

# Regional and urban–rural variations in the association of neighbourhood deprivation with community resource access: a national study

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Received 11 January 2007; in revised form 22 March 2007; published online 5 August 2008

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**Abstract.** Recent work has identified growing geographical inequalities in health between deprived and nondeprived areas in a number of countries. Despite the plethora of studies monitoring these trends, the explanations for this growing spatial divide remain unclear. This lack of clarity has been a hindrance to the implementation of strategies by policymakers to reduce health inequalities. One explanation for the noted spatial differences in health is that geographical access to a range of community resources, such as health care facilities, supermarkets, and recreational amenities, is lower in deprived areas. However, the evidence base for this explanation is low. In our previous work we noted a strong relationship at the national level between community resource accessibility and social deprivation, with access tending to be better in *more* deprived neighbourhoods. Other research suggests that the relationship between community resources varies at a subnational scale. Here, we consider whether the relationship of better access to community resources in more deprived areas persists for all regions of New Zealand, urban and rural. Using geographical information systems, we calculate levels of geographical access to sixteen types of community resources in 38 350 small census areas across the country and, using an index of deprivation, examine whether access varies between deprived and nondeprived areas of the country. The results suggest that access to community resources in New Zealand is to some extent context specific. In urban areas, access is better in more deprived neighbourhoods, and the same is true of intermediate urban/rural areas although the gradient is considerably more pronounced. However, for rural areas, the relationship between community resource access and deprivation is more mixed, with access to the majority of resources being worse in more deprived areas. Similarly, there are regional variations in the relationship between deprivation and community resource access. These results challenge some aspects of neomaterial interpretations of geographical inequalities in health.

## Introduction

Recent studies in a number of countries have firmly established a strong social gradient in a range of health outcomes including mortality (Blakely et al, 2005a; 2005b; Mackenbach et al, 2003; Shaw et al, 1999), various types of morbidity such as cancer incidence (Parikh et al, 2003), and health-related behaviours including smoking patterns (Barnett et al, 2005). Most of these studies have tended to find higher rates of ill health among more socially and materially disadvantaged groups, and the health gap between low and high socioeconomic groups appears to have increased in relative risk terms in most countries over the past twenty years (Blakely et al, 2005a; Davey Smith et al, 2002;

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Mackenbach et al, 2003). One area of growing interest concerns geographical inequalities in health between areas of differing socioeconomic circumstances. For example, in the UK it has been demonstrated that inequalities between rich and poor areas of the country widened during the 1980s and 1990s, and have continued to widen in the early part of the 21st century, despite the current government's rhetoric about reducing the health divide (Shaw et al, 2005). New Zealand is no exception to this trend, with wide regional variations in health including mortality (Tobias et al, 2001), cancer incidence (Pearce et al, 2006a) and health-related behaviours such as smoking (Barnett et al, 2005). Furthermore, it has been reported that the mortality gap widened between socially deprived and nondeprived regions of the country during the 1980s and 1990s (Pearce et al, 2006b). Over these two decades, the geographical inequalities in mortality for regions across New Zealand have increased by about 50% (Pearce and Dorling, 2006).

Despite the attention that has been given to monitoring growing geographical inequalities in health, the explanation for this widening spatial divide remains unclear. One area of explanation that has received much attention is the importance of place or neighbourhood effects in explaining geographical and social variations in health (Diez-Roux et al, 1997; Yen and Kaplan, 1999). The focus of such work has been to consider whether particular attributes of the places in which people live have an effect upon their health, independently of an individual's sociodemographic characteristics. A review of research into neighbourhood determinants of health concluded that most studies have found that contextual factors are significant in explaining variations in health outcomes and health-related behaviour, although the effect is generally small relative to individual factors (Pickett and Pearl, 2001). The growing interest in neighbourhoods and health has resulted in a number of studies which have demonstrated that certain aspects of the physical and social environments in which people live can promote or inhibit health (Macintyre and Ellaway, 2003). A renewed focus on place as a key theoretical and policy-relevant determinant of health has ensued, and intervention at the area level has become an important part of strategies to reduce health inequalities (Acheson, 1998; Kearns et al, 2000).

A number of different neighbourhood characteristics have been suggested as having an independent effect upon the health of residents. These characteristics include area deprivation (Breeze et al, 2005), social capital (Kawachi et al, 2004), residential segregation (Collins and Williams, 1999), differential accessibility to a range of community resources (Macintyre et al, 1993), social inequality (Barnett et al, 2005), as well as aspects of the physical environment including air pollution (Brunekreef and Holgate, 2002). Importantly, it has been suggested that these characteristics of the local neighbourhood may make an important contribution to increasing geographical inequalities in health (Macintyre et al, 2002). One domain of the neighbourhoods and health literature has been to consider the influence of the physical infrastructure or community resources upon a range of health outcomes. It has been suggested that differential access to a range of community resources between neighbourhoods may be an important component of understanding why health varies between neighbourhoods (Macintyre et al, 1993). However, most studies have examined whether aggregate measures of neighbourhood socioeconomic context are related to health, and have merely speculated about the possible importance of differential access to community resources that may be correlated with neighbourhood socioeconomic context. To date there has been little research which directly measures specific community resources within an area, establishes whether access to these resources actually varies by neighbourhood socioeconomic context, and determines whether community resources predict health outcomes (Diez-Roux, 2001).

An implicit assumption in the provision of community resources by central and local government is that they contribute to the well-being of citizens. The assumption has been more explicit in recent policy initiatives in a number of countries, including New Zealand, where investment in urban renewal programmes and community resource development in more deprived neighbourhoods has been used as a strategy to reduce health inequalities and social exclusion (Greenaway and Witten, 2005; Judge and Bauld, 2001; Sullivan et al, 2004). The World Health Organization's 'Healthy Cities' programme, for example, endeavours to engage local governments in recognising the wider determinants of health and health inequalities in economic regeneration and development efforts (Davies and Kelly, 1993).

