



D4.1: First version of definition and taxonomy on medical deserts

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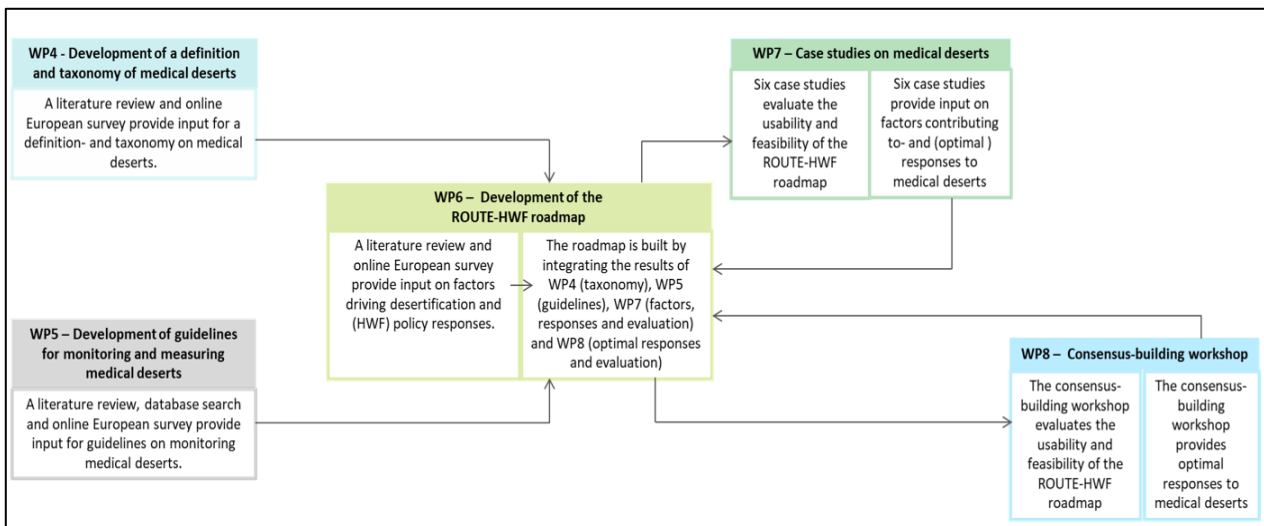
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1. Introduction and goal

The aim of this Deliverable 4.1, which is the first deliverable of Work Package 4, is to provide a first version of a definition and taxonomy on medical deserts. The guidelines are designed to help public authorities and health professionals to gain a better understanding of (1) the origin and development of medical deserts, (2) how to monitor them, and (3) how to investigate and evaluate the effects of health workforce (HWF) policy measures to mitigate or eliminate medical deserts which is now often lacking (Ono et al., 2014). The goal of the guidelines is to provide a practical set of tools that contribute to an improved measurement system for medical deserts across Europe.

Together with the measuring and monitoring guidelines (as developed in Work Package 5), the definition and taxonomy will feed into the creation of the ‘Roadmap out of medical deserts’ that will be created in Work Package 6. The interplay between the definition and taxonomy, measuring and monitoring guidelines and the ROUTE-HWF roadmap is presented in Figure 1 below, along with the corresponding WPs and methods of data collection and stakeholder engagement.

Figure 1. The interplay between the ROUTE Work Packages on the definition and taxonomy, measuring and monitoring guidelines, that feed the ROUTE-HWF roadmap on medical deserts



This first deliverable of Work Package 4 (a first definition and taxonomy on medical deserts) will be followed by deliverables 4.2 and 4.3 that will be published later on in the ROUTE-HWF project. Deliverable 4.2 and 4.3 will provide a second and a third version respectively of the definition and taxonomy, based on six country case studies and the final event during which the guidelines will be presented to stakeholders and feedback received.

By connecting the definition and taxonomy of medical deserts with the measuring and monitoring guidelines (provided in Deliverable 5.1), the project is paving the way towards creating the ROUTE-HWF roadmap out of medical deserts. The ROUTE-HWF roadmap will support EU Member States in a tailored manner, i.e., supporting them to design and implement specific policies related to specific types of medical deserts. It will provide a rationale for public authorities and health professionals at national and subnational levels to apply an optimal mix of HWF policies to their particular medical deserts – taking the context-sensitivity of these policies and medical deserts into account. The final goal is to mitigate the effects of medical deserts and dissolving these, and hence to improve access to healthcare as well as quality of healthcare for citizens living in these areas, now and in the future.

