Financial assistance in areas with low access to primary health care: a review of policy methods in Belgium

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Abstract

In some countries, financial assistance is awarded to physicians who settle in an area that is designated as a shortage area, to prevent unequal access to primary health care. Policy makers use fairly simple methods to define health care accessibility, for example physician-to-population ratios (PPRs) within predefined administrative boundaries. Our purpose is to check whether these methods give accurate estimations of health care accessibility. More in particular we test the potential of various floating catchment area (FCA) methods. The basic PPR method offers only a crude representation of health care accessibility, because large contiguous areas are considered. Local variations can therefore often not be detected. The enhanced two-step floating catchment area (E2SFCA) method is able to calculate accessibility at a small scale (e.g. census tracts), takes interaction between physicians into account, and considers distance decay. The resulting accessibility is much more geographically spread and offers a better representation of reality. Therefore this method is preferable used by policy makers to define shortage areas for awarding financial assistance.

Keywords: Primary health care, accessibility, geographical information systems (GIS), floating catchment area (FCA)

1 Introduction

Primary health care is the first line of defence for the population and can therefore prevent or reduce unnecessary, expensive speciality care [1–3]. To prevent unequal access to primary health care, health service planners and policy makers need accurate measures of accessibility, so shortage areas can be identified, to award financial assistance to physicians who settle in such areas [3]. An example is Impulseo I, an incentive program in Belgium. Physicians receive €20,000 when they settle in a physician zone with a low physician-to-population ratio (PPR < 90 physicians/100,000 inhabitants, or PPR < 120 physicians/100,000 inhabitants and population density < 125 inhabitants/km^2) [4]. A physician zone is a contiguous geographic area of one or more municipalities.

As can be deduced from the parameter in Impulseo I, and also from other incentive programs [5], policy makers currently use fairly simple methods to define health care accessibility and shortage areas. Geographical information systems (GIS) offer a wide range of more advanced methods to calculate physician density and shortage areas. Therefore, GIS can help policy makers to examine access needs, to better identify shortage areas, and to monitor the impacts of intervention policies [6], [7]. GIS are software tools for researchers or policy makers to input, store, manipulate, analyse, and visualise spatial information [8].

2 Background

2.1 Potential spatial accessibility

Health care accessibility can be classified into two categories: revealed and potential accessibility [9–11]. The former focuses on the actual use of health care services, while the latter focuses on the aggregated supply of available health care in an area and thus the potential use of services. Both can be further divided into spatial and non-spatial accessibility. Spatial accessibility is based on spatial factors, including the distribution of primary health care providers (supply) and population (demand), and the distance/time between supply and demand [12]. Non-spatial accessibility is based on non-spatial factors such as socio-economic factors, the health status of the population, and people's knowledge about the health care system [9], [12]. In this paper, we will focus on potential spatial accessibility (henceforth briefly referred to as accessibility), because it is essential toward any effective government intervention program to identify where potential shortage areas are located [2], [13].

2.2 Measures of potential spatial accessibility

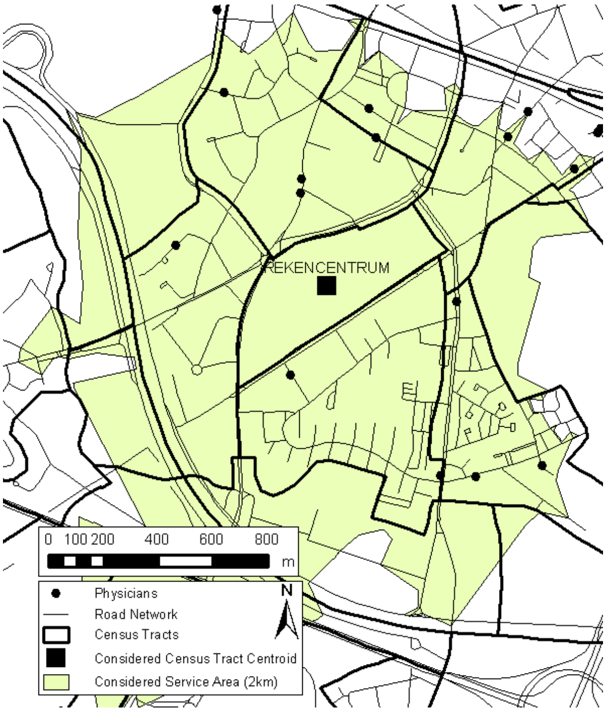
To calculate primary health care accessibility in general and physician shortage areas in particular, various methods can be used. Simple methods include distance/time to the nearest physician, and the number of physicians within a certain distance/time [14]. However, these methods often give only a rough estimation of accessibility. Distance to the nearest provider for example does not capture full accessibility, because it is often observed that people bypass the nearest service when there is more than one service to choose from [15], [16].

