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OASES

Promoting evidence-based reforms on medical deserts

D4.2-
Report on a Scenario Building exercise based on data available in countries: Input parameters

31/08/2022

Co-funded by the Health Programme of the European Union

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Contributors	Marie Bonal, Guillaume Chevillard, Fei Gao
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Introduction

In the OASES Project, disparities in access to care are considered through the lens of the WHO AAAQ (accessibility, availability, acceptability, and quality) framework, first developed for the concept of "effective coverage", then adopted for the health workforce (Campbell and al., 2013).

By effective coverage we mean the proportion of people who have received satisfactory health services relative to the number needing such services. Availability of the healthcare workforce covers the adequate amount of health workers and their competence in relation to the population needs. Acceptability refers to health workers´ abilities and characteristics (for example, language and age) which enable trustful relationships and treating patients with dignity. Accessibility means that healthcare workforce is equally distributed geographically, demographically and in different social and healthcare sectors. Quality refers to health workers´ competence and skills (WHO, 2016; WHO, 2021).

OASES project chose to focus mainly on availability and accessibility as mentioned in the deliverable 5.2, even if some partners have nevertheless included quality in their approach.

The objective of this note corresponds to the Deliverable 4.2 (based on the previous step: Milestone 15) of the OASES project which is related to the construction of a template based on the set of tools proposed by the work package 4 to approach medical desert focusing on the countries of the OASES project.

1 Framework for analysis

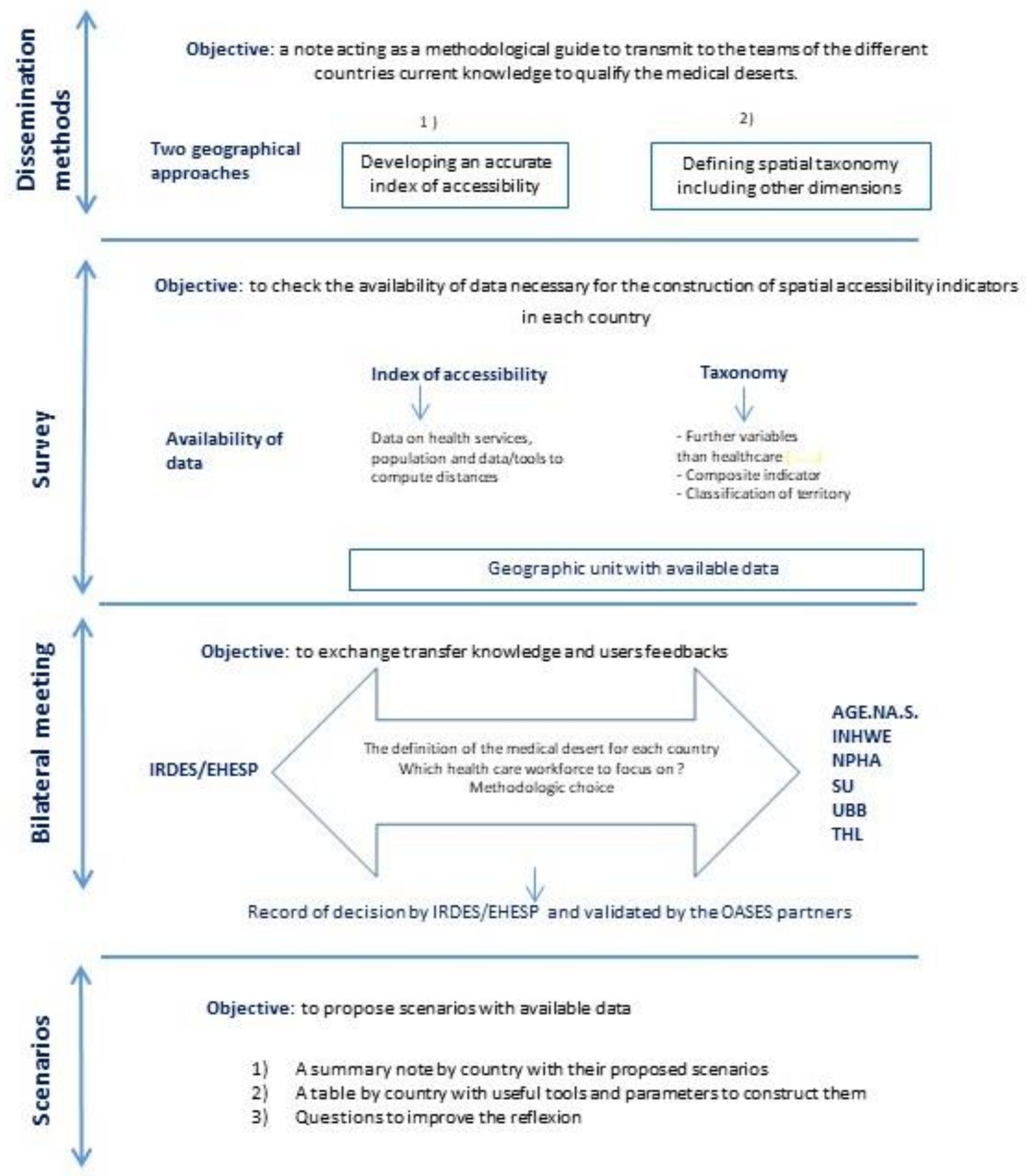
1.1 Process

The expression "medical desert" is commonly used in the public and mediatic field referring to several situations or areas where people have difficulties to have access to care. The identification of such areas has become a major issue and a challenge because 'the greatest obstacle to the application of the concept of accessibility lies in the difficulty of translating it in the form of operational indicators' (Handy and Niemer, 1997). This is exacerbated by the fact that the accessibility itself is complex to address due to its multidimensional nature (spatial, physical, temporal, financial, and cultural) (Penchansky and Thomas, 1981; Russel, 2013).

Beyond this difficulty linked to the polymorphic nature of the notion of accessibility, the way to qualify it also depends on the configuration of the healthcare system, indicators, and tools available in each country.