2. Approach and methods

In general, the search for a solution to a problem is shaped by how a problem is defined. In other words; the definition of a problem establishes the framework for all subsequent actions, including policies and other actions and initiatives (Wagner, 2014). At the same time, different classifications might be required, depending on the particular problems being analysed (Nordregio, 2020). This is also the case for medical deserts. Because of the diversity of the concept and its strong context-dependency, having a common definition for all countries and regions within Europe is nearly impossible. Therefore, a definition will be developed to serve as a starting point for building a taxonomy. A taxonomy permits decomposing the complex concept of medical deserts – with its various characteristics, causes and consequences – into understandable and clear pieces of information (Hernandez-Ardieta, Gonzalez-Tablas, De Fuentes, & Ramos, 2013). A taxonomy of medical deserts should be seen as a common vocabulary, on which several solutions may be built (Robert, Genest, & Loiseau, 2018) supporting HWF policies and other initiatives on medical deserts.

For the development of this first version of the medical desert taxonomy, the iterative method by Nickerson, Varshney and Muntermann (Nickerson, Varshney, & Muntermann, 2013) will be followed. According to Nickerson et al., a taxonomy should comply the following four basic rules:

- **It should be concise.** It should contain a limited number of dimensions or a limited number of characteristics in each dimension, because an extensive classification scheme with many dimensions and many characteristics would be difficult to comprehend and difficult to apply.
- **It should be sufficiently inclusive.** It should contain enough dimensions and characteristics to be of interest. For example, a taxonomy with only one dimension and two characteristics within that dimension would not be very interesting. This attribute can conflict with the conciseness attribute.
- **It should be comprehensive.** It should provide for classification of all current objects within the domain under consideration
- **It should be extendible.** It should allow for additional dimensions and new characteristics within a dimension when new types of objects appear.

In addition, they formulated eight steps of “The taxonomy development method” that are embedded in three consecutive phases:

Phase 1: The empirical deductive approach

1. Examine subset of objects
2. Identify general distinguishing characteristics of objects
3. Group characteristics into dimensions to create first taxonomy

Phase 2: The deductive empirical approach

4. Conceptualize new characteristics and dimensions
5. Examine objects for new characteristics and dimensions
6. Revise taxonomy to create next version

Phase 3: The use of the taxonomy

7. Identify missing objects in taxonomy
8. Design new objects

The result of the first three steps are reported in this deliverable. The results of step four, five and six will be reported in the next deliverables of this Work Package 4, as well as steps seven and eight in the final report of the ROUTE-HWF project.

For the first step, 'examine a subset of objects', a scoping review (Seils et al., 2022; Flinterman et al., 2022) was conducted. Step 2 ('identify general distinguishing characteristics of objects') and step 3 ('group characteristics into dimensions to create first taxonomy') were based on a country survey and five country workshops that were executed within the ROUTE-HWF project so far. Here, results of the scoping review were used to develop questions for the survey and as discussion points in the five country workshops. The outcomes of the country survey and workshops were used for grouping and ordering the objects into dimensions to create a first version of the definition and taxonomy.

3. Results: Toward a first definition and taxonomy on medical deserts

Step 1: Examine a subset of objects as a base for a definition and taxonomy on medical deserts

In 2021 and 2022, a scoping review was conducted of 240 studies on characteristics of and policy responses to medical deserts (Seils et al., 2022; Flinterman et al., 2022). From the review it has been found that most studies define medical deserts as 'rural areas', 'underserved areas' or used a measure of distance/time to a health facility or a combination of these. Key findings as they pertain to the definition of medical deserts were:

- Sixty-nine papers defined medical deserts as 'rural areas' but subsequently did not describe how rural areas were defined;
- Fifty-eight used a single criterion to define a 'rural area', such as the ratio between the population and the HWF, the size of the population in an area, distance to the nearest health facility, distance to the nearest town, or the number of hospital beds in the region;
- The criteria previously listed were part of the several more formal definitions that were used by 78 studies;
- Twenty studies used a combination of criteria or factors to define rural areas;
- Rural areas and/or medical deserts were all defined from the perspective of the population, except from the 'Rural Ranking scale'¹ which is defined from the perspective of general practitioners (GPs).