Physicians co-exist in a network of overlapping catchments, and people are free to choose health care wherever and from whomever. Therefore, physicians compete for the population's use of their services [16]. Because there is no single pathway between the population and physicians, some methods are based on PPRs to measure accessibility in a certain area, as is the case in Impulseo I. The advantage of this method is that it is easy to implement and comprehend. However, these traditional PPRs have several limitations [17–19]. First, PPRs are usually calculated with zonal data, which are based on administrative boundaries (e.g. municipalities).

In Impulseo I, PPRs are calculated per physician zone, which have a median area of 86.53 km^2 with a median population of 36,613. When using administrative zones, boundaries are considered impermeable and as a result, the interaction across borders is not sufficiently taken into consideration [9], [13]. Secondly, the distance between the population and physicians is not equal for all inhabitants of the considered zone, which causes accessibility to vary within a zone [13]. However, the PPR method assumes equal access to services independent of where they live in the zone [8].

A method that overcomes these limitations is the floating catchment area (FCA) method [2], based on Peng [20], who used a similar method to calculate job accessibility. To execute this method, only population data and the location of physicians are needed. In this method, a circle (catchment) of some reasonable radius centered on the census tract centroid is used as the basic unit instead of using a predefined administrative boundary to calculate PPRs [2]. Because catchments are used instead of administrative borders, crossing of borders is now possible. This can be seen in Figure 1, where an example of a catchment from a census tract centroid is shown. This catchment is strongly related with the road network and intersects with the census tract boundaries. FCA-based methods have the advantage of calculating accessibility on a much smaller scale than is feasible with PPRs [19]. The catchment radius is defined as the maximum distance/time, where all physicians are considered accessible and equally proximate to that particular population (centered at the census tract centroid). The catchment that is hereby formed floats from census tract centroid to census tract centroid, hence the name of the method.

Figure 1: Example of a service area around a census tract centroid, which show the alignment with the road network and the intersection with the census tract boundaries.



A shortcoming of the FCA method is that it assumes that all physicians within a catchment are fully available for all residents. This assumption is faulty because physicians at the periphery of the catchment can also serve people from outside the catchment [8]. To overcome this limitation, Luo [21] proposed the two-step floating catchment area (2SFCA) method, based on the spatial decomposition idea by Radke & Mu [22]. The major change is that the PPR is calculated from both the physician location and the population location. This way, the method considers interaction between population and physicians [8], [16].

Both in the FCA and 2SFCA method, the assumption of equal accessibility within the catchment and no accessibility outside stands [19], [23]. The enhanced two-step floating catchment area (E2SFCA) overcomes this by applying a distance decay function [3]. Each catchment is divided into multiple sub catchments, which receive varying weights. By doing this, it is accepted that services that are closer to the census tract centroid are more accessible. This E2SFCA method is now considered the standard FCA method, and is used in a variety of studies [3], [24], [25].

The purpose of this paper is to check whether the current, simple calculations used by policy makers are accurate enough to define shortage areas based on physician density and whether or not more advanced GIS methods give better estimations of health care accessibility for our case study of Belgium.

3 Data and methods

3.1 Data

The study area of the paper is the whole country of Belgium, with a population of about 10.8 million inhabitants in 2009 on an area of 30,528 km^2. Belgium is divided into 161 physician zones, 589 municipalities, or 19,781 census tracts. Population data per census tract is available for the year 2011. The addresses (of 2011) of all physicians in Belgium with at least 500 patient contacts per year were geocoded at the street level.

3.2 Methods

All calculations were performed in ArcGIS 9.3^{TM}. First, PPRs and population densities were calculated, per physician zone, and per municipality.