In this paper we focus on access to community resources at the neighbourhood level and question whether variation in access by neighbourhood deprivation may contribute to geographic inequalities in health. Residential location determines a household's access to an assortment of community resources such as shops, parks, schools, and health services (Knox, 1982). Proximity to these and other neighbourhood services and amenities can be theorised as contributing to health and well-being in a number of ways. For example, a park provides opportunities for physical activity which in turn may reduce the burden of chronic illnesses such as heart disease, and a supermarket provides access to healthy food. Additionally, the time and financial costs of access are reduced where resources are nearby, releasing individual and household resources for use elsewhere. We report on geographical accessibility to sixteen types of community resources, all of which can be theoretically linked to one or more health outcomes. The community resources can be grouped into five domains: recreation amenities; shopping facilities; education facilities; health facilities; and marae (a Māori meeting place). Our analysis does not suppose to incorporate all community resources that influence health but, rather, identifies the key resources that are pertinent in the New Zealand context and for which national data were available.

In our previous work we found that there were regional differences in access to all resources between urban and rural New Zealand and that there were also noticeable differences in accessibility between neighbourhoods in urban areas (Pearce et al, 2006c). We also found that there was a strong social gradient in access to most of the community resources we measured in New Zealand, with access being *better* in the *more* deprived neighbourhoods (Pearce et al, 2007). In this paper we extend this work by addressing two research questions:

- Does the association of neighbourhood deprivation with community resource access vary by rurality?
- Does the association of neighbourhood deprivation with community resource access vary by region?

Why might we expect the relationship between deprivation and community resource access to vary by rurality and region in New Zealand? There is some evidence that rural areas have pockets of extreme deprivation in New Zealand—not just in income and personal socioeconomic resources, but also in terms of community resources (Barnett and Barnett, 2001; 2003; Janes et al, 2001). We formally test this hypothesis, regarding possible variations by region. Current patterns of service provision reflect varying histories of regional development and resource provision over time as well as contemporary resource allocation policies. For example, changing practices in industries such as agriculture, manufacturing, and tourism have led to changing rural population profiles with differential impacts on the service and amenity landscapes of neighbourhoods and regions (Le Heron and Pawson, 1996; Witten et al, 2003a). Resource allocation decisions at each level of government in New Zealand—central, regional, and local—can determine levels of service and amenity access in

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local neighbourhoods. The private sector is also influential in the siting of shops and primary health care. Of the government agencies, central government has jurisdiction over the spatial distribution and quality of education and health services, regional government has a mandate to oversee regional parks and public transport, while local government is concerned with the provision of social and recreational facilities such as libraries, swimming pools, local parks, and playgrounds. Local government income, and therefore expenditure on community resources, is largely determined by the rates levied from residents so it reflects the socioeconomic characteristics of the area. However, all levels of government have the potential to adopt more or less redistributive policies with respect to service and amenity provision, policies that could over time result in differing relationships between deprivation and community resource access by region and rurality in New Zealand.

### **Geographical access to community resources**

Neomaterialist theorising on explanations for health inequalities posits a systematic underinvestment in community infrastructure in poor areas (Lynch, 2000). It has been theorised that residential proximity to community resources such as parks and recreational facilities, health care provision, and shops selling healthy food contributes to health and well-being in a number of ways. However, surprisingly little research has examined whether geographical access to community resources varies between deprived and nondeprived neighbourhoods at a local or regional scale, and we know of no work that has examined trends at a national level. From the research that has been undertaken in urban areas, no consistent picture has emerged on the relationship between the socio-economic characteristics of areas and their community resource access. In some cities socioeconomically poorer areas, or areas that are ethnically segregated, have been found to be relatively poorly endowed with community resources (Pacione, 1989; Sooman and Macintyre, 1995). However, research in other urban areas has shown no clear association between socioeconomic deprivation and community resource access, or areas of higher deprivation have been found to have higher levels of community resource access (Field et al, 2004; Knox, 1982; Levy et al, 1974; Lineberry, 1977; McLafferty, 1982). A review of early studies by Lineberry (1977) indicated that “*pockets* of discrimination can be found, but probably not *patterns* of discrimination” (page 186, emphasis in original). In Lineberry’s ‘pockets of discrimination’ low levels of community resource access coincided with areas in which residents’ access to individual resources was also low. A recent New Zealand study found that access to community resources in two cities within the urban area of Auckland (North Shore and Waitakere) was, overall, better in the more wealthy city, but within both cities the deprived areas had the best access (Field et al, 2004; Witten et al, 2003b).

Prior to detailing the methods and results for our own New Zealand research, we review research that has examined geographical inequalities in access to specific health-related community resources: health care provision, recreational amenities, shops selling healthy food, and educational facilities.

### **Access to health care provision**

Perhaps the health-related community resource which has received the most attention in the neighbourhoods and health literature is geographical access to health care provision. It has been argued that greater distances to health care provision may provide a barrier to the utilisation of primary (Haynes et al, 2003), secondary (Arcury et al, 2005; Hippisley-Cox and Pringle, 2000; Pierce et al, 1998) and preventative services (Clements et al, 1998; Hyndman and Holman, 2000; Iredale et al, 2005). In particular, many researchers have examined whether people living in the most deprived

areas of a region have the worst access to health care services: an example of the 'inverse care law' (Hart, 1971).

In deprived areas access to secondary care such as specialist physicians (Mansfield et al, 1999) and pharmacies (Dokmeci and Ozus, 2004; Lin et al, 2005) has been found to be worse than in nondeprived areas in the United States and Turkey. This is an important finding as poor access has been shown to reduce utilisation, especially for vulnerable groups such as older people (McCarthy and Blow, 2004), the physically disabled (LaVela et al, 2004), and the mentally ill (Allard et al, 2003; Schmitt et al, 2003).

In contrast, research on inequalities in proximity to primary health care provision is mixed. British research studies have found that access to a GP is better in more deprived neighbourhoods (wards) across the country (Adams and White, 2005), and in rural areas access tends to be better in the poorer locations where health needs are greatest (Lovett et al, 2002). Similar results have been noted in Perth, Australia, where average distances to the closest GP were shown to be significantly lower in poorer areas of the city (Hyndman and Holman, 2001). However, the opposite trend has been noted in the United States, where, for example, more deprived areas have been found to have poorer access to primary care (Guagliardo et al, 2004).

