Australasian Transport Research Forum 2010 Proceedings
29 September – 1 October 2010, Canberra, Australia
Publication website: http://www.patrec.org/atrf.aspx

# Investigating the Spatial Distribution of the Elderly and its Implications for Service Provision in Adelaide Metropolitan Area

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## Abstract

South Australia's population structure is set to change substantially over the next 50 years as the ageing of the baby boomer generation substantially increases the number of elderly households.

Elderly people are less likely to travel long distances or make complex trips and consequently their level of access to services is often less than that of younger people living in the same area. An appropriate residential location may therefore be more critical in old age than at any other time in life.

This research uses GIS software to quantify twenty variables that the literature suggests impact elderly residential location decisions. It then examines how well each of these variables explains the current distribution of Adelaide's elderly population. The focus of the research is on the impact of service accessibility on elderly residential distribution. The results are used to build a conceptual framework of elderly migration that can assist decision makers in State Government, as well as other stakeholders, who endeavour to strategically improve the quality of life of elderly people in Metropolitan Adelaide.

The research finds that the distribution of people aged 75 years and over is explained better by an area's access to services than it is by socio-economic, migration or housing related data. The results enable the importance of specific services to be ranked for four elderly age groups (55-64, 65-74, 75-84 and 85+).

***Key words***: Ageing, Elderly, Services, Accessibility, Population modelling, Liveability, Adelaide, South Australia.

## 1. Introduction

South Australia's population structure is set to change substantially over the next 50 years as the ageing of the baby boomer generation substantially increases the number of elderly households. This population ageing has made elderly migration more significant in absolute terms, contributing to heightened interest in the migration and residential location decisions of elderly people.

The need to meet the service requirements of the growing elderly population is vital to the success of the Government's commitment to sustainable mobility. It is also vital since independence is fundamentally important for elderly people to retain a high quality of life as their income, health and mobility levels change (Metz, 2000 and Titheridge 2009).

Mobility typically decreases with age. Elderly people are less likely to travel long distances or make complex trips and consequently their level of access to services is often less than that of younger people living in the same area. An appropriate residential location may therefore be more critical in old age than at any other time in life.

Older people consider similar issues when they think about moving to a different suburb. For example: does the new suburb have many other elderly people living there; are there many

suitable one or two person dwellings in the suburb; what are the rents/property prices in the suburb and is there good access to health facilities, shopping areas, public transportation and leisure activities? This research quantifies twenty variables, including those just listed, and examines how well each explains the current distribution of Adelaide's elderly population. The focus of the research is on the impact of service accessibility on elderly residential choice. The results are used to build a conceptual framework of elderly migration from a decision making perspective. Generalisations about the elderly migration decision process can then be quantifiably translated into likely future migration patterns.

Better understanding the distribution of Adelaide's elderly population will enable future growth of this population to be better managed. The findings of this paper therefore have important implications for elderly service provision and social infrastructure investment in Adelaide.

# 2. Population Ageing

Since the baby-boom generation began entering school in the 1950s, it has been followed closely by marketers, policymakers, and political consultants (Frey, 2000). In the next ten years many early boomers, born between 1945 and 1955, will retire from regular jobs as they make the transition from empty-nesters to retirees.

Between 2006 and 2011 the proportion of South Australia's population aged over 65 will grow by 2.3% per annum, more than twice as fast as the total population. Between 2011 and 2021 it will grow at more than double this rate as the baby boomers move en-masse into the 65 plus age group (ABS, 2008). Thereafter growth rates of the 65+ population will decrease to 1.73% in 2006-31. By 2056 25% of South Australia's population is expected to be aged 65 years or over (in 2008 this value was 15%) (ABS, 2008). The growth rates for the 75+ population are also expected to be high, over 4% per annum in both 2011-21 and 2021-26.

# 3. Elderly Residential Mobility

Place is integral to how old age is experienced and constructed (Kontos, 2000). The fit between the functional capacity of individuals and their living environments often weakens between retirement and old age (Meyer, 1985). It is well established in the literature that when elderly individuals cope inadequately with their environment there are three main options for improving their situation; Lawton (1982) described these as follows:

1. To increase the capability of the individual to cope with their situation;
2. To modify the individual's current housing environment to make it more manageable;
3. To move the individuals to a new residence that better fits their functional capacity.

With regard to moving house (option 3 above) the elderly are less geographically mobile than younger persons (Bryant & El-Attar 1984). This is seen in the fact that relocation rates among adults generally decline steadily with age (ABS, 2008). Between 1996 and 2001, census data reveals that 21% of Australians aged 65 and over moved residence, about 4% each year (Olsberg & Winters 2005). Although this figure may be small in comparison with other age groups in absolute terms, it shows that significant numbers of elderly people do relocate.

One of the unique features of post retirement residential mobility is that many of the key triggers which initiate movement at younger ages are not applicable. Movement among the aged, for example, is typically not connected to career opportunities, new marriages, or growth in family size. In contrast to younger adults, the elderly are most likely to move for amenities, to receive assistance from others, or to prepare for ageing by seeking out more suitable environments such as smaller housing units (Meyer & Speare 1985).

Wiseman (1980) developed a behavioural model defining the elderly relocation process. The model splits the process into a set of interrelated decisions: when to move, where to move and decisions concerning living arrangements. In addition to these there is also arguably a

decision regarding the size and location of the 'search space', that is the area in which an individual looks for housing options. The search space is constructed by rules set by the individual such as proximity to a railway station or family members residence.