Second, three FCA-based methods were executed per census tract, because in these methods administrative borders can be crossed. Based on other studies [8], [14], the FCA and 2SFCA were performed with a catchment of 5 and 10 km. Following McGrail [16], in the E2SFCA, we used the following slow step-decay function: 1, 0.80, 0.55, and 0.15, respectively for the catchments 1 km, 2 km, 5 km, and 10 km. Our maximal value is limited to 10 km because population and physician density in Belgium is relatively high and therefore taking greater distances/times into consideration is not necessary.

Where distances needed to be calculated, these were calculated along the network, instead of using straight-line distances, because this is more realistic [2], [14]. We prefer to use network distances above times, because we did not want to differentiate between different transportation modes.

Shortage areas are defined in the PPR method using the same condition 1 as in Impulseo I. In the FCA based methods this condition is also used, however only the PPR parameter, since population density is indirectly incorporated in the FCA methods because all catchments have equal sizes, which is not the case when using predefined administrative borders.

The different methods are compared with the official Impulseo I method using a bar graph, showing the number of census tracts which are underserved or not. The results of the PPR methods and the E2SFCA method are also visually presented in various maps, showing the area of Ghent, indicating which census tracts are considered shortage areas.

4 Results

4.1 PPR per physician zone and per municipality

Physician zones cover large areas, and therefore the zones where financial assistance is given or not are large contiguous areas, as can be seen on Figure 2. In total 41.2 % of census tracts (8,157 from a total of 19,781) lie within a physician zone that is considered a shortage area.

Because physician zones cover large geographic areas, we calculated the PPR per municipality, using the same condition as used for the physician zones. Figure 2 shows that the ascription of financial assistance is now more geographically diversified, indicating differences within physician zones that are not visible with the official method. This makes it possible to give financial assistance to the areas that need it the most. Also, 9,498 census tracts are now considered as shortage areas. From Figure 3, there can be seen that 5,841 census tracts are in both methods considered as shortage areas and 7,967 census tracts are in both methods considered as non-shortage areas. There are however 2,316 census tracts that were considered as shortage areas, that are no longer seen as shortage areas and 3,657 the other way round. This means that 69.8 % of all census tracts are considered the same in the two methods and 30.2 % differently.

4.2 FCA, 2SFCA, E2SFCA

The first FCA-based method is the original FCA method. From Figure 3, we can deduce that when using a 5 km catchment 6,790 census tracts are considered as shortage area and 12,991 are not. Also, 12,620 census tracts (63.8 %) are considered the same in both methods, and 7,161 (36.2 %) are not. When using a 10 km catchment 4,916 census tracts are seen as shortage area and 14,865 are not. 13,112 census tracts (66.3 %) are in both methods considered the same, and 6,669 (33.7 %) are not.

Following is the 2SFCA method. From Figure 3, we can deduce that when using a 5 km catchment 9,024 census tracts are considered as shortage area and 10,757 are not. Also, 11,682 census tracts (59.1 %) are considered the same in both methods, and 8,099 (40.9 %) are not. When using a 10 km catchment 8,121 census tracts are seen as shortage area and 11,660 are not. 12,183 census tracts (61.6 %) are in both methods considered the same, and 7,598 (38.4 %) are not.

Finally, when using the E2SFCA method, we can see from Figure 3 that 8,968 census tracts are considered as a shortage area and 10,813 are not. 11,914 census tracts (60.2 %) are in both methods considered the same, and 7,867 (39.8 %) are not. When using this method, the ascription of financial assistance is geographically diversified even further (Figure 2).

Figure 2: Map of a selected area of Ghent showing in which census tracts physicians receive financial assistance when settling there, using the i) PPR per physician zone (official Impulseo I method), ii) PPR per municipality, and iii) E2SFCA method (0 means no financial assistance, 1 means financial assistance).

