a demand-responsive analysis of accessibility, that is, calculating accessibility conditional on Swiss children's actual needs of cancer care, but analysed in-principle accessibility of PCCs.

2.5 | Location-allocation modelling

Location-allocation models use two essential elements for location problems: (1) multiple facility location options are considered and (2) the allocation of services provided by those facilities to the sides of demand (Church & Medrano, 2018). Therefore, these models can assist healthcare planning in an appropriate manner. The analysis can support decision-making processes for openings, closings and redistributions, considering a variety of factors (Mestre et al., 2015). Designating (or building) new facilities is one way to improve access and minimise inequality (Wang & Onega, 2015). Thus, aiming to determine

the location of one additional PCC that most effectively improves overall accessibility of PCCs, we employed location-allocation analysis (ArcGis Desktop, 2022). Several calculation methods have been developed in the past (Church & Murray, 2009). We selected the 'minimize impedance' type provided by ArcGIS Pro, which locates facilities (e.g., PCCs) in a way that the sum of all weighted costs (i.e., travel times weighted by the number of children residing in the respective raster cell) between demand points (i.e., raster cells) and solution facilities (i.e., PCCs) is minimised. For this purpose, we designated numerous candidate facilities for one additional PCC, namely, 20 already existing children's hospitals (certified as training centres by the Swiss Institute for Continuing Medical Education and Training) that currently do not provide paediatric oncology care (Swiss Institute for Continuing Medical Education and Training, 2022). Employing the methods described above, the impact of the best mitigation scenario was quantified by estimating improved accessibility.

2.6 | Statistical analysis

Quantitative data of SAA were exported from ArcGIS to SPSS.28. We employed descriptive statistical analyses to better understand accessibility of PCCs and visualised findings to illustrate the spatial dimensions of accessibility. Since travel times represent the entire population of the respective area, inferential statistics are not applicable.
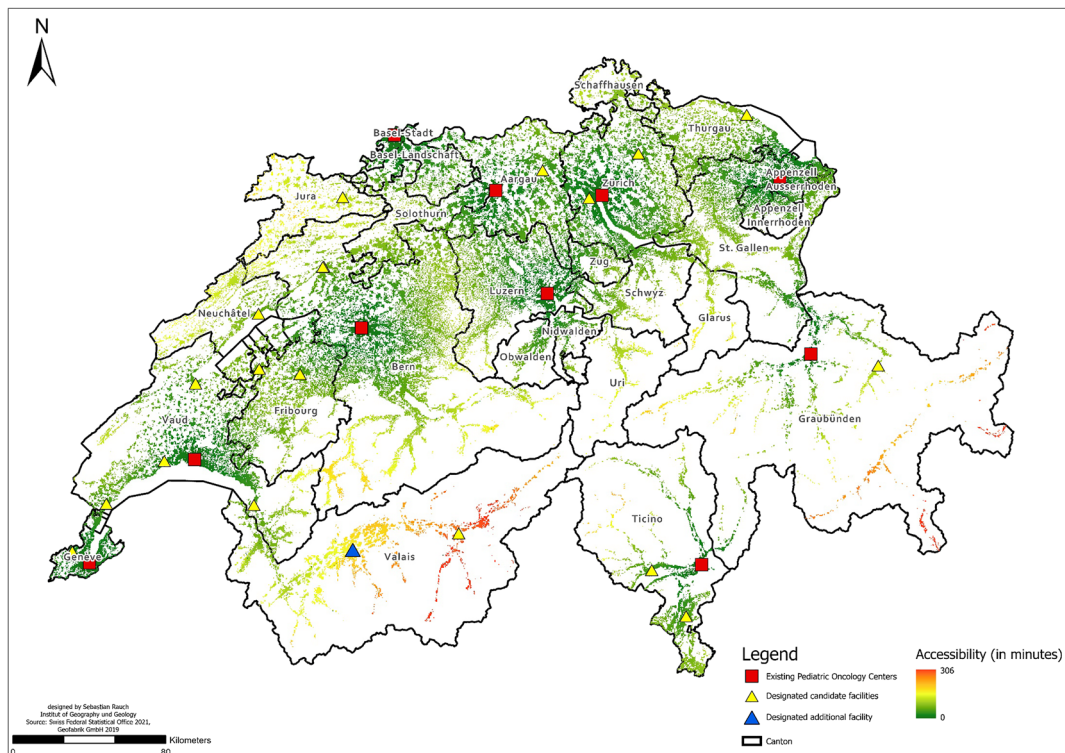