Litwak and Longino (1987) advanced Wiseman's model by placing the residential mobility of older persons in a developmental perspective with three stages when mobility is likely. The first stage follows retirement, when there is no longer the need to be near the place of work and so retirees are able to move to more desirable locations that were not previously practical. This move is typically facilitated by the loss of dependents from the house (i.e. children move out) which gives more freedom in residential choice and also creates a need to downsize (Duncombe, 2003). The second stage is prompted by actual or impending health declines which cause a move closer to children or others who can provide assistance. Elderly persons may move in with a child or other close relative in this stage, although previous research has shown a strong tendency to remain independent (Wister, 1985). In the third stage, major disability requires more assistance than kin resources can provide and so there is a move into an institution where constant care is available.

# 4. Elderly Service Use

Previous researchers have established that elderly use of a particular service is determined by a complex array of motivating and restraining forces in the life of the individual. Frequently identified influences on service use by elderly persons have included race, residential history, socioeconomic status, knowledge about the service, financial capability to pay for the service, strength of kinship networks and other informal supports, objective and self-defined need and affiliative tendencies. Perhaps the most fundamental determinant of service use is accessibility (Alun, 1991). As such an elderly person's capacity to traverse urban space to undertake recreational activities and to obtain the various goods and services that contribute to social well-being is highly dependent upon their available transport options (Convey 2009) as well as their residential location (Naess, 2009).

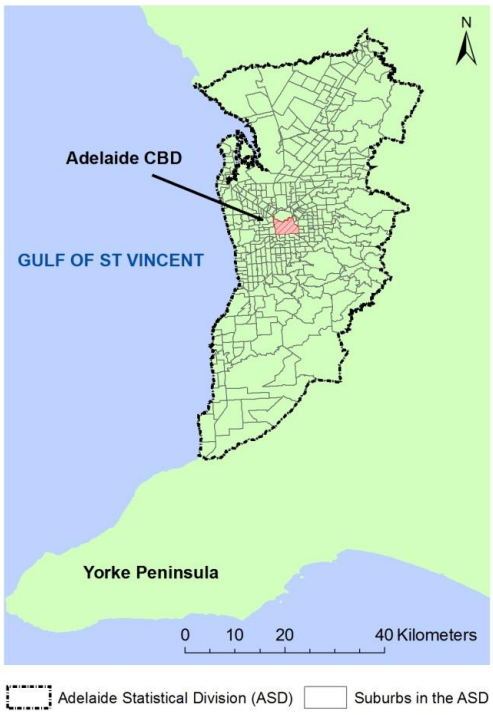
Morris and Wigan (1979) and Morris (1981) were among the earliest Australian authors to investigate social equity issues in transport research, finding that the needy, young people, disabled persons and the elderly were most likely to have poor access to public transport.

Coveney (2009) conducted interviews around Adelaide with people that did not have private transport and found that living in a food desert (an area with few food shopping options) did not by itself impose food access difficulties. Coveney concluded that access to independent transport to shops was more important. Access to government schemes and systems that for some made food shopping much easier were found to be particularly important. So food access problems in Adelaide are not so much the product of geographic distance between home and shop, as the social welfare networks that allow people to travel independently.

Whilst transport mobility is obviously important in defining the general population's accessibility to services it is not necessarily so important when studying elderly accessibility to services. Transport mobility typically decreases with age and so, relatively, residential location is more important in defining service accessibility for the elderly than it is for the working population. With all forms of transport elderly people are typically less likely to travel long distances, undertake trips that take a long time or make complex chaining trips. Consequently their level of access to services is often less than that of younger people living in the same area. So for a person to maintain their level of access to services as they age they may need to relocate their residence as services they once used become inaccessible from their current residence. This is evident in Sommers (1992) finding that elders who used community mobility services were less likely to relocate their place of residence. An appropriate residential location may therefore be more critical in old age than at any other time in life.

# 5. Study Area and Data Sources

**Figure 1: Study Area**




This study is focused on Adelaide Statistical Division (ASD), as defined by the Australian Standard Geographical Classification (Australian Bureau of Statistics, 2006).

The ASD covers more than 1,800km$^2$ and contains the majority of South Australia's population. It stretches over 30 kilometres north and south of Adelaide's central business district (Figure 1).

The ASD is split into 399 suburbs of varying sizes. Each of these suburbs is then split into census district areas, which also vary in size as well as in the number per suburb. In total the ASD contains 2,222 census districts.

This study uses data from the most recent Australian census (August 2006) collected at a census district level for the whole ASD. For ease of interpretation the results are expressed and discussed per suburb as the average of all of the census districts in each suburb.

The second primary data source for this study is the South Australian Digital Cadastral Database (DCDb). The DCDb is a spatial database of the legal land parcel boundaries within South Australia. It comprises data on approximately 920,000 land parcels. The data held for each land parcel includes a description of the area's landuse.

# 6. Method

## 6.1. Defining Elderly Age Groups

The analysis presented in this in this paper is undertaken for four age groups: pre retirees (aged 55-64), the young elderly (aged 65-74), the elderly (aged 75-84) and the old elderly (aged 85 and over). The three eldest age groups in this categorisation should broadly match the three stages in Litwak and Longino's (1987) model (see Section 3).

