Report

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The role of a bus network in access to primary health care in Metropolitan Auckland, New Zealand

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ABSTRACT

Background: This study examined the spatial accessibility of the population of metropolitan Auckland, New Zealand to the bus network, to connect them to primary health providers, in this case doctors (GP) and dentists. Analysis of accessibility by ethnic identity and socio-economic status were also carried out, because of existing health inequalities along these dimensions. The underlying hypothesis was that most people would live within easy reach of primary health providers, or easy bus transport to such providers.

Methods: An integrated geographic model of bus transport routes and stops, with population and primary health providers (medical and dental practices) was developed and analysed.

Results: Although the network of buses in metropolitan Auckland is substantial and robust it was evident that many people live more than 150 metres from a stop.

Conclusion: Improving the access to bus stops, particularly in areas of high primary health care need (doctors and dentists), would certainly be an opportunity to enhance spatial access in a growing metropolitan area.

INTRODUCTION

New Zealand has a population of approximately 4 million people, distributed unevenly, with Auckland on the North Island being the largest city by population. As a community with close links to its local Pacific Island neighbours, and historical links to England and Europe, it has a mixture of societal and ethnic groups. Maori and Pacific Islander people make up approximately 21% of the total New Zealand population (Statistics New Zealand, 2007). Overall, New Zealanders are one of the healthiest populations in the world, but significant inequalities in health still exist (Jamieson, 2006, Thomson et al., 2002, Thomson et al., 2004) (Ministry of Health, 2013). Ethnic identity and socio-economic status are important dimensions of health inequalities in New Zealand, with the health of Maori and those of low socio-economic status demonstrably poorer than that of other New Zealanders (New Zealand Ministry of Health, 2013).

Access to primary health services is a key issue for New Zealand, and successive governments have focused on improved access to primary health care services (New Zealand Ministry of Health, 2001, New Zealand Ministry of Health, 2009). Although private car ownership is high (Ministry of Transport, 2015), public transport is the only option for those not in possession of private cars. Public transport can include travel by train, buses, and taxis. Auckland, as a small-medium metropolis, has an active public transport system. Despite recent development of the train system, the public transport network remains focused on buses (Mavoa et al., 2012). The buses form a network of connections across the metropolitan area and provide access to many services, including primary health services. Access to primary health care is an important societal health issue. One key aspect of accessibility is spatial accessibility (ie the physical location of health services, relative to the population), and in this study we focus on this aspect of accessibility (Rocha et al., 2014). The ability of a population to physically reach primary health services in order to receive care is an important variable in a healthy city concept. Groups within the population that are reliant on public transport, are often also those in most need of health care services. The use of public transport is often due to low income or incapacity, and the elderly, marginalised, youth and parents of young children are major users of public transport (Martin et al, 2008, Mavoa et al., 2012).

Recent studies have used spatial analysis to measure potential accessibility to primary and secondary health services in order to identify the geographic inequalities in health care delivery (Kruger et al., 2013). This study examined the spatial accessibility of the population of Auckland, New Zealand, to the bus transport system to connect them to primary health care providers, in this case medical doctors (general practitioners) and dentists. Analysis of accessibility by ethnic identity and socio-economic status was also carried out, because of unknown health inequalities along these dimensions. The working hypothesis was that most people would live within easy reach of primary health providers or easy bus transport to such providers.

METHODS

All the data were collected from open access web-based sources and therefore no ethics approval was necessary.

Dental and Medical clinic locations: The address for each dental and medical clinic in New Zealand was obtained from the government websites, and were cross-checked against the yellow pages (phone directory) as at June 2011. All the addresses were entered into a database.

Population statistics: All population data were obtained from the New Zealand Census (Statistics New Zealand, 2007). Population data were divided by area unit (AU) and the geographic boundaries of each AU were obtained from the Statistics New Zealand (2001) website. Additional geographic and population data (including boundary files) for district health boards were obtained from the New Zealand Ministry of Health website (New Zealand Ministry of Health, 2012).