FIGURE 1 Location-allocation modelling

3 | RESULTS

## 3.1 | General accessibility at a national level

Overall, 97.4% of Swiss resident population could reach the nearest PCC within 120 min, 95.0% within 90 min, 86.5% within 1 h and 48.5% within half an hour (Figure 2). Median travel time was 31.0 min (Q1 = 12.8, Q3 = 47.6, M = 36.0, SD = 32.3). Location-allocation analysis revealed that one further PCC located in the city of Sion (in the federal state of Valais) could most effectively improve accessibility of PCCs at a national level (Figure 1). Due to a ceiling effect (i.e., already good accessibility cannot be increased significantly), the additional PCC increased the proportions of people reaching a PCC within 30 min (from 48.5%) to 49.7%, within 60 min (from 86.5%) to 88.6%, within 90 min (from 95.0%) to 97.2% and within 120 min (from 97.4%) to 99.3% (Figure 2).

Additionally, we determined the number of children within the various catchment areas of PCCs to provide an estimate for children (i.e., potential patients) per PCC, indicating that significant differences

exist across Swiss PCCs (Table 2): for the 30 min threshold, eight times more children lived in the catchment area of the PCC in Zurich (297,429) as compared to the PCC in Chur (35,858); for the 60 min threshold, this increased to 10 times more children (673,297 vs. 68,003). Exact numbers are presented in Table 2.

3.2 | Spatial categories: rural, intermediate and urban areas

Proportions of people with access within the analysed time thresholds varied considerably across spatial categories (Figure 2). While 60.9% of people had access within 30 min in urban areas, this number decreased to 33.7% in intermediate and to 14.4% in rural areas. These differences were less pronounced for the 60 min threshold: 91.4% of people in urban, 82.1% in intermediate and 70.5% in rural areas. Only insignificant differences across spatial categories existed for the 90 and 120 min thresholds (Figure 2). Moreover, median travel time in urban areas was considerably shorter (median = 21.1) than in
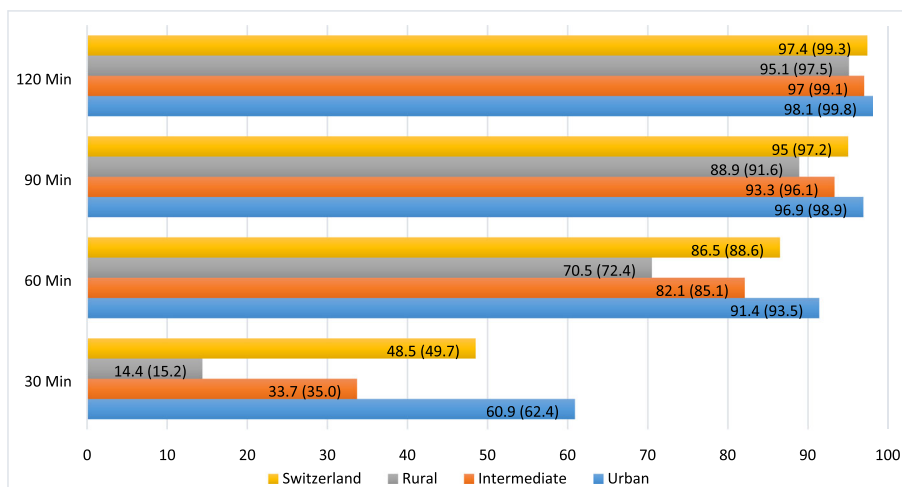
FIGURE 2 Proportion of people (%) with access to a PCC within various time thresholds

Note. Proportion of people (%) with one additional PCC in parentheses.

TABLE 2 Number of children (0–19) in various catchment areas of Swiss PCCs

PCC	30 min	60 min	90 min	120 min
Zurich	297.429	673.297	1.028.468	1.388.953
Aarau	99.174	444.615	1.043.591	1.401.167
Bern	128.079	389.921	595.546	943.677
Lucerne	108.703	313.468	832.444	1.214.954
Lausanne	144.384	286.366	459.865	740.529
St. Gallen	90.739	224.451	366.805	792.546
Basel	125.862	183.356	388.637	793.905
Geneva	139.652	169.078	216.782	343.455
Bellinzona	37.359	100.367	114.895	116.009
Chur	35.858	68.003	142.944	333.779
Sion (not existing, but designated)	49.270	75.770	121.879	219.465

Note: Sorted descending based on number of children in 60 min catchment area.

