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Modelling spatial access to General Practitioner surgeries: Does public transport availability matter?

Gary Higgs^{a,*}, Renee Zahnow^b, Jonathan Corcoran^b, Mitchel Langford^a, Richard Fry^c

^a GIS Research Centre, Wales Institute of Social and Economic Research, Data and Methods, Faculty of Computing, Engineering and Science, University of South Wales, Pontypridd CF37 1DL, UK

^b School of Geography, Planning and Environmental Management, The University of Queensland, 4072, Australia

^c Farr Institute, College of Medicine, Institute of Life Science 2 (ILS2), Swansea University, Singleton Park, Swansea SA2 8PP, UK

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ABSTRACT

Existing approaches investigating access to primary health care tend to use relatively crude measures that compare supply to demand ratios for administrative units or use GIS to calculate straight-line or network distances to the nearest facility. The latter however largely assume access is via private modes of transport. The aim of this paper is to investigate the impact of different modes of travel (car versus bus) on associations between different measures of General Practitioner (GP) supply and area level deprivation and the percentage of elderly patients. Multivariate regression techniques are employed to examine relationships between demand and potential accessibility to GP services for different modes of travel for a study area in South Wales, UK. Accessibility measures are calculated using 'traditional' GIS-based approaches and Enhanced Two-Step Floating Catchment Area (E2SFCA) techniques. Findings suggest that, whilst the direction and strength of the association between deprivation and accessibility measures varies by mode of travel, the main differences are actually across measures of accessibility. This has important implications for studies of potential inequalities in health service accessibility and suggests there is a need to develop consistent measures of accessibility if we are to truly understand the relationship between demand and supply. Such studies should ideally incorporate the availability of alternative modes of transport particularly in areas where there are vulnerable groups such as the elderly who are typically more dependent on public transportation to access health care services.

1. Introduction

Concerns regarding the recruitment and retention of General Practitioners (GPs) entering practice in the UK have led to a number of studies that have used quantitative approaches to investigate whether the geographical distribution of GPs is equitable given current and predicted demographic trends and pressures (Gravelle and Sutton, 2001; Hann and Gravelle, 2004; Goddard et al., 2010). Trends in the provision of GPs have to be considered in combination with health needs and a range of demographic variables used to compare supply of, and demand for, primary care services (Asthana and Gibson, 2008). In his paper proposing the existence of an Inverse Care Law, in former coal-mining communities located within the study area adopted for this paper, Tudor Hart (1971) drew attention to an unequal provision of services stemming from a negative relationship between health needs and the availability of health care. He further predicted some of the problems facing those residents living in areas experiencing barriers to the recruitment

* Corresponding author.

E-mail address: gary.higgs@southwales.ac.uk (G. Higgs).

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of doctors. These areas tended to be geographically isolated communities undergoing major changes in demographic and socio-economic conditions. They were areas that were often experiencing poor levels of public transport provision, low levels of car ownership or household car availability and that were also witnessing a centralisation of health care services. More recently, a study of the spatial distribution, age profile and gender of GPs by practice deprivation in Scotland found that there are more GPs in the least deprived deciles compared to more deprived areas. Further, the more deprived areas also have an older age profile of GPs (Blane et al., 2015).

Yet, the presence of sufficient GP services to meet population demand is only one facet of healthcare accessibility. Another component is an adequate transportation system to facilitate service access. Transportation has been identified as a general barrier to health care in a number of studies. In a study examining healthcare accessibility in Ohio for example, 30 percent of respondents considered transportation as a barrier to accessing health services, with those living in poverty disproportionately affected (Ahmed et al., 2001). Further, Rittner and Kirk (1995) report that the poor and the elderly rely most heavily on public transportation for access to healthcare and are more affected by underservice of both health care providers and transportation systems. The increasing adoption of mapping software has led to a large number of studies that have used modelling tools to derive measures of spatial proximity to health facilities that can be employed to investigate associations between measures of health service availability/quality and socioeconomic characteristics of areas (Higgs, 2004). Overwhelmingly, these studies focus on access by private transport (car) and tend not consider healthcare service accessibility via public transportation systems.

A recent National Health Service (NHS) report has re-iterated the need to ensure access to primary care services through the siting of practices at 'convenient locations' close to people's homes (Primary Care Workforce Commission, 2015). Geographical methods such as spatial regression continue to be used to gain an understanding of the relationship between the distribution of primary care physicians (supply-side) and potential demand arising from neighbourhood level factors such as poverty and racial composition (Ye and Kim, 2015). The specific focus of the present study concerns a comparison of the supply of GPs based at primary care surgeries for a study area in South Wales, UK with potential population demand within user-defined travel times and by different modes of travel. These have been incorporated into familiar measures of accessibility that have been adopted by a wide range of studies as well as a variant of a gravity model in order to investigate whether there are inequalities in access to GPs within the study area. This study builds on previous approaches to examine the direction and strength of the relationship between accessibility and socio-economic characteristics by incorporating measures of public transport availability.

Traditional approaches to identifying trends in provision of health services tend to be simplistically based either on calculating area-based provider-to-population ratios, straight-line or network distance models to the nearest GP surgery or straightforward counts of facilities within specified travel time catchments that generally take no account of potential demand on the service. Comparisons of the use of these different approaches to measuring potential spatial access to health services have formed the basis for a number of previous studies (e.g. Yang et al., 2006; Neutens, 2015). Such studies have also drawn attention to the types of methodological considerations which may be important when interpreting findings including the use of straight-line versus network-based distance calculations to health facilities (e.g. Boscoe et al., 2012), the use of point representations to summarise the location of potential demand for services (Jones et al., 2010) and the potential use of perceived or subjective measures of distance rather than more sophisticated GIS-generated models of distance (Fone et al., 2006). Until relatively recently however such studies also tended to be based on the assumption that access to services is via the car (Guagliardo et al., 2004; Apparicio et al., 2008). Despite recent calls for more research that extends such models to include public transport availability, few studies to date have adopted such models to include network representations that permit alternative modes of transport to health facilities to be incorporated into accessibility measures (Lovett et al., 2002; Martin et al., 2008; Langford et al., 2016).

Another motivation for the present paper is that few studies to date have compared the sensitivity of findings to the types of access measures used; in a notable exception Rosenthal et al. (2005) compared trends in the numbers of full time equivalent physicians in relation to expected demand for twenty-three states in the United States. Their findings highlight the limitations of straightforward physician-to-population calculations for identifying supply and demand inequalities and call for more refined measures of spatial availability of physician services. Whilst some aspects of the study, such as health insurance coverage, are US-specific concerns their conclusions regarding the relative dearth of research concerned with comparing the use of different measures of accessibility to health services by different modes of transport are applicable in different health contexts. The present study addresses such research gaps by showing how GIS-based network approaches can be used to investigate small-area variations in demand/supply relationships which account for the mitigating influence of distance and which accommodate dedicated representations of private (car) and public (bus) modes of transport. Using the example of access to general practitioners, the aim is to demonstrate how such techniques can be used to examine socio-economic variations in access to primary health care which may provide a reappraisal of the Inverse Care Law using quantitative measures that account for different modes of transport. This study draws on openly available digital data sources in the UK and uses code that is being made freely available to researchers in order to test the reproducibility of these findings for other situational contexts.

2. Methods

2.1. Data sources

In this study spatial variation in access scores using car and bus travel times were derived for three methods of measuring accessibility to GPs based at primary healthcare surgeries and analysed at the Lower Super Output Area (LSOA) level for a study area in South Wales (Fig. 1). This was chosen partly because it includes communities that were part of Tudor Hart (1971) original study

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