An investigation of the effect of accessibility to General Practitioner services on healthcare utilisation among older people

Equity in access to healthcare services is regarded as an important policy goal in the organisation of modern healthcare systems. Physical accessibility to healthcare services is recognised as a key component of access. Older people are more frequent and intensive users of healthcare, but reduced mobility and poorer access to transport may negatively influence patterns of utilisation. We investigate the extent to which supply-side factors in primary healthcare are associated with utilisation of General Practitioner (GP) services for over 50s in Ireland. We explore the effect of network distance on GP visits, and two novel access variables: an estimate of the number of addresses the nearest GP serves, and the number of providers within walking distance of a person's home. The results indicate that geographic accessibility to GP services does not in general explain differences in the utilisation of GP services in Ireland. However, we find that the effect of the number of GPs is significant for those who can exercise choice in selecting a GP, i.e., those without public health insurance. For these individuals, the number of GPs within walking distance exerts a positive and significant effect on the utilisation of GP services.

Keywords: General Practitioner (GP) services; primary care; healthcare supply; physical access; older population; Ireland; TILDA

1 Introduction

Equity in access to healthcare services is regarded as an important policy goal in the organisation of modern healthcare systems. Generally, equity of access relates to the supply side of healthcare, where individuals with equivalent health needs can avail of equivalent health services[1,2]. While the concept of access itself is complex and multi-faceted, physical accessibility to healthcare facilities and services is recognised as a key component of access[2,3]. The World Health Organization[4] (WHO) describes physical accessibility 'as the availability of good health services within reasonable reach of those who need them […,] when they need them'. Furthermore, in the context of the human right to health, the WHO[5] emphasizes that healthcare should be within physical reach for vulnerable or marginalized groups, where older persons and residents of rural areas are listed among at risk groups.

There is some discussion in the literature as to the practical meaning of access and whether this is demonstrated by utilisation of services[6]. According to Mooney[7], access is entirely a supply-side phenomenon, while utilisation is the result of the interaction between supply and demand. Therefore, according to this reasoning, equality of access concerns equal opportunity, but whether this opportunity is exercised or not is not fundamental to ensuring equity of access. On the other hand, the Donabedian[8] view asserts that access is not merely the existence of a facility but rather the use of the service provides proof of access. This study pursues the Donabedian interpretation, and looks at annual attendances at GP consultations, where utilisation is the barometer of access.

To date, there is no accepted measure of physical accessibility. From a geographical point of view, achieving equal access for equal need may be viewed as an unfeasible goal[9]. Since health facilities concentrate in particular locations, these are invariably more accessible to proximal residents than for those who live further away. Three metrics of accessibility were constructed for this analysis (detailed in the supplementary file), which build-on and expand upon the existing tools used in the literature.

Older people are more frequent and intensive users of healthcare. Access barriers, such as personal mobility, access to transport and information, may present more significant obstacles for this group[10–13]. In finding little effect of the removal of GP charges for over 70s in Ireland on GP attendances, Layte *et al.*[11] suggest that GP and area-level characteristics such as transport links, practice size and composition may be just as important in influencing visitation. This study responds to this suggestion, investigating the effect of the spatial distribution of GP services in Ireland on GP visits.

This case study of primary care in Ireland adds a distinctive offering to the evidence base assessing the influence of the supply of healthcare since Ireland is a European country without universal primary healthcare. Irish primary care is more akin to the set-up in the US that provides public insurance for low income and older populations. The pressures on healthcare budgets, particularly post the global recession of 2008, may prompt policymakers to consider implementing user charges such as co-payments. Furthermore, because GPs in Ireland are self-employed, while in other countries they may be employed by the state, which may also control GP location, this study also provides evidence as to whether the market can satisfy geographic distribution requirements. The results are relevant for other settings where GPs act as gatekeepers for secondary care. The methods of this investigation of supply-side issues present a novel proxy measure of the workload of a GP; this may be relevant for countries that do not have patient lists. Finally, the focus of our study on access to GP services for over 50s is relevant for many developed countries that are experiencing an ageing of their population.

The remainder of this paper is organised as follows. An overview of the Irish healthcare system is provided in Section 2. The findings of the extant literature, exploring the effects of supply of healthcare services on utilisation and outcomes, is described in Section 3. The data and methods used to assess the impact of the supply of GP services on utilisation are outlined in Sections 4 and 5, and the results presented in Section 6. An interpretation of the findings is discussed along with the merits and drawbacks of the approaches employed and implications for research and policy in Section 7.

2 Institutional context

In Ireland, primary care is usually the first point of contact for individuals with the healthcare system. GPs are a central part of primary care provision, although the delivery of primary care may also involve nurses and other healthcare professionals. A consultation with a GP usually entails patient assessment with diagnosis and treatment in the primary setting. GPs act as gatekeepers for onward referral to secondary or specialist care. Ireland is the only European country that does not offer universal coverage of primary care[14]. The current financing arrangement for GP care in Ireland requires the majority of the population to pay full cost at the point of use. Currently, the average cost of a GP consultation is €52.50[15]. This fee-for-service complicates equity of access considerations. However, a substantial proportion of the population can avail of free GP care where they are entitled to a medical card or a GP visit card (generally referred to as 'public' patients). These entitlements are income means-tested or age-based offered on a discretionary basis to patients with health needs that would cause them undue hardship[16]. In 2010, 35.5% of the population held a medical card, and 2.6% had a GP visit card. In 2016, 35.5% were medical card holders, but the prevalence of GP visit cards increased to 9.9%, because of the introduction of universal GP visit cards for over 70s and under 6s in 2015[17]. A further complication in the Irish healthcare system is the existence of private health insurance, availed of by 43% of the population in 2016. Private insurance mainly provides cover for private hospital services, but several schemes offer partial reimbursement for primary care expenses (e.g. GP visits, physiotherapy).

