

The potential geographic accessibility of hospital services in Cluj County

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Accessibility to medical services is an essential element for a higher quality of life. In a geographical sense, accessibility relies on location and distance. In the case of health geography, it is concerned with the location of health services and how they serve the health needs of the population. The present study tries to measure the potential access to hospital services for the population of Cluj County, using time and distance records provided by Google Maps API. For the most accurate measurement, two scenarios were considered. Both scenarios take place in heavy traffic conditions at different time intervals. The first scenario represents accessibility values for the morning period, between 09:00 and 11:00. The second scenario represents accessibility during the evening, between 16:00 and 18:00. The results show that Cluj County has good accessibility to hospitals, with over 70% of the population reaching the nearest hospital in less than 30 minutes, especially in Cluj-Napoca and the surrounding localities. The most challenging areas in terms of the accessibility to medical services are mainly in the southwest of the county. The discoveries provide a scientific basis to improve medical access in the mountainous areas of Cluj County.

Key Words: *health care, hospital, potential accessibility, Cluj County, Cluj-Napoca, Romania.*

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Introduction

The general consensus on the concept of accessibility is that it is a measure of the effort or ease with which spatial separation can be overcome. Usually, the actions taken in studying accessibility are applied in setting up business or industrial zones, drawing new routes for motor vehicles, population distribution and growth rate in a specific area, etc. (Allen et al., 1993). The notion of accessibility rests on two key concepts. The first is location, where its relative position is estimated in relation to transport networks, as they are the basis of mobility; hospital medical units mainly represent the places that constitute the object of this study. The second is the distance that derives from the connectivity between places, i.e., the possibility that transport networks link two places. Thus, location and distance contribute to the study of networks as key elements in spatial analysis and prove to be paramount in assessing accessibility (Rodrigue et al., 2020).

Health geography is concerned with the location of health services and how they serve the population's health needs. In terms of accessibility to medical services, it can be assessed from a geographical point of view through temporal access and/or spatial access. Even though we can analyse the two terms separately from a theoretical point of view, they influence each other in the real world (Ciutan & Sasu, 2008). Also, in the case of health geography, there is a distinction between “having access” to health care and “available access”. Having access to healthcare services represents a legislative form by which an individual is entitled to seek medical services, while available access represents the financial, organisational and socio-cultural ability to be able to use the medical services provided to him (Higgs, 2004).

The distance to medical facilities is essential for patients, doctors and other employees in the health system. Existing accessibility focuses on the actual use of a service, while potential accessibility signifies the likely use of a service (Wang, 2015). Spatial accessibility is only one dimension of accessibility to services of general interest, along with other aspects such as financial accessibility or service quality. Previous studies have demonstrated that spatial accessibility to different types of services of general interest influences, sometimes quite strongly, the addressability of the population to that service.

Globally, only 8.9% of the population (646 million) cannot access medical services in less than an hour without access to motorized transport. Of those who can reach medical services in less than 60 minutes, 60.3% (4.39 billion) live less than 10 minutes from a clinic or hospital, 82.6% (6.02 billion) live less than 30 minutes away, and 91.1% (6.64 billion) live at least 60 minutes away. On the other hand, 43.3% or 3.16 billion people cannot reach a medical service point on foot in less than an hour. Furthermore, only 14.2% of the global population (1.19 billion) can access medical facilities within a 10-minute walk, and 56.9 (4.13 billion) can access medical services up to an hour of walking. Also, people in precarious financial situations and isolated areas are the most vulnerable regarding the accessibility of medical services (Weiss et al., 2020).

In Europe, most countries have achieved universal coverage for a basic set of health services, although the range of services covered and the degree of cost-sharing may vary. Among the factors that can limit the accessibility of medical services (finances, lack of workforce, long waiting times) and the distance, sometimes increased travel times to the nearest medical facility, play an important role. Nevertheless, in most EU countries, only a tiny part of the population reported not having their medical needs met. Instead, the motivation is financial; of this proportion, most belong to low-income households (European Commission, 2019).