If we elaborate on the 'objects' that were used in the rural area and/or medical desert definitions found in the literature, the following list can be constructed from the scoping review:

1. Population size of the area;
2. Percentage of poverty in the area;
3. Percentage of population aged 65 and over;
4. Infant mortality rate in the area;
5. Mobility of the population in the area;
6. Health needs of the population in the area;
7. Number of HWF in the area;
8. Economic resources in the area;
9. Education and occupation options in the area;
10. Presence of a hospital or other health services in the area;

¹ The Rural Ranking Scale (RRS) is based on the location of general practices in a country or region, and combines characteristics of general practices as on call duty, on-call for major traumas, travelling time to nearest GP colleague, travelling time to most distant practice boundary, travelling time to regular peripheral clinic, and travelling time from surgery to major hospital (Steinhauser et al., 2014; Janes et al., 2004).

11. Population to provider ratio;
12. Distance/time to facilities;
13. Distance/adjacent to metropolitan area.

This long list of objects can be subsequently summarized into four main categories:

- I. Elements regarding the size and geographical characteristics of an area's population;
- II. Elements regarding the demographic, social or health characteristics of an area's population;
- III. Elements regarding the availability of health services in the area;
- IV. Elements regarding the physical or travelling distance to an area's health services.

These objects are further elaborated in the next chapter, validating them against the practical visions and experiences of experts in a number of European countries.

Step 2: Identify the distinguishing characteristics of the objects selected for a definition and taxonomy on medical deserts

The next challenge is to find the *characteristics* that fit with the different objects and to explore if additional objects are needed to define medical deserts. Doing so, we adhered to the Nickerson's taxonomy rule that each type of medical desert can only fit one characteristic within an object (see chapter 2). This implies that characteristics are exclusive within each object.

To execute this step, a survey was conducted among EU Member States and five stakeholder workshops were held by the ROUTE-HWF consortium members in 2022 in their respective countries (the Netherlands, Finland, Spain, Poland and Croatia). Both tasks were based on the scoping review as the outcome of step 1, allowing experts and stakeholders to reflect on the relevance, comprehensiveness and usefulness of the objects to define and taxonomize medical deserts in their countries.

The next table shows how the relevance of each object to define and classify medical deserts was perceived by the participants of the stakeholder workshops held in the Netherlands, Finland, Spain, Poland and Croatia. Before the workshop, experts completed a survey that was also sent to other countries. In the table below, we summarize the workshop results per object, coding it as "relevant" (i.e., "X" in the table) if the majority of the workshop participants agreed on this (on average 5 to 12 experts participated in each workshop).

Table 1. Outcomes of the stakeholder workshops held in The Netherlands, Spain, Croatia, Finland and Poland, judging 12 objects to define medical deserts as found in the scoping review

Medical desert object/element as found in the scoping review	Relevant according to the participant of the workshop held in:				
	The Netherlands	Spain	Croatia	Finland	Poland
Population size					X
Percentage of poverty	X				X
Percentage population aged 65 and over	X		X	X	X
Infant mortality rate					
Mobility of the population	X	X	X		X
Health needs of the population					X
Economic resources	X			X	X
Education and occupation options			X		
Presence of hospital health services	X	X			X
Population-provider ratio		X		X	X
Distance/time to facilities	X	X		X	X
Distance/adjacent to metropolitan area	X				X

The table shows that the following six objects were judged by three or more countries as relevant for defining medical deserts:

1. Percentage population aged 65 and over;
2. Mobility of the population;
3. Economic resources;
4. Population-provider ratio;
5. Presence healthcare services;
6. Distance/time to facilities.

With regard to these six objects, the workshop participants mentioned several interrelations and overlap between them, which should be taken into account when interpreting these objects to define and taxonomize medical deserts.

First, economic resources can be seen as a key element because the social economic status of the population strongly determines health care needs. And because a population's social economic status is related to health care needs, it is also related to the required population-provider ratio. This drives another interrelationship, as areas with a low social economic status can also be (or become) areas where health workers are less likely to want to work. This does not only apply to rural or remote areas. Also, urban areas with lower social economic status can be confronted with shortages of health workers for that reason. In addition, population mobility can be related to an area's lower social economic status, resulting in lower health literacy among the population and larger cultural and language differences.