A substantial literature base has emerged due to concerns around the economic accessibility of primary care in Ireland. Exposure to the out-of-pocket charge has been found to reduce GP attendances for the general population[18,19], older people[13,20] and children[21,22]. This investigation incorporates the considerations of the previous economic accessibility literature, exploring the impact of physical accessibility on GP attendance.

Equity of access and geographic proximity to health facilities is a recurring objective in Irish health policy[23–26]. Ireland's *Programme for Government 2016-2019*[26] outlines ambitions to 'increase access to safe, timely care, as close to patients' homes as possible'. Safeguarding the sustainability of GP practices in rural Ireland and in disadvantaged urban areas is underscored. Access to care is also a focus of *The National Positive Ageing Strategy*[25], which emphasises that 'Older persons should have access to healthcare to help them to maintain or regain the optimum level of physical, mental and emotional wellbeing and to prevent or delay the onset of illness'.

At present, there are no restrictions on where GPs can choose to locate in Ireland. However, we note that, prior to 2012, General Medical Service (GMS) contracts, which a GP must hold to provide free-of-charge care to medical or GP visit cardholders, were restricted to specific locations. Previously, under the contract, GPs provided services for public patients within a defined geographical area, and contracts were life-long, acting as a barrier to entry for other GPs. These constraints have since been lifted and there are no geographical restrictions on the establishment of GP practices with GMS contracts.

3 Literature on physical accessibility to healthcare

In a systematic review, Kelly *et al*.[27] investigated whether travel time or distance to healthcare facilities affected health outcomes in developed countries. Of the 108 included studies, the preponderance of evidence exhibited a distance decay effect in access to healthcare (77% of studies), where there was an inverse relationship between a patient's physical location (usually residential) and their use of healthcare services or health outcomes. That said, no association between proximity to services and health outcomes/utilisation was uncovered for a sizeable 18% of studies, and a small number of investigations (six studies) reported a distance bias effect, where there was a positive association between distance and health outcomes/utilisation. Due to the great variety of study designs, metrics of distance/time and a gamut of outcomes, a meta-analysis was not undertaken. Fourteen studies specifically looked at distance/travel time to GP or primary care services, with thirteen uncovering a

distance burden. The distance burden was more obvious for less serious illnesses, while more proximal patients had greater likelihoods of attending check-up or follow-up appointments. Deprivation emerged as an important consideration in modelling the relationship between distance and health outcomes – though the direction of the effect differed across studies[28,29].

A small body of Irish studies consider the effect of proximity to a healthcare facility on an assortment of health-related indicators. A study from the 1980s explored the potential for physician-induced demand[18], including distance (measurement undefined) as an explanatory variable in explaining return visits to a GP. A strong distance decay effect was estimated. The focal independent variable was a measure of physician density, the GP-population ratio. Physician density had a positive effect on return visits, lending support to the hypothesis that Irish GPs stimulated demand. However, more recent research has found limited evidence of physician-induced demand[19], and thus a new investigation of the effect of distance is justified.

A number of other Irish studies have found evidence of a distance burden, for example, distance to treatment hospital on quality of life of surviving colorectal cancer patients[30], and uptake of diabetes screening during pregnancy and distance to a screening hospital[31]. However, several studies found no association between health and physical accessibility measures. These include a study investigating the association between thickness of melanoma and distance to diagnosing hospital[32], and a study of rural-dwellers' access to health services (GP, hospitals) and self-rated health or quality of life[33].

We note that non-linear relationships between distance and health outcomes have been observed in the international literature[10,28,34]. Field and Briggs[10] suggest that areas which benefit from a GP within walking distance profit from good accessibility, while residents in remote areas are more likely to have a car enabling access, but residents of intermediate distances may rely on public transport, constraining accessibility.

Access to GP services has also been found to affect the use of other healthcare services such as hospital attendances. Evidence suggests the greater the distance to a GP surgery, the lower are hospital episodes, particularly elective admissions[35]. Distance is also found to have a diminishing effect on telephone contact with out-of-hours GP provision[36,37], with the effect especially pronounced for those aged sixty-five plus[36].

In terms of the number or level of GP provision in an area, the supply of GPs has been studied in two ways: the supply of GPs may influence utilisation of services simply by virtue of supply itself, or alternatively, the supply of GPs may prompt utilisation because of physician-induced demand. An Irish study found that a greater supply of GPs was associated with a reduction in hospital discharges for chronic obstructive pulmonary disease and diabetes[38]. Another study found that higher emergency department utilisation may be explained by under-provision of GPs and out-of-hours services in the vicinity of these acute departments[39]. The current stock of evidence pertaining to the question of supplier-induced demand is mixed. As noted, the fee for GP service arrangement in Ireland was understood to have encouraged supplier-induced-demand in a study from the 1980s[18]; however, more contemporary evidence from 2005[19] finds less support for this phenomenon. In Germany, the supply of physicians among the population was not found to significantly influence doctor visits or hospital nights[40]. However, a systematic review of twenty-five studies consistently found a significant relationship between physician density and healthcare consumption[41].