#### **Access to recreational resources**

Access to a range of recreation resources and spaces (such as parks, beaches, sports and leisure centres, swimming pools, tennis courts, and skating rinks) has been noted as important to a local community's health (Ellaway and Macintyre, 1996). Such spaces are postulated to improve health and well-being by providing the opportunity structures that enable regular exercise to become a local community norm and communal spaces for social interaction that builds social capital (Bedimo-Rung et al, 2005). Some studies have found that access to leisure facilities, including open green space, increases levels of physical activity and reduces levels of obesity (Ellaway et al, 2005; Sallis et al, 1998), although others suggest that any effect may be slight (Giles-Corti and Donovan, 2002). There is also some evidence that there is a social gradient in access to recreational resources (Giles-Corti and Donovan, 2002). For example, research in Scotland has noted an inequitable distribution in recreational facilities in the favour of high-income neighbourhoods which, it has been suggested, may contribute to lower levels of physical activity in disadvantaged areas (Macintyre et al, 1993). Other research has noted the importance of access to *safe* recreational facilities (Humpel et al, 2002; Talen and Anselin, 1998). A link has been suggested between poor access to safe facilities in deprived areas, levels of exercise that are sufficiently low to endanger health, and a high level of exercise-related problems such as obesity (Kavanagh et al, 2005; Oliver and Hayes, 2005).

#### **Access to food shopping facilities**

There has been considerable focus upon whether socially deprived neighbourhoods have poor access to shops selling high-quality and nutritious food, or, in other words, whether there is a presence of what has become termed a 'food desert' (Clarke et al, 2002). Researchers in Scotland have suggested that access to supermarket shopping is associated with a better diet in terms of fruit and vegetable consumption, compared with shopping in smaller shops as the larger stores offer a greater range of foods at lower prices (Cummins and Macintyre, 2002a). The strongest evidence for food deserts comes from the USA where it has been suggested that supermarkets are shifting away from poorer inner-city areas, increasing the chance of food deserts developing; residents of such areas tend to eat fewer fruit and vegetables (Alwitt and Donley, 1997; Zenk et al, 2005). For example, a study in four areas of the USA found a larger

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proportion of supermarkets and gas stations with convenient stores in wealthier and white-dominated neighbourhoods compared with the poorest and black neighbourhoods (Morland et al, 2002).

Outside of North America, the evidence for food deserts is more mixed (Cummins and Macintyre, 2006). Early work in Glasgow supported the existence of food deserts (Ellaway and Macintyre, 2000; Sooman and Macintyre, 1992) but more recent work has not (Cummins and Macintyre, 1999; 2002b; Cummins et al, 2005). On the other hand, results of work in Leeds has generally been supportive of food deserts (Clarke et al, 2002; Whelan et al, 2002). Both research teams studied the effects of an opening of a new supermarket in a deprived area on the diet of the local community. The Glasgow group found no difference in diet (Cummins et al, 2005) whereas the Leeds group found a small improvement (Wrigley et al, 2002; 2003). Other work in Britain (Pearson et al, 2005) and work in Australia (Winkler et al, 2006) also failed to find evidence of food deserts.

### **Access to educational facilities**

In contrast to the plethora of literature on access to health care, exercise opportunities, and good diet, there is very little on access to education facilities and health. The rationale for examining access to education facilities is twofold: the association between educational achievement, mortality, and health outcomes; and the place of schools as common sites of neighbourhood participation and interaction (Witten et al, 2001). The decline of communities in the wake of school closures has highlighted the crucial role of schools in neighbourhood social relations (Valencia, 1984).

Distance is a strong factor when choosing a preschool (Davis and Connelly, 2005; Hofferth et al, 1996). Poorer access has been found in deprived areas for some types of preschool in Sheffield (Holloway, 1998), and to American primary schools in areas where rural poverty is an issue (Talen, 2001). With respect to secondary school choice, lower socioeconomic households are less likely than higher socioeconomic households to pursue entry to their school of choice as the distance from home to school increases (Lauder et al, 1995). Distance is only one of several factors that determine school choice and access. School quality, or parents' perception of school quality, is associated with choice and access and in turn with residential attachment and stability or conversely with neighbourhood instability and decline (Power, 2000).

In summary, the literature on access to community resources as it relates to area-level deprivation is ambiguous, with findings varying by context and for specific resources. To date, most studies have undertaken analysis within a local context (eg comparing neighbourhood access with community resources in one city or region), not on a national scale (ie comparing neighbourhood access with community resources across the whole nation). In this paper we consider whether there are strong neighbourhood inequalities in access to community resources across New Zealand. In particular, we focus on whether accessibility varies with neighbourhood deprivation. We use an index of community resources which has been constructed for neighbourhoods across the whole of New Zealand. A nationally created index allows us to explore variations in the association of neighbourhood deprivation and community resource access between urban and rural areas, and variations across different regions.

### **Data and methods**

In this study we adopt a geographical information systems (GIS) approach to measure community resource accessibility. A GIS approach enables access to a range of key community resources to be measured in small areas across the country.

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**Community resource access data**

Access to sixteen different types of community resources that have been empirically linked to health was calculated for small areas across New Zealand (see table 1 below). Data were obtained on the location of community resources at the national level (where possible) in order to maintain a consistent and directly comparable dataset. Some datasets (eg food outlets) had to be requested from the seventy-four individual territorial authorities (local authorities with some delegated governance with an average population of 50 000) across New Zealand and then the precise location of each record was computed from its address by using geocoding software. All datasets were the most accurate at the time of collection (2004–05) and no dataset was older than 2002.

