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Using GIS methods to analyse the spatial distribution and public accessibility of pharmacies in Craiova city, Romania

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Abstract. The present study represents a social and geographical analysis of the spatial distribution of pharmacies in Craiova city using GIS methods. This study aims to present the evolution in the pharmacies' number, location, density and accessibility to the population of Craiova city on the background of an analysis of European and national legislation concerning the pharmaceutical sector. The paper also outlines the uneven distribution of pharmacies in the city by analysing the ratio between the number of pharmacies and the number of people within a district. Distance and time are considered important, especially when using different transport types. Indicators like density of pharmacies, distribution of population density, and population size in districts were taken into account in this study. Although the GIS-based analysis revealed that accessibility of pharmacies in terms of time and distance and the ratio of population size to number of pharmacies were both good and had increased over the years, the study also indicated residential areas with no pharmacy, and therefore an uneven distribution of pharmaceutical services.

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Contents:

1. Introduction

Pharmacies play an important role in people's lives, being described as health centres where people can benefit from medicines and services offered by qualified personnel. Sometimes, especially in rural areas, the pharmacist can play the role of general physician (Miftode and Stefanache, 2011), as people do not have access to another health centre or specialist in the area or cannot reach one due to the considerable distances and costs involved (Oliver and Mossialos, 2004; De Rijdt et al., 2008; Koehler and Brown, 2017). So, most of the time, when in need, the patient's first point of contact is the pharmacist even before consulting a general physician. In these cases, they usually request a treatment for a common sickness and symptoms (colds, various aches, digestive problems) that do not need a prescription or previous medical advice from a specialist. However, most of the people that need frequent, even monthly, medicines are those with chronic diseases. These people visit a pharmacy more often than they ask advice of any other healthcare specialist (Eades et al., 2011). Therefore, geographic accessibility becomes very important if we take into consideration the ever-growing role of the pharmacy. However, we also have to acknowledge the fact that geographic accessibility is not sufficient, as accessibility implies many aspects such as proximity, availability, affordability (Turnbull et al., 2008; Law et al., 2013).

The European legislation is very heterogeneous regarding the establishment and functioning of pharmacies, especially for community pharmacies. Therefore, some European states such as Great Britain, the Netherlands, Ireland, Norway and Sweden took measures to deregulate and liberalise the pharmaceutical sector in order to improve accessibility to pharmaceutical services and to reduce the cost of medicines, while states like Romania, Austria, Denmark, Finland and Spain have geographic or demographic criteria to regulate the establishment of pharmacies (Thomsen et al., 2011; Vogler et al., 2012; Vogler, 2014; Martins et al., 2015; Svensberg et al., 2015). Although there are certain pressures to deregulate the pharmaceutical sector in other member states, too, in countries like Romania this action can highlight disparities in location and geographical access to pharmacies in rural areas (Azhar et al., 2009). Deregulation can also lead to strengthening the existing pharmaceutical chains on the market.

In Romania, the law concerning the pharmaceutical sector (Law 266/2008 republished; Ordinance of the Minister of Health 926/2009) regulates the establishment of community pharmacies, pharmacies with a closed circuit (located within hospitals and other health centres) and drug stores in rural or urban areas, based on different criteria and establishment taxes. One important criterion applied only in urban areas is demography, regulating that a pharmacy can be established depending of the demographic size of the urban settlement as follows: one pharmacy to every 3,000 people for a capital city, one pharmacy per 3,500 people for county seat cities and one pharmacy per 4,000 people for other cities (Law 266/2008 republished). At the national level, pressures have been made to extend this criterion in rural areas, too, because of major disparities reported in some cases. Other criteria refer to establishment taxes differentiated for rural areas (about 35 euro) and urban areas (about 650 euro) and an exception for establishing pharmacies in commercial centres. Initially, the law foresaw a geographic criterion regulating the minimum distance between two pharmacies (at least 500 metres, subsequently reduced to 250 metres), but it was ultimately eliminated.