In Romania's case, accessibility to hospitals is different, depending on geodemographic characteristics. In general, over 80% of Romania's population can reach any hospital in less than 30 minutes, using their personal car as a means of transport. But for hospitals that offer complex hospital services, the time to the destination increases for 34% of the population, reaching from 90 minutes to 120 minutes. Furthermore, the geographical distribution of medical staff reveals major disparities between regions and especially between urban and rural areas: less than 20% of doctors (5,592 from 52,541 in 2012) practice in rural areas, 66% of medical staff are concentrated in six big cities (Bucharest, Iasi, Timișoara, Cluj-Napoca, Craiova, Galați), while 5% of rural communities do not have a doctor.

The territorial distribution of doctors shows obvious inequalities between the north, north-west and south-east regions of the country and the other regions; the lack of doctors in poorer regions, in small towns or remote rural areas has become a common phenomenon, with few immediate solutions (Dumitrache et al., 2016).

Therefore, the concentration of hospital infrastructure and specialised personnel in specific regions and cities leads to limited access for the general population to benefit from quality medical services. The distances and travel times to the nearest hospital exceed the values recorded at the European level due to the concentration of emergency medical services only in certain regions close to large urban areas in Romania. Almost 4 million inhabitants live in areas with low accessibility to the nearest hospital, while 6.7 million inhabitants live in areas with high accessibility to hospital services (Dumitrache et al., 2020).

Methodology

The analysis aimed to measure the degree of temporal and geographical accessibility to the nearest medical services in Cluj County. The study area is located in the north-western part of Romania and includes 76 rural settlements and 5 cities on a surface of 6,674 km². According to data from the National Institute of Statistics, in January 2019, Cluj County registered a total population of 732,913 inhabitants; the demographic share in Romania's total population was 3.3%, of which 35% lived in rural areas and 65% in urban areas. The county's average population density was 110 inhabitants/km², higher than the national one (93.18 inhabitants/km²), which illustrates a densely populated county. The

population distribution by gender in 2019 was quite balanced, with the share of women in the total population being 51.80% and that of men 48.20%.

Access to medical services and, therefore, the right to health is a fundamental right that is part of the economic, social and cultural rights category. This represents not only the basic obligation to provide or facilitate the availability of medical services but also to respect people's health through equal access to health services, regardless of their form of ownership (Mocanu, 2008).

The lack of medical services nearby or their uneven territorial distribution represents one of the barriers to ensuring the local population's access to these services; in this context, the paper's main objective is the analysis of the geographical accessibility of hospital services.

Starting from the spatial distribution of hospitals, a relevant indicator was considered regarding potential geographic accessibility: the time to the nearest hospital using the Google Directions API. Calculating this parameter (travel/drive time) is a difficult task to perform because this indicator must be individualised depending on the existing local and particular conditions, such as the type of road access roads (asphalted, paved, unimproved, etc.), the state of the roads road access (disused, impassable during winter, rains, etc.), communication systems (telephone, etc.), organisation of the ambulance service in the area, etc. (Ciutan & Sasu, 2008). The lack of medical services nearby or their uneven territorial distribution represents one of the barriers to ensuring the accessibility of the local population to these services; in this context, the paper's main objective is the analysis of the geographical accessibility of hospital services. The primary element is the administrative-territorial unit, with a population that varies at the administrative-territorial unit level between 638 and 325,179 people. Unfortunately, the National Institute of Statistics provides data only at the territorial level without capturing the population's spatial distribution. Thus, in order to take into account the population from a geographical point of view, the surface of each territorial unit was framed in several polygons, representing categories of time and distance, fitting more than half of the area of a territorial unit into one of the polygons resulted in consideration of the entire population of that settlement. A total of 81 territorial-administrative units were considered to calculate the time to the nearest hospital. Of the total population, the elderly and children under the age of 5 are most affected due to the increased likelihood of illness or death. Thus, the territorial distribution of the age groups 0-4 years and over 65 years was analysed using data available on the National Institute of Statistics platform for 2019. Also, data from the Diagnosis Related Groups system (DRG), a platform coordinated by the National Institute of Health Services Management, were used to measure hospitalised morbidity from 2009-2019.