**Calculating community resource accessibility**

Accessibility was calculated for each type of community resource for all 38 350 census ‘meshblocks’ or ‘neighbourhoods’ across New Zealand. Meshblocks are the smallest unit of dissemination of census data in New Zealand, with each area representing approximately 100 people. In this analysis each meshblock was represented by its population-weighted centroid (the centre of population in the area rather than the geometric centroid) and the time taken to travel to each community resource along the road network was calculated using the network functionality in a GIS. In order to represent accessibility more accurately, it is important to use the distance between each meshblock and the location of each community resource through the road network to calculate total travel time rather than the euclidean (or straight line) distance (Witten et al, 2003b). All segments in the road system were adjusted to account for variations in speed limits, type of road surface, sinuosity, and differences in the topography across the network. These modifications to the road network were important because they allowed for realistic estimates of the least cost (ie quickest route) from each population-weighted meshblock centroid to each facility. In all 38 350 meshblocks, the travel time along the road network between each population-weighted meshblock centroid and the closest example of each type of community resource (eg the travel time to the nearest school) was calculated. Full details of the methodology used to calculate accessibility is documented elsewhere (Pearce et al, 2006c).

**Analysis**

Because the travel time variables are highly skewed, nonparametric analysis was appropriate. To consider whether access to each of the sixteen types of community resources varied between areas of differing levels of social deprivation, the median travel time to each community resource was calculated for neighbourhoods divided into quintiles of deprivation. Neighbourhood deprivation was defined using the 2001 New Zealand Deprivation Index (NZDep 2001), an index based on nine socioeconomic variables taken from the 2001 New Zealand Census (Salmond and Crampton, 2002).

We initially describe the association of neighbourhood deprivation with community resources access across all of New Zealand—partly reproducing previous work, but providing valuable context to this paper. In the main analyses, we examined whether the neighbourhood-level relationship between community resources accessibility and deprivation varied by urban/rural status. Using the New Zealand Urban–Rural Profile classification (Statistics New Zealand, 2005), we allocated an urban, rural, or intermediate rural/urban classification to all meshblock neighbourhoods across the country. The index categorises all neighbourhoods into one of seven urban/rural categories ranging from major urban centres to highly rural areas. Due to the small numbers of meshblocks in some urban/rural categories, the seven categories were collapsed into three groups: urban (main urban areas), intermediate (satellite urban areas; independent urban areas; rural areas with high urban influence; rural areas with moderate

urban influence), and rural (rural areas with low urban influence; highly rural/remote areas).

Within the three urban/rural strata, we conducted a simple unweighted linear regression model between neighbourhood deprivation (NZDep 2001 quintiles) and the median travel distance for each of the domains and types of community resources. The ratios of the regression-based estimates in deprivation quintile 5:deprivation quintile 1 were derived to provide a measure of the strength of association between deprivation and community resource access in each urban/rural category for each resource (see the appendix for details). We also considered whether the relationship between the deprivation and community resource accessibility varied between the sixteen New Zealand regional council areas (excluding the Chatham Islands (figure 1) by using the same regression-based estimation procedure.



**Figure 1.** Map of the sixteen regions across New Zealand.



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## Results

Table 1 shows travel times to each of the sixteen resources for all neighbourhoods in New Zealand, the ratio for deprived compared with nondeprived neighbourhoods across New Zealand, and travel times by rurality (and the main urban:rural ratio) across New Zealand. Some of these results have been presented elsewhere (Pearce et al, 2007), but are reproduced here to provide context for the subsequent analyses of the deprivation – resource association *stratified* by rurality and region.

There is a clear deprivation gradient in access to community resources for mesh-blocks across New Zealand (table 1). Median travel times were greater in the least deprived quintile compared with the most deprived quintile for all community resources except beaches. Median travel times in the most deprived quintile ranged from three quarters to half those in the least deprived quintile. Ratios of travel times comparing the most deprived with the least deprived quintiles were lowest for the diet and marae domains and highest (ie approaching 1.0) for the recreation domain. There was the most variation within the health domain, with a stronger gradient for GPs and pharmacies than for fire and ambulance stations. An inspection of the Kendall's tau-B measure demonstrates that for all community resources, except beaches, access was significantly related to deprivation (table 1), with the relationship being strongest for the education, diet, and marae domains. Looking at the relationship between urban/rural status and travel time to community resources, we found, unsurprisingly, there was better geographical access in more urban parts of the country, and the strength of association is consistently strong for all resources (table 2).

### **Does the association of neighbourhood deprivation with community resource access vary by rurality?**

To explore the interaction between deprivation and the urban/rural status, we examined whether there is a social gradient in geographical access to community resources in urban, rural, and intermediate urban/rural areas of New Zealand. The appendix provides details of regression analyses of the relationship between travel time and deprivation for all community resources across the three urban/rural strata. Figure 2 shows the ratio of the regression-based estimates of the relationship between deprivation and median travel time to each community resource for quintile 5 to quintile 1. When the ratio is less than 1 it indicates that geographical access is better in more deprived neighbourhoods, whereas when the value is greater than 1, less deprived neighbourhoods have better access.

In urban areas the ratio value is less than 1 for all domains and types of community resources, except for beaches (1.33). The effect size in urban areas is reasonably consistent as, with the exception of beaches, the ratio values range from 0.88 (recreation) to 0.57 (food shops) (see the appendix). In intermediate urban/rural areas, the ratio value was less than 1 for most domains and community resources, with the exception of ambulance stations, fire stations, and beaches (ratios ranging from 1.01 to 1.36). However, the ratio values for the remaining community resources tended to be much smaller than in urban areas, with few values exceeding 0.4. These results indicate that access to most types of community resources tends to be far better in deprived neighbourhoods in intermediate urban/rural areas.

In rural New Zealand the relationship between community resource accessibility and deprivation was generally the converse. For some community resources (parks, beaches, primary, and intermediate schools) the ratio value was negative, but for most resources the ratio was positive. For some resources, including Plunket (a government-funded well child service), ambulance stations, fire stations, supermarkets, and sport and leisure centres, the effect sizes were relatively large, with ratios of greater than 2. It should be noted that the ratio values represent the results *within* strata of rurality and,

**Table 1.** Average travel times (minutes) to community resources, and variations in travel time by neighbourhood deprivation and rurality: results for all neighbourhoods in New Zealand.