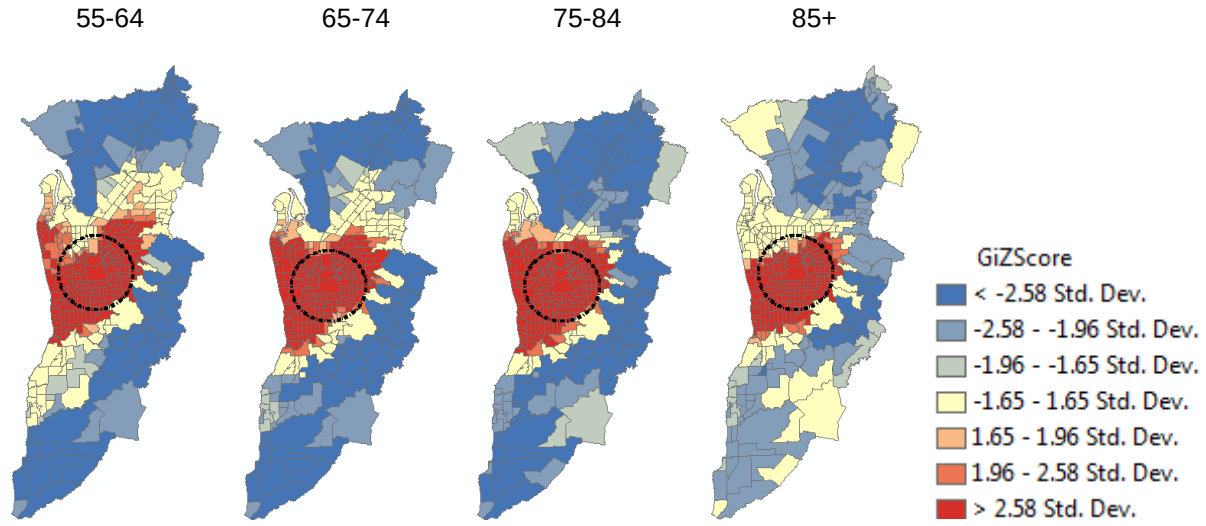
## 6.2. Defining the Current Distribution of the Elderly in the ASD

The way a population chooses to locate itself is important because it reflects the diversity of that population's needs. The distribution of Adelaide's population was examined using Hot Spot Analysis to calculate the Getis-Ord Gi statistic of each suburb for the density of people in each elderly age group. The Getis-Ord Gi statistic describes the extent to which suburbs with either high or low densities of elderly people cluster more than might be expected by random chance. This process looks at each suburb within the context of its neighbouring suburbs. If a suburb has a high density of old people and the density of old people in all of its neighbouring suburbs is also high then it is defined as part of a hot spot. Suburbs with large Getis-Ord Gi statistics are in areas with the most intense clustering of suburbs with high densities of elderly people (hot spots). Suburbs with statistically significant negative Getis-Ord Gi statistics are in areas with the most intense clustering of suburbs with low densities of elderly people (cold spots).

The units of the Gi statistic are a measure of standard deviation (a z score). They represent the statistical significance and confidence that can be associated with the clustering. Areas

with scores less than -1.96 or more than +1.96 have a 5% probability of being clustered by random chance. When analysing 2006 census data the distribution of the elderly, like the distribution of the total population, ostensibly appears to be focused around the centre of Adelaide (Figure 2).

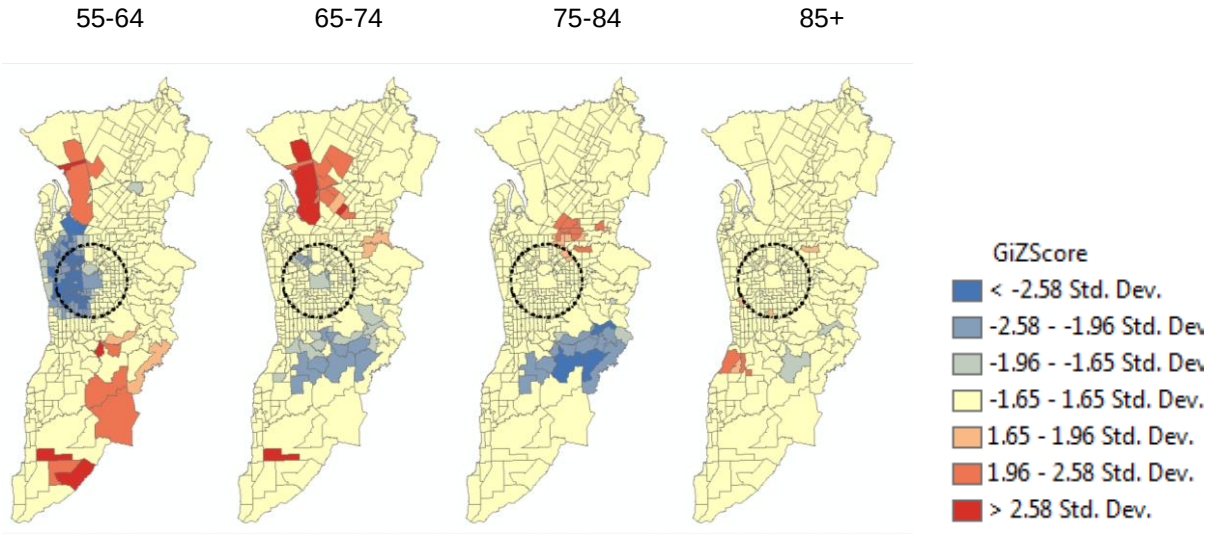
**Figure 2 - Hot Spot Analysis (Getis-ord Gi) of the Density of Elderly Age Groups per Km$^2$**




*Note: Dashed black line marks a 7 km radius of Adelaide's CBD*

Whilst Figure 2 is a valid way of examining the distribution of Adelaide's elderly, it only shows a reflection of the distribution of the total population. The figure fails to show how the elderly population clusters relative to the rest of the population. In Figure 3 the distribution is shown as a percentage of the total number of people in each suburb. This Figure reveals an area north of the city where people from both the 55-64 and 65-74 age group congregate. As well as an area south of the city which is avoided by people in both the 65-74 and 75-84 age group. It is noticeable that the for the two younger age groups the centre of the hotspots are further from the centre of Adelaide than the hot spots for the two more elderly age groups. This may be because of suburbanisation; the working population is choosing to move further from the city centre than it has done historically.