In Romania, the number of pharmacies registered a positive trend, increasing significantly from 4,800 in the year 2005 to 8,000 in 2012. In 2017, the number slightly decreased to 7,802 with an average of one pharmacy per 2,500 people. Following a continuous increase, in 2010 the pharmaceutical sector represented over 1% of the GDP (Șteliac, 2015). In 2014, Romania was ranked eighth in Europe according to number of existing, reported pharmacies per inhabitant, surpassing other countries such as Italy, Germany, France or Great Britain (average of 1 pharmacy per 6,500 people), all having a population greater than Romania. Despite the great number of pharmacies, in our country the situation is very different in terms of location of pharmacies and the geographic accessibility of their service, not only in some rural areas, but also in certain cities in counties such as Covasna and Vrancea (each with 65 pharmacies), Caraș-Severin (77) and Ialomița (80). Last year, the statistics reported 53.60% of the population living in urban areas, though in 26 of the 41

counties (excepting Bucharest) the urban population registered less than 50% (Dâmbovița – 31.93%, Giurgiu – 32.53%, Teleorman – 36.39%). Regarding the distribution of pharmacies in urban and rural areas, counties such as Giurgiu and Ilfov have a considerably larger proportion of their pharmacies in rural areas, at 78% and 79%, respectively. This situation may have two explanations. One is due to most of the population living in rural areas and the proximity to Bucharest, the capital (especially in the case of Ilfov county); the second is related to the permissive legislation regarding the establishment of pharmacies in rural areas (no demographic criterion is applied) compared to urban areas.

These statistical data raise two questions about the increasing number of pharmacies and their density pattern: the increased request for pharmaceutical products and primary medical advice, and a possible degradation in the population's health status.

As in most of the European states, the Romanian healthcare sector deals with major challenges caused by aging, changes in the risk factors to population health, the number of healthcare personnel and the economic pressure caused by crisis. The demographic challenges exert a constant pressure on the health services in terms of accessibility, need and costs. In this general context, the pharmaceutical sector and the personnel faced an increasing request not only for medicines, but also for other complementary health services, being forced to play a significant role in providing quality health services at efficient costs (DiPietro Mager and Farris, 2016; Egorova and Akhmetova, 2015).

Although in the 1990s the health status of Romanians improved due to increasing resources available for health, and due to economic development (National Institute of Public Health), in Europe, Romania has one of the lowest life expectancies, with an average of 75 years – about 5.6 years below the European average. This value can be explained by the delay in the transition process and the fact that healthcare was not a priority in the government policies after 1990 (Leopold and Vogler, 2010). If we add in the decrease in available health resources caused by the 2008/2009 economic recession, the resultant consequences indicate a deterioration in population health status compared to other countries in the region (European Commission report, 2017).

The percentage of expenditure allocated to healthcare from the GDP over the last decade ranks Romania among the last places in Europe (4.9% in 2015, decreasing compared to 2014; about 814 euro/person), with increased expenditures for medical products (37%), but with a small amount allocated to preventive healthcare (0.8%) (Eurostat data). These facts also reflect in the following index values: DALY (Disability Adjusted Life Year), YLD (Years Lived with Disability) and YLL (Years of Life Lost). The values calculated for these indicators in 2016 registered the following rates: 36,513.95 for DALY, 13,531.60 for YLD and 22,982.34 for YLL. According to the latest data released by the WHO, Romania loses an average of 16,000 years of active life to disease and disability per 100,000 persons over their lifetime (Ministry of Health, 2014; IHME, 2016). Therefore, Romania is listed among the countries with the highest burden due to disease in the ECE. Over 40% of the general burden of disability in 2015 (measured in DALY) can be attributed to behavioural risk factors, including smoking and alcohol consumption, food risk and poor physical activity (IHME 2016). Studies proved that high values of DALY can cause financial losses that influence the level of economic development in a country.

Despite the fact that 78% of the healthcare expenditures are publicly financed , personal costs (both formal and informal) are higher than the European average (Tambor et al., 2014; Björnberg, 2016). Also, the evolution of sales for medicines for the last period shows an increasing trend for medical products (Institute of Economic Prognosis, 2012). These facts confirm the lack of significant actions from the public authority to transform the healthcare system in Romania.

2. Research materials and methods

"Accessibility" can have a broad meaning, but in this research paper it refers to physical accessibility determined by walking or driving distance between the residential area and the locations of pharmacies. Therefore, in order to determine the accessibility of the population to pharmacies a database was set up

including the locations and density of pharmacies within city districts, population density within districts, and the street network retrieved from Open Street Map and subsequently completed with public transport routes and their directions.

The case study consists in a GIS-based spatial analysis regarding the distribution of pharmacies in Craiova city and the geographical accessibility of the population to these medical services. The analysis method used to determine the accessibility was a straight-line distance measurement (Euclidean distance in ArcMap) or the buffer method (Flater, 2011). Thus, in order to determine mainly the walking accessibility of the population to pharmacies, 150-m, 300-m, 500-m and 750-m buffers were considered and buffers of 1 km, 2 km and 3 km if another means of transport was used.