TABLE 3 Accessibility of PCCs (in min) broken down by nationality

	Mdn (M, SD)			
	Urban	**Intermediate**	**Rural**	**Switzerland**
Total population	21.1 (28.9, 29.6)	37.3 (44.3, 30.3)	47.9 (56.2, 35.2)	31.0 (36.0, 32.3)
Swiss citizens	22.4 (29.8, 30.1)	37.3 (44.4, 30.6)	47.9 (56.3, 35.2)	32.4 (37.4, 32.7)
Foreign residents total	18.1 (27.1, 28.5)	37.4 (44.4, 29.7)	47.9 (56.2, 35.6)	27.3 (32.7, 31.1)
EU/EFTA	18.4 (27.9, 30.0)	38.2 (46.1, 31.6)	49.1 (58.1, 37.9)	28.7 (34.5, 33.1)
Non-EU Europe (incl. GB)	23.6 (28.1, 25.4)	36.0 (40.6, 25.3)	45.2 (49.8, 26.9)	29.0 (32.0, 26.5)
Non-European	13.8 (24.7, 26.7)	36.5 (41.6, 25.7)	47.1 (53.1, 29.6)	21.3 (29.1, 28.2)
Federal asylum centres	Q1 = 14.7, Mdn = 40.0, Q3 = 61.8 (M = 42.8, SD = 30.9)			

Abbreviations: EU/EFTA, European Union/European Free Trade Association; GB, Great Britain; M, mean; Mdn, median; Q, quartile; SD, standard deviation.

intermediate (median = 37.3) and in rural areas (median = 47.9; Table 3). Finally, the additional PCC only marginally mitigates disparities between rural and urban areas (Figure 2).

3.3 | Nationalities: Swiss and foreign (EU/EFTA, non-EU Europe and non-European)

At a national level, the biggest discrepancies in median travel times existed between Swiss citizens (median = 32.4) and non-European (median = 21.3) residents (Table 3). Both access of EU/EFTA residents (median = 28.7) and of residents from non-EU Europe (median = 29.0) was only marginally better than Swiss citizens' (Table 3). Lastly, at the national level, the additional PCC did not mitigate disparities between different nationalities, but equally decreased median travel times for all analysed nationalities: Swiss citizens' 31.5 min, foreign residents' 26.4 min, EU/EFTA residents' 27.5 min, non-EU European residents' 28.6 min and non-European residents 20.5 min (see Table 3 for a comparison with actual travel times without the additional PCC).

3.4 | Nationalities and spatial categories

In urban areas, both EU/EFTA residents (median = 18.4) and non-European residents (median = 13.8) had better access to PCCs than Swiss citizens (median = 22.4); residents from non-EU Europe (median = 23.6) had marginally worse access than Swiss citizens (Table 3). There was no association between the proportion of foreign residents and travel times in intermediate areas ($r = 0.003$) and rural areas ($r = -0.001$). Finally, people living in Swiss federal asylum centres had significantly worse access to PCCs (median = 40.0) than the total resident population (median = 31.0). Table 3 contains more information on accessibility of PCCs broken down by nationality.

In sum, better access of EU/EFTA and non-European residents at a national level was caused by those among them residing in urban areas who had better access; better access of residents from non-EU Europe at a national level was caused by those among them residing in intermediate and rural areas who had marginally better access.

4 | DISCUSSION

Disparities in health status are directly related to various social, political and economic determinants of health. Our analysis yielded several findings that contribute towards facilitating timely access to comprehensive specialised paediatric oncology care in Switzerland. This is crucial, since the benefits of multidisciplinary cancer treatment for quality of care and care outcomes have been well documented (American Academy of Paediatrics, 2014).