Domain ( <i>italics</i> ) and type	Average travel time for all neighbourhoods in New Zealand (minutes) <sup>a</sup>			Variation in travel times by neighbourhood deprivation <sup>a</sup>		Travel times, and variation, by rurality				
	mean	median	standard deviation	ratio quintile 5: quintile 1	tau-B <sup>b</sup>	rural	inter-mediate	main urban areas	ratio main urban: rural	tau-B
<i>Health</i>	5.17	2.00	9.65	0.54	-0.201	12.99	2.27	1.63	0.13	-0.365
Accident and emergency	21.24	11.41	36.75	0.63	-0.130	34.68	17.94	8.75	0.25	-0.364
General practitioners	5.83	2.39	11.32	0.56	-0.192	14.23	2.84	1.91	0.13	-0.381
Pharmacy	6.60	2.54	13.72	0.57	-0.192	15.63	3.03	2.06	0.13	-0.386
Plunket <sup>c</sup>	11.39	4.04	23.23	0.66	-0.116	21.45	4.22	3.28	0.15	-0.329
Fire station	21.16	10.66	28.82	0.78	-0.102	33.29	11.04	4.57	0.14	-0.408
Ambulance	14.58	5.73	23.36	0.67	-0.085	41.38	16.65	8.11	0.20	-0.361
<i>Diet</i>	3.97	1.54	8.67	0.47	-0.254	8.93	1.69	1.29	0.14	-0.326
Food establishment	4.25	1.61	8.94	0.47	-0.245	9.57	1.80	1.34	0.14	-0.334
Supermarket	6.95	3.17	13.52	0.56	-0.211	14.02	2.89	2.75	0.20	-0.298
<i>Recreation</i>	2.17	1.29	3.52	0.70	-0.149	3.91	1.36	1.12	0.29	-0.273
Park	2.28	1.33	5.24	0.71	-0.145	3.97	1.45	1.15	0.29	-0.280
Beach	22.74	16.89	18.85	1.06	-0.005	34.94	22.45	13.94	0.40	-0.235
Sports and leisure facility	9.83	5.07	19.00	0.62	-0.171	17.88	4.30	4.44	0.25	-0.274
<i>Marae</i>	13.09	7.36	22.80	0.48	-0.241	18.19	7.63	6.34	0.35	-0.244
<i>Education</i>	2.87	1.41	6.69	0.55	-0.225	5.45	1.54	1.20	0.22	-0.354
Kindergarten or day care	4.61	1.72	10.88	0.56	-0.199	10.17	2.00	1.41	0.14	-0.367
Primary school	3.41	2.04	6.70	0.60	-0.226	5.73	2.11	1.82	0.32	-0.267
Intermediate or full primary school	3.59	2.05	6.95	0.58	-0.228	6.31	2.10	1.82	0.29	-0.276
Secondary school	7.53	4.08	11.70	0.59	-0.198	15.40	4.26	3.48	0.23	-0.322

<sup>a</sup> Results reproduced from table 2 of Pearce et al (2007).

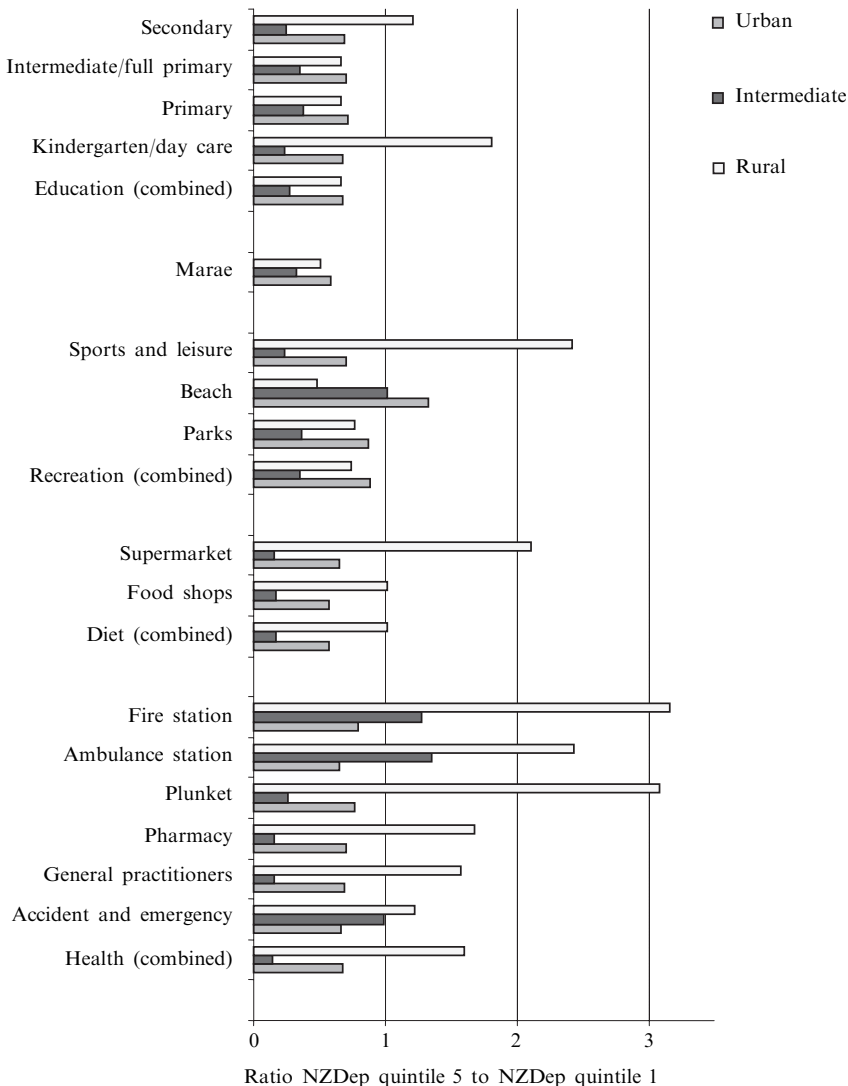
<sup>b</sup> The tau-B statistic is a nonparametric measure of correlation for ordinal or ranked variables which ranges between +1 and -1 (Korey, 2005). Its absolute value indicates the strength of the association between deprivation (quintiles) and rurality (trichotomous) and resource access, and the sign indicates the direction of association. *P*-values for all tau-B statistics were less than 0.001, *except* beaches by neighbourhood deprivation (*p* = 0.26).