The effect of physical accessibility on health utilisation among the older population has received relatively little attention in the existing literature. A qualitative study of perceived barriers in access to healthcare for older rural residents of West Virginia[42] highlighted inadequacies in transportation, limited choice of physicians and long-term care, and poorer quality of healthcare as significant structural issues. However, a quantitative investigation found no association between distance and visits to physicians for over 65s in rural Vermont[43], though the location of a doctor in relation to an older person's activity space (where they conducted day-to-day activities e.g. grocery shopping,

socialising) was an important predictor of visiting. Another empirical study of the determinants of healthcare trips (routine check-ups, chronic care, and emergency care) for over 60s in four US states found that neither distance nor ability to drive were significant determinants of healthcare usage[44].

Evidence that combines economic and physical accessibility considerations in the same study is scarce. The interplay between economic factors and geographic accessibility has been explored in a unique study where proximity to Walmart, a source of cheap generic prescription drugs, increased utilisation of antihypertensive medication and reduced avoidable hospitalisations[45].

4 Data

4.1 Data sources

To investigate the extent to which the supply of GP services is a determinant of utilisation of GP services among older people in Ireland, information from the Irish Longitudinal Study on Ageing (TILDA) was linked to data on the location and number of GPs in Ireland. These sources are described in turn.

4.1.1 TILDA

TILDA is a nationally representative survey of those aged 50 years or older in Ireland (living in residential households at baseline). The dataset contains a rich set of variables on the health and socio-economic circumstances of respondents. The first wave of data was collected between October 2009 and July 2011 with 8,175 interviews undertaken with participants from 6,279 households (achieving a response rate of 62%). An additional 329 interviews were conducted with younger partners of eligible individuals. The survey involved three modes of data collection: a face-to-face computer assisted personal interview (CAPI) in the participant's home; a self-complete questionnaire containing sensitive questions to return via mail; and a nurse-led health assessment undertaken at a centre in Dublin or Cork, or where travel was impractical, a modified partial assessment was carried out in the respondent's home. The self-complete questionnaire achieved an 85% response (n=7,196)

and 72% of participants underwent the health assessment (n=6,150). To ensure best representation of the Irish population, weights were applied to the TILDA data, correcting for selection bias. For this investigation, the residential addresses of TILDA respondents were only available for wave one of the survey.

4.1.2 Sources of information on GPs in Ireland

There is no central register of GPs in the Republic of Ireland. In 2015, an exercise was conducted to derive a database of practising GPs with the aim of characterising the GP workforce[46]. Using lists from the Irish College of GPs (ICGP) and the Irish Medical Directory, researchers collated information on the location and number of GPs. ICGP members represent 85% of practising GPs. The Irish Medical Directory catalogues all registered medical practitioners. The number of full-time equivalent GPs was derived since some GPs work across multiple practices and/or part-time. The list was updated in 2016, with 2016 data used in this investigation. While ideally a measure of GP supply in 2010 (to coincide with wave one of TILDA) would be available, the distribution of GPs across urban and rural areas remained essentially unchanged between 2005 and 2015[46]. In addition, residential mobility has been low across the waves of TILDA (between wave one, 2009-11, and wave two, 2012-13, 2.7% of respondents moved house[47]).

4.2 Creation of access variables

The addresses of TILDA respondents and the location of GPs were mapped using Geographic Information Services techniques (QGIS v.2.16), affording the creation of three supply-side 'access' variables:

1. Road network distance (kilometres) from TILDA respondent's residence to the nearest GP. The road network source was OpenStreetMap. This variable provides an indication of geographical proximity. It is a superior measure than straight-line Euclidian distances since it reflects actual distances along roads. The distance variable for each individual is expressed as a quintile to protect

respondent anonymity. Quintile one represents the fifth of respondents with the shortest distance to a GP.

2. The number of residential addresses potentially served by the nearest GP. Data on all residential addresses in Ireland from the An Post Geodirectory were used to estimate the number of addresses to which each GP practice is the nearest, again using network distance. Each address in the country was assigned to its nearest GP. This indicator acts as a proxy for the workload/congestion/capacity of the local GP. This variable is novel in terms of the existing literature on accessibility. The addresses/workload variable for each individual is in quintile form. The first quintile represents the fifth of respondents where their local GP has the lowest 'workload'.
3. The number of GPs within walking distance (1.6km radius) of a respondent's residence. This variable provides an indication of the availability/density/choice of primary care providers available to respondents in their locality. The 1.6km buffer, based on Euclidean distance, equates to a twenty minute walk and has been used extensively in other studies of walking distance[48,49]. The final 'choice' variable for the individual is defined as zero where there are no GPs within 1.6km, and where there are GPs in walking distance these are split into tertiles. The first tertile represents individuals who have a GP within 1.6km, but the choice of GPs is low. We also crosscheck the results using an 800 metre buffer, a 10 minute walk, since older people may have lower mobility.