In this respect, first, a note acting as a methodological guide was transmitted by IRDES/EHESP to the partners of the OASES project to share current knowledge to qualify medical deserts. In a second time, a survey on data available was sent to the partners to help them to define their own indicators. Then, before proposed scenarios according to information on datasets availability, several steps have been needed between IRDES/EHESP and the other OASES partners to transfer knowledge, discuss and have feedbacks from countries (see figure 1).

Figure 1: Flow chart of the framework analysis



The dissemination guide contains current knowledge to define medical deserts (see deliverable 4.1). It refers to two geographical approaches consisting of: (1) developing accurate index of accessibility and (2) defining spatial typology including other dimensions than healthcare accessibility like population characteristics and spatial attractiveness. These two approaches are complementary and not mutually exclusive. Also, the degree of complexity of the accessibility indicator constructed by each country will depend on the type of typology that may be mobilized (e.g. balance of dimensions).

1.2 Survey

Before sending the survey to all countries, a presentation and discussion of expectations have been presented during one of the global meetings with all countries.

Each participating team was invited to assess the availability and accessibility of different datasets in their own country and provide datasets examples (see deliverable 4.1). With all information on the availability of detailed datasets, all possible scenarios were analyzed in order to determine the elementary, intermediate and advanced sets of parameters for the qualification of medical deserts. The methodology support could be a spatial accessibility index to identify and / or a spatial typology to describe medical desert.

1.2.1 Building spatial accessibility index

The deployment of potential spatial access measures requires the specification of a set of six input parameters, namely: (1) a spatial unit of reference for the population, i.e. a definition of residential areas (e.g. census tracts); (2) an aggregation method, i.e. to determine the point of each residential areas where population and supply will be counted; (3) a supply/demand measure; (4) a supply/demand interactions modelling method (5) a type of distance to be used in computing the accessibility measures selected (Apparicio 2008) and (6) an accessibility measure (see table 1).

Table 1 : Scenarios on accessibility measures according to available data

	Spatial unit of reference	Aggregation methods		Supply/Demand volume		Accessibility measures	Types of distance
		Health services/professionals (HS/HP)	Population	HS/HP	Population		
Elementary ↓ Advanced	-Region -Department -Postal codes -Census tracts -Census blocks The choice depending on data availability of each participating country Data: maps shapefiles (shp)	-At spatial unit's centroid Data: geocoded centroid of spatial unit (latitude, longitude) -At their professional addresses Data: geocoded professional addresses (latitude, longitude)	-At spatial unit's centroid Data: geocoded centroid of spatial unit (latitude, longitude) -Population weighted mean center Data: distribution of population/ residential buildings maps	-HS/HP number Data: number of HS/HP by type for each spatial unit -HP FTE Data: full time equivalent (FTE) of HP by type by spatial unit	-Population volume Data: population distribution by age and sex for each spatial unit	-Physician-to-population ratio -Distance to the closest HS/HP -Two-step floating catchment area (2SFCA) methods -Enhanced 2SFCA with decay function Data: global travel behavior of patients when they look for a type of HS/HP.	-Euclidean distance -Shortest network distances -Shortest network travel time on foot, by car, by bicycle, or by public transit Data: road network, sources of data on bicycle paths, general transit feed specification (GTFS) files

1.2.2 Building spatial typology

To describe medical deserts according to the specificities of each country, three approaches are possible: one single variable, a composite index as a global view and a categorization of your geographical units. The deployment of spatial typology requires the input parameters (1) availability of variables in other domains than healthcare and useful to describe the territory, (2) availability of composite indexes that already exist and are validated in the country and (3) the definition of the suitable geographic unit (table 2).

Table 2 Scenarios for spatial typology

	Spatial unit of reference	Selection of the dimensions	Method to aggregate dimensions
Elementary	Region (NUTS2) Department (NUTS3)	Selection of the dimensions according to the characteristics of the country and the health care system &	Composite index, single variable by dimension
Advanced	Municipalities Census block	the availability of data to present these characteristics	Principal component analysis (to select appropriate factors for each dimension) and typology to define classes of geographic unit according to dimensions combined

2 Results

2.1 Scenario building synthesis

Based on summary notes of each country with tools and indicators proposed, suggesting scenarios of accessibility measures is performed at three levels: elementary, intermediate and advanced.

To identify the levels of scenarios, we considered three criteria:

1) Scope of health professionals: elementary when the study focuses on a category of health professional and advanced when the study covers several health professionals.

2) Ambulatory/hospital: elementary when the study focuses only on ambulatory care and advanced when the study focuses on ambulatory and hospital care.

3) Cross referencing of indicators: elementary when the methodological approach is by health professionals/services (the indicators on accessibility to the various health professionals are studied one by one and are not crossed). Advanced choice when analysis is as an integrated approach (the indicators on accessibility to different health professionals are crossed by means of a typology or a composite indicator for example).

2.2 Characteristics of indicators chosen by countries

The main input parameters used for the construction of the indicators of all countries are summarized in Table 3[1].

Most of the countries have included general practitioners or medical doctors and nurses as health professionals selected (Finland, Hungary, Moldova, Italy and France). Only Romania has focused on geriatrics and gerontologists[2]. The field selected refers to the key role of primary care in health system which has been promoted for a long time by the World Health Organization as "the first level of contact of individuals with the national health system" (WHO 1978, 2018).

In a more extensive definition of primary care (Donaldson and al., 1996; Muldoon and al., 2006), France, Hungary and Italy wish to broaden the scope of the professions and services considered. Although there is a very large number of professions involved in the field of primary care, some health professions could be qualified as “daily partners” of GPs (pediatricians, nurses, physiotherapists, pharmacies, medical laboratories and radiology practices) considering the strong complementarity of their activity with that of GPs. It also refers more broadly to their role in the health care system with regards to ambulatory shift (return to home) and coordination process linked to a growing and changing demand for care due to the increased prevalence of chronic pathologies and multi-morbidity. Beyond primary care, the proposal of France also includes a part of hospital care taking into account emergency care. France considers, as the French Ministry of Health does, that for a medical desert of first necessity it is difficult to exclude emergencies because getting an immediate response to a need for care - especially when it is a life-threatening emergency - is essential (Vergier and Chaput, 2017). Italy considers an even broader range of hospital care. With regard to the quality of services and access by population groups, the data produced by AGENAS within the framework of the National Outcomes Evaluation Programme (https://pne.agenas.it/) will be used, starting from the data of the Hospital Discharge Forms. This tool, configured as an observatory on hospital care, is able to analyse the variability of outcomes and care processes between providers and population groups, and also to provide an indirect representation of primary care. Some indicators, referring to ambulatory care sensitive conditions, will provide an indirect measurement of the quality of primary health care and continuity of care services[3]. With regard to considering healthcare professionals other than medical doctors, while regarding it as a hypothesis to be examined, Italy reports some measurement issues due to the difficulty in finding the necessary data.