Data on the number and types of hospitals in the study area were taken from the internal questionnaire applied by the National Institute of Statistics. In selecting hospitals, the legal ownership regime was also considered, with both public and private hospitals being selected. 17 hospitals were selected from 9 territorial administrative units: Cluj-Napoca (8), Gherla (2), Baci (1), Borşa (1), Câmpia Turzii (1), Ciurila (1), Dej (1), Huedin (1), Turda (1). Accessibility to

hospital units was measured for all 81 administrative-territorial units located on the territory of Cluj County. Each hospital was geolocated using Google Maps, and if the location was not found automatically, it was entered manually. QGIS 3.16 was used for the geolocation of the hospitals.

The study aims to measure accessibility only for hospitals because the decrease in the number of family medical practices, whose role is to maintain access to hospital services, as well as the concentration of an already small number of doctors in urban areas, forces people to go directly to hospitals to solve any health problems. Thus, Romania has more hospitalisations than any other European country (European Commission, 2019).

Two scenarios were considered in determining population accessibility to hospitals. Both scenarios took place in heavy traffic during the morning and evening. For the morning period, the time interval 9:00 and 11:00 was selected, and for the evening period, the time interval 16:00 - 18:00 was chosen. In this regard, the service provided by Google (Google Maps Application Programming Interface) was selected to measure the distance and time required from the point of origin to the destination. An advantage is the integration of certain factors that can influence traffic in real-time, such as congestion or accidents, thus offering alternative routes (García-Albertos et al., 2018). Also, another advantage of the Google Maps Application Programming Interface (API) is minimal data preparation and the need for minimal GIS knowledge (Wang & Xu, 2011). The chosen means of transport was the car, and the selected day was Monday; the direction chosen was to the hospital, and the resulting starting points formed a polygon of time and space.

The minimum travel time served as an indicator for measuring spatial accessibility. Based on the travel time for the two selected scenarios, the degree of accessibility was divided into four categories using a time scale with intervals of <10 minutes, 11-20 minutes, 21-50 minutes and >50 minutes. The accuracy of the results can be influenced by the lack of the exact address of the patients, chosen route, chosen means of transport, speed, and potential patients from vulnerable groups which will not be able to use a car to get to the nearest hospital (Kelly et al., 2016). The chosen day is important because traffic may be less congested, and speeds may be higher at the end of the week (Li et al., 2011). In addition, there are possible traffic events, accidents or works to the transport infrastructure that can change the travel time.

Results and Discussion

Population's potential healthcare need

The age-based model and the hospitalised morbidity were considered to assess the potential population needs. The population groups over 65 years and those 0-4 years were considered the primary consumers of medical services because they are the most vulnerable. According to the National Health Strategy 2014-

2020, between 2007-2010, at the national level, healthy life expectancy at 65 decreased from 7.7 to 5.9 years for men and from 7.8 at 5 years for women. Thus, after 65 years, women live about 5 years without ailments that can limit their activity, another 7.5 years with moderate limitation and another 4.8 years with severe limitation, and men thus spend about 5.9 years, 5.6 years and respectively 2.5 years of life.

Figure 1 shows the main diseases that require hospitalisation and are morbidity risks: the circulatory system, digestive system, respiratory system, and nervous system. Risk factors for these diseases include a poor diet, alcohol consumption, tobacco use, and low physical activity. Romania is below the European average, 62% compared to 44%, in terms of physical activity, and tobacco consumption is a public health problem (European Commission, 2019).

Population ageing is one of the factors recognised to cause an increase in the needs and implicitly the demand for health services (Panait, 2011). The population over 65 years old represents 17.48% of the total population, while the 0-4 age group represents 4.96%. The majority of the vulnerable population is concentrated in the northern, northeastern and western areas of Cluj County (Figure 2). Almost half of all territorial administrative units in Cluj County fall into the second category; 37 localities have between 22 and 27% of the population in need of medical services. In general, the category over 65 years is more numerous than the category 0-4 years, with the exception of Floreşti commune. This fact demonstrates the presence of population ageing in almost the entire county territory, which corresponds to the ageing phenomenon at the national level. Only in 2019, demographic ageing intensified, with the elderly population aged 65 and over (3,702,000) exceeding the young population aged 0-14 (3,231,000) by 471,000 people (Marinescu & Aruştei, 2019).