First, overall accessibility of PCCs in Switzerland is satisfactory and better than or comparable to similar studies in this field (Fluchel et al., 2014; Onega et al., 2008; Pritchard-Jones et al., 2011; van Goudoever, 2015). Yet previous research from Switzerland found that 15.7% of children did not receive treatment in a PCC (Adam et al., 2010). Discussing possible reasons, the authors dismissed the hypothesis that distance between a family's residence and the nearest PCC play a major role and argued that only very few families need to travel more than 1 or 2 h (Adam et al., 2010). In fact, as our study shows, only 13.5% of the analysed population need to travel longer than 1 h, and only 2.6% longer than 2 h. Nevertheless, these findings warrant careful examination. Given the cumulative nature of the high number of inpatient stays (each with multiple visits by the family) and outpatient visits, it seems questionable whether travel times of more than 1 or 2 h can be seen as reasonable access (Rost, Wangmo, et al., 2018). To illustrate this with an example from own research, travel time of a child with 25 inpatient stays totalling 6 months of time being inpatient and numerous outpatient visits quickly adds up to more than 150 car rides (75 to, 75 from the hospital; corresponding to 150 or 300 h total travel time) (Rost, Wangmo, et al., 2018). Generally, it is recommended that children's inpatient stays should be limited to what is necessary by drawing on outpatient visits and provision of care at home (European Association for Children in Hospital, 2022). However, Swiss paediatric oncology providers noted that a

nationwide bridging care system that supports and improves familial caregiving for children with cancer at home is absent due to cross-organisational barriers (e.g., insurance issues and restrictive reimbursement systems) as a consequence of inadequate financial resources (Rost et al., 2020). This increases the need for reasonable access to PCCs. Furthermore, travel times of more than 1 or 2 h to the nearest PCC were found to be associated with increased risks for ambulance utilisation and emergency air transport, resulting in higher costs for the healthcare system (Fluchel et al., 2014).

Second, despite very good overall accessibility of PCCs, disparities exist between urban, intermediate and rural areas and between Swiss citizens and foreign residents. Poorer access to PCCs among the rural population is not surprising and has been reported elsewhere (Lemieux-Sarrasin et al., 2021; Walling et al., 2019). Nevertheless, our findings paint a more nuanced picture of the access of a heterogeneous Swiss migrant population and are not entirely in line with previous studies revealing poorer access to healthcare (including cancer care) for some migrant populations (Fluchel et al., 2014; Klein & von dem Knesebeck, 2018; Onega et al., 2008; Skrabek, 2013). In urban areas, people from EU/EFTA and non-European countries had better access to PCCs than Swiss citizens and residents from non-EU European countries, hinting towards negative impacts of gentrification on healthcare access in major Swiss cities (Lim et al., 2017) (differences between Swiss citizens and foreign residents in intermediate and rural areas were negligible). To illustrate this, two comparative examples based on empirical findings are given in the following. Imagine two migrant children with cancer residing in Switzerland (ceteris paribus), a Canadian (13.8 min to nearest PCC) and an Albanian (23.6 min to nearest PCC). Families of both children have to go to the hospital 75 times (150 car rides), resulting in 24.5 h less travel time for the Canadian family (2.070 min for Canadian family, 3,540 min for Albanian family). While such differences are likely to persist, they should not be disregarded but should be acknowledged in the individualisation of care. Also, the same expenditure of time might represent a higher burden for families with a low economic status in which both parents have to work to sustain a family.

Third, people living in asylum centres (median = 40.0) had worse access to PCCs than the entire Swiss resident population (median = 31.0). Departing from the conviction that healthcare disparities are a major challenge for Switzerland and that access to healthcare is a fundamental human right, various national initiatives have been launched (e.g., National Programme on Migration and Health, Migrant Friendly Hospital) (Schweizer Verband der Spitäler, 2003; Swiss Federal Office of Public Health, 2013; United Nations, 1948). Related to this, the Swiss Federal Office of Public Health emphasised that more research is needed regarding problems in accessing healthcare (Swiss Federal Office of Public Health, 2013). Against this background, it can be stated that the entirety of Switzerland's migrant population does not have poorer access to PCCs. However, poorer access (most likely also to other healthcare facilities) of people living in asylum centres indicates that these centres have primarily been located in intermediate and rural areas, which appears to contradict at least to some extent the abovementioned initiatives' aspirations. This situation can be seen as an example of an insufficient migrant orientation of the Swiss healthcare system as described by the Swiss Federal Office of Public Health (2013) and is likely to result in a worsening of existing practical barriers to healthcare access (e.g., avoiding contact with authorities and lack of awareness of healthcare system) (Human Network—Health for Undocumented Migrants and Asylum Seekers, 2009).

