Developing a composite index of spatial accessibility across different health care sectors: A German example

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ABSTRACT

The evolving lack of ambulatory care providers especially in rural areas increasingly challenges the strict separation between ambulatory and inpatient care in Germany. Some consider allowing hospitals to treat ambulatory patients to tackle potential shortages of ambulatory care in underserved areas. In this paper, we develop an integrated index of spatial accessibility covering multiple dimensions of health care. This index may contribute to the empirical evidence concerning potential risks and benefits of integrating the currently separated health care sectors. Accessibility is measured separately for each type of care based on official data at the district level. Applying an Improved Gravity Model allows us to factor in potential cross-border utilization. We combine the accessibilities for each type of care into a univariate index by adapting the concept of regional multiple deprivation measurement to allow for a limited substitutability between health care sectors. The results suggest that better health care accessibility in urban areas persists when taking a holistic view. We believe that this new index may provide an empirical basis for an inter-sectoral capacity planning.

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1. Introduction

A major aim of health care systems is to provide a fair and equitable access to health care. Despite being a broader concept (as e.g. described by Penchansky and Thomas [1]), access to health care clearly depends on the spatial accessibility of services, which is a major determinant of health care utilization. Exworthy and Peckham [2], for example, note that the patients' willingness to travel may largely determine the choice of the provider, and Arcury et al. [3] highlight the importance of the spatial accessibility of a health service for regular care visits. Kopetsch and Schmitz [4] found the density of general practitioners (GPs), specialist practitioners (SPs) and psychotherapists to be an important determinant for doctor utilization, and Vogt et al. [5] report similar results for preventive cancer screenings. Furthermore, Sundmacher and Busse [6] suggest a link between health outcomes and health care accessibility by showing a negative association between avoidable cancer deaths and physician density. Weinhold and Gurtner [7] provide an extensive discussion of potential sources and consequences of health care shortages in rural areas and the role that accessibility might play therein.

Although spatial accessibility received attention from researchers over several decades, previous analyses were mostly focused on single health care sectors or types of providers. This seems justified when assuming that different providers offer different services in different settings. However, even inpatient and ambulatory care may become substitute forms of health services. German hospitals, for

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example, are already allowed to extend their services to the ambulatory care sector in some rural areas lacking sufficient ambulatory care supply [8], as well as for a pre-defined set of complicated or rare diseases and complex procedures. Current policy debates consider extending this regulation to a general opening of hospitals for ambulatory care to overcome shortages in underserved areas and to facilitate accessibility in all regions. We argue that partial analyses focusing on single types of health care and simply pooling across different sectors may both lead to a misguided interpretation of accessibility. We therefore suggest an integrated index of spatial accessibility covering multiple dimensions of health care to identify regions where access is relatively good or poor.

Joseph and Bantock [9] were the first to apply an Improved Gravity Model (IGM) approach to the measurement of the spatial accessibility of GPs. A two step floating catchment area approach (2SFCA) was suggested as a special case of the IGM [10], followed by several refinements concerning the treatment of distance and catchment sizes [11–14], which may depend largely on the residents' activity space [15]. The main difference between the IGM applied in Joseph and Bantock [9] and the 2SFCA approach derived by Luo et al. [10] is that the latter does not include all providers in a country weighted by some inverse distance function, but requires a (potentially arbitrary) cutoff. This makes the borders of catchment areas artificially sharp while assuming homogeneous accessibility within the catchment area [16]. Comparing three common measures of spatial health care accessibility, Gautam and Johnson [17] conclude that travel time or distance to the nearest hospital may be crucial when analyzing the accessibility of emergency care providers, whereas population to provider ratios and the IGM approach may provide valuable information in the context of non-emergency care. Guagliardo [16], Gautam and Johnson [17] and Wang [18] provide good reviews of accessibility measures and their potential advantages and shortcomings. As we use official data at the district level and include only non-emergency services, we measure accessibility of each type of care using the IGM [9,16], allowing us to factor in different district sizes, population densities and district border crossing.

The German health care system is taken as an example because it grants free choice of doctors and access to all levels of care despite being partitioned into inpatient and ambulatory care sectors. Although German hospitals are sometimes authorized to provide ambulatory care in areas where it would otherwise be unavailable [8], the different sectors are imperfect substitutes at best. There is no simple rule to determine, for instance, the hospital capacity required to compensate a missing ambulatory internist. Simply summing up disparate facilities considered reachable may lead to fairly misleading results, and the diversity of health care sectors can be seen as the major challenge when deriving an integrated measure of accessibility. Similar problems of multidimensionality were addressed before in the context of regional multiple deprivation measurement, where a class of indicators was derived to rank small areas by a set of different socio-economic and environmental deprivation domains (see Noble et al. [19] for a detailed technical discussion and [20–23] for applications).

We use official district-level data for Germany as an example and suggest an overall index of spatial health services accessibility which can be computed in four steps. The first step is taken from the literature on spatial accessibility measurement. We suggest using the IGM [9,16,18] to measure the spatial accessibility of health services separately for each type of care. The remaining three steps are entirely adopted from the literature on regional multiple deprivation measurement. The second step combines the accessibility measures for each type of health service into predefined health care domains. The common approach in the literature is to apply explorative factor analysis to obtain one single indicator per domain [19]. In a third step, the domain indicators are ranked and exponentially distributed scores for each domain are computed. These non-linear scores are combined into an index of overall health services accessibility in the fourth and final step. The resulting index might be a valuable tool for researchers in need of a simple measure of overall health care accessibility. Furthermore, the index allows policymakers to compare the relative situation of overall health services accessibility between districts.

2. Health care domains in Germany

The regional distribution of ambulatory care in Germany is largely regulated in the capacity planning directive (*Bedarfsplanungsrichtlinie*), which defines different groups of ambulatory care providers and sets target values in terms of providers per capita. Physicians are grouped with respect to the degree of specialization. Target values per capita are defined at the smallest area level for GPs and at larger area units for higher degrees of specialization. We suggest using the classifications from the German capacity planning directive and define three domains for ambulatory care as shown in Table 1. The first domain comprises ambulatory GPs, the second domain includes ambulatory SPs and the third domain includes ambulatory highly specialized practitioners (note that all ambulatory physicians are office-based and provide care independently from the hospital system in Germany).

According to §6 of the German hospital funding law (KHG: *Krankenhausfinanzierungsgesetz)*, hospital planning schemes are organized at federal state level. The hospital funding law does not define different levels of specialization and does further not demand for different area levels for hospital planning. Each federal state regulates the numbers of hospitals as well as their exact locations and capacities at a smaller area level. We adapt the scheme for the ambulatory sector and consider clinics for internal medicine, surgical clinics and orthopedic clinics to be an inpatient pendant to the ambulatory general care domain. All other inpatient clinics are considered in the specialized inpatient care domain.

3. Computing the index of health services accessibility

3.1. Spatial accessibility of providers

Given the free choice of physicians and hospitals warranted by the German health care system