<sup>c</sup> Plunket is a government-funded well child service established in 1907.

**Table 2.** Ratios of median travel time access to community resources for most deprived compared with least deprived quintiles of neighbourhoods, by region across the North Island. (Ratios are regression-based using all five quintiles, see 'Data and methods' section. Deprivation was measured using the NZDep 2001 index.)

Community resources	Northland	Auckland	Waikato	Bay of Plenty	Gisborne	Hawkes Bay	Taranaki	Manawatu-Wanganui	Wellington
<i>Health</i>	0.73	0.85	0.14	0.43	0.20	0.28	0.12	0.19	0.61
Accident and emergency facility	1.50	0.64	0.75	0.80	0.73	0.76	0.79	0.50	0.73
General practitioners	0.81	0.84	0.14	0.44	0.22	0.30	0.14	0.21	0.60
Pharmacy	0.80	0.88	0.18	0.46	0.26	0.27	0.19	0.25	0.61
Plunket <sup>a</sup>	1.05	0.79	0.64	0.59	0.58	0.34	0.23	0.32	0.69
Fire station	6.39	0.70	0.72	0.79	0.51	0.66	0.17	0.81	0.72
Ambulance	7.99	0.85	0.62	0.81	0.51	0.57	0.97	0.50	0.85
<i>Diet</i>	0.40	0.68	0.15	0.43	0.31	0.19	0.09	0.14	0.49
Food establishment	0.44	0.67	0.15	0.38	0.31	0.21	0.10	0.14	0.50
Supermarket	0.65	0.77	0.19	0.41	0.45	0.40	0.25	0.23	0.54
<i>Recreation</i>	0.57	0.89	0.24	0.66	0.33	0.40	0.29	0.39	0.80
Park	0.58	0.88	0.25	0.67	0.33	0.38	0.32	0.43	0.82
Beach	0.75	1.83	0.94	1.03	0.55	0.87	0.26	0.78	1.45
Sports and leisure facility	1.74	0.82	0.34	0.57	0.48	0.35	0.27	0.38	0.60
<i>Marae</i>	0.59	0.61	0.36	0.51	0.74	0.66	0.65	0.53	0.55
<i>Education</i>	0.91	0.63	0.55	0.71	0.58	0.52	0.43	0.55	0.60
Kindergarten or day care	0.65	0.78	0.18	0.46	0.36	0.23	0.16	0.22	0.60
Primary school	0.58	0.74	0.34	0.51	0.43	0.38	0.35	0.34	0.67
Intermediate or full primary school	0.61	0.70	0.30	0.49	0.44	0.39	0.38	0.32	0.68
Secondary school	0.85	0.73	0.31	0.44	0.43	0.47	0.29	0.30	0.71

<sup>a</sup> Plunket is a government-funded well child service established in 1907.



**Figure 2.** Ratios of median travel time access to community resources for most deprived compared with least deprived quintiles of neighbourhoods, by urban, intermediate, and rural areas across New Zealand (see the appendix for the data from which the figure is derived; ratios are regression-based using all five quintiles, see 'Data and methods' section. Deprivation was measured using the NZDep 2001 index).

as detailed in table 1, that the median travel distances in rural areas of the country are, on average, considerably higher than those in urban neighbourhoods, for both deprived and nondeprived neighbourhoods (figure 2).

#### **Does the association of neighbourhood deprivation with community resource access vary by region?**

The analysis presented in tables 2 and 3 illustrates regional variations in the relationship between deprivation and access to each of the community resources. Most regions demonstrate a ratio of less than 1 for most resources (ie better access in more deprived neighbourhoods); the effect sizes differ between regions. In some regions, such as Gisborne, West Coast, Taranaki (three coastal and remote regions), and Waikato and Otago (rural areas with service towns and cities) the ratio values are relatively small

**Table 3.** Ratios of median travel time access to community resources for most deprived compared with least deprived quintiles of neighbourhoods, by region across the South Island (ratios are regression-based using all five quintiles, see ‘Data and methods’ section; deprivation was measured using the NZDep 2001 index).

Community resources	West Coast	Canterbury	Otago	Southland	Tasman, Nelson, and Marlborough
<i>Health</i>	0.19	0.31	0.18	-0.05 <sup>a</sup>	0.39
Accident and emergency facility	0.64	0.51	0.07	0.20	0.43
General practitioners	0.26	0.30	0.19	0.00	0.47
Pharmacy	0.36	0.33	0.18	-0.03 <sup>a</sup>	0.46
Plunket	0.35	0.40	0.18	0.23	0.55
Fire station	1.87	0.48	0.26	0.02	1.02
Ambulance	1.94	0.44	0.21	0.05	0.79
<i>Diet</i>	0.21	0.29	0.12	-0.02 <sup>a</sup>	0.38
Food establishment	0.23	0.29	0.12	-0.02 <sup>a</sup>	0.38
Supermarket	0.33	0.39	0.17	0.02	0.49
<i>Recreation</i>	0.46	0.71	0.41	0.11	0.52
Park	0.49	0.74	0.42	0.11	0.53
Beach	0.82	0.59	0.53	0.52	0.34
Sports and leisure facility	0.19	0.36	0.25	0.14	0.69
<i>Marae</i>	2.60	0.31	0.26	0.01	0.60
<i>Education</i>	0.50	0.47	0.43	0.42	0.52
Kindergarten or day care	0.17	0.37	0.18	0.03	0.37
Primary school	0.39	0.53	0.36	0.17	0.59
Intermediate or full primary school	0.40	0.51	0.32	0.14	0.54
Secondary school	0.39	0.35	0.23	0.16	0.43

<sup>a</sup> The actual estimated ratios were less than 0, a function of an extremely strong association and the regression line crossing the  $x$ -axis. Hence, it is best to conclude here that the association was very strong—albeit unstable.

across most community resources, indicating that access to resources is far better in more deprived neighbourhoods. By contrast, in Northland, Auckland, and Wellington, access to some community resources (accident and emergency, Plunket, ambulance stations, fire stations, and sports and leisure centres) is actually worse in more deprived areas of the region (Northland is in the far north of New Zealand, with large areas of relatively impoverished rural communities but also pockets of extremely affluent coastal communities; Auckland and Wellington are the two largest urban areas in New Zealand).