The study used the most recent demographic data, geographic data, other statistic data (number of pharmacies, public transport data) provided by the Regional Department of Statistic and field information acquired by researchers. City districts were delimited by processing and digitising information available in different existing cartographic sources (Open Street Map, old city maps, online city map – https://www.nanoterra.ro/harti/craiova.html). Statistical data were processed in the GIS environment (using the ArcMap 10.5 software functions) to analyse the spatial distribution, density and geographic accessibility of pharmacies. Field investigations were made to check the location of pharmacies using a GPS and to verify the opening hours. The number and location of all existing pharmacies were correlated with the number and density of the population in the districts of Craiova to see exactly which residential areas are facing either low access to, or a lack of, pharmacies.

The background regarding the regulation of the pharmaceutical sector in Europe and Romania, the general picture of population health status, and the accessibility of pharmacies in urban and rural areas, were rendered based on the interpretation of official reports and existing legislation.

3. Results and discussion

In addition to the existence of pharmacies, emphasis is also placed on accessibility to their services, representing an asset for the value of public health, especially in the context of the dismantling of many medical checkpoints, especially from rural areas (Egorova and Akhmetova, 2015). Pharmacies can easily become the most accessible healthcare facility for the public during extended opening hours, often without any prior appointment with a specialist. Thus, community pharmacies are often the population's first point of contact with a healthcare provider. In these cases, pharmacists also become healthcare providers (Horon et al., 2010; Lakić et al., 2012). That is why, besides the opening hours, accessibility in terms of distance and time is very important. In the EU, approximately 98% of citizens can reach a pharmacy within 30 minutes, while only 58% have their nearest pharmacy 5 minutes away. In 2016, at European level, the average density of pharmacy was 31/100,000 people, while at the national level it was only 40/100,000 people. Romania, with 7,932 pharmacies, had the same density as Ireland, with a total number of 1,818 pharmacies. Presently, there is one pharmacy for every 2,500 people.

For the case study, the area of analysis is represented by Craiova city, the seat of Dolj county. It is one of seven national urban growth poles, and the most developed urban settlement in the South-West Oltenia development region, with a population of 305,946 inhabitants (Regional Direction of Statistics, 2018) and an average density of 3,758 inhabitants/km^2.

Craiova city holds 44% of the urban population of Dolj county and 161 pharmacies (43% of the total number in the county), without taking into account the pharmaceutical points located in hospitals or those with special status. The average value is 1/1,888 inhabitants, exceeding the national average. This value clearly shows that the demographic criterion established by law for urban settlements, has been exceeded. The surpassing value can be explained by the pharmacies set up in commercial complexes, although these are not in great number. Officially, the authorities have declared that no new pharmacy can be established in Craiova. New phar-

macies can be set up only by buying a license from another.

Regarding the geographical distribution of all 161 pharmacies in Craiova municipality, the distribution pattern is relatively concentrated, as they are mainly located in the city centre and along the main traffic routes. Thus, the areas with the highest density (of 11–30 pharmacies) are located in residential areas, including the area of the municipal hospital. At the same time, the high pharmacy densities coincide with areas of high population density, in the ranges of 10,000–30,000 and over 30,000. There are also large areas with population density of 3,000–10,000 that have a low number of (or zero) pharmaceutical points within a range of 2–3 km. These areas are mainly located in the north-eastern, north-western and southern parts of the city, comprising largely residential areas developed after 2007. Besides these areas facing problems of accessibility, there are also certain isolated districts with lower population densities that have no pharmacy, but where there is at least one bus or tram station nearby that can facilitate access to a pharmacy (Fig. 1).

In terms of accessibility during opening hours, in Craiova city, there are six pharmacies open 24 hours a day, including weekends, and one pharmacy open between 8 a.m. and midnight. Three of these pharmacies are in the city centre, two near the municipal hospital and one in the most populated district, in the north-east of the city (Fig. 1). In addition, major pharmaceutical chains have pharmacies with late opening hours, up to 10 p.m. and short opening hours over weekends.