**Figure 3 - Hot Spot Analysis (Getis-ord Gi) of the Number of People in each Elderly Age Group as a Percentage of the Total number of persons in each suburb.**




*Note: Dashed black line marks a 7 km radius of Adelaide's CBD*

## 6.3. Defining Service Accessibility

The analysis in this paper focuses on the nine services/amenities that are listed in Table 1. Each of these was deemed important in the determination of elderly residential relocation.

**Table 1 – Categorisation of DCDb Land Uses to Service Types**

| Service Categorisation | | |
|---|---|---|
| **HEALTH SERVICES**<br>• Chemist;<br>• Chiropodist;<br>• Chiropractor;<br>• Community hospital;<br>• Dentist;<br>• Hospital;<br>• Mental Hospital;<br>• Medical and health;<br>• Physicians and surgeons;<br>• Physiotherapist;<br>• Private hospital. | **LOCAL FOOD SERVICES**<br>• Bakery;<br>• Bread cakes and pastry;<br>• Butcher;<br>• Delicatessen;<br>• Grocer;<br>• Licensed grocer;<br>• Newsagent / book shop;<br>• Post office. | **ENTERTAINMENT**<br>• Golf courses;<br>• Library and book lending service;<br>• Library and reading;<br>• Social entertainment club licensed;<br>• Social entertainment club unlicensed. |
| **ELDERLY RESIDENTUAL CARE**<br>• Old folks homes;<br>• Retired and aged accommodation. | **DINNING OUT**<br>• Restaurant licensed;<br>• Restaurant unlicensed;<br>• Café. | **SHOPPING CENTRES**<br>• Retail trade shops, shopping centres;<br>• Department and general stores. |
| **FINANCIAL INSTITUTIONS**<br>• Banks;<br>• Building Society. | **REGIONAL FOOD SERVICES**<br>• Supermarkets. | **RELIGIOUS BUILDINGS**<br>• Churches. |

ESRI Arcview Network Analyst is a piece of GIS software (Geographical Information System) used to conduct network based spatial analysis. The software contains a tool that can be used like a car sat nav to identify the best route from one location to another. A road network model of the ASD was built in Arcview. It used travel time as an impedance (road length divided by road speed limit) and road hierarchy was enabled (so that main roads were chosen in preference to minor roads).

The road network model was used to calculate average travel times (in minutes) to the ten nearest facilities in each of the nine service categories listed in Table 1 from the following points: census districts centroids, suburb centroids and 10 randomly generated points in each suburb (to improve the accuracy of the results in areas with very large census districts). The results of these calculations were then summarised by averaging at a suburb level. An example of the output is shown in Figure 4. The Figure shows that the areas with the shortest travel time to health services are close to the centre of Adelaide. Similar calculations were also made for natural amenities such as the travel time to the beach (Figure 5).

It should be noted that although the units of the averaged travel time values are minutes the values overestimate travel time to the closest service because they display the average of the travel times to the ten nearest services in each category. For this reason the averaged travel time values are here on referred to as accessibility scores. Higher accessibility scores

represent suburbs where a service is more difficult to obtain because it takes longer to travel to.

Figure 4 – Access to Health Care

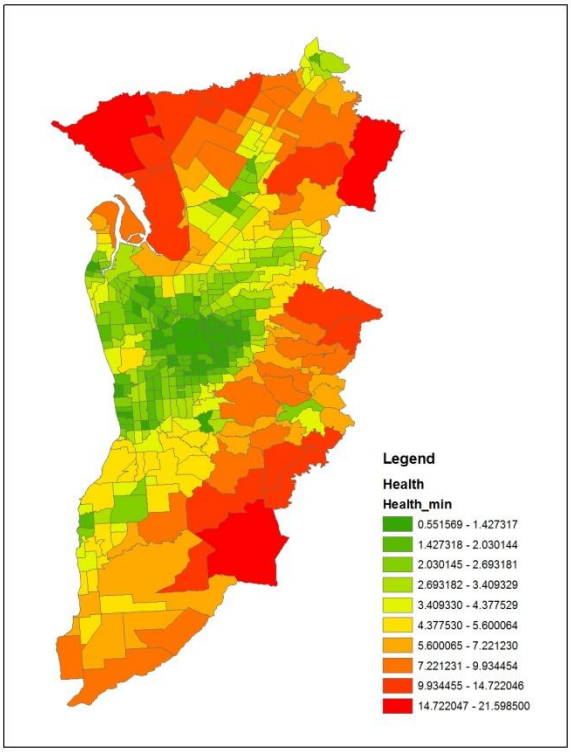
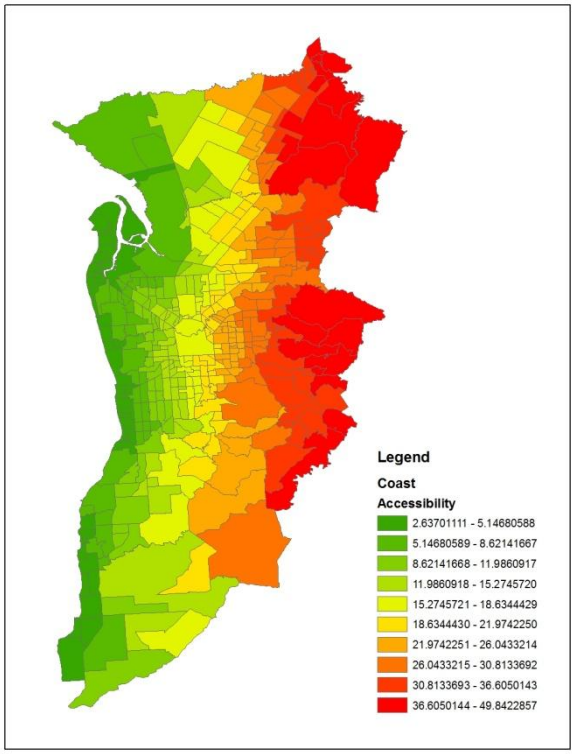