Fourth, the number of children within various catchment areas of Swiss PCCs varied considerably. For example, the number for the PCC in Zurich was 10 times higher than for the PCC in Chur (60 min catchment area). Location-allocation analysis suggested that one additional PCC located in the city of Sion can only slightly improve overall accessibility of PCCs but cannot mitigate existing disparities. For this additional PCC, the number of children within a 60 min catchment area was 75,770, which ranks second-lowest among existing PCCs. This is mainly due to the fact that there are already PCCs in all major Swiss urban areas. Nevertheless, this approach offers an additional tool for policymakers and health politics who in light of areas with poorer access, besides shared care and allocating new resources, should also consider designating new facilities for maximising equality in access (van Goudoever, 2015; Wang & Onega, 2015). Apart from outpatient services and bridging care, using existing certified children's hospitals can be one cost-saving way forward.

Finally, given the comparatively small number of childhood cancer cases in Switzerland, centralisation of care must also be considered for rare types of cancer and highly specialised treatments (Wijnen & Hulscher, 2022). Since this could increase providers' experience with such cancer types and ultimately improves outcomes, a careful balancing act of risks (e.g., longer travel times) and benefits (e.g., more specialised centres) is required.

4.1 | Limitations

The nearest centre hypothesis underlying our analysis can be mistaken for families who are not treated in the nearest PCC. It is possible that small parts of treatments cannot be provided in the nearest PCC (e.g., stem-cell or organ transplantation). In these cases, travel times would be even longer, and thus, our results represent a conservative scenario. Also, for 1476 raster cells (corresponding to 18,822 persons), we were not able to calculate travel times due to topological errors of street network data (e.g., isolated street fragments and unconnected intersections) and incompatibility of different data sources. Still, our analysis included 99.8% of Swiss population. Furthermore, we did not include travel routes through neighbouring countries, which can occur in actuality and can result in shorter travel times for some regions close to borders. Moreover, due to unavailability of data, we could not include undocumented migrants, and a more fine-grained analysis (e.g., people from Eastern Europe) was not possible. Further, paediatric oncologists, primary care physicians and children hospitals can also play a role in diagnosing and providing treatment for childhood cancer but were not included in the analysis.

Finally, due to data protection (i.e., rendering the identification of a single person impossible), each raster cell of the available population data with an actual value of '1' or '2' (i.e., fewer than three persons residing) got assigned the value '3', which leads to an artificial increase of the overall N of the analysed population as compared to the actual population.

4.2 | Conclusion

Wang and Onega (2015) outline a three-staged framework for research on access to cancer care, in which (1) measuring cancer care accessibility and (2) examining association of accessibility, utilisation and cancer outcomes precede (3) the final step of designing policy scenarios for minimal disparities in accessibility. Our study covers the first step and presents high-resolution insights into accessibility of Swiss PCCs. Future research should hence establish the association between accessibility, utilisation and health outcomes to enable policymakers to mitigate inequalities and to evaluate potential benefits of centralisation. Although healthcare planning is confronted with escalating health expenditures, it should still strive to improve access. Re-examining accessibility of PCCs has the potential to save costs due to, for example, better early detection, better access to effective treatment or reduced emergency transport utilisation (Dang-Tan & Franco, 2007; Fluchel et al., 2014; Skrabek, 2013). Most importantly, however, it has the potential to improve patient outcomes, especially for groups with health disparities.

CONFLICT OF INTEREST
The authors declare that there is no conflict of interest.

DATA AVAILABILITY STATEMENT
Population data are available from Swiss Federal Statistical Office but restrictions apply to the availability of these data, which were used under licence for the current study, and so are not publicly available. The datasets generated and analysed during the current study are not publicly available, since they employed the above mentioned population data. Further results for smaller administrative areas (e.g., communities and cities) or comparisons between different geographical areas can be made available by the corresponding author upon reasonable request.

ORCID
Michael Rost https://orcid.org/0000-0001-6537-9793

ENDNOTE
[1] Each type contains three community types: rural = rural peri-urban community of low density, rural centrally located community and rural peripheral community; intermediate = peri-urban community of high density, peri-urban community of medium density and rural central community; urban = urban community of a big agglomeration, urban community of a medium agglomeration and urban community of a small or out of an agglomeration.