[1] Data for Cyprus are missing for the moment.

[2] Romania is already involved in another project about medical desert (AHEAD Project). It is therefore important to avoid overlap between the two projects and to work in a complementary manner. For the AHEAD project they already study medical desert through the lens of family doctors, pediatric doctors and community nurses. So, for the OASES project they choose to focus mainly on geriatrics and gerontologists.

[3] Agency for Healthcare Research and Quality. Guide to Prevention Quality Indicators: Hospital Admission for Ambulatory Care Sensitive Conditions. October 2001. AHRQ Pub. No. 02-R0203: Guide to Prevention Quality Indicators: Hospital Admission for Ambulatory Care Sensitive Conditions (ahrq.gov).

Even for medical doctors, data are not publicly available, making it necessary to use data collected by a private subject. It is also to be noted that, while indicators have been defined, they are susceptible to adjustments following the results of calculation tests.

Concerning the geographic unit of reference, all countries decided to analyze medical deserts using indicators at a geographic level equal or higher than municipality, but not lower. It is a fine administrative scale employed to calculate average distances or integrated into XSFCA-type indicators that combine availability and distance (France). However, we know that municipalities level has its limits (particularly for primary care where distances are small) because it is assumed that the distance between inhabitants and health professionals in the same municipality is centered on one point (the center of it or the city hall point)[4]. Nevertheless, a reasoned approach is therefore to use this level for two purposes: the first one is because municipality is often the finest level available for a national approach based on medical-administrative and population data. The second one is to use an observation unit large enough to allow geolocation and respect the technical constraints of processing capacity when calculating the indicator on the whole national territory. When the indicators are calculated at a higher geographical level, the classic spatial accessibility indicators of density or distance are calculated on geographical units that correspond either to the availability of data (at the level of raion in Moldova, county for Romania and JARAS for Hungary) or to the local/intermediate level of organization of the health care system (county in Finland[5], local health unit or administrative divisions mobilized for the planning of health resources (region and province) in Italy).

The major difference between countries was in the choice of measure of accessibility. Of the 6 countries, all have decided to use the density indicators for some or all health professionals/services (Moldova, Romania, Hungary, Finland, Italy and France), 3 countries plan to use distance too (Finland, Italy and France). The choice of the last indicator reflects both the importance of this criterion for some countries, given their size and the dispersion of the population in their territory as in Finland, and the technical possibility of calculating this indicator for the whole country which is limited at this time (for Moldova and Hungary[6] for example). In addition, only France plans to use at this time the more complex measure, named 2 steps floating catchment areas (2SFCA), which combines density and distance in one single measure. The principle of the xSFCA indicator is to take into account the supply of care and demand in the geographical unit under consideration, but also that of the surrounding geographical units (see annexes 1 and 3). The French indicator, called local potential accessibility (LPA), has been adapted to the French context to take into account the level of activity of practicing professionals as well as the age structure of the population in each municipality (Barlet and al., 2012), which influences the need for

[4] The choice of the municipality as the geographical level tends to underestimate the access time to health care if the municipality is large and the population or medical supply is dispersed (unbalanced for example). It can also on the contrary overestimate the access time to health care (if certain populations living on the edge of the municipality can have access to a closer supply in the neighboring municipality). Moreover, the diversity of size (surface) of the municipalities makes the measurement exercise heterogeneous from one municipality to another. Finally, in big cities there are important disparities which are masked by a municipality level. It's essential to foreground that medical desert don't concern only rural areas but also deprived urban areas. That's why it could be interesting to study differences in access to care at a sub-municipal level (Lucas-Gabrielli, Mangeney 2019).
[5] The Finnish health system is decentralized because primary care is managed independently at the municipal level. There are therefore major disparities between municipalities, which do not all have the same resources or the same organization. But the system is changing: the organization of primary care is expected to move to the county level by 2023. Indicators will be computed at the municipal and county level.
[6] For Hungary, lack of GIS files that distinguish the different types of roads might generate biased results about medical deserts.

care. It is an indicator commonly used in France to measure spatial accessibility to primary care, profession by profession (general practitioners, nurses, physiotherapists, dental surgeons)[7].

[7] The indicator has also been calculated for medical, surgical and obstetrics facilities (acute care) and Postoperative and Rehabilitation Care facilities in the North of France (Gao 2021), developments are underway to define it for outpatient specialties too at the national level.

Table 3 Main input parameters included in the indicator's construction by country

Field of health professionals/ services	Spatial unit of reference	Aggregation method	Supply/demand volume	Accessibility measures	Types of distance
Finland					
Health center medical doctors and nurses	County (future health and social services areas) (NUTS-3) Municipality (LAU)	At spatial unit centroid for the population Health Professionals (HP): address of the health center	Number of visits and consultations Population volume	Density Distance	Average distance to the nearest health center (km) by municipalities
France					
General practitioners, nurses, physiotherapists, pharmacies, medical laboratories, radiology practices and emergency services	Municipality (LAU)	At spatial unit centroid for services and population	FTE of HP or number Population volume (weighted by age or not)	Density Distance 2SFCA indicators according to services analysed in a spatial typology	Distance to the nearest service (minutes)
Hungary					
General practitioners, nurses, pediatricians, dentists, and some other primary health professionals to define	Sub-county (LAU-1)	At spatial unit centroid for services and population	Number of HP Population volume	Density	None

Table 3 (continued))