## Discussion

As noted in our earlier work, we found that at the national level a significant, negative relationship exists between deprivation and travel time access to most community resources (Pearce et al, 2007). With the exception of beaches, at the national level geographical access to all domains and types of community resources is better in more deprived small areas of the country. The consistency and strength of these findings is perhaps surprising given the mixed results in the international literature and the body of evidence that suggests that the richest and most powerful neighbourhoods disproportionately benefit from decision making affecting the allocation, location,

and organisation of public goods and services (Johnston, 1984; Knox, 1982; Miranda and Ittipone, 1994). Previous studies outside of New Zealand have found varied evidence for a social gradient in access to health care provision, recreational resources, food shopping facilities, and educational facilities and for some resources, such as secondary health care provision, most of the international literature suggests that access is worse in more deprived areas (Dokmeci and Ozus, 2004; Lin et al, 2005; Mansfield et al, 1999). Nonetheless, some researchers have noted a lack of correspondence between the socioeconomic characteristics of neighbourhoods and the geographical organisations of community resources (Rich, 1982), including earlier work in two New Zealand cities which found that access to resources was better in more deprived areas of these cities (Field et al, 2004; Witten et al, 2003b).

The key research questions addressed in this paper, however, were whether this association between neighbourhood deprivation and community resource access varied by rurality or region. We found that it did. The deprivation gradient in access observed nationally was reproduced for urban and intermediate urban/rural areas, whereas in rural parts of the country a distinctly different pattern was evident with access generally poorer in more deprived neighbourhoods. Further, for some community resources—namely supermarkets, sports and leisure, kindergarten/day care facilities—and for fire and ambulance services, the effect sizes were relatively large, suggesting that there is a strong deprivation gradient in access to these resources in rural New Zealand. Key health services such as general practitioners and pharmacies were also markedly less accessible in poorer compared with more affluent rural areas.

What about regional variation in the association of neighbourhood deprivation and access to community resources? While access patterns in most regions generally mirror those established at the national level, there are variations between regions. For example, in Northland (remote in many parts, largely rural, with a high Māori population) access to accident and emergency services, ambulance, fire stations, and sports and leisure facilities is notably poorer in more deprived areas. However, there is no clear pattern of systematic variation in the association between access and neighbourhood deprivation by region. Rather, in regions with significant rural poverty, there appear to be pockets of poor access in socially disadvantaged communities. In the case of Northland there are examples of relatively poor access to community resources funded by the central, regional, and local government and the private sector.

The results of this study are not limited to academic interest. Better understanding of how neighbourhood environments may be related to health can have important implications for health promotion and for the reduction in health inequalities (DiezRoux, 2001). Poor access to key health-related community resources may be particularly important in the context of the spatial concentration of poverty. Our results suggest that at a national level, geographical accessibility to services and amenities alone is unlikely to be a key mediator between deprivation and health in urban areas. However, regional variation in access to resources in rural communities has implications for resource allocation decisions. If allocative decisions are made based on area deprivation without taking account of existing inequities between regions, access inequities may be magnified.

The limitations of this study need to be considered. Firstly, our examination focused only on *locational* accessibility and, as has been suggested elsewhere, there are, of course, other important barriers to utilising community resources beyond residential proximity to community resources such as cost and perceived quality of services (Kelaher et al, 2006). For example, in New Zealand there is a cost associated with visiting a general practitioner, a key barrier that has been found to limit utilisation of health care, particularly in socially deprived communities (Barnett et al, 2000).

Secondly, the perceived safety of the neighbourhood through which people pass to reach a service or amenity, particularly if they are walking, may also impact on its use (Kavanagh et al, 2005). For example, locational access to parks may be health-promoting in some neighbourhoods, yet in other neighbourhoods it may be associated with fear and violence. There is some evidence that perceptions of neighbourhood disorder and safety are associated with the socioeconomic characteristics of an area (Sampson and Raudenbush, 2005). Third, there are other health-related community resources that we were not able to evaluate due to data limitations, including access to public transport options and local community halls. Fourth, the index is based on travel times by car, but access to cars themselves is patterned by neighbourhood socioeconomic characteristics. This is pertinent in the New Zealand context where public transport is poor or nonexistent in many areas.

We noted earlier the equivocal nature of the international evidence on the relationship between community resource accessibility and social deprivation, and the varied findings from place to place. If we take the 'food deserts' literature as an example, results of studies have varied within and between countries and even within cities (Cummins and Macintyre, 2002a; Sooman and Macintyre, 1992). These contrasting results suggest that historical and social factors that have determined the development of neighbourhood infrastructure and service provisions in different places at different times, may need to be examined if we are to better understand the relationships observed between community resource accessibility and social deprivation in different contexts (Popay et al, 1998). The dominant transport mode at the time of settlement, patterns of agricultural and industrial development, landownership, and land-use planning decisions have all been potent influences on urban and rural development in the New Zealand context. Differential access to community resources reflects the chequered history of different places. An improved understanding of patterns of access between rural and urban areas and between regions and neighbourhoods underpins more informed policies and resource allocation decisions to redress observed inequities.

In conclusion, this study has used methodological advances in GIS to better represent one important aspect of neighbourhood context which has been postulated as influencing individual health outcomes and well-being. These results have potentially important implications for our understanding of the way neighbourhood infrastructure may be modified to improve population health and reduce health inequalities. Our results suggest that at the national level poor locational access to community resources in deprived neighbourhoods in New Zealand is unlikely to be an explanation for the relatively poor health outcomes in these neighbourhoods. Rather, neighbourhood inequalities in health by deprivation may actually be tempered by the pro-equity distribution of community resources. However, for rural areas, and in some regions of the country, the relationship between community resource access and deprivation is more mixed, with access to the majority of resources being worse in more deprived areas. These findings highlight the importance of evaluating the distribution of an assortment of health-related community resources at the national level and also in a range of contexts prior to developing strategies to reduce health inequalities based on 'factoid' type assumptions (Cummins and Macintyre, 2002b).