REFERENCES

Adam, M., von der Weid, N., Michel, G., Zwahlen, M., Lutz, J. M., Probst-Hensch, N., Niggli, F., Kuehni, C., Swiss Pediatric Oncology Group (SPOG), & Swiss Association of Cancer Registries (ASRT). (2010). Access to specialized pediatric cancer care in Switzerland. *Pediatric Blood & Cancer*, *54*(5), 721–727. https://doi.org/10.1002/pbc.22426

Albritton, K. H., Wiggins, C. H., Nelson, H. E., & Weeks, J. C. (2007). Site of oncologic specialty care for older adolescents in Utah. *Journal of Clinical Oncology*, *25*(29), 4616–4621. https://doi.org/10.1200/jco.2006.08.4103

American Academy of Pediatrics. (2014). Standards for pediatric cancer centers. *Pediatrics*, *134*, 410–414. https://doi.org/10.1542/peds.2014-1526

ArcGis Desktop. (2022). Location-allocation analysis. Retrieved from https://desktop.arcgis.com/en/arcmap/latest/extensions/network-analyst/location-allocation.htm

Bhatia, S., Landier, W., Paskett, E. D., Peters, K. B., Merrill, J. K., Phillips, J., & Osarogiagbon, R. U. (2022). Rural-urban disparities in cancer outcomes: Opportunities for future research. *JNCI: Journal of the National Cancer Institute.*, *114*, 940–952. https://doi.org/10.1093/jnci/djac030

Bundesinstitut für Bau- Stadt- und Raumforschung im Bundesamt für Bauwesen und Raumordnung. (2019). Methodische Weiterentwicklungen der Erreichbarkeitsanalysen des BBSR.

Church, R., & Medrano, F. A. (2018). Location-allocation modeling and GIS. In *The Geographic Information Science & Technology Body of Knowledge*. Association of American Geographers.

Church, R., & Murray, A. (2009). *Business site selection, location analysis, and GIS*. John Wiley & Sons.

Dang-Tan, T., & Franco, E. L. (2007). Diagnosis delays in childhood cancer. *Cancer*, *110*(4), 703–713. https://doi.org/10.1002/cncr.22849

Davis, J., Burrows, J. F., Ben Khallouq, B., & Rosen, P. (2017). Predictors of patient satisfaction in pediatric oncology. *Journal of Pediatric Oncology Nursing*, *34*(6), 435–438. https://doi.org/10.1177/1043454217717239

Delavar, A., Feng, Q., & Johnson, K. J. (2019). Rural/urban residence and childhood and adolescent cancer survival in the United States. *Cancer*, *125*(2), 261–268. https://doi.org/10.1002/cncr.31704

European Association for Children in Hospital. (2022). EACH Charter.

European Commission. (2022). ECIS—European Cancer Information System. Retrieved from https://ecis.jrc.ec.europa.eu/index.php

Fluchel, M. N., Kirchhoff, A. C., Bodson, J., Sweeney, C., Edwards, S. L., Ding, Q., Stoddard, G. J., & Kinney, A. Y. (2014). Geography and the burden of care in pediatric cancers. *Pediatric Blood & Cancer*, *61*(11), 1918–1924. https://doi.org/10.1002/pbc.25170

Gehri, M., Jaeger, F., Wagner, N., & Gehri, M. (2016). Primary care for the migrant population in Switzerland: A paediatric focus. *Paediatrica*, *27*(Special issue: migrants), 9–15.

Guagliardo, M. F. (2004). Spatial accessibility of primary care: concepts, methods and challenges. *International Journal of Health Geographics*, *3*(1), 3–3. https://doi.org/10.1186/1476-072X-3-3

Haesen, S., Rauch, S., Elger, B., & Rost, M. (2021). Equivalence of care? Accessibility and availability of dialysis services for older prisoners in Switzerland. *International Journal of Prisoner Health*, *17*, 533–545. https://doi.org/10.1108/ijph-11-2020-0096

Human Network—Health for Undocumented Migrants and Asylum Seekers. (2009). Access to health care for undocumented migrants and asylum seekers in 10 EU countries. Law and Practice. Retrieved from http://www.episouth.org/doc/r_documents/Rapport_huma-network.pdf

Jaeger, F. N., Hossain, M., Kiss, L., & Zimmerman, C. (2012). The health of migrant children in Switzerland. *International Journal of Public Health*, *57*(4), 659–671. https://doi.org/10.1007/s00038-012-0375-8

Khan, A. A. (1992). An integrated approach to measuring potential spatial access to health care services. *Socio-Economic Planning Sciences*, *26*(4), 275–287. https://doi.org/10.1016/0038-0121(92)90004-o

Klein, J., & von dem Knesebeck, O. (2018). Inequalities in health care utilization among migrants and non-migrants in Germany: A systematic review. *International Journal for Equity in Health*, *17*, 160. https://doi.org/10.1186/s12939-018-0876-z