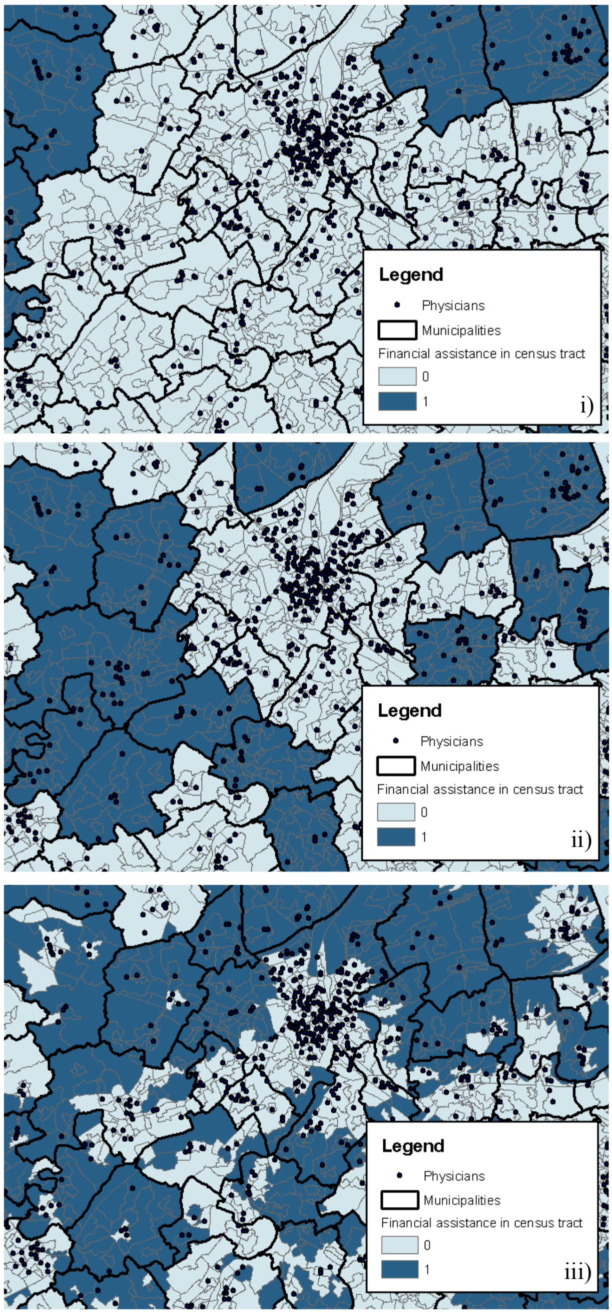
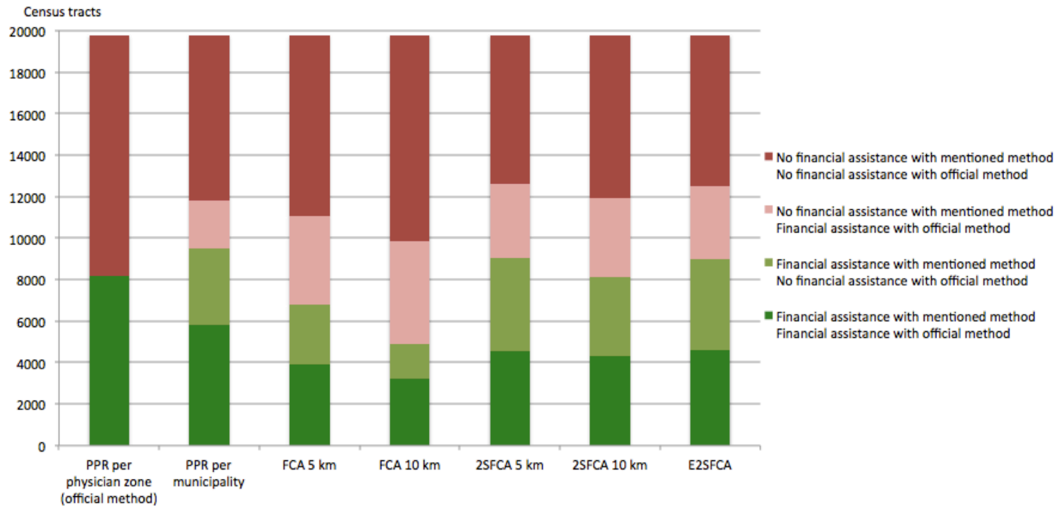


Figure 3: Bar graph showing the results from the different methods.