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## Appendix

**Table A1.** Results of OLS regression analysis between deprivation and access to community resources in urban intermediate, and rural areas of New Zealand.

Community resources	$\beta$	Standard error	Significance	NZDep 2001 quintile 1	NZDep 2001 quintile 5	Ratio quintile 5: quintile 1
<b>Urban</b>						
<i>Health (combined)</i>	-0.157	0.044	0.038	1.969	1.342	0.682
Accident and emergency facility	-0.912	0.188	0.017	10.751	7.103	0.661
General practitioners	-0.182	0.052	0.040	2.309	1.581	0.685
Pharmacy	-0.179	0.054	0.045	2.450	1.735	0.708
Plunket <sup>a</sup>	-0.212	0.035	0.009	3.694	2.845	0.770
Fire station	-0.853	0.139	0.009	9.836	6.424	0.653
Ambulance	-0.271	0.095	0.065	5.102	4.017	0.787
<i>Diet (combined)</i>	-0.184	0.037	0.016	1.710	0.973	0.569
Food establishment	-0.191	0.038	0.015	1.767	1.003	0.568
Supermarket	-0.289	0.059	0.016	3.352	2.196	0.655
<i>Recreation (combined)</i>	-0.035	0.007	0.013	1.199	1.059	0.883
Parks	-0.038	0.009	0.022	1.235	1.082	0.876
Beach	0.977	0.264	0.034	12.028	15.938	1.325
Sports and leisure facility	-0.389	0.109	0.038	5.218	3.660	0.701
<i>Marae</i>	-0.834	0.066	0.001	8.107	4.771	0.588
<i>Education (combined)</i>	-0.119	0.021	0.012	1.487	1.013	0.681
Kindergarten or day care	-0.138	0.023	0.009	1.708	1.155	0.676
Primary school	-0.156	0.017	0.003	2.180	1.556	0.714
Intermediate or full primary school	-0.163	0.019	0.003	2.191	1.537	0.702
Secondary school	-0.318	0.062	0.014	4.161	2.888	0.694
<b>Intermediate</b>						
<i>Health (combined)</i>	-1.115	0.243	0.019	5.224	0.763	0.146
Accident and emergency facility	-0.066	0.509	0.905	18.149	17.886	0.985
General practitioners	-1.358	0.283	0.017	6.423	0.992	0.154
Pharmacy	-1.451	0.312	0.019	6.903	1.100	0.159
Plunket	-1.436	0.371	0.030	7.723	1.978	0.256
Fire station	0.651	1.025	0.570	9.667	12.272	1.269
Ambulance	1.271	0.377	0.043	14.161	19.244	1.359
<i>Diet (combined)</i>	-0.812	0.182	0.021	3.881	0.632	0.163
Food establishment	-0.836	0.179	0.019	4.050	0.707	0.175
Supermarket	-1.353	0.309	0.022	6.456	1.043	0.162
<i>Recreation (combined)</i>	-0.388	0.073	0.013	2.390	0.838	0.351
Parks	-0.394	0.072	0.012	2.479	0.902	0.363
Beach	0.073	0.835	0.936	22.110	22.401	1.013
Sports and leisure facility	-1.552	0.325	0.017	8.152	1.945	0.239
<i>Marae</i>	-2.081	0.145	0.001	12.281	3.955	0.322
<i>Education (combined)</i>	-0.539	0.099	0.012	2.989	0.835	0.279
Kindergarten or day care	-0.771	0.158	0.017	4.040	0.958	0.237
Primary school	-0.549	0.076	0.005	3.510	1.315	0.375
Intermediate or full primary school	-0.589	0.085	0.006	3.637	1.283	0.353
Secondary school	-1.592	0.308	0.014	8.431	2.062	0.245

**Table A1** (continued).

Community resources	$\beta$	Standard error	Significance	NZDep 2001 quintile 1	NZDep 2001 quintile 5	Ratio quintile 5: quintile 1
<b>Rural</b>						
<i>Health (combined)</i>	1.678	0.714	0.100	11.185	17.898	1.600
Accident and emergency facility	1.831	1.000	0.164	32.807	40.132	1.223
General practitioners	1.776	0.588	0.057	12.394	19.499	1.573
Pharmacy	2.220	0.734	0.057	13.115	21.993	1.677
Plunket	6.970	1.796	0.030	13.411	41.291	3.079
Fire station	10.730	2.487	0.023	19.890	62.811	3.158
Ambulance	10.117	2.251	0.021	28.137	68.607	2.438
<i>Diet (combined)</i>	0.038	0.431	0.935	9.386	9.538	1.016
Food establishment	0.033	0.352	0.931	10.002	10.135	1.013
Supermarket	2.979	1.139	0.079	10.697	22.612	2.114
<i>Recreation (combined)</i>	-0.284	0.178	0.208	4.444	3.307	0.744
Parks	-0.253	0.180	0.254	4.456	3.442	0.773
Beach	-5.581	0.464	0.001	43.434	21.109	0.486
Sports and leisure facility	4.545	1.130	0.028	12.812	30.992	2.419
<i>Marae</i>	-2.973	0.777	0.031	24.180	12.287	0.508
<i>Education (combined)</i>	-0.551	0.093	0.010	6.592	4.387	0.666
Kindergarten or day care	1.705	0.763	0.112	8.472	15.291	1.805
Primary school	-0.602	0.104	0.010	7.059	4.649	0.659
Intermediate or full primary school	-0.661	0.144	0.019	7.777	5.132	0.660
Secondary school	0.781	0.357	0.117	14.866	17.989	1.210

<sup>a</sup> Plunket is a government-funded well child service established in 1907.

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