Kyu, H. H., Stein, C. E., Boschi Pinto, C., Rakovac, I., Weber, M. W., Dannemann Purnat, T., Amuah, J. E., Glenn, S. D., Cercy, K., Biryukov, S., Gold, A. L., Chew, A., Mooney, M. D., O'Rourke, K. F., Sligar, A., Murray, C. J. L., Mokdad, A. H., & Naghavi, M. (2018). Causes of death among children aged 5-14 years in the WHO European Region: A systematic analysis for the Global Burden of Disease Study 2016. *Lancet Child Adolesc Health*, *2*(5), 321–337. https://doi.org/10.1016/S2352-4642(18)30095-6

Lemieux-Sarrasin, D., Pelland-Marcotte, M.-C., Simonyan, D., Martineau, É., Desbiens, B., & Michon, B. (2021). Distance to the pediatric oncology center does not affect survival in children with acute lymphoblastic leukemia: A report from CYP-C. *Leukemia & Lymphoma*, *62*(4), 960–966. https://doi.org/10.1080/10428194.2020.1849673

Lim, S., Chan, P. Y., Walters, S., Culp, G., Huynh, M., & Gould, L. H. (2017). Impact of residential displacement on healthcare access and mental health among original residents of gentrifying neighborhoods in New York City. *PLoS ONE*, *12*(12), e0190139. https://doi.org/10.1371/journal.pone.0190139

Mestre, A., Oliveira, M., & Barbosa-Povoa, A. (2015). Location–allocation approaches for hospital network planning under uncertainty. *European Journal of Operational Research*, *240*, 791–806. https://doi.org/10.1016/j.ejor.2014.07.024

Neumeier, S. (2016). Accessibility to services in rural areas. *disP – The Planning Review*, *52*(3), 32–49. https://doi.org/10.1080/02513625.2016.1235877

Neutens, T. (2015). Accessibility, equity and health care: Review and research directions for transport geographers. *Journal of Transport Geography*, *43*, 14–27. https://doi.org/10.1016/j.jtrangeo.2014.12.006

Onega, T., Duell, E. J., Shi, X., Wang, D., Demidenko, E., & Goodman, D. (2008). Geographic access to cancer care in the U.S. *Cancer*, *112*(4), 909–918. https://doi.org/10.1002/cncr.23229

OpenStreetMap. (2022). OpenStreetMap. Retrieved from www.openstreetmap.org

Pritchard-Jones, K., Lewison, G., Camporesi, S., Vassal, G., Ladenstein, R., Benoit, Y., ... Sullivan, R. (2011). The state of research into children with cancer across Europe: New policies for a new decade. *Ecancermedicalscience*, *5*, 210–210. https://doi.org/10.3332/ecancer.2011.210

Rauch, S., & Rauh, J. (2016). Verfahren der GIS-Modellierung von Erreichbarkeiten für Schlaganfallversorgungszentren. *Raumforschung und Raumordnung - Spatial Research and Planning*, *74*(5), 437–450. https://doi.org/10.1007/s13147-016-0432-5

Rauch, S., Taubenböck, H., Knopp, C., & Rauh, J. (2021). Risk and space: modelling the accessibility of stroke centers using day- & nighttime population distribution and different transportation scenarios. *International Journal of Health Geographics*, *20*(1), 31. https://doi.org/10.1186/s12942-021-00284-y

Rost, M., Acheson, E., Kühne, T., Ansari, M., Pacurari, N., Brazzola, P., Niggli, F., Elger, B. S., & Wangmo, T. (2018). Palliative care in Swiss pediatric oncology settings: A retrospective analysis of medical records. *Support Care Cancer*, *26*(8), 2707–2715. https://doi.org/10.1007/s00520-018-4100-x

Rost, M., De Clercq, E., Rakic, M., Wangmo, T., & Elger, B. (2020). Barriers to palliative care in pediatric oncology in Switzerland: A focus group study. *Journal of Pediatric Oncology Nursing*, *37*(1), 35–45.

Rost, M., Wangmo, T., Rakic, M., Acheson, E., Rischewski, J., Hengartner, H., Kühne, T., & Elger, B. S. (2018). Burden of treatment in the face of childhood cancer: A quantitative study using medical records of deceased children. *European Journal of Cancer Care*, *27*(6), e12879. https://doi.org/10.1111/ecc.12879

Schwarze, B., & Spiekermann, K. (2018). *Flächendeckender Vergleich der Straßennetzmodelle. Projektnotiz MORO ACC PN 7*. S&W.