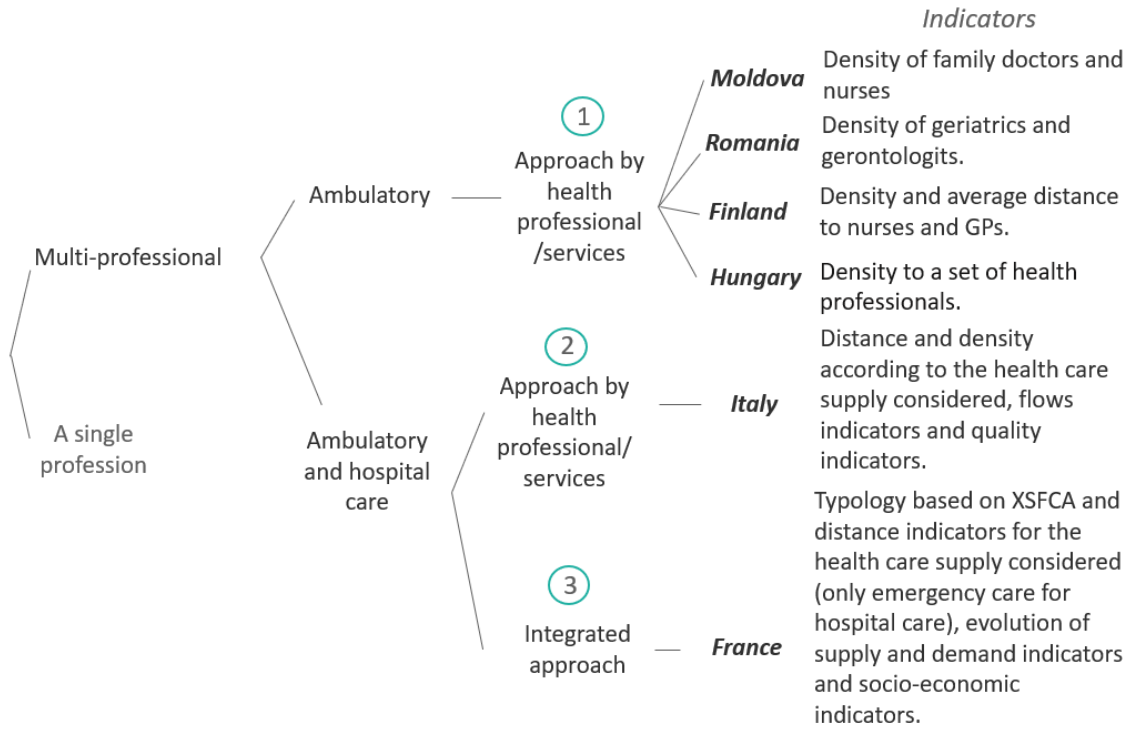
Italy*					
By group of health professionals (Ambulatory and hospital care)	National, Regional (NUTS-2), Province (NUTS-3); Local health unit**; Municipality (LAU)	At spatial unit centroid for services and population	Number of HP Population volume and specific focus on particular user	Density Distance	Average distance to the nearest service (km)
Moldova					
Family doctors and nurses	Raion***	At spatial unit centroid for services and population	Number of HP Population volume	Density	None
Romania					
Geriatric Gerontologists	County (NUTS-3) Villages, towns and cities (LAU)	At spatial unit centroid for services and population	Number of HP Population volume (weighted by age)	Density 2SFCA in a next step	None

* Italy considers three pivots: availability (presence and coverage), quality (performance and protection) and equity (accessibility and usability) in the definition of medical deserts. See next part for more details on the scope of services.
** local health unit: local public bodies responsible for the management of healthcare services in Italy.
***raion (administrative units ranging from 295 to 1546 square km).

2.3 Three levels of scenarios identified

In accordance with the scenario building synthesis described above (see figure 2), the countries in each of the defined levels were analyzed. Different scopes of health professionals / health services were considered in the building of indicators, but all the countries deal with at least more than one health professional.

Figure 2 Diagram of the three levels of scenarios identified



First level: <u>multi-professionals with an ambulatory approach focused on primary care</u>

Finland, Hungary, Moldova, Romania focus only on the scope of primary care. Moldova and Finland plan to focus on GPs (medical doctors) and nurses, Hungary on general practitioners and other primary health professionals and Romania on geriatrics and gerontologists health care professionals. To take into account the medical deserts according to these professionals, Hungary, Moldova and Romania have chosen the density as indicators. Finland plans to use density and distance to health professionals. Generally, countries use geographic scales higher than the municipality because the density indicator cannot be calculated at a too fine scale[8].

Second level: <u>multi-professionals with an ambulatory and hospital care approach / approach according to an indicator's matrix</u>

For Italy, "medical desert" refers to a situation or context in which patients have difficulty in accessing to care. It refers not only to the simple 'lack' of health professionals and services, but also to the poor quality and equity of access to health care. In order to make such a broad definition usable for the analysis, a specific matrix was developed (table 4), which shows in the columns three dimensions characterizing the provision of care (availability, quality and equity), elaborated on the basis of the WHO framework, and in the rows two ways through which it is possible to "look" at the provision itself: from

8 The density indicator provides the aggregate supply of health care available in a given area, but has the disadvantage of not taking into account interactions with neighboring geographical areas. In other words, density refers in the first instance only to the availability of a health care service in a given territory and implicitly makes the assumption that the service or professional located on the other side of the zone boundary will not be accessible. It ignores population movements across administrative boundaries, although these are frequent, especially when density is measured for small areas (Salze et al. 2011).

the point of view of the territory, understood as area, and from that of the population, as bearer of health needs (see table 4 and annex 2).

The matrix highlights six areas, the first of which concerns 'presence', i.e. the health services and professionals in a given territory. Then there is 'coverage', understood as provisioning in relation to the population and its particular epidemiological and demographic characteristics. With reference to quality, the 'performance' dimension is identified, understood with reference to the production function (and thus to the providers), and the 'protection' function, with reference to the level of care guaranteed to a specific target population (e.g. those residing in a municipality or a Local Health Unit). With regard to equity, there is 'accessibility', understood as distance with respect to the location of professionals and services (and thus with reference to the homogeneity of distribution over the territory), and 'usability', as the possibility of use by specific population groups.