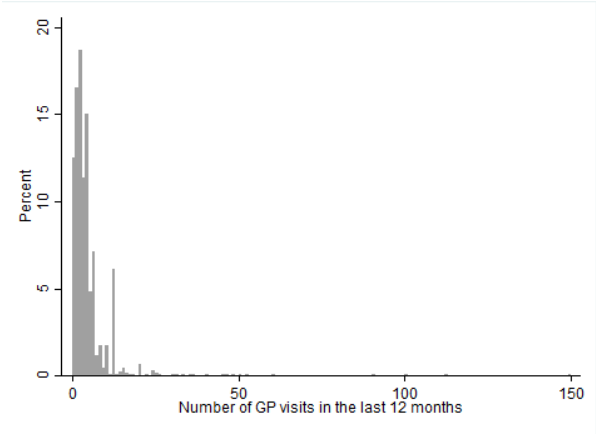
5 Methods

5.1 Theoretical framework

The use of GP services is the dependent variable, and is represented by the self-reported number of GP visits the respondent attended in the previous twelve months. In the sample for analysis, the

average number of GP visits was 4.1, and the variable had a positive, right-tailed distribution as displayed in Figure 1.

Figure 1: Distribution of GP visits



Number of GP visits in previous 12 months	
N	8,164
0	12.5%
1	16.5%
2	18.7%
3	11.4%
4	15.0%
5+	25.8%
Mean	4.1
Standard deviation	5.6
Variance	31.1
Median	3.0
Range	0-150

In this paper, we use the Andersen framework[50,51] as the conceptual framework underlying the analysis of GP utilisation. Andersen's determinants of healthcare utilisation are distinguished as: *predisposing factors* which encompass the socio-cultural characteristics of individuals that exist prior to illness, *enabling factors* which concern the logistical aspects of obtaining care, and *need factors* which relate to the most immediate cause of health service use, typically health or functioning problems that prompt a need for services.

The enabling resources of the model reflect the context in which utilisation occurs and include the availability of health personnel and facilities, as well as a person's means to use the services. In a review of his behaviour model, Andersen[51] points out that there has been a lack of attention in the literature paid to organisational factors as enabling resources. Furthermore, unlike the demographic, socio-economic or need components, enabling characteristics have a high degree of mutability. The absence of consideration of provider-related variables in healthcare utilisation behaviour studies is confirmed in a systematic review of studies which employ the Andersen structure[52]. Our investigation is concerned with Andersen's enabling resources as the supply of GPs in Ireland, expressly as three access variables of distance, workload and the count of GPs in one's vicinity. Therefore, we contribute

to the wider literature on the empirical application of Andersen's model, addressing the gap in inquiries of enabling characteristics.

Our enabling access variables are hypothesised to influence utilisation of GP services in the following ways:

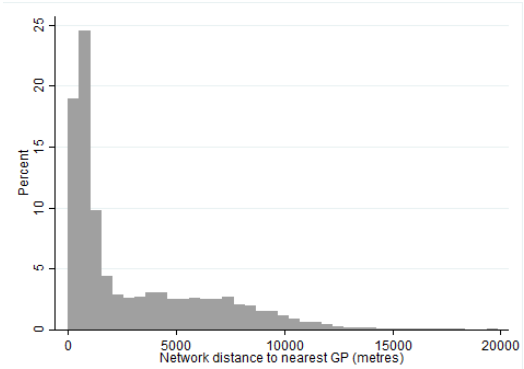
1. One might expect that the further a person lives from their GP, the less convenient it is to visit the GP, and thus distance is expected to demonstrate an inverse relationship with consultations. The bulk of existing literature finds evidence of a distance burden.
2. A greater number of addresses for the local GP is anticipated to reduce GP visits, since these GPs may experience capacity bottlenecks and thus appointments may be harder to arrange. To the authors' knowledge there is no existing literature testing a variable of this nature.
3. The more GPs within a close vicinity of one's home facilitates greater convenience in seeing a GP and thus is hypothesised to result in a higher number of attendances. There is some evidence, relating to supplier-induced demand concerns, that a greater density of providers generates more visits.

Descriptive statistics of the access variables are displayed in Table 1.

Table 1: Description of access variables

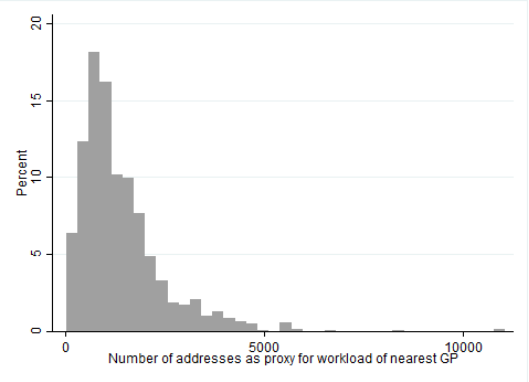
Distribution of variable	Quintile/tertile boundaries

Network distance



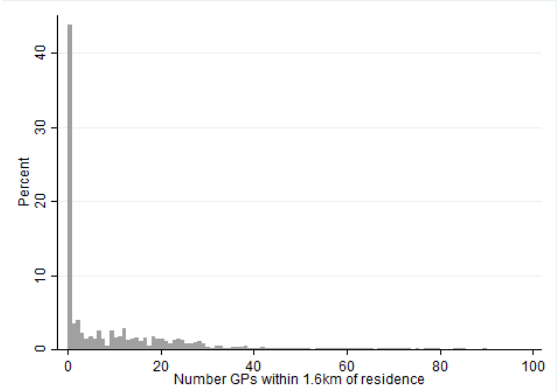
Quintile	N	Range			Mean
1	1642	1	-	528	329
2	1652	529	-	929	708
3	1629	930	-	2505	1465
4	1619	2505	-	6197	4325
5	1622	6198	-	19897	8787
Total	8164				

Number of residential addresses assigned to local GP



Quintile	N	Range			Mean
1	1650	17	-	596	383
2	1634	599	-	922	765
3	1628	924	-	1334	1104
4	1645	1334	-	1975	1635
5	1607	1980	-	11064	3070
Total	8164				

Number of GPs within walking distance



	N	Range			Mean
0	3436	0			0
Tertile					
1	1602	0.2	-	7.5	3.3
2	1561	7.7	-	18.5	13.0
3	1576	18.7	-	90	29.1
Total	8175				

*Fractional numbers of GPs arise since the measure is full-time equivalents. For example, where there is 0.2 GPs this may be interpreted as a respondent has access to a GP for one day per week within 1.6km.