Figure 5 – Access to Coastline

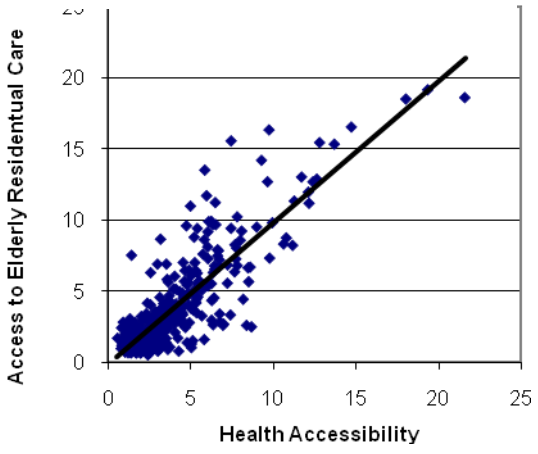



The output of the road network modelling was a table listing all of the suburbs in the ASD and giving an accessibility score to each of the previously described service groups. An additional column was added to this table by summing all of the accessibility scores for each suburb, giving an overall indicator of service access in each suburb.

# 7. Results

Unsurprisingly a number of the accessibility scores correlated with one another. For example suburbs that had good access to health services also had good access to elderly residential care homes (Figure 6).

**Figure 6 - Multicollinearity**




The next task was to identify how well the accessibility scores correlated with statistics describing the distribution of the elderly age groups across the suburbs in the ASD.

Table 2 shows the Pearson product-moment correlation coefficient between the accessibility scores for each service category and the distribution of people in each elderly age group. The table quantifies the distribution of each elderly age group in each suburb in three ways: as the density of people (number per km$^2$ per suburb), as a percentage of the total population in the suburb (%) as well as in absolute terms (total number per suburb). The correlation coefficient range between -1 indicating significant negative linear dependence and +1 indicating significant positive linear dependence. Values around zero indicate that changing the value of the X variable has no impact on the value of Y variable.

**Table 2 – Correlation between Service Access and the Distribution of the Elderly**

| | Health Accesibility | Supmarket Accesibility | Elderly Care Home Accesibility | Local Food Outlets Accesibility | Dinning Out Accesibility | Entertainment Accesibility | Financial Institution Accesibility | Coast Accesibility | Sum of Service Accessibility |
|---|---|---|---|---|---|---|---|---|---|
| Total Population | -0.12 | -0.02 | -0.10 | -0.02 | -0.05 | -0.09 | -0.05 | -0.06 | -0.08 |
| Median age of Population | 0.01 | -0.09 | 0.04 | -0.06 | -0.03 | -0.01 | -0.04 | -0.01 | -0.03 |
| Total number of people aged 45-54 in suburb | -0.08 | 0.00 | -0.05 | 0.02 | -0.01 | -0.06 | -0.03 | -0.05 | -0.04 |
| Total number of people aged 55-64 in suburb | -0.10 | -0.02 | -0.07 | -0.02 | -0.05 | -0.09 | -0.06 | -0.06 | -0.07 |
| Total number of people aged 65-74 in suburb | -0.18 | -0.08 | -0.18 | -0.09 | -0.12 | -0.15 | -0.11 | -0.10 | -0.15 |
| Total number of people aged 75-84 in suburb | -0.31 | -0.22 | -0.31 | -0.24 | -0.27 | -0.27 | -0.25 | -0.21 | -0.31 |
| Total number of people aged 85 and over in suburb | -0.33 | -0.26 | -0.33 | -0.29 | -0.32 | -0.28 | -0.30 | -0.16 | -0.32 |
| Number of people aged 45-54 as percentage of suburb population | 0.25 | 0.18 | 0.36 | 0.21 | 0.20 | 0.24 | 0.21 | 0.23 | 0.28 |
| Number of people aged 55-64 as percentage of suburb population | 0.25 | 0.10 | 0.32 | 0.18 | 0.19 | 0.18 | 0.18 | 0.21 | 0.24 |
| Number of people aged 65-74 as percentage of suburb population | -0.05 | -0.03 | -0.06 | -0.02 | -0.02 | -0.01 | 0.01 | -0.06 | -0.04 |
| Number of people aged 75-84 as percentage of suburb population | -0.44 | -0.37 | -0.45 | -0.43 | -0.43 | -0.36 | -0.39 | -0.24 | -0.45 |
| Number of people aged 85 and over as percentage of suburb population | -0.38 | -0.33 | -0.35 | -0.39 | -0.39 | -0.32 | -0.38 | -0.12 | -0.37 |
| Number of people aged 45-54 in suburb (per km2) | -0.69 | -0.62 | -0.66 | -0.63 | -0.69 | -0.61 | -0.67 | -0.27 | -0.69 |
| Number of people aged 55-64 in suburb (per km2) | -0.68 | -0.62 | -0.65 | -0.63 | -0.68 | -0.62 | -0.66 | -0.26 | -0.68 |
| Number of people aged 65-74 in suburb (per km2) | -0.67 | -0.60 | -0.67 | -0.62 | -0.65 | -0.61 | -0.63 | -0.28 | -0.67 |
| Number of people aged 75-84 in suburb (per km2) | -0.64 | -0.60 | -0.63 | -0.62 | -0.63 | -0.58 | -0.61 | -0.31 | -0.66 |
| Number of people aged 85 in suburb (per km2) | -0.48 | -0.46 | -0.46 | -0.48 | -0.50 | -0.42 | -0.48 | -0.18 | -0.49 |