5 Discussion

5.1 General discussion

Policy makers often define shortage areas by calculating PPR per physician zone, for the simple reason that it is an easy calculation and it offers an understandable measure of accessibility. The advantage of this method is that it considers both the number of physicians and the population within the zone. However, it only offers a very crude representation of access to primary health care because physician zones cover large geographic areas [17–19]. When calculating PPR per municipality, we see that there are slightly more census tracts that are considered shortage areas. This means that when using physician zones some municipalities are not considered as shortage areas, while in fact they should be. There are however also some municipalities that are wrongly considered as shortage areas. There can nevertheless be variations at an even smaller scale (e.g. census tracts), which cannot be detected using this method. Another disadvantage of this method is that interaction across borders is not sufficiently taken into consideration [9], [13].

FCA based methods overcome these limitations by looking at both the supply and demand side, and by not using predefined administrative borders. Another advantage is that the analysis can be done at a very small scale (census tracts) [14], [16]. From our results we see that when using the FCA method with a catchment of 5 km there are slightly less shortage areas than when the PPR method is used. This is even more visible when looking at the results of the FCA method with a 10 km catchment. The reason for this is that the FCA method does not take interaction with other physicians into account. In the 10 km catchment there are a lot of physicians that are considered accessible while they are in fact not. When using the 2SFCA method we see a higher amount of census tracts considered as shortage areas because this method does take interaction/competition between physicians into account. Here we also see that with using a larger catchment, less census tracts are considered shortage areas, again because there are more physicians within the catchment. The E2SFCA method is preferred because this method reckons with distance decay by using a weight function [3], [8]. The use of this weight function results in slightly more shortage areas compared to the 2SFCA method, because only the physicians close to the census tracts centroid are highly accessible, which decreases overall accessibility.

When comparing the results of the official Impulseo I method (PPR per physician zone) with the results of the E2SFCA method, we can see that the ascription of financial assistance is much more geographically diversified (see Figure 2). It is striking that the defined shortage areas follow the distribution of physicians much better when using the E2SFCA method. Therefore we suggest that in the future policy makers use more advanced GIS methods (e.g. the E2SFCA method) to identify shortage areas and award financial assistance to prevent unequal access to primary health care.

5.2 Study strengths and limitations

This study has several strengths. First, previous studies are all regional, while ours is nation-wide. A disadvantage of a regional study is that there can occur edge effects, because people can also go to a physician in a neighbouring region [2]. Our nation-wide study limits this, because it is less likely that inhabitants of Belgium will go to a doctor in a neighbouring country. Also, with our nation-wide study, we can link our results with the conducted policy of the entire country to check whether the policy decisions correspond with the scientific results. Second, most previous studies using FCA-based methods use the centroid of the municipality where physicians live as physician location [2], [3], [13], [21], whereas we use the exact location of physicians. Third, distance in this study is not considered following a straight line, but following the street network. In many studies (e.g. [2], [14]) the lack of using street network data is considered a major limitation.

However, this study also has some limitations. First, accessibility is considered from the home location. However, people can also access primary health care from their working location, which can influence accessibility [13]. Nevertheless, people shall probably be inclined to go to a physician from their home environment they know, rather than a physician they don't know in person from their working location. Second, according to some studies, the size of the catchment should vary depending on whether it is urban or rural [3], [19], [23]. Despite the small differences between urban and rural populations in Belgium, adding a varying catchment size function (larger catchment sizes for rural populations) could improve the results.

6 Conclusions

Because of the simplicity of basic PPR methods, policy makers often use these to award financial assistance to shortage areas considering primary health care accessibility. Despite the fact that the PPR takes both supply and demand into consideration, a major disadvantage is its zonal approach. Considering the factors that influence potential spatial accessibility to primary health care (e.g. supply and demand), and because of the possible small geographical scale, FCA based methods are highly suitable to define shortage areas. Limitations that still occurred with the FCA and 2SFCA method are solved in the E2SFCA method, which on the one hand takes the interaction between population and physicians into account, and on the other hand considers distance decay by applying a weight function (which can be adjusted depending on the type or importance of a service). Also the E2SFCA method is based on the PPR, which makes it possible to use the same thresholds to define shortage areas. Besides road network data, no other extra data is needed to perform this analysis.

The use of such optimised methods causes a better measure for access to primary health care and thus a better distribution of finances (e.g. €20,000 per physician who locates in a shortage area), causing more help for the most needy populations. These methods can however also be used to define access to other services, e.g. dentists, pharmacies, and hospitals. Network data is more and more accessible, and the effective use of network analysis software makes it possible to easily calculate more advanced GIS measures.

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