Second, with regard to the population-provider ratio, participants stressed that this ratio can vary with the type of HWF and health services. This includes differences between the demand and supply of public and private health services, primary and specialized care, dental care, mental care, and other types of services. Therefore, the population-provider ratio needs to be specified according to the 'provider' element to tailor its relevance for classifying different types of medical deserts and their challenges. Here the interrelation with the presence and distance to facilities objects appears. For instance, if the nearest hospital is 100 km away, GPs will have more consultations and more responsibility in (e.g.,) emergency care. Consequently, the

population-provider ratio for GPs will vary with the presence of a hospital that provides emergency or specialized care.

Thirdly, it was mentioned in the workshops that characteristics of the area itself also determine the objects that were found relevant. The presence and distance to facilities is strongly related, while both are directly dependent on the (physical) accessibility of the area itself. For most countries and this reason, small islands and mountains are particularly mentioned in relation to medical deserts, as they have specific transportation barriers and severe limitations to establish facilities due to lack of scale with high costs. Again, this is interconnected to the point if health workers want to live and work in those areas and hence its population-provider ratio. While some island or mountain areas might fit the needs and demands of health care workers, their small scale and particular situation might result in less diversity in the HWF, which can lower the attractiveness of an area, and subsequently increase the 'image' that an area will be considered (and actually become) a medical desert.

We derive from the workshops discussions that all six objects can serve as 'independent' dimensions of the taxonomy to be constructed. But it should also be recognized that they need to represent different aspects and mechanisms of how medical deserts can emerge, exist and develop. For this reason, we cluster the six objects in the following manner:

First, we cluster the two objects addressing the 'population side' of medical deserts as a phenomenon, i.e., (a) percentage population aged 65 and over, and (b) economic resources. Both determine the potential health care needs of the population living in a certain area. While population age strongly determines healthcare status and hence the volume and probability of healthcare needs and usage, socio-economic position determines how a population handles their healthcare status and hence their healthcare behaviour and healthcare usage.

Second, we cluster the three objects: (a) presence healthcare services, (b) distance/time to facilities and (c) mobility of the population. All three represent access to health services in the area, in terms of the physical infrastructure being present (e.g., buildings, equipment, ICT, administration, support, management), physical proximity and travel time. In this respect, the objects also overlap. Obviously, 'presence healthcare services' determines 'distance/time to facilities', and subsequently 'travel distance/time' is determined by 'mobility of the population'. While presence of a health service facility in an area generally can mean smaller distance and less travel time to access that health service facility, this will also depend on the mobility resources and transportation infrastructure available. Here, we should also take into account that the accessibility of health service facilities also depends on financial barriers, i.e., whether health services are public or private, and likewise transportation services are public or private. Taking these notions together, and arguing from a patient perspective, we state that *travel time to public health care facilities by public transport* is the key object/dimension to (co)define areas as potential medical deserts. Both 'presence' and 'distance' are objects/dimensions that are actually expressed or included in 'travel time' as the key dimension.

Finally, we consider 'population-provider ratio' as the 'last' separate object to be used for the medical desert definition. While the previous (redefined) object 'travel time to public health care facilities by public transport' addresses the physical accessibility of health services, population-provider ratio represents the availability of human resources within these services. This represents the most recognized problem of staff shortages in medical desert areas. While there might be 'sufficient' health services available and accessible within or close to the area, the availability of healthcare workers is a critical condition to actually provide the health service as such. In addition, 'population-provider ratio' is covering the mechanism that medical deserts might not be attractive areas for health professionals to settle and practice.

In conclusion, to most critically select the most independent and relevant (key) objects for our medical desert definition and taxonomy, the following four *key* dimensions will be included:

1. Percentage population aged 65 and over;
2. Economic resources of the population;
3. Travel time to public health facilities by public transport;
4. Population-provider ratio.

Note that these four objects/dimensions match the four main categories of factors that originally were found by our literature review (see end of Step 1 above). The next and final chapter will elaborate how these four objects build the first medical desert taxonomy.

4. Conclusion: The first version of definition and taxonomy on medical deserts

Step 3: Turn group characteristics into dimensions to create the first definition and taxonomy on medical deserts

In the workshops executed, all participants mentioned that a definition and taxonomy of medical deserts should contain multiple objects and should take their characteristics and interrelations into account. This aligns with the taxonomy development method by Nickerson we apply (see chapter 2), i.e., that the taxonomy should be concise, inclusive and comprehensive. In addition, it should be kept in mind that the taxonomy should define different *types* of medical deserts as a nominal variable. Therefore, a single object cannot define *if (or the degree to which)* an area should be considered or coded as a medical desert. Instead, it's the unique *combination* of all relevant objects that constructs the taxonomy, and its classification. This way, the taxonomy can support countries by identifying similar types of medical deserts, helping them to exchange tailored policies for possible solutions and 'routes out of medical deserts'.