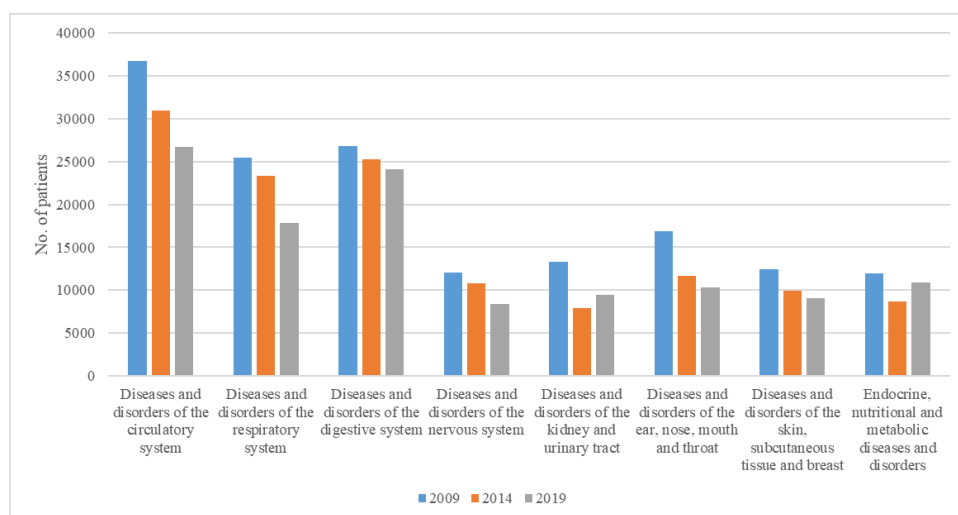


Figure 1. Hospitalized morbidity between 2009 – 2019

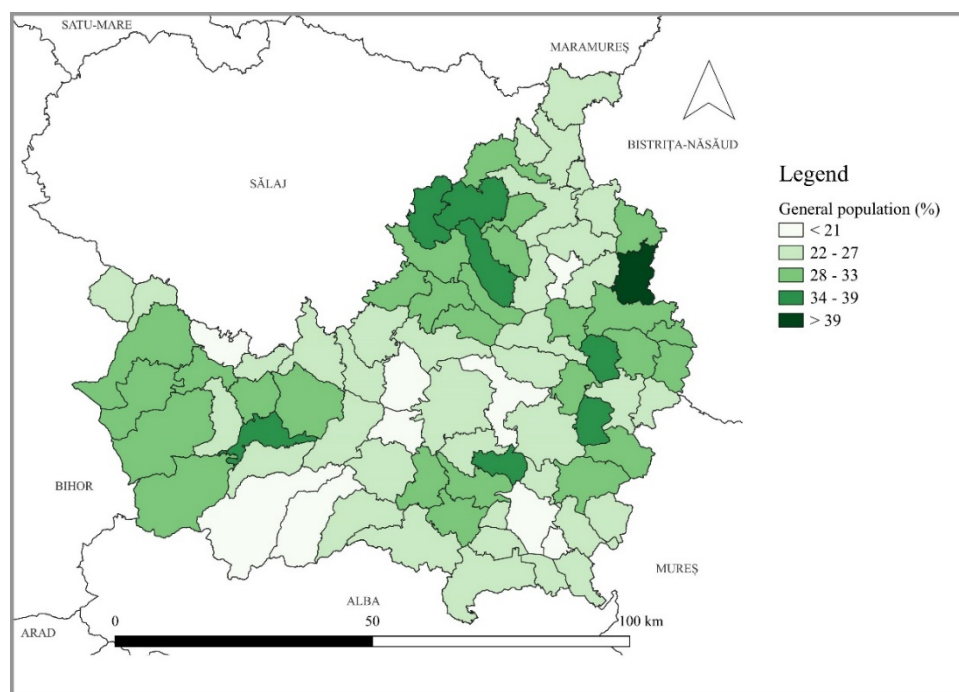


Figure 2. Population over 65 years + 0 - 4 years population / total population (territorial administrative units' level)