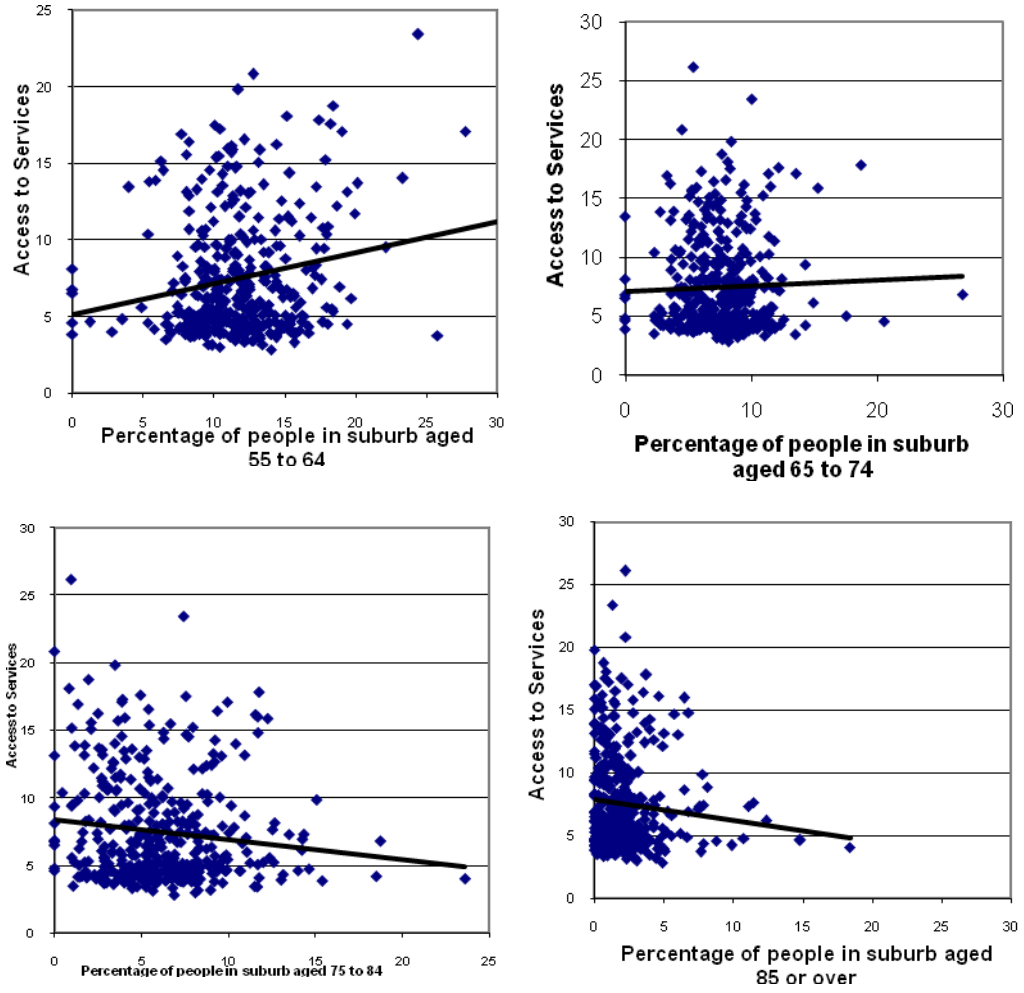
*Note: Strong correlations (those between –1 and –0.6 or +0.6 and 1 are highlighted*

The bottom part of Table 2 shows that most of the service accessibility scores correlate well with the density of each of the elderly age groups. The correlation values in this part of the Table are all negative because increasing travel time to the services decreases the density of people likely to be found in each age group. The correlations in the bottom right of the table between the sum of all of the service accessibility scores and the density of people in each age group reveal that services are slightly better at predicting the population density of pre retirees (for the 45-54 age group the correlation is –0.69) than of the more elderly age groups (for the 75- 84 age group the correlation is –0.66). The correlation of the 85 plus age group to the sum of the accessibility scores is –0.49. This is significantly different to the values for the other age groups and suggests a fundamentally different decision process is controlling the way this population chooses to locate itself relative to the other age groups.

When the service accessibility scores are correlated with the total number of people in each age group (or to the total population) similar relationships are observed but their coefficients reveal they are not as strong as those to the density of people in each age group. This is simply because density accounts for the varying sizes of the suburbs. The largest suburb in the ASD is Humbug Scrub (87.36 $km^2$) the smallest suburb is Thorngate (0.09 $km^2$). The large range in suburb sizes means it is not appropriate to compare them in absolute terms. Humbug scrub may have more people living in it but Thorngate has a higher population density. If Thorngate were the same size as Humbug scrub its population would be much greater.