The first version of the definition and taxonomy will therefore be based on the *all combinations* of the four objects we finally selected as most distinctive and relevant in the previous chapter:

1. Percentage population aged 65 and over;
2. Economic resources of the population;
3. Travel time to public health facilities by public transport;
4. Population-provider ratio.

Following Nickerson's taxonomy development method, the operationalization of these four objects should be based on (a) a limited number of exclusive categories that (b) can be applied to different countries and areas. Therefore, we propose to use two exclusive and relative categories per object, not absolute or discrete numbers. This way, we can control for differences in population size, facility distances that naturally exist between and within countries. In Deliverable 5.1 ('First version of the guidelines on monitoring and measuring medical deserts'), this will be elaborated in terms of selecting the most appropriate indicators and how to execute the actual measurements for each object.

Here, to construct the first version of our taxonomy, we propose to distinct the following two exclusive categories for each of the four objects:

1. Percentage population aged 65 and over, categorized by:
 - The proportion of inhabitants aged 65 and over living in an area, is higher than the proportion of all inhabitants in a country living in this area, *versus*
 - The proportion of inhabitants aged 65 and over living in an area, is equal or lower than the proportion of all inhabitants in a country living in this area.
2. Economic resources of the population, categorized by:
 - The proportion of inhabitants below the poverty line living in an area, is higher than the proportion of all inhabitants in a country living in this area, *versus*
 - The proportion of inhabitants below the poverty line living in an area, is equal or lower than the proportion of all inhabitants in a country living in this area.
3. Travel time to public health facilities by public transport, categorized by:
 - The average travel time by public transport to the nearest public healthcare facility in an area is larger than the average travel time at the national level of the country, *versus*
 - The average travel time by public transport to the nearest public healthcare facility in an area is equal or lower than the average travel time at the national level of the country.

4. Population-provider ratio, categorized by:

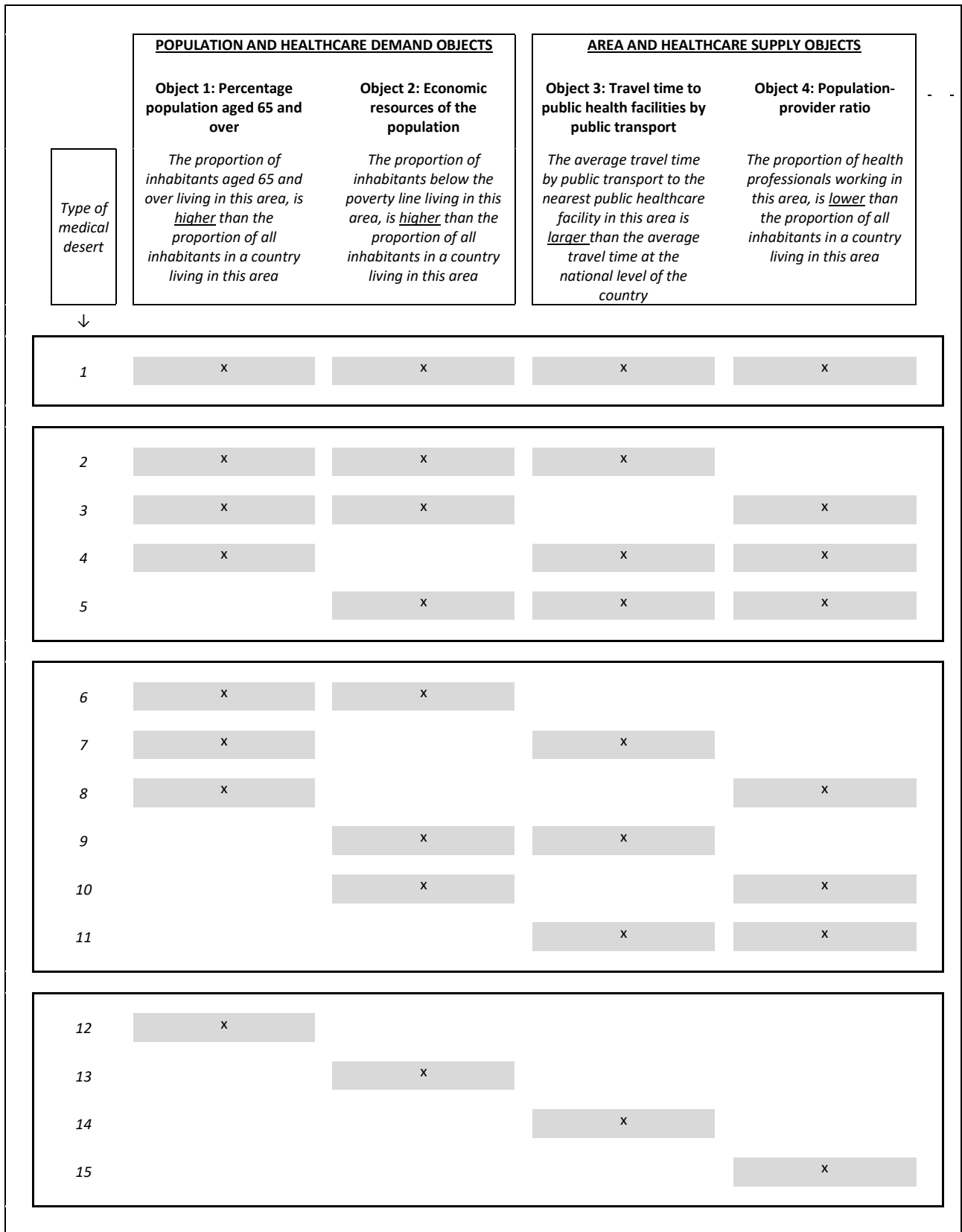
- The proportion of health professionals working in this area, is lower than the proportion of all inhabitants in a country living in an area, *versus*
- The proportion of health professionals working in this area, is equal or higher than the proportion of all inhabitants in a country living in an area.