Sanitary infrastructure

Hospitals are an essential component of the health care system and central to the reform process, and yet as institutions, they have received remarkably little attention from policymakers. Despite numerous reforms to reduce hospital capacity and strengthen primary care, the hospital has proven to be a complex, change-resistant institution that continues to dominate the healthcare landscape in Romania (Zamfir et al., 2015; Dumitrache et al., 2020).

According to Law 95/2006, the hospital “constitutes the sanitary unit with beds, of public utility, with legal personality, public or private property, which provides medical services”. Depending on the location, hospitals are classified into county, municipal, city, and communal hospitals. Depending on the specific pathology, they are classified into general hospitals (which have at least 3 of the 4 basic specialities, namely internal medicine, paediatrics, obstetrics - gynaecology and surgery), emergency hospitals (with a complex structure of specialities, equipment appropriate medical, specialised staff, covering the needs of a population in vast territories), specialised hospitals (offering services in a specific specialisation), hospitals for patients with chronic diseases. From the view of ownership, hospitals are classified into: state hospitals, which can be public or private hospitals owned by state or local authorities, private hospitals owned by other legal entities and mixed hospitals (Romanian Government, 2015).

The medical infrastructure in the analysed area is made up of 34 hospitals, of which 24 are located in Cluj-Napoca. From a legal point of view, Cluj County has

both public and private hospitals, and according to other classifications: 9 clinical hospitals and one emergency county hospital in Cluj-Napoca.

In addition, in its rural area, the county has a hospital for patients with mental disorders in the commune of Borșa and two other private hospitals in the communes of Baciú and Ciurila.

Apart from hospitals, the public health system is mainly represented by local facilities, such as family medical offices, dental offices, and pharmacies. According to the National Institute of Statistics, most territorial administrative units have at least one family medical office (Figure 4). Most are located in Cluj-Napoca, with some 165 offices or 48% of a total of 342 units, at the county level. The urban area attracts medical personnel to the disadvantage of the rural regions. This phenomenon can best be observed in the Cluj-Napoca area. If, in the municipality, a family doctor has 1,390 inhabitants in the neighbouring communes, this number increases exponentially. Thus, in Florești commune, a family doctor cared for 5,470 inhabitants in 2019. In Apahida, a family doctor looks after 4,620 inhabitants; in Baciú and Chinteni communes, a family doctor takes care of 2,974 and 3,346 inhabitants, respectively.

On the other hand, for the communes of Ploșcoș Suatu and Vad, no doctors were registered as active in 2019. The explanation is that Ploșcoș has 651 inhabitants, and the number is too small to allow a doctor to present himself as a family doctor to serve a community of fewer than 1,000 patients. In the Suatu commune, the family doctor has retired and medical services are provided by the family doctor from the neighboring commune, Pălatca, who comes to consultations twice a week and in Vad commune, most of the residents are on the list of a military doctor from the municipality of Dej or on the lists of other doctors, according to local media (Magradean, 2019; Puriș, 2020).

Another disadvantage regarding family medical offices is that many of them are located on *Main Street*, that is, on the main traffic arteries of a commune. This can lead to increased accessibility to medical services for people in the localities of residence but low accessibility for those from other localities because the county's geographical area makes it difficult to easily connect to the public services located in the place of residence of the commune.

Geographical accessibility of medical services

From a geographical point of view, accessibility is based on two key factors: time and space. The concept of temporal accessibility can be defined by the actual physical time in which patients can benefit from the requested medical services. Temporal accessibility quantifies more faithfully the level of access to health services than spatial accessibility, but, at the same time, it is more difficult to measure from a practical point of view. The optimum in terms of temporal accessibility was defined by an intervention time, in general, of a maximum of 30 minutes. This period can be measured by the access time to health facilities.