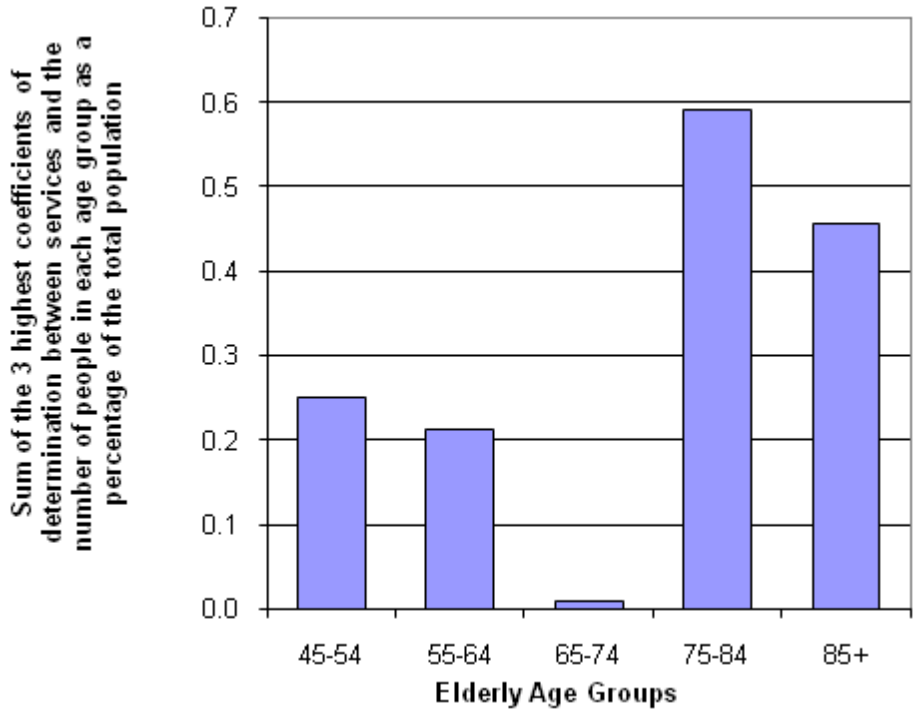
The middle section of Table 2 shows the correlations between the service accessibility scores and the number of people in each age group as a percentage of the total population. This part of the table is of most interest in because it describes how the elderly age groups cluster relative to the rest of the population. The key thing to note is that the correlation scores progressively move from being positive for the younger age groups to negative for the more elderly age groups. Figure 7 shows the data behind these correlations. The key thing to note from the figure is that suburbs with high percentages of people in the 55-64 age group are likely to have worse access to services than suburbs with low percentages of people in that age group. Conversely suburbs with high percentages of people in the 85 plus age group are likely to have better access to services than suburbs with low percentages of people in that age group.

**Figure 7 – Sum of Service Accessibility Scores vs Percentage of People in Age Groups**




To investigate this further the coefficient of determination was calculated for each pair of variables in Table 2, excluding the sum of the service accessibility scores. The coefficient of determination estimates the fraction of variance in Y that is explained by X in a linear regression analysis. The values range from 0 (where none of the variance is explained) to 1 (where all of the variance is explained). Figure 8 shows the sum of the three highest coefficients of determination values between services and the number of people in each age group as a percentage of the total population. The results show that the distribution of people in the 75-84 age group and in the 85 plus age group is much better predicted by service accessibility than those in the two lowest age groups. Meanwhile the 65-74 age group is not well predicted by service accessibility. This fits with the first stage of Litwak and Longino (1987) model where recent retirees who are transport mobile are able to move residence freely without considering commuting distances or the needs of dependants in their household. Meanwhile the two youngest age groups shown on Figure 8 are still in full time work and are more likely to have dependents in their household. Their distribution is therefore better explained by service accessibility. The need of these age groups to work means they are more likely to be located in places that reduce the amount of time they need to commute; since more people are employed in the city than in more rural areas for most people this will be an urban area, where there are typically more services. Hence the correlation. It is noteworthy that service accessibility is approximately twice as good at predicting the percentage distribution of the two most elderly age groups than the two youngest. This shows that service accessibility is most important for the older generations.

**Figure 8 – Sum of the Three Highest Coefficients of Determination for each Age Group**




In the next stage, data for each suburb was added to the analysis from the 2006 Census to see if it were able to better explain the distribution of the elderly. Most of the data that was added fell into one of three categories:

- Housing (available types, average sizes, density, cost etc);
- Socio economic status (average income, average number of motor car per home etc);
- Migration (number of people living at same address 1 and 5 years ago).

Table 3 shows Pearson product-moment correlation coefficients comparing the census data to the distribution of elderly people.