Socio-economic status: Data were downloaded in January 2011. The Index of Deprivation (NZDep2006) aggregated to AU level formed the basis of the measure of socioeconomic disadvantage. The NZDep2006 is a composite measure derived

from multiple weighted socio-economic variables collected in the 2006 New Zealand Census (Salmond et al., 2007) This index includes nine variables that either reflect or measure material and social disadvantage. NZDep2006 values were ranked into deciles ranging from one (lowest deprivation) to ten (highest deprivation) (SoD).

Bus Data: All bus data were obtained for a single randomly chosen working day from the open access (General Transit Feed Specification) Auckland Transport website (http://www.maxx.co.nz/about-maxx/google-transit-feed.aspx). These data were imported into MySQL for analysis and reformatted, ready for geographic analysis. All bus stops were included, and the number of times a bus stopped at each stop was calculated for the time between the hours of 8am and 4pm. . This variable was called work hours stops (WHS) and was used as a measure of the regularity of services. Stops were classified into Large, Medium, Small and Tiny, based on the number of bus movements at a stop. Tiny was less than 32 stops per day (approximately one per half hour). Small was between 32 and 64 movements per day, Medium was between 64 and 96 movements per day, and Large was greater than 96 movements per day.

Road data: All road data for New Zealand was obtained from the openstreetmap website (http://www.openstreetmap.org/). These data provide street geography for all roads including high frequency roads (classified for this study as Motorways, Primary, Secondary and Tertiary) as well as residential and local streets.

Geographic integration and analysis: Geographic boundary data for each AU, roadway, bus stop, the population data and socio-economic data were geo-coded using QGIS (v1.8.0, open source, http://www.qgis.org/en/site). Metropolitan Auckland for this study was determined by a polygon, drawn by hand, around contiguous AUs where the density of bus stops and population were high (Figure 1). Nominal 150m walking zones were placed around each bus stop. There is no defined distance for people to walk to a bus stop. The 150m size was chosen for this study based on a range of ages and abilities to walk.

Analysis of geographic measures was completed using the QGIS software, and data analysis of outputs was completed using Microsoft Excel. From the population data (divided into Maori/Pacific Islander and Other), for each AU QGIS was able to distribute this population randomly across the region. Although this distribution is not exactly house-by-house level distribution, for high-density city-based AUs, a random distribution is a reasonable estimate of population across geography.

RESULTS

A total of 331 dental, and 275 medical practices were distributed across metropolitan Auckland. These practices overlayed a total of 124,551 Maori/Pacific Islander people, and 816,822 others (Table 1).

Bus stops: The region had a total of 4,621 bus stops of all sizes, with 191,000 movements at these stops. Of these, 2,862 (62%) stops were classified as tiny (i.e. less than 32 movements in a day). Of total bus movements at large stops, (n=78,000), 97% of the movements occurred on high frequency roads. Similarly, for large and medium stops combined, there was a total of 102,000 movements with 94% of these occurring on high frequency roads.

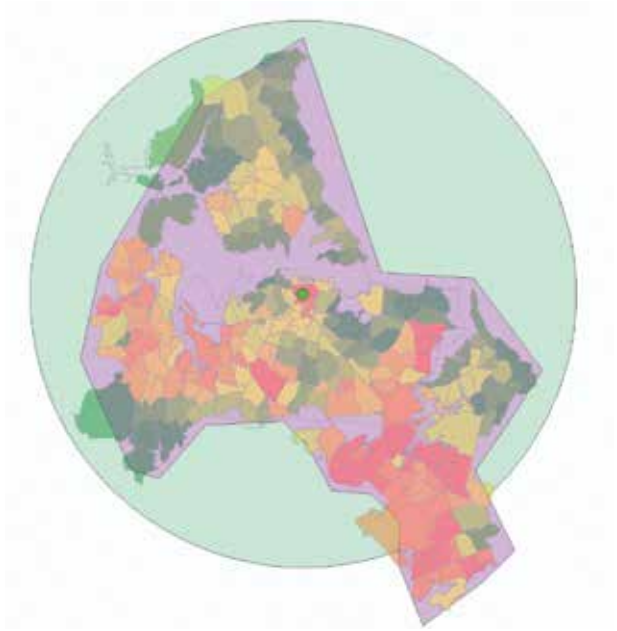

Figure 1. Auckland region with a 20km circle (centred on the general post office with the studied region highlighted in pink overlayed by the census Area Units (AU) shaded from green to red for socioeconomic deprivation deciles 1 through to 10.