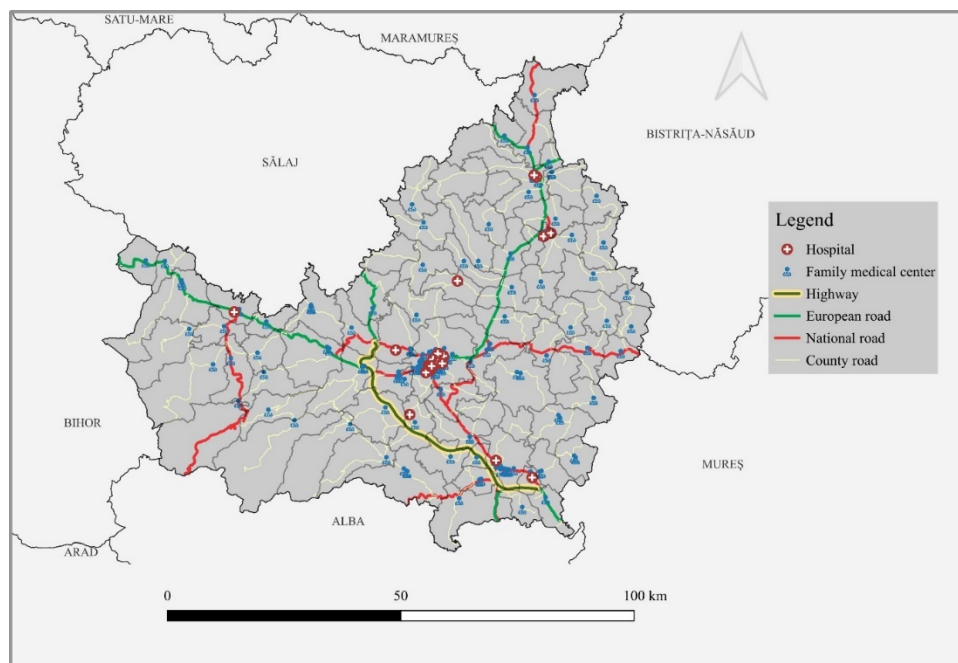


Figure 3. Location of hospitals and family medical centres in Cluj County in 2019

The concept of spatial accessibility refers to the proximity of health service providers compared to the population served, which can be quantified by the distance the patient has to travel to the health facility where the medical services he needs and requests are provided.

The optimum from the point of view of spatial accessibility primarily includes the possibility of access in both directions, both to and from the respective medical unit of the patient to the provider, but also of the provider to the patient (Ciutan & Sasu, 2008). The existence of such conditions influences both the supply of services in the area and the demand for health services, especially in the case of children and the elderly because they depend on transportation to the nearest medical facility to receive treatment or for various medical emergencies (Dumitrache & Dumbrăveanu, 2008).

The main limiting factor in the accessibility to medical services is the travel time to the nearest hospital, which makes it necessary to study it, especially during busy periods (09:00 - 11:00 and 16:00 - 18:00). According to the European Observatory on Health Systems and Policies (2019), in 2017, 4.7% of Romanians reported unmet medical care needs due to costs, distance or waiting time, compared to an average of 1.7% in the EU. As is the case in most EU countries, those with the lowest incomes report the most critical unmet needs. In 2017, approximately 6.5% of Romanians from low-income households stated that they had given up medical care for financial reasons, compared to 2.3% in the EU. However, the percentage value was better than the 14.5% reported in 2010. Dumitrache et al. (2020) note that 17% of Romanians live within a 30–90 minute drive to a hospital, while those requiring a long drive to the nearest facility represent less than 0,2%.

This research's measurements have proven that during the morning (between 9:00 and 11:00), 80% of the population can reach the nearest hospital in less than 20 minutes. Only 2% of the population of Cluj County has difficulties accessing hospital services at intervals longer than 50 minutes (Table 1).