While the focus of this paper is supply-side factors, TILDA also contains extensive information on predisposing characteristics: socio–economic determinants of healthcare utilisation such as gender, age, marital status, education, employment and household location in the rural/urban context. Further enabling characteristics that are not key variables of interest, but remain important are the

healthcare entitlement status of the individual (public, private and no coverage) and their usual means of transport. The healthcare need characteristics as identified by Andersen are captured in the TILDA interview reports of respondent's self-rated health, number of chronic conditions, disability (presence of problems with an activity of daily living (ADL) or instrumental activity of daily living (IADL)), taking of medicines, depression score (measured by the Centre for Epidemiological Studies Depression scale). The TILDA health assessment collects additional objective measures of healthcare need such as hypertension, cholesterol, body mass index, osteoporosis, timed-up-and-go speed, and respondent's cognitive score. The results for our models that include health assessment variables are presented in the supplementary file. Descriptive statistics of our explanatory variables are displayed in Table 2.

Table 2: Sample characteristics

		Percent
Gender	Male	47.9
	Female	52.1
Marital status	Married	67.8
	Never married	9.7
	Separated/divorced	6.6
	Widowed	15.9
Education	Primary	38.2
	Secondary	43.2
	Tertiary	18.5
Employment	Employed/self-employed	24.1
	Retired	35.3
	Unemployed	5.4
	All other non-employed	23.8
Urban	Dublin	22.5
	Urban not Dublin	28.1
	Rural	49.4
Healthcare eligibility	Medical/GP visit card only	36.4
	Private insurance only	36.6
	Private insurance & medical card	16.0
	No coverage	11.0
Usual means of transport	Drive oneself	68.9
	Driven as a passenger	18.4
	Other non-car transport	11.6
Self-rated health	Excellent health	14.2
	Very good health	27.9
	Good health	33.0
	Fair/poor health	24.9
Chronic conditions	No chronic conditions	22.6
	One chronic	27.8
	Two chronic	50.7
	Three or more	26.7
Any disability		12.9
On medication		72.0

	Mean	Standard deviation	Minimum	Maximum
Age	64.0	10.1	50	105
Depression score	6.0	7.3	0	53

5.2 Econometric modelling

The nature of the GP visits variable is discrete and non-negative, with a skewed distribution. The variance of GP visits at 31.1 is larger than the mean, 4.1, indicating the variable is over-dispersed. Therefore, negative binomial regression is a more appropriate count modelling approach than Poisson regression.

The estimated negative binomial model of GP visits may be expressed as:

$$Pr(y_i = y_i^*) = \frac{\Gamma(y_i^* + \upsilon)}{\Gamma(y_i^* + 1)\Gamma(\upsilon)}\left(\frac{\upsilon}{\upsilon + u_i}\right)^{\upsilon} \times \left(\frac{u_i}{\upsilon + u_i}\right)^{y_i^*}, y_i^* = 0,1,2,\ldots \quad (1)$$

where Γ is the gamma distribution function, y_i is the annual number of GP visits, with $u_i = exp(x_i\beta)$, $\upsilon = \alpha^{-1}exp(x_i\beta)$, x_i is the vector of explanatory variables, including the access variables of interest, and β are parameters to be estimated. When $\alpha = 0$, the model reduces to a Poisson specification.

The results are checked to exclude observations that had extreme numbers of GP visits – visits greater than three standard deviations from the mean. Reported coefficients are marginal effects. A further assessment of the robustness of the results is conducted using a two-step modelling approach to healthcare utilisation, described in the supplementary file along with the estimated results. We check whether the results for the walking distance variable are different when the distance is halved to 800m.

Subgroup analyses were also conducted for different groups of the population that may be differentially affected by access considerations. Analysis was run separately for groups of rural and urban respondents, those who may have mobility difficulties including those who report a disability, no car access, who live alone and those aged over 75 years. We make reference to the results of these subgroup analyses in Section 7 (subgroup results are available on request from the authors).

Because the payment arrangements for GP services in Ireland is so unusual internationally, we also investigate whether there is a difference in the accessibility effects depending on whether a person must pay out-of-pocket for a GP consultation (as represented by no medical or GP visit card status). As it is not technically possible to obtain marginal effects for interaction terms[53], we calculate predicted GP visits for those covered by a medical or GP visit card (public insurance) and those not, and present the results graphically.

6 Results

For each access variable, we first examine an age-sex-adjusted association between access and GP visits, before moving on to a full model specification that includes the full set of predisposing, enabling and need variables.

Beginning with distance to the nearest GP, the chart in panel (a) of Table 3 demonstrates little variation in GP visits across the quintiles. Across deciles, the relationship is also unvarying (see supplementary file). A lack of influence of distance on GP visiting behaviour is confirmed in the estimation results in Table 3.