Schweizer Verband der Spitäler. (2003). Migrant friendly hospital. Retrieved from https://www.ncbi.ch/de/projekte/inaktive-projekte/migrant-friendly-hospital/

Skrabek, P. (2013). Importance of accessible cancer care. *Transfusion and Apheresis Science*, *49*(2), 139–143. https://doi.org/10.1016/j.transci.2013.07.015

Stangl, S., Rauch, S., Rauh, J., Meyer, M., Müller-Nordhorn, J., Wildner, M., Wöckel, A., & Heuschmann, P. U. (2021). Disparities in accessibility to evidence-based breast cancer care facilities by rural and urban areas in Bavaria, Germany. *Cancer*, *127*, 2319–2332. https://doi.org/10.1002/cncr.33493

Swiss Childhood Cancer Registry. (2019). Annual Report 2017/2018.

Swiss Confederation—Federal Office of Public Health. (2011). Health Care for Undocumented Migrants in Switzerland: Policies—People—Practices. Retrieved from https://www.bag.admin.ch/bag/en/home/strategie-und-politik/nationale-gesundheitsstrategien/gesundheitliche-chancengleichheit/chancengleichheit-in-der-gesundheitsversorgung/gesundheitsversorgung-der-sans-papiers.html

Swiss Federal Office of Public Health. (2013). National Programme on Migration and Health—2008–2013 results and priorities for 2014–2017.

Swiss Federal Statistical Office. (2014). Raumgliederungen der Schweiz—Gemeindetypologie und Stadt/Land-Typologie 2012. Retrieved from https://www.bfs.admin.ch/bfs/de/home/statistiken/querschnittsthemen/raeumliche-analysen/raeumliche-gliederungen/raeumliche-typologien.assetdetail.2543323.html

Swiss Federal Statistical Office. (2017a). Gemeindetypologie und Stadt/-Land-Typologie 2012. Retrieved from https://www.bfs.admin.ch/bfs/de/home.gnpdetail.2017-0593.html

Swiss Federal Statistical Office. (2017b). Statistischer Bericht zur Integration der Bevölkerung mit Migrationshintergrund.

Swiss Federal Statistical Office. (2018). Bevölkerung nach Migrationsstatus 2017.

Swiss Federal Statistical Office. (2020a). Foreign population. Retrieved from https://www.bfs.admin.ch/bfs/en/home/statistics/population/migration-integration/foreign.html

Swiss Federal Statistical Office. (2020b). Räumliche Typologien. Retrieved from https://www.bfs.admin.ch/bfs/de/home/statistiken/querschnittsthemen/raeumliche-analysen/raeumliche-gliederungen/raeumliche-typologien.html

Swiss Federal Statistical Office. (2020c). Statistik der Bevölkerung und Haushalte (STATPOP), Geodaten 2020. Retrieved from https://www.bfs.admin.ch/bfs/en/home/services/geostat/swiss-federal-statistics-geodata/population-buildings-dwellings-persons/population-houshold-from-2010.assetdetail.19106709.html

Swiss Institute for Continuing Medical Education and Training. (2022). Register der zertifizierten Weiterbildungsstätten. Retrieved from https://www.siwf-register.ch/

United Nations. (1948). Universal Declaration of Human Rights.

van Goudoever, H. (2015). Concentrating childhood cancer treatment in the Netherlands. *Pädiatrie und Pädologie*, *50*(Suppl 2), 38–41. https://doi.org/10.1007/s00608-015-0282-3

Walling, E. B., Fiala, M., Connolly, A., Drevenak, A., & Gehlert, S. (2019). Challenges associated with living remotely from a pediatric cancer center: A qualitative study. *Journal of Oncology Practice/ American*

Society of Clinical Oncology, *15*(3), e219–e229. https://doi.org/10.1200/JOP.18.00115

Wang, F., & Onega, T. (2015). Accessibility of cancer care: disparities, outcomes and mitigation. *Annals of GIS*, *21*(2), 119–125. https://doi.org/10.1080/19475683.2015.1007893

Wijnen, M. H. W. A., & Hulscher, J. B. F. (2022). Centralization of pediatric surgical care in the Netherlands: Lessons learned. *Journal of Pediatric Surgery*, *57*(2), 178–181. https://doi.org/10.1016/j.jpedsurg.2021.10.023