When analysing the potential access to hospitals during the evening, between 16:00 and 18:00 (heavy traffic interval) and comparing the values recorded during the morning, the percentage of the population that can reach the hospital in less than 20 minutes to the nearest hospital dropped by 5% to 75%. In heavy traffic conditions, people with the most challenging time accessing medical services during the evening increased by 2%, reaching 4% of the total population (Table 2). The potential access to hospitals, depending on distance, during the morning (09:00 - 11:00) shows that 31 of the 81 territorial administrative units in Cluj County are 15 - 36 kilometres from the nearest hospital (Figure 4). Depending on the distance, the potential access to hospitals during the evening (18:00) shows that 38 of the 81 territorial administrative units in Cluj County are 15 - 36 kilometres from the nearest hospital (Figure 5).

Urban localities have the best degree of accessibility to medical services in the morning, in addition to most rural localities up to a distance of approximately 6 or 14 kilometres, depending on the state of the infrastructure or local traffic conditions. The lowest access to hospitals is visible primarily in the mountainous area located in the south-western part of the county, with distances of over 36 kilometres to the nearest hospital unit. Also, not all the population in the study area owns a car, so these distances are potential; there are also people who have to use public transport, needing more time to get to the nearest hospital (they are conditioned by both the public transport routes and its timetable). Urban residents and those close to hospitals have the best accessibility. Although the proximity to the city of Cluj-Napoca represents a considerable advantage, the level of infrastructure development differs considerably from locality to locality. Economic activity is concentrated in specific areas, and social problems still persist.

Table 1. Population access to hospitals (morning)

Morning	Population	% total population
<10 minutes	496,704	68
11-20 minutes	583,838	80
21-50 minutes	86,876	12
>50 minutes	16,725	2

Source: Author's calculations

Table 2. Population access to hospitals (evening)

Evening	Population	% total population
<10 minutes	496,704	68
11-20 minutes	549,910	75
21-50 minutes	152,513	21
>50 minutes	26,802	4

Source: Author's calculations

These include marginalisation and exclusion based on territorial positioning and lack of accessibility (the case of communes in the mountain area). These factors also influence the population's access to hospitals, as the level of development of certain ethnic groups and limited financial resources also affect accessibility (Dumitrache & Dumbrăveanu, 2008).