At the margins of the matrix, further elements characterizing the context can be identified, to be understood as interacting factors that could attenuate or exacerbate the condition of medical deserts. These factors refer, in particular, to urban planning (urban/rural context, areas under repopulation/depopulation, etc.) and orography (e.g. presence of natural barriers); to regulatory and organizational aspects (such as the residence requirement for access to services); to the presence of infrastructures and means of transport (e.g. availability and quality of the road network, railway stations, taxis, etc.); to qualifying environmental characteristics (green areas, level of pollution); to welfare measures; to the presence of social capital (associations, voluntary work etc.); to socio-demographic and economic-occupational characteristics; finally, to the population's state of health (measured and perceived).The indicators developed for each of the areas of the matrix, appropriately rendered in graphic form, will fill thematic maps of the country. These maps, read from a synoptic viewpoint, will make it possible to provide an analysis of the health care deserts in this broader sense that has been adopted.

With respect to specific selected contexts, a calculation of the 2SFCA indicator will also be proposed, adapted to the peculiarities of the Italian situation and on the basis of available data.

Table 4 Matrix of dimensions covered to analyze medical deserts in Italy

.		**Availability**	**Quality**	**Equity**
How to survey the offer	**TERRITORY (geographical area)**	Presence	Performance	Accessibility
	POPULATION (health demand)	Coverage (in relation to population and its characteristics)	Protection	Usability
Interaction factors: aspects that are able to mitigate or exacerbate the condition of health desertification	**CONTEXT (development)**	Urban and orographic structure (urban vs rural context, area undergoing repopulation vs depopulation, attractiveness of the territory, etc.) Regulatory aspects Infrastructure (e.g. road network, public transport, etc.) Environmental aspects (green areas, level of pollution, etc.) Welfare Social capital (associations, voluntary work, etc.) Socio-demographic and economic-occupational characteristics of the population Measured and perceived health status of the population (disability rate, infant mortality, life expectancy, etc.)		

Third level: <u>multi-professionals with an ambulatory and hospital care approach using an integrated approach to deal with all professionals</u>

For France, the optimal way to qualify medical deserts is by analyzing the presence and the interaction of a very large number of professions involved in the field of primary care (GPs, "daily partners" of GPs and emergency care, as mentioned previously). For that, the objectives were 1) to identify medical deserts using a score which indicates areas that accumulate disadvantages or advantages indicators of accessibility to professions and 2) to describe areas in terms of medical desert and other factors that could influence accessibility to health care.

To identify medical desert

First, the indicator of located potential accessibility (LPA) was initially developed to present health care professionals according to their availability and accessibility characteristics. For all French municipalities, LPA was calculated based on the E2SFCA method. While initially the LPA was calculated for general practitioners, it was quickly extended in 2013 to other professions of the primary care field and services including nurses, physiotherapists and midwives. LPA is now institutionalized in France and provided periodically by the Ministry of Health. It is therefore used as a basis for French public policy zoning by profession.

As this indicator is calculated for each health professional, it is important to note that this indicator does not give an overall view of disparities in access to care but rather a view by profession. For the OASES project, one proposal is to give an overall view of disparities in accessibility to care rather than a view by profession. First, Principal Component Analysis (PCA) was used to synthesize information by groups of professions (GPs, daily partners of GPs, other professionals and emergency care) and then a sum of the coordinates resulting from the PCA allowed to have a score of disadvantaged potential accessibility of professions. This approach offers the advantages of (1) assessing the accessibility of the different health professionals or needs and taking into account the correlation between them (2) determining the weight of each variable in the group of professions.

To describe areas of medical desert

In a second time, other dimensions have been included to those related to health care professions to better qualify both supply and demand side: the dynamics of supply (with the temporal evolution of supply) and the needs of healthcare professionals (with income and the premature and global mortality as a proxy of higher needs of care). First, Principal Component Analysis (PCA) was used to synthesize information on the dimension of needs of healthcare.

In a second step, a hierarchical clustering was used to classify municipalities in categories according to all dimensions diverse by nature (groups of professions, temporal evolution and needs of healthcare). This method consists in grouping individuals (here spatial units) in relation to each other, according to their similarities (within a class or group) and dissimilarities (between classes or groups) based on their characteristics defined by a set of variables. The typology thus makes it possible to synthesize information by grouping individuals into classes. Then, to describe the factors that would influence medical deserts, other dimensions (urbanicity, attractiveness…) will be analysed by categories. Accessibility indicators will therefore be at the forefront of the analysis and the variables aiming at characterizing medical desertification will only be illustrative and will not enter into the characterization of classes.

Conclusion

Many countries focus on primary care to define the scope of medical desert, which refers, from a general point of view, to the organization of health systems based on the foundation of primary health care as "the first level of contact of individuals with the national health system" (WHO 1978, 2018) as opposed to specialized, secondary or tertiary care. For many countries of the OASES project, the field of primary care considered is at least that of the general practitioner-nurse pair. A useful proposition is to widen the scope considered to other professionals to underline the required complementarity of these professions for the diagnosis and treatment of patients alongside the GPs, which promotes a better patient-centered integrated approach of care. Focusing on a small number of primary actors deals with the scope of primary care services to be considered according to countries. The number of services is sometimes larger by including the hospital domain. In that case, the production of knowledge on territorial disparities is a view by indicators/professions that is promoted rather than an overall view of disparities. Some countries have proposed an atlas, composite index or a typology as a solution.

Indicators used to measure accessibility to care services are often those of densities and distances. Densities have the advantage of being easy to calculate and intuitive for professionals and decision-makers. Distance is a good indicator of the performance of resource allocation in a given territory, because controlling and reducing distance is a permanent concern in the planning of health care provision in particular for certain services such as primary care or certain hospital services. In a general way, the adequacy of the geographical unit with the object of analysis is often too little inquired. Therefore, particular attention must be paid to the scale at which indicators are calculated. In that way, xSFCA indicators, which combine distance and availability, are a suitable solution to define indicators of accessibility for small geographic units. They are, in particular, well adapted for primary care, for which the challenge is to have a diagnosis of accessibility that is precise for constructing hypotheses (the distance between patient and physician is measured as close as possible to the patient's place of residence and the professional's place of practice) and for its results (at a small geographical unit).