The final step of the taxonomy construction is in combining the four objects (and their two categories) to create a population of all the different types of medical deserts that potentially can be defined. In theory, there are $2 \times 2 \times 2 \times 2 = 16$ unique combinations, that hence represent 16 different types of medicals. One 'extreme' of this array is the combination in which *all four* dimensions are indicating the existence of a medical desert (i.e., in all four respects). This combination concerns an area or type medical desert that is:

- Inhabited by a (relative) large population of elderly (65 plus),
- *also* has inhabitants with (relative) lower economic resources (living below the poverty line),
- *also* deals with (relative) long travel times to the nearest public health facility, and
- *also* deals with (relatively) under-staffing of healthcare workers.

At the other end of the array, is the combination for which *none of the four* dimensions are indicating the existence medical desert (i.e., in none of the respects). In between the two extreme types, there are areas that deal with three out of four medical desert dimensions/objects, two out of four, or 'only' deal with one object/dimension. The figure below depicts all 15 relevant combinations, clustered by the number of objects that are at stake (four, three, two or one). Within each cluster the different combinations possible are showed.

Figure 2. First version of a taxonomy to define and classify 15 different types medical deserts by four objects/dimensions



This first version of a definition and taxonomy of medical deserts serves as base for the ROUTE-HWF project. Although it is based on a five-country validation and elaborated of the existing literature on medical deserts, the usefulness, applicability and policy relevance of this taxonomy is critical and to be further investigated. One type of investigation is to explore how many of the 15 medical desert types will actually be identified in European countries. If it becomes clear how this taxonomy empirically works out, it can also be investigated what type(s) of medical deserts are most common, relevant and equal in terms of their drivers and solutions.

The next Deliverable 4.2 will be based on a continuation of the iterative method by Nickerson, Varshney and Muntermann (Nickerson, Varshney, & Muntermann, 2013) that we are following as it was described in the first chapter. While this Deliverable has executed phase 1 of their method:

Phase 1: the empirical deductive approach

1. Examine subset of objects
2. Identify general distinguishing characteristics of objects
3. Group characteristics into dimensions to create first taxonomy

The next WP 4 deliverable (D4.2) will further refine the definition and taxonomy and process the next steps being:

Phase 2: the deductive empirical approach

4. Conceptualize new characteristics and dimensions
5. Examine objects for new characteristics and dimensions
6. Revise taxonomy to create next version

Phase 3: the use of the taxonomy

7. Identify missing objects in taxonomy
8. Design new objects

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