The spatial accessibility of pharmacies to pedestrians, but also by any means of transportation, is very important for the provision of basic services, especially in residential areas. The distances selected to calculate physical accessibility ranged from 150 m, 300 m and 500 m to 750 m (Fig. 2a), considering that a person can walk these distances in less than 5 minutes (Meshkini et al., 2014). Taking into

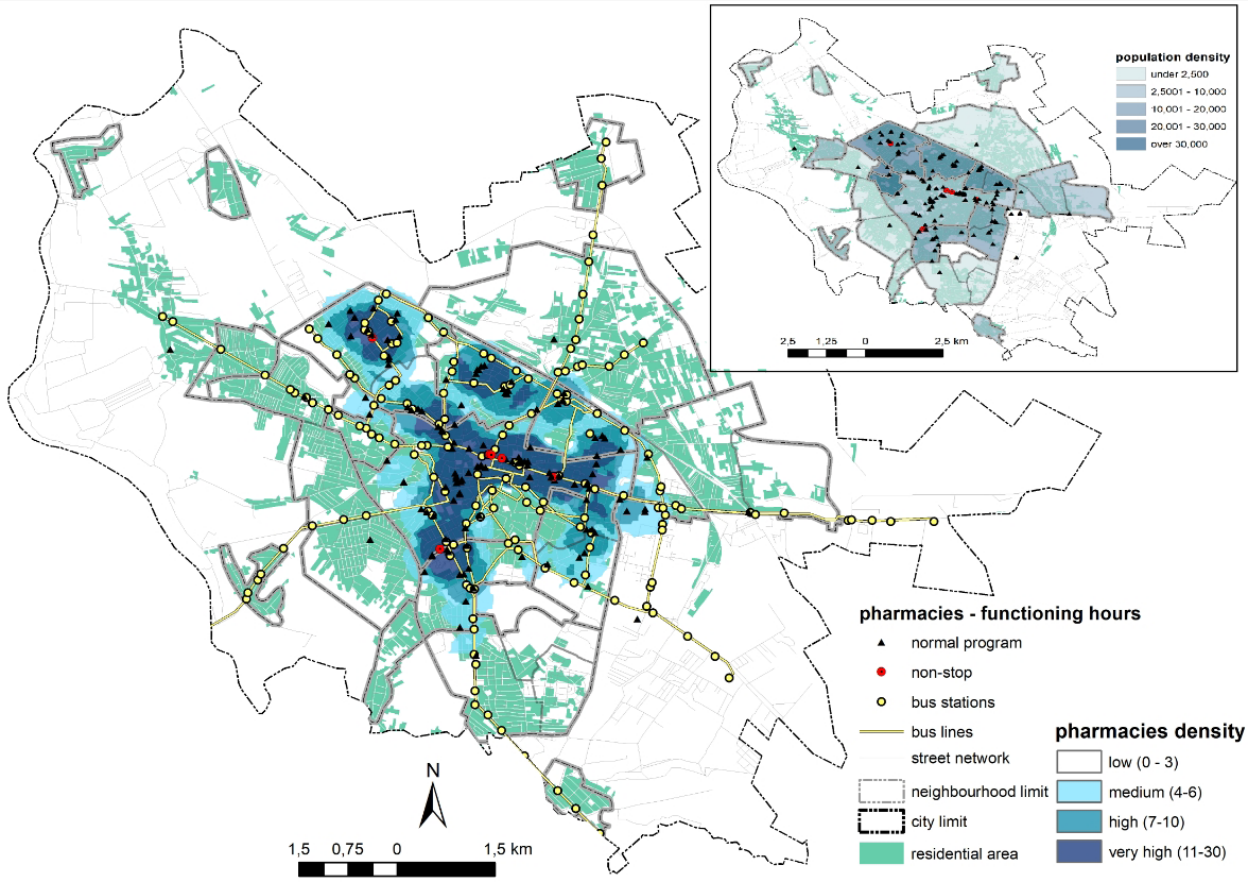

Fig. 1. Distribution of pharmacies in Craiova. Source: Author's own elaboration using ArcGIS 10.5

account that the maximum distance from the city centre to the outskirts is 4.5–5.5 km to the north or south and 8.5 km to the east or west, a straight-line distance of 1 km, 2 km and 3 km has been taken into account in the case of using public or private transport. These distances were selected taking into consideration that most of the pharmacies, including those with a non-stop programme, are located along the main traffic routes (Fig. 2b).