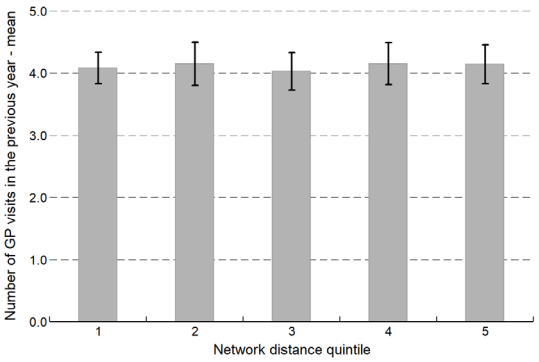
A significant effect of addresses on the number of GP consultations is also not evident in Table 3, panel (b). The results show that for a basic model, which controls only for demographics, there is a marginally significant positive relationship between the quintile representing respondents for which their GP has potentially the heaviest workload, counter to expectations. However, when all explanatory variables are included this effect does not persist.

The graph showing the number of GP visits across the categories representing increasing GP provision in a respondent's locality also shows no significant association; see panel (c). Tertiles two and three, signifying those with the greatest availability of GPs, have lower GP visits than those without a GP in walking distance. This association is corroborated by the modelling results in Table 3. A smaller walking distance of 800 metres does not demonstrate different results (see supplementary file).

Table 3: GP visits across access variable categories and estimation results

Mean GP visits by access variables | **Estimation results**

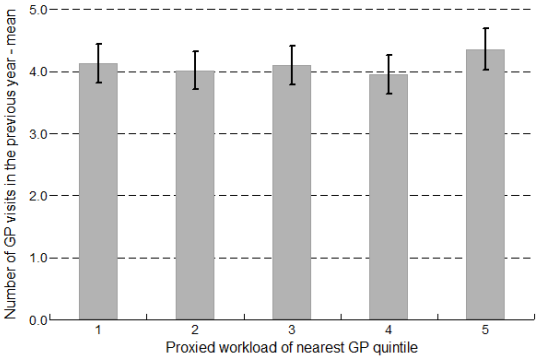
(a) Network distance



	Basic specification	Full model
Network distance quintile 1 – reference		
Distance quintile 2	0.159	0.157
	(0.203)	(0.141)
Distance quintile 3	0.098	-0.051
	(0.174)	(0.114)
Distance quintile 4	0.125	0.046
	(0.178)	(0.147)
Distance quintile 5	0.138	0.041
	(0.173)	(0.147)
N	8141	7987
Log-Likelihood	-20076.1	-18063.7

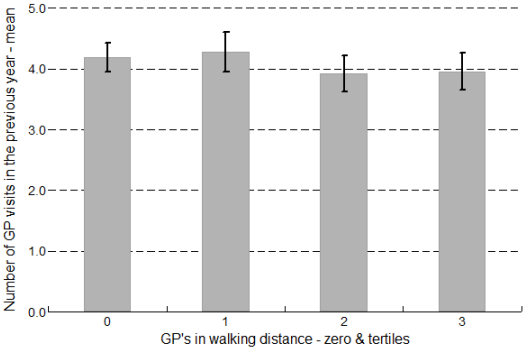
Marginal effects (robust standard errors in parentheses)
Statistical significance: + p<0.1, *p<0.05, **p<0.01, ***p<0.001

(b) Addresses– proxied workload



	Basic specification	Full model
Addresses quintile 1 - reference		
Workload quintile 2	-0.014	-0.092
	(0.182)	(0.115)
Workload quintile 3	0.014	-0.025
	(0.182)	(0.131)
Workload quintile 4	-0.093	0.004
	(0.169)	(0.117)
Workload quintile 5	0.375+	0.030
	(0.198)	(0.117)
N	8141	7987
Log-Likelihood	-20070.0	-18065.2