In addition, density indicators do not consider the specific and differentiated needs of populations, which leads health authorities to combine them with other socio-demographic indicators. Nevertheless, the need to combine medical densities with other indicators reflecting the heterogeneity of the needs of populations reveals the operational limitations of density indicators. In addition, the use of composite indicators dilutes the nature of the statistical instrument, which no longer makes it possible to distinguish between problems of distribution of the supply of health care and social inequalities in health (Ricketts and al. 2007). Some studies (Barlet and al. 2012, Lucas and Mangeney 2019; Ngui, 2011) improve the quantification of the volume of health care supply and the health care needs by analyzing the supply that is effectively available and accessible considering the level of activity of the professionals, and by weighting the population by sex, age and/or social characteristics.

Beyond the methodological choices, numerous countries have also raised concerns regarding data availability on human resources for health and have argued that the lack of data or the difficulties to obtain them (pay-per-use data, limited access rules for example) represent one of the main obstacles to define more relevant indicators. This has already been noted in reports of health planning resources (EU 2012; EU 2021). For example, Romania mentioned some problems of reliability of data (and specifically on migration of healthcare professionals that is a key issue as a general cause of health professionals' shortage) and Moldova notes as well the lack of local data. Other countries mention the difficulty of easy access to distance calculation tools or data required for their countries (Hungary, Moldova) too. For Finland, the Finnish primary care system being fragmented (between three parallel provisions of services: a public system, a private system and an occupational system) and decentralized (municipalities in charge of public primary care not always report data uniformly at the national level), potential accessibility measures are difficult to set up. In this respect, the Finnish team is exploring data on the use of public health and social services based on population register data to improve the first indicators defined. For France and Italy, as the national indicator has limitations due to the availability of data at national level, new avenues for the future are opened at the local level thanks to more data available. A study carried out by the Regional Health Observatory of Ile de France and the Institute for Research and information in Health Economics has therefore made it possible to calculate a multimodal LPA considering the use of public transport or the car in the territories (Lucas-Gabrielli and Mangeney, 2019) and to define it on a much finer scale as an infra-communal scale: a 200-meter grid in order to minimize approximation of measure due to scale measure.

To conclude, whatever their choice to identify areas of medical deserts, countries could improve their definition by improving the knowledge of their territory. Well describing the territory could allow the countries to better understand why areas are in concerns. Some factors as deprivation, the degree of urbanicity or attractiveness have been demonstrated previously in France to be important factors influencing negatively or positively the level of medical desertification (Chevillard and Mousquès, 2018; Padilla, 2016). Knowing these factors may help public policy to focus its recommendations.

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4 Annexes

Annex 1: List of indicators to approach “medical desert” in Italy

Table 1: list of indicators (first part)

Dimension	Areas	Indicator number	Indicator name	Type of measurement	Numerator	Denominator
AVAILABILITY	PRESENCE	Indicator 1	Volume of active health workers	Absolute number	Number of active health workers, defined in headcounts, working in a specific facility type	
		Indicator 2	Percentage of active health workers over 60 years old	Proportion (%)	Number of active health workers ≥60	Total number of active health workers, defined in headcounts
		Indicator 3	Percentage of active female health workers	Proportion (%)	Number of active female health workers	Total number of active health workers, defined in headcounts
		Indicator 4	Density of health workers (per km^2)	Ratio	Number of active medical doctors, defined in headcounts	No. of km^2
		Indicator 5	Density of health facilities (per km^2)	Ratio	Number of health facilities	No. of km^2
	COVERAGE	Indicator 6	Density of health workers per amount of population	Ratio	Number of health workers, defined in headcounts	Total resident population
		Indicator 7	Density of health facilities per amount of population	Ratio	Number of health facilities	Total resident population

Table 1: list of indicators (continued)

Dimension	Areas	Indicator number	Disaggregation/ Stratification	Further information
AVAILABILITY	PRESENCE	Indicator 1	• Geographical: a) National, b) Regional, c) Province; d) Municipality • Employed by facility type • By groups of health professionals	To be considered: developing the indicator as a trend over the last X years and/or as a percentage of the total number of active health workers, defined in headcounts
		Indicator 2	• Geographical: a) National, b) Regional, c) Province; d) Municipality • Employed by facility type • By groups of health professionals	To be considered: developing the indicator for different age groups and/or as summary values (mean age, median age)
		Indicator 3	• Geographical: a) National, b) Regional, c) Province; d) Municipality • Employed by facility type • By groups of health professionals	
		Indicator 4	• Geographical: a) National, b) Regional, c) Province, d) Municipality • By groups of health professionals	
		Indicator 5	• Geographical: a) National, b) Regional, c) Province • Health facility types	
	COVERAGE	Indicator 6	• Geographical: a) National, b) Regional, c) Province, d) Municipality • By groups of health professionals • By population groups (e.g. paediatric, elderly ...)	
		Indicator 7	• Geographical: a) National, b) Regional, c) Province, d) Municipality • Specific focus on particular user and health facility types	

Table 2: list of indicators (second part)

Dimension	Areas	Indicator number	Indicator name	Type of measurement	Numerator	Denominator
QUALITY	PERFORMANCE	Indicator 8	Percentage of hospitals that do not meet regulatory/ standard thresholds of process/ outcome, out of total hospital facilities	Proportion (%)	Number of facilities that do not meet regulatory/standard thresholds of process/outcome	Total number of hospitals
		Indicator 9	Percentage of hospitals with wards performing a high volume of activity in relation to the number of hospitals	Proportion (%)	Number of facilities/wards performing a high volume of activity	Total number of facilities/hospital wards
		Indicator 10	Attraction index (interregional active mobility)	Proportion (%)	Number of interventions/ hospitalizations of non-residents in the region	Total number of interventions/hospitalizations in the region
	PROTECTION	Indicator 11	Percentage of hospitalizations of/ interventions performed on residents in facilities that do not meet thresholds/standards of process/ outcome, out of total hospitalizations/ interventions of residents	Proportion (%)	Number of hospitalizations of/interventions performed on residents in facilities that do not meet thresholds/standards of process/outcome	Total number of hospitalizations of/interventions performed on residents
		Indicator 12	Percentage of hospitalizations of/interventions performed on residents in high volume hospital facilities/ wards, out of total hospitalizations/ interventions of residents	Proportion (%)	Number of hospitalizations in high volume facilities/wards	Total number of hospitalizations of/interventions performed on residents
		Indicator 13	Escape index (passive interregional mobility)	Proportion (%)	Number of interventions performed on/ hospitalizations of residents in other regions	Total number of interventions performed on/hospitalizations of residents
		Indicator 14	Adjusted rates of avoidable hospitalization	Rate	Number of hospitalizations referable to ambulatory care sensitive conditions	Total resident population