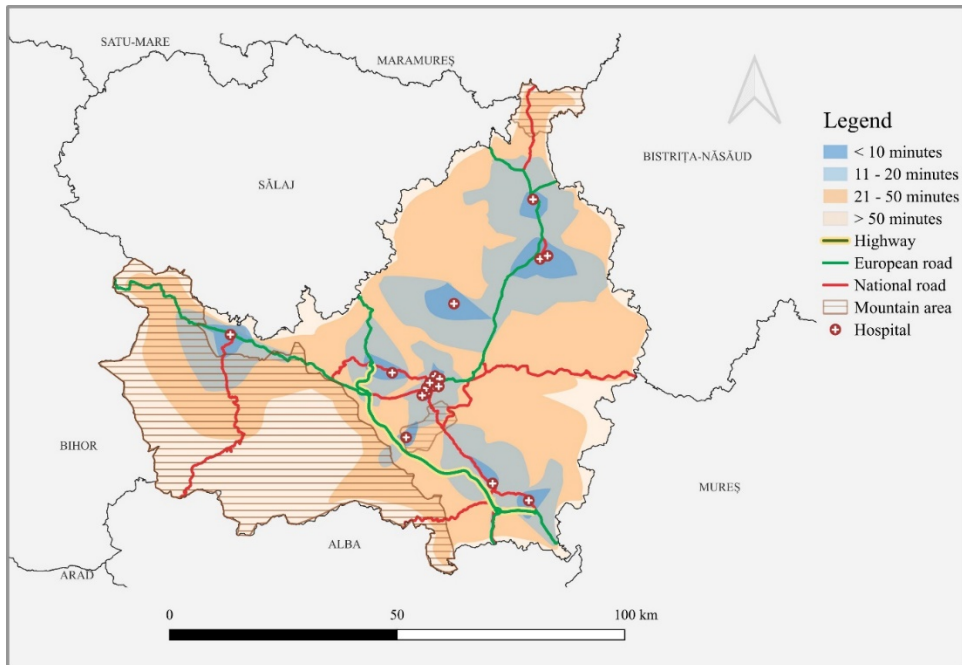


Figure 4. Potential access to hospitals during the morning in Cluj County

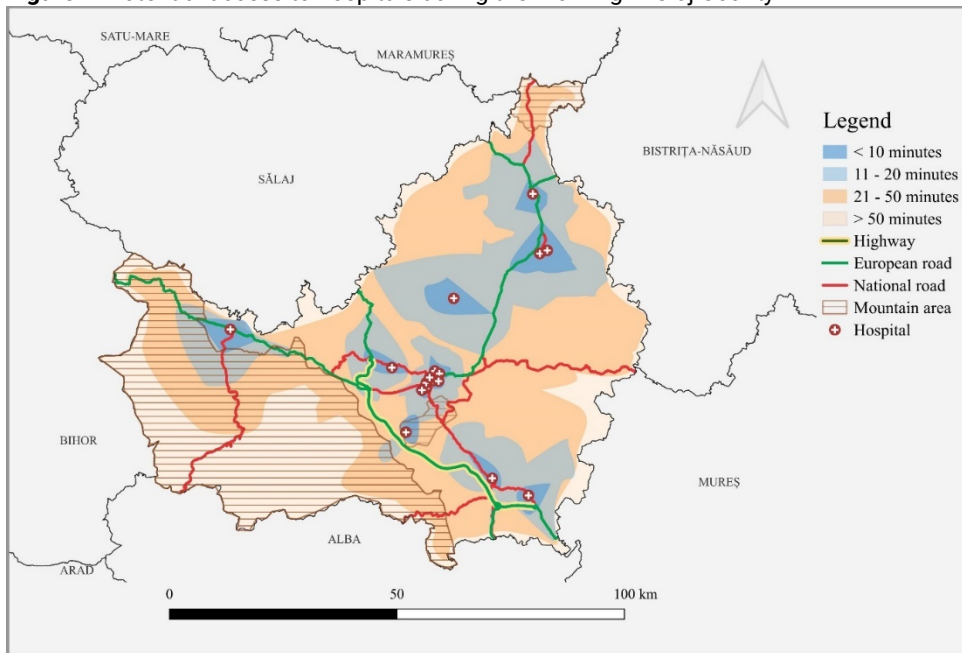


Figure 5. Potential access to hospitals during the evening in Cluj County

Conclusions

This study explores the population's potential need for medical services and spatial accessibility at public hospitals. Google Maps API navigation services are suitable for providing real-time travel distance and time data. Data were used for morning and evening rush hours to compare spatial accessibility during heavy traffic at different times of the day. In this study, public and private hospitals were considered, and the resulting times allowed for the identification of differences between the chosen moments.

The results confirm that Cluj County has good accessibility to public and private hospitals, over 70% of the population living less than 20 minutes from the nearest hospital. The proximity to Cluj-Napoca makes access possible for residents from the areas bordering the city. Still, it represents a disadvantage for challenging areas from a geographical point of view or located further away from the county's main urban centre.

As the research showed, the travel time chosen influences the population's access to medical services. In the peak period - in the morning, the population's accessibility to medical services decreases due to heavy traffic. In the evening, during the period of heavy traffic, the population's accessibility to medical services decreased by up to 5%. This shows that traffic significantly affects the potential accessibility of medical services. The time chosen for the journey, distance, means of transport selected, and speed represent the main factors that influence the accessibility of the population to medical services. The south-western part of the study area has the greatest potential need for health services, but it also has less accessibility, as the population in that area needs 50-60 minutes to reach the nearest hospital.

This research contributes to a better understanding of the geographic accessibility of the population to public hospitals, helping to identify polarisation trends. The results obtained can help decision-makers to develop urban planning strategies and optimise investments in health infrastructure. Future studies will consider using other means of transport and different time slots.

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