(c) GPs within walking distance

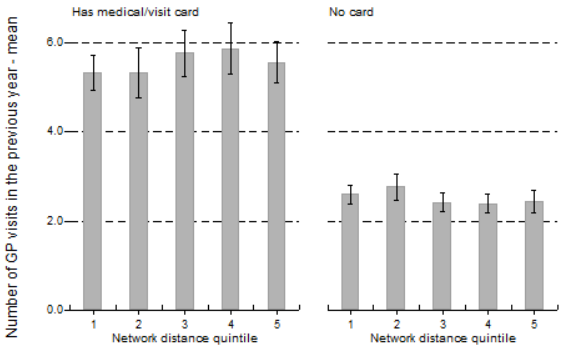
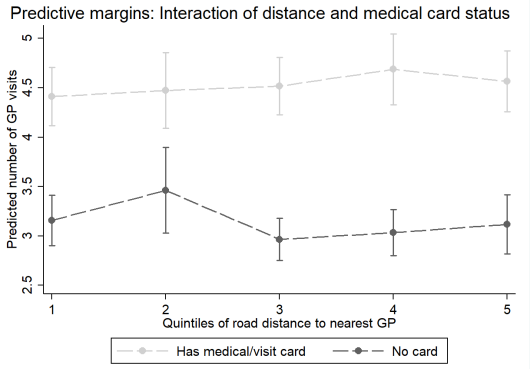
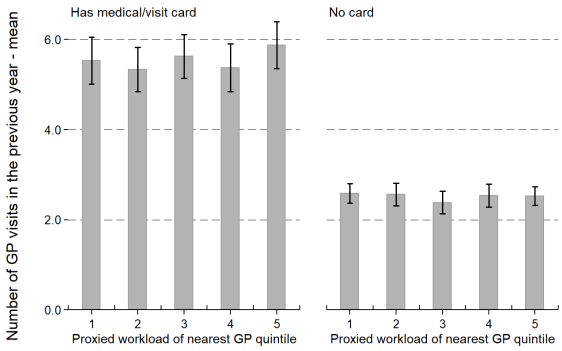
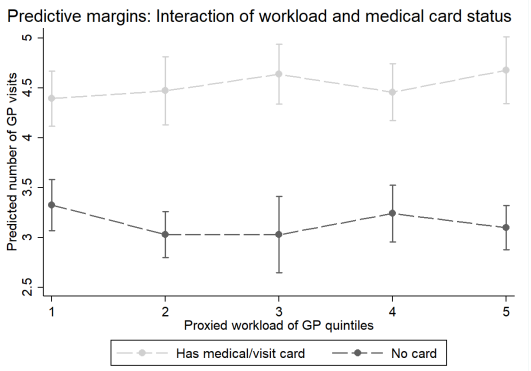
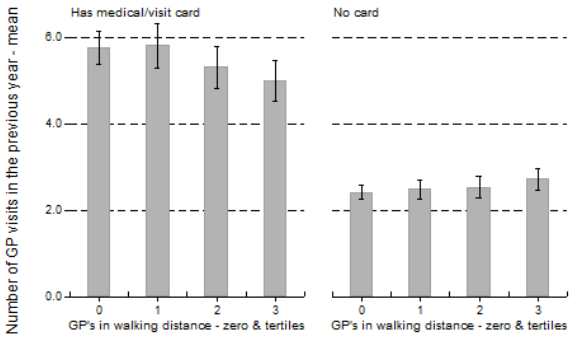
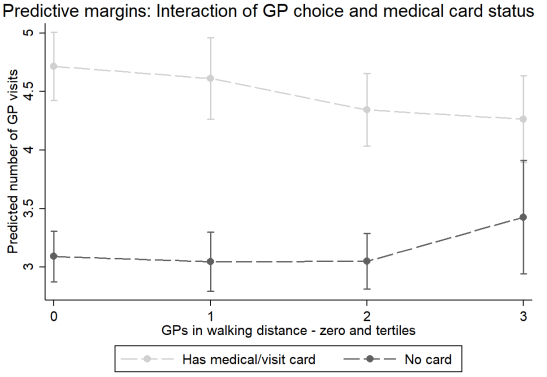


	Basic specification	Full model
No GPs in walking distance - reference		
Proximal GPs tertile 1	0.101	-0.060
	(0.171)	(0.122)
Proximal GPs tertile 2	-0.195	-0.169
	(0.144)	(0.149)
Proximal GPs tertile 3	-0.264	-0.035
	(0.163)	(0.200)
N	8152	7998
Log-Likelihood	-20108.7	-18098.0

No significant associations were uncovered for the interaction between public health insurance (i.e., medical or GP visit card) and the access variables of distance and number of addresses, evident in Table 4, panels (a) and (b). However, a significant interaction effect between public health insurance and the extent of GP provision in a respondent's locality was found. Panel (c) shows that for those

without a medical or GP visit card (over 50% of the sample), GP visits were significantly higher when they lived in areas well served by GPs (equivalent to approximately 0.5 extra visits per annum).

Table 4: Medical card status and access variable

Mean GP visits by access variables over medical card status	**Predictive margins**
(a) Distance	
	
(b) Addresses – proxied workload	
	
(c) GPs within walking distance	
	

The subgroup analysis did not reveal many distinct associations for the influence of access variables on utilisation. There was some evidence that those with a disability and those with a chronic condition have significantly lower levels of visitation with a greater extent of GP choice. While GPs act as gatekeepers for secondary care, we acknowledge that not all chronic conditions are managed in primary care.

7 Discussion

The results of the models that test for an effect of three accessibility variables on GP utilisation do not demonstrate that the local supply of GPs is a major barrier to healthcare access for older people in Ireland. For those who must pay for their GP appointments however, visiting rates are higher for those with a higher number of GPs in their vicinity.

7.1 Explaining the results

Geographically, Ireland is a small-sized country. Many of the studies that found evidence of a distance burden[27] originate from countries with a large geographic area such as the USA, Canada and Australia, as well as larger European countries like France, Norway, Finland and Italy. The findings of this study are important for policymakers of other geographically small-sized countries. Our research shows that the conventional assumption of a distance decay effect cannot presume to exist.

Ireland is a high-income country by international standards and 68.9% of the interviewed over 50 year olds drive a car as their most usual form of transport, with a further 18.4% with access to a car, driven by someone else. Thus, the majority of the sample has good mobility and, by implication, ease of transport for appointments. Where the reported distance to providers or the ability to drive were not found to be significant determinants of healthcare usage for older people, Mattson[44] suggests that those who needed to avail of healthcare services were able to access required transportation irrespective of distance or driving ability. For those who did not drive, having someone else in the household resulted in a greater odds of making journeys. They hypothesise that older persons living

alone or widowed may be disadvantaged in obtaining necessary healthcare. However, in our study of older people in Ireland, we did not find that the subgroup of those living alone experience greater hindrances in utilisation. Moreover, a paper describing focus group discussions of mobility among older people in Ireland[54] finds that while in rural areas 'necessary' trips – those for food shopping, health and financial services – may be difficult to make, they are always made, even if these incur a financial toll or dependency on others. Older people may ask for lifts from family or friends or pay for taxis for these types of outings. While we cannot tell from the TILDA survey, rural respondents may also avail of the Rural Transport Programme, which provides for local community transport services, to attend doctor appointments.