Table 2: list of indicators (second part) (continued)

Dimension	Areas	Indicator number	Disaggregation/ Stratification	Further information
QUALITY	PERFORMANCE	Indicator 8	Geographical: a) National, b) Regional, c) Province	Selection of outcome/volume indicators for which there is a normatively defined threshold (e.g. DM70/2015), for different nosological areas (maternal-child-musculoskeletal-cardiovascular-oncological-general surgery). The indicator protocols can be consulted online on the National Outcomes Evaluation Programme (PNE) website (https://pne.agenas.it/).
		Indicator 9	Geographical: a) National, b) Regional, c) Province	Selection of indicators for which there is a proven correlation between volume and outcome e.g: (a) hip fracture b) laparoscopic cholecystectomy c) deliveries d) hospitalizations for acute myocardial infarction. The indicator protocols can be consulted online on the National Outcomes Evaluation Programme (PNE) website (https://pne.agenas.it/).
		Indicator 10	Geographical: a) Regional; b) Province/ Local Health Unit	Calculation of active mobility on a selection of representative indicators per nosological area
	PROTECTION	Indicator 11	• Geographical: a) Province/ Local Health Unit	Selection of outcome/volume indicators for which there is a normatively defined threshold (e.g. DM70/2015), for different nosological areas (maternal-child-musculoskeletal-cardiovascular-oncological-general surgery). The indicator protocols can be consulted online on the National Outcomes Evaluation Programme (PNE) website (https://pne.agenas.it/).
		Indicator 12	Geographical: a) Province/ASL	Selection of indicators for which there is a proven correlation between volume and outcome e.g: a) hip fracture b) laparoscopic cholecystectomy c) deliveries d) hospitalizations for acute myocardial infarction. The indicator protocols can be consulted online on the National Outcomes Evaluation Programme (PNE) website (https://pne.agenas.it/).
		Indicator 13	Geographical: a) Regional; b) Province/ Local Health Unit	Calculation of passive mobility on a selection of representative indicators per nosological area. The indicator protocols can be consulted online on the National Outcomes Evaluation Programme (PNE) website (https://pne.agenas.it/).
		Indicator 14	Geographical: a) Province/ Local Health Unit	Proxy for the quality of territorial care. The indicator protocols can be consulted online on the National Outcomes Evaluation Programme (PNE) website (https://pne.agenas.it/).

Table 3: list of indicators (third part)

Dimension	Areas	Indicator number	Indicator name	Type of measurement	Numerator	Denominator
EQUITY	ACCESSIBILITY	Indicator 15	Average distance (km) of services from the centroids of the municipalities, by Province/Local Health Unit	Mean	Not applicable	Not applicable
		Indicator 16	Average distance (minutes) of services from the centroids of the municipalities, by Province/Local Health Unit	Mean	Not applicable	Not applicable
	USABILITY	Indicator 17	Stratified outcome by gender	Risk/Rate		
		Indicator 18	Outcome stratified by citizenship	Risk/Rate		

Table 3: list of indicators (continued)

Dimension	Areas	Indicator number	Disaggregation/ Stratification	Further information
EQUITY	ACCESSIBILITY	Indicator 15	• Geographical: a) Province/ Local Health Unit • Health facility types	
EQUITY	ACCESSIBILITY	Indicator 16	• Geographical: a) Province/ Local Health Unit • Health facility types	
EQUITY	USABILITY	Indicator 17	Geographical: a) Province/ Local Health Unit	Selection of indicators used by the equity study on the basis of the Italian National Outcomes Evaluation Programme. Those are available on the website (https://pne.agenas.it/equita/index.php) in particular for the areas: - cardiovascular - musculoskeletal - respiratory - oncological * cardiovascular area: a) proportion of ST-elevation myocardial infarctions treated with percutaneous coronary intervention within 90 min out of total number of treated within 12 hours b) proportion of ST-elevation myocardial infarctions treated with percutaneous coronary intervention within 12 hours out of total number of treated with percutaneous coronary intervention c) major adverse cardiac and cerebrovascular events within 12 months of an episode of acute myocardial infarction d) isolated coronary artery bypass: 30-day mortality ** musculoskeletal area: a) surgery within 48 hours for hip fracture in the elderly (>65 years) b) hip fracture in the elderly (>65 years): 1-year mortality *** oncological area: a) intervention for lung cancer: 30-day mortality **** respiratory area: a) exacerbated chronic obstructive pulmonary disease: 30-day mortality. The indicator protocols can be consulted online on the National Outcomes Evaluation Programme (PNE) website (https://pne.agenas.it/).
EQUITY	USABILITY	Indicator 18	Geographical: a) Regional	Selection of indicators used by the equity study on the basis of the Italian National Outcomes Evaluation Programme. Those are available on the website (https://pne.agenas.it/equita/index.php) in particular for the areas: - maternal-child - avoidable hospitalization * maternal-child a) Proportion of primary caesarean deliveries b) Proportion of vaginal deliveries in women with prior caesarean delivery c) Primary caesarean delivery: hospital readmissions during puerperium **avoidable hospitalizations a) hospitalizations for chronic obstructive pulmonary disease b) hospitalizations for short- and long-term complications of diabetes. The indicator protocols can be consulted online on the National Outcomes Evaluation Programme (PNE) website (https://pne.agenas.it/).