Table 1 – Distribution of the population, dental and medical clinics over the three groups of socioeconomic status.

Socioeconomic status of area units (AU)	Population:			Dental clinics	Medical clinics
	Maori/Pacific Islander	Others	Total		
SoD 1-3*	22,077 18%	280,914 34%	302,991 32%	117 35%	79 29%
SoD 4-7	40,056 32%	293,472 36%	333,528 36%	129 39%	97 35%
SoD 8-10^	62,418 50%	242,436 30%	304,854 32%	85 26%	99 36%
Total	**124,551 100%**	**816,822 100%**	**941,373 100%**	**331 100%**	**275 100%**

*30% least disadvantaged, ^30% most disadvantaged

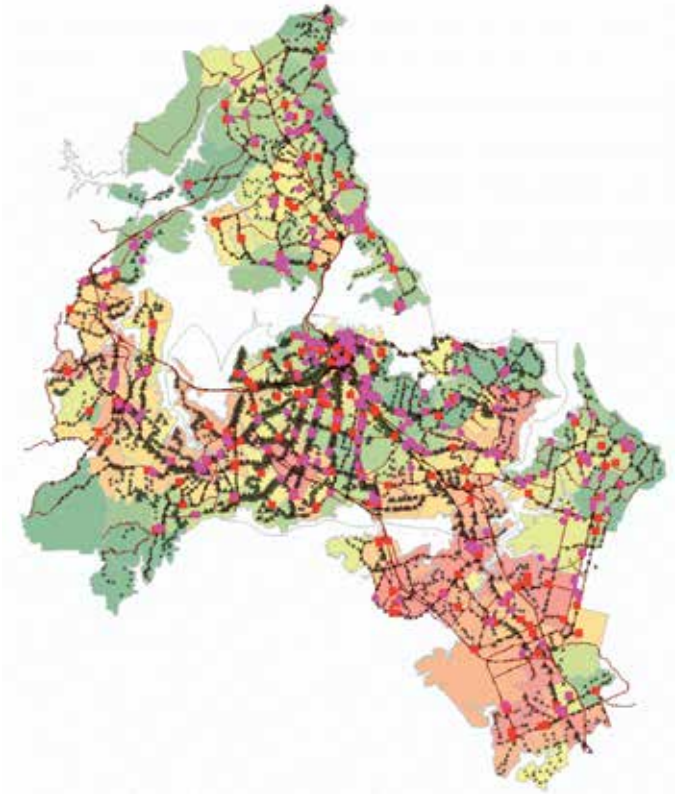

Figure 2. Medical (red squares) and dental (pink dots) practices overlayed on high frequency roads (red lines) with bus stops (black triangles). The relative size of each bus stop is a measure of the frequency of bus movements at that stop.

Practice proximity of transport: Of all 331 dental practices within metropolitan Auckland 254 (77%) were within 150 metres of any bus stop, and 192 (58%) were within 150 metres of a non-tiny stop. For doctors there were 275 practices in the region, with 224 (81%) being within 150 metres of any stop and 151 (55%) within 150 metres of a non-tiny stop (Figure 2).

Population proximity to transport: Of all Maori and Pacific Islander people 48,000 (38%) lived within 150 metres of any bus stop with 17,000 (13%) living within 150 metres of a non-tiny stop. For the rest of the population, 316,000 (39%) of people lived within 150 metres of any stop, and 135,000 (16%) of these were within 150 metres of a non-tiny stop (Figure 3).

Socioeconomic analysis: Of the 48,000 Mario/Pacific Islander people living within 150 metres of any bus stop, 25,000 (52%) were from AUs with a SoD of 8-10 (poorest 30% of the population) and 19,000 (39%) were from AUs with a SoD of 1-3 (wealthiest 30% of the population). For all other people 101,000 (32%) were from SoD 8-10 and 142,000 (45%) were from AUs with a SoD of 1-3 (Table 1).