In addition, the prevailing literature on this subject suggests that the context of rurality may also influence propensities for health-related travel, and distance may be interpreted as relative, with travel for services an accepted part of the rural lifestyle[55,56]. It may also be that in developed countries older people know they need to visit the GP and attend regardless of accessibility issues, and this explains the lack of effect in this study and for others in the literature[43,44]. Older individuals feel that their most important transport undertaking 'in this stage of their lifecycle is to attend health services'[57].

There are stronger predictors, such as need for care as indicated by reported 'fair or poor health' and taking of medications, which determine the number of GP visits (see supplementary file for all results). The eligibility status also has a strong influence on consultation rates, with those eligible for free visits via public insurance and those with private health insurance having more consultations than those without any coverage.

The lower levels of visitation for areas that are very well served by GPs may reflect the reality that these areas are also likely to be very well served in terms of alternative healthcare options, such as pharmacies or emergency departments.

The differential effect of the extent of number of GPs for those with free entitlements for GP care and those who must pay for the service may be explained by the fact that holders of a medical or GP visit card must register with a specific GP who holds a GMS contract. Their choice is constrained to this GP, irrespective of the number of providers in their area. For private patients their options are not limited in this way and where there is greater GP provision we observe higher visitation rates, indicating that choice is exercised. While it is also possible that this effect for the number of GPs may also indicate potential supplier-induced demand (as GPs receive a fee-for-service from patients without a medical or GP visit card), the fact that these individuals must pay the full cost out-of-pocket makes this alternative explanation unlikely. In areas benefitting from a large endowment of GPs, these GPs may be more likely to compete on price, quality and advertising, which may explain more visits.

7.2 Strengths and limitations

This study investigates the association between various indicators of GP supply and service utilisation among the older population in Ireland. In contrast to previous studies, we test three different access variables – the network distance variable affords a comparison of the results for older people in Ireland with extant studies; the addresses variable presents a novel gauge of accessibility; and the number of GPs within walking distance, interpreted as an indicator of choice for individuals, is presented in a slightly alterative way to the existing literature on the supply of physicians.

The TILDA dataset is a large, nationally-representative sample and provides rich information on the demographic, socio-economic, locational and health characteristics of older people, which allows us to control for other potential confounders in the relationship between supply and GP visiting. We use the latest, most comprehensive estimate of the number of GPs in Ireland, and the availability of geo-codes for both GPs and TILDA respondents allows us to link these data together for the first time. The study is unique in the literature in that it considers both physical and economic accessibility for GP services. In particular, we consider the interaction of supply and public insurance, providing new evidence on the differential effects of supply across the population.

A limitation of this paper is that the dependent variable, GP visits, is self-reported and has the potential for measurement error. Unfortunately, there is no administrative data source on GP visiting in Ireland. Secondly, this paper uses the nearest GP as a proxy for geographical accessibility of GP services. We do not know whether the TILDA respondent uses their nearest GP. An Irish study estimates that only 40% of patients travel to their nearest GP practice, 59% to the nearest two, 71% to the nearest three[58]. A survey of GP surgery attributes in Perth[59] found that only 17% of respondents attended their nearest surgery, although a quarter of respondents in areas regarded as having poor access attended the nearest surgery. Other attributes such as the ability to secure appointments, timeliness, whether there is proximal pharmacy, weekend opening and billing arrangements emerged as important factors in choice of surgery. We do not have such information on GP attributes from the GP data source. The TILDA dataset also does not contain information on the details of the visit to the GP, such as duration or reason for consultation, whether a diagnostic test was ordered or carried out, or whether a prescription was written or a follow-up visit arranged.

This analysis is cross-sectional, based on observational data. The analysis can only make inferences about the association between accessibility and GP visiting behaviour for the older population. While we have controlled for an extensive set of possible confounding factors, it is still possible that unmeasured factors associated with both GP supply and GP visiting may explain some of the findings we observe.

7.3 Implications for research and policy

The health policy emphasis on geographic accessibility in Ireland and internationally means that an empirical investigation of accessibility is merited. Contrary to initial expectations, we found little evidence for a relationship between various indicators of GP supply and GP visiting. In particular, the evidence from this study is different to previous findings of a distance decay effect. From an equity standpoint, this is a good news story. While there is considerable variation across the population in the dimensions of accessibility we examine, physical accessibility is, in general, not a significant barrier

to accessing GP services among the older population of Ireland. However, we did find evidence of an interaction between accessibility (as indicated by the number of GPs in one's vicinity) and public insurance status. This study highlights that the issue of physical accessibility is highly context specific, and research from a variety of jurisdictions can illuminate the barriers as well as the enablers of healthcare access.

Looking to the future, technological advancement has permitted the advent of telemedicine where patients can video consult with a GP from their own home and a prescription may be delivered to the patient's address. Therefore, physical accessibility may become less of a barrier to obtaining GP care in the future. However, computer literacy is likely to present obstacles for older people who lack these skills - in the Irish Census 2016, 41% of 60-74 year olds never used the internet. Furthermore, those in rural areas may not benefit from sufficient broadband. These may be remedied by policies to upgrade broadband connections and initiatives to improve IT skills.

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