The results obtained show some disparities in the spatial distribution of pharmacies at the district level. Although accessibility is acceptable for most city residents, there are some aspects to be considered. As can be noted, all residential areas have access to a pharmacy within a maximum of 3 km driving distance. Also, if a person uses public transportation, distance buffers were used to calculate the percentage of pharmacies located close to the nearest bus station. The results indicated that 36% of pharmacies are located within 100 metres of a bus or tram station, while 89% of the pharmacies are at most 300 metres from such a transport station. Among the pharmacies with non-stop opening hours, 50% are within 100 metres of a bus station and 100% are within 300 metres. Of course, whene considering accessibility using public transport, one should take into account the time and distance from the home to the bus station and the travel period that can be added to the distance. In this case, the disadvantage of difficult accessibility is present in isolated districts of the city – those in the north-west and south (Fig. 1). But this aspect may not be so important, as these areas are mostly new residential areas that developed over the last decade, and most residents use personal transport to travel (Vîlcea et al., 2018).

4. Conclusions

The present study identified no major problems concerning spatial accessibility, but we need to consider that the use of straight-line distance (Euclidean distance) does not provide the best results because it simplifies reality without taking into account the barriers that may occur while getting around the city on foot or by driving. This method is often used as it is easier to understand. It is usually used in geoprocessing stages that involve the analysis of proximity or distance.

Given the slow, but positive, evolution in the number of pharmacies in Craiova city, up to the point of exceeding the threshold imposed by the demographic criterion, it can be concluded that the community pharmacies in Craiova may be associated with a public health hub for the general public. Besides their main role, the community pharmacies are also primary monitoring or investigation points. Therefore, pharmacies often participate, together with other partners in the healthcare field or with the authorities, in campaigns to disseminate information about the incorrect use of antibiotics, the need for cancer screening or the effects of smoking, or to promote a healthier lifestyle. Most of the pharmacies provide other health services, such as blood

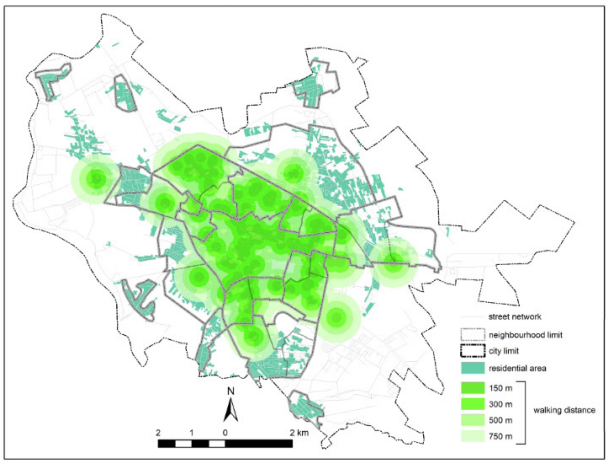

Fig. 2a. Accessibility by walking (straight line)

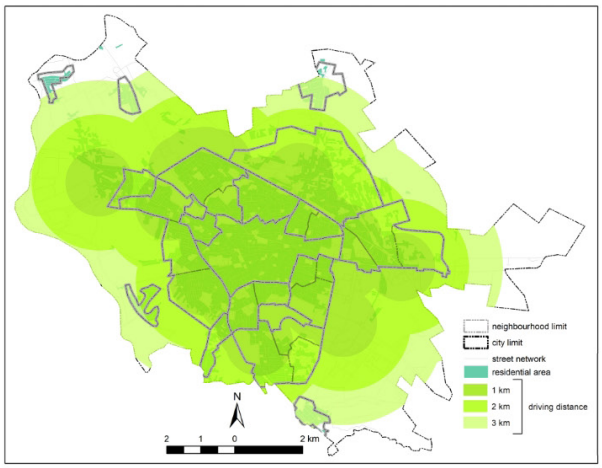

Fig. 2b. Accessibility by driving (straight line)

pressure measurement, free glycaemia tests, calculation of body mass and fat index, etc. that allow a person to detect possible health problems in time.

In conclusion, the spatial analysis showed a trend of urban clustering of pharmacies, with a central distribution pattern explained by the existence of the most attractive locations, in terms of accessibility, and a concentration of services that generate large flows of people most of the time. Access to a community pharmacy is not difficult and the number of pharmacies may increase, especially in the metropolitan area of Craiova city, as new authorisations can no longer be issued for Craiova city. Taking into consideration the fact that the residential areas recently developed out towards the rural area surrounding the city, new pharmacies may be established nearby.

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