DISCUSSION

The spatial analysis of the Auckland metropolitan area revealed some differences in the characteristics of the city population from the wider national data. While at national population level, Maori/Pacific Islander people account for approximately 20% of the population, in the area studied only 13% of the population was Maori/Pacific Island. Historically, Maori and Pacific Islander people, as a minority ethnic group, suffer greater disadvantage when compared to the average population (New Zealand Ministry of Health, 2013). In the study area, 50% of Maori/Pacific Island people were living in areas classified as having greatest disadvantage (SoD 8-10). It should be noted though that SoD values reflect the average socioeconomic status of the AUs, which can slightly skew the outcome as average does not represent the full range.

Primary health service providers (doctors and dentists) were distributed relatively evenly across the three socioeconomic groups, and proximity to bus stops was relatively high, with more than 70% of the clinics being less than 150 metres of a bus stop and more than 50% of the clinics located less than 150 metres away from a "non-tiny" bus stop. The spatial distribution of the stops reflected population density and was quite regular across areas with different socioeconomic backgrounds. However, "non-tiny" stops serve (i.e. within 150 metres of) only 20% of Auckland's population. Transit frequency has been identified as an important component of public transport accessibility to health services (Mavoa et al., 2012; Rocha et al., 2013). The proportion of the population that lived within 150 metres of a "non-Tiny" bus stop (between 13% and 17%) was relatively small, and indeed just over one third (38%) of people were within 150 metres of any bus stop. This is inverse to primary health providers where one half to three quarters of all practices were close to bus stops.

The dichotomy between primary health services being closely associated with bus stops, whilst population being relatively distant could be an indicator of a number of confounders. Ownership of private cars in Auckland is relatively high by world standards, and the cost of personal transport is relatively low. Some organised and voluntary transport options also exists to access health services, including transport by friends and relatives of those that do not own private cars.

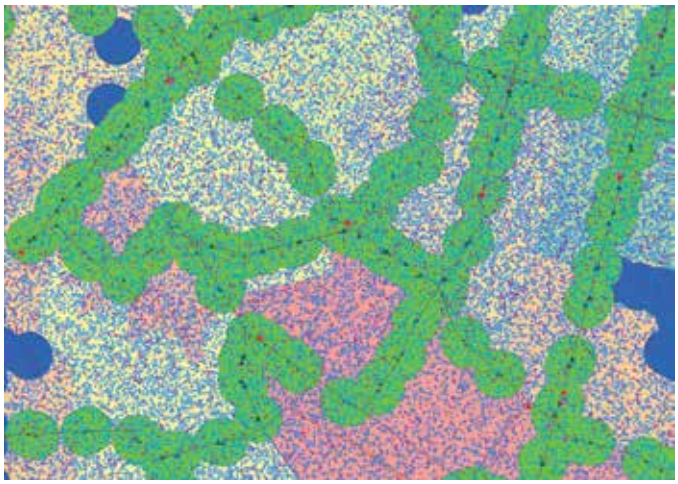

Figure 3. A high magnification area of the Auckland region showing bus stops (triangles) surrounded by 150 metre buffer zones (green around stops with more than 32 bus movements per day and blue around the rest). Medical (red squares) and dental (pink dots) practices are overlayed on the AUs which are shaded from green through to red for socioeconomic deprivation (1 through to 10 respectively). The pink and blue dots are randomly located within each AU for Maori/Pacific Islander people and other people.

Transport can also take place by train or taxi service, although the latter is a high-cost alternative. Notwithstanding that alternative modes of transport (other than bus) are likely impactors on the arrangement of public transport access points, this study does highlight the real opportunity for increasing the connectedness of the primary health service network with the public transport network to enhance access.

Another factor that should be considered is the ageing of the population. As the population of developed countries (including New Zealand) continues to age, reliable access to public transport to seek primary health care will become an increasingly important issue. Not only do older people need more health services, but they are also more reliant on public transport to access those services. This study provides an early indicator of the opportunity that Auckland has to prepare for an ageing and growing population.

CONCLUSION

Although the network of buses in metropolitan Auckland is substantial and robust it was evident that many people live more than 150 metres from a stop, whilst conversely, primary health care providers (doctors and dentists) are clustered around these transport access points. Enhancing the access to bus stops; particularly in areas of high primary health care (doctors and dentists), would be an opportunity to enhance spatial access.

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