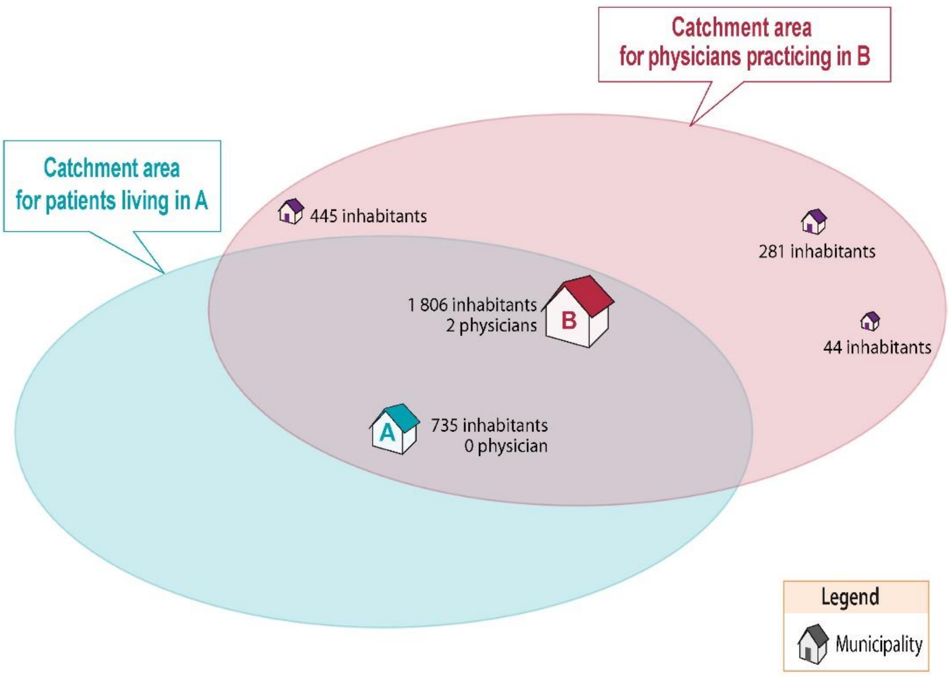
Annex 2 The local potential accessibility

The local potential accessibility used in France is an application of the XSFCA family method and more precisely of 2SFCA one.

2SFCA indicator

The 2SFCA method is based on the construction of 'floating catchment areas' instead of predefined zones (Luo and Wang 2003). A floating catchment area is associated to each municipality and is defined as a zone limited by an isochronous curve centered on the seat of the municipality being studied (town hall). We thus consider that the inhabitants in a given municipality have access to all GPs located at a shorter distance from their place of residence than the reference distance (patients' catchment area) (see figure 3). At the same time, each GP potentially satisfies the demand of all the inhabitants in municipalities located at a shorter distance than this reference distance (physicians' catchment area). The 2SFCA indicator is thus constructed in two phases and integrates this potential 'competition' effect between municipalities as the GP services supply can be shared between different municipalities.

Figure 3 Example of a patient catchment area and a physician catchment area



It is implemented as follows:

Step1: for each municipality j with GP's service, the number of GPs Sj was counted and the population living in the physician catchment area i so located within a threshold drive time dmax from the GP's service center j was estimated. Then, the provider-to-population ratio Rj within the physician catchment area of j was determined with Equation 1:

$$R_j = \frac{S_j}{\sum_{i \in \{d_{ij} \leq d_{max}\}} P_i * w_{ij}} \qquad \text{Equation (1)}$$

where Pi is the population in the municipality i, the centroid of which falls within the physician catchment area j (i.e. dij < dmax), Sj is the number of GPs available in the municipality center j, and Wij is the weighting coefficient relating to the distance.

Step 2: we define for each municipality i, all the physicians' municipalities j accessible at the driving time dmax from location i. We then total the corresponding ratios Rj by weighting them according to distance. The result obtained represents the Index of Spatial Accessibility (Ai) at location i taking into account Wij, the weighting coefficient relating to the distance (Equation 2).

$$A_i = \sum_{j \in \{d_{ij} \leq d_{max}\}} R_j\, w_{i,j} \qquad \text{Equation (2)}$$

3SFCA indicator

To minimize the demand overestimation problem of gravity-based spatial access models mentioned above, a three-step floating catchment area (3SFCA) method modifies the 2SFCA indicator as follows:

The 2SFCA type measures consider that the probability of using the supply decreases when the distance to access increases, until it becomes zero beyond a certain threshold. The 3SFCA type measures consider that the probability of using the supply decreases with the distance but also with the volume of accessible supply in proximity. In other words, the 2SFCA accepts, or rather assumes, that people do not consult a doctor too far from home and that they give preference to the various services available nearby. The 3SFCA starts from the same assumption but qualifies it: individuals prefer proximity all the more if a local supply is accessible and available.

This method was implemented in three steps, as follows:

Step 1: for each municipality j with GP's service within the threshold driving time dmax from location i the weighting factors (probability of use) G(i,j) are calculated by measuring the supply available in j, Sj weighting by the coefficient relating to the distance W(i,j) **in relation to** the weight of all alternative supplies k available in the patient catchment area of the municipality i (Equation 3).

$$G_{i,j} = \frac{S_j W_{i,j}}{\sum_{k \in \{d_{i,k} \leq d_{max}\}} S_k * w_{ik}} \qquad \text{Equation (3)}$$

Step 2: for each municipality j with GP's service the provider-to-population ratio Rj within the physician catchment area of j was determined by relating the quantity of available doctors Sj to the population living in the physician catchment area Pi weighted by the probability of recourse Gij estimated in the previous step and the distance weight Wij (Equation 4).

$$R_j = \frac{S_j}{\sum_{i \in \{d_{ij} \leq d_{max}\}} P_i * Wij * G_{ij}} \qquad \text{Equation (4)}$$

Step 3: Compute the spatial access of each municipality i by summing for all municipalities j with GP's service that were within the patient catchment area of i, the ratio of provider-to-population Rj multiplied by the probability of recourse Gij.

The ratio should be multiplied by the selection probability and the distance weight sum (Rj*Gij*Wij) *100000 as i3SFCA with equation 5:

Equation (5)

$$A_i = \sum_{j \in \{d_{ij} \leq d_{max}\}} R_j \, G_{i,j} W i, j$$

Promoting evidence-based reforms on medical deserts

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