**Table 3 – Correlation between Selected Migration Census data and the Distribution of the Elderly**

| | Average Number of Motor Vehicles per dwelling | Median Individual Income | Median rent ($ per week) | Average houshold size | Number of separate house dwellings | Number of one storey dwellings | Number of two or more storey dwellings (excluding flats) | Number of dwellings in one or two storey flats | Number of dwellings in flats with three or more storeys | Total Dwellings | Average no of dwellings per km$^2$ | Number of people living at the same address 1 year ago | Number of people living at the same address 5 years ago | Number of people living at the same address 1 year ago as percentage of suburbs population | Percentage living at same address 5 years ago as percentage of suburbs population |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Population | 0.99 | -0.08 | 0.08 | 0.14 | 0.97 | 0.48 | 0.25 | 0.44 | 0.17 | 0.99 | 0.19 | 0.99 | 0.97 | 0.08 | 0.04 |
| Median age of Population | -0.16 | 0.08 | 0.06 | -0.15 | -0.17 | -0.04 | -0.07 | 0.01 | -0.06 | -0.16 | -0.05 | -0.17 | -0.13 | 0.07 | 0.19 |
| Total number of people aged 45-54 in suburb | 0.96 | -0.02 | 0.12 | 0.19 | 0.96 | 0.41 | 0.20 | 0.38 | 0.12 | 0.96 | 0.15 | 0.98 | 0.97 | 0.12 | 0.09 |
| Total number of people aged 55-64 in suburb | 0.95 | -0.04 | 0.12 | 0.14 | 0.93 | 0.44 | 0.23 | 0.41 | 0.15 | 0.94 | 0.15 | 0.95 | 0.95 | 0.13 | 0.12 |
| Total number of people aged 65-74 in suburb | 0.92 | -0.19 | 0.03 | 0.03 | 0.87 | 0.57 | 0.20 | 0.53 | 0.11 | 0.92 | 0.24 | 0.89 | 0.90 | 0.11 | 0.12 |
| Total number of people aged 75-84 in suburb | 0.80 | -0.21 | -0.02 | -0.12 | 0.69 | 0.64 | 0.23 | 0.66 | 0.14 | 0.80 | 0.38 | 0.74 | 0.74 | 0.07 | 0.06 |
| Total number of people aged 85 and over in suburb | 0.62 | -0.10 | 0.01 | -0.16 | 0.50 | 0.53 | 0.25 | 0.65 | 0.16 | 0.62 | 0.39 | 0.56 | 0.55 | 0.01 | -0.02 |
| Number of people aged 45-54 as percentage of suburb population | -0.09 | 0.44 | 0.38 | 0.59 | -0.03 | -0.19 | -0.09 | -0.17 | -0.10 | -0.09 | -0.16 | -0.04 | -0.01 | 0.60 | 0.61 |
| Number of people aged 55-64 as percentage of suburb population | -0.10 | 0.36 | 0.35 | 0.37 | -0.06 | -0.14 | -0.03 | -0.15 | -0.04 | -0.10 | -0.26 | -0.07 | -0.03 | 0.48 | 0.53 |
| Number of people aged 65-74 as percentage of suburb population | -0.00 | -0.25 | 0.01 | -0.05 | -0.03 | 0.15 | -0.04 | 0.11 | -0.05 | 0.00 | 0.06 | -0.04 | -0.00 | 0.29 | 0.33 |
| Number of people aged 75-84 as percentage of suburb population | 0.02 | -0.27 | -0.08 | -0.36 | -0.07 | 0.28 | 0.03 | 0.32 | 0.03 | 0.03 | 0.40 | -0.04 | -0.03 | -0.01 | 0.00 |
| Number of people aged 85 and over as percentage of suburb population | -0.00 | -0.10 | -0.07 | -0.37 | -0.08 | 0.17 | 0.06 | 0.27 | 0.07 | -0.00 | 0.33 | -0.04 | -0.04 | -0.17 | -0.21 |
| Number of people aged 45-54 in suburb (per km2) | 0.25 | 0.17 | 0.17 | -0.13 | 0.18 | 0.28 | 0.09 | 0.39 | 0.06 | 0.25 | 0.93 | 0.22 | 0.22 | 0.06 | 0.03 |
| Number of people aged 55-64 in suburb (per km2) | 0.27 | 0.17 | 0.21 | -0.15 | 0.19 | 0.31 | 0.12 | 0.40 | 0.09 | 0.27 | 0.88 | 0.23 | 0.24 | 0.07 | 0.05 |
| Number of people aged 65-74 in suburb (per km2) | 0.26 | -0.08 | 0.05 | -0.25 | 0.16 | 0.40 | 0.08 | 0.47 | 0.06 | 0.27 | 0.88 | 0.19 | 0.21 | 0.06 | 0.06 |
| Number of people aged 75-84 in suburb (per km2) | 0.15 | -0.07 | -0.00 | -0.31 | 0.03 | 0.37 | 0.08 | 0.49 | 0.09 | 0.15 | 0.82 | 0.07 | 0.08 | 0.01 | -0.02 |
| Number of people aged 85 in suburb (per km2) | 0.06 | 0.05 | 0.03 | -0.26 | -0.04 | 0.23 | 0.08 | 0.39 | 0.11 | 0.07 | 0.62 | 0.01 | 0.01 | -0.04 | -0.09 |

Table 4 shows the average coefficient of determination between elderly distribution and each of the three groups of 2006 Census data as well as for the service access data. It reveals that the accessibility to services data is more than twice as good at forecasting elderly distribution than housing, migration or socio-economic data. On average service accessibility explains 34% of the variation in the density of the elderly and 8% of the variation in their number as a percentage of the total population.

**Table 4 – Comparing different Indicators of Elderly Distribution**

| | Service Accessibility data | Housing data | Migration data | Socioeconomic data |
|---|---|---|---|---|
| Total population | 0.01 | 0.28 | 0.49 | 0.50 |
| Median age of Population | 0.00 | 0.01 | 0.02 | 0.02 |
| Total numbers in elderly age groups | 0.04 | 0.24 | 0.36 | 0.38 |
| Elderly age groups expressed as a percentage of total population | 0.08 | 0.04 | 0.05 | 0.10 |
| Elderly age groups expressed as a density (number per $km^2$) | 0.34 | 0.13 | 0.03 | 0.01 |

Based on their coefficient of determination Table 5 ranks the top five individual variables that this analysis has shown best predicts the distribution of each of the four elderly age groups. It is noteworthy that for the two youngest age groups these are housing, socio-economic and migration related variables, whilst for the two eldest age groups they are all service accessibility variables. The natural segregation of the working and non labour force populations agrees with the findings of Massey (1980).

**Table 5 – Top Five Variable for Predicting the Number of People in each Age Group as a Percentage of the Total**

a)

| Number of people aged 55-64 as percentage of suburb population | |
|---|---|
| Independent Variable | Correlation |
| Number living at same address 5 years ago as percentage of suburbs population | 0.281 |
| Number of people living at the same address 1 year ago as percentage of suburbs population | 0.232 |
| Average houshold size | 0.135 |
| Median Individual Income | 0.133 |
| Median rent ($ per week) | 0.120 |
| *Sum:* | *0.901* |

b)

| Number of people aged 65-74 as percentage of suburb population | |
|---|---|
| Independent Variable | Correlation |
| Number living at same address 5 years ago as percentage of suburbs population | 0.108 |
| Number of people living at the same address 1 year ago as percentage of suburbs population | 0.087 |
| Median Individual Income | 0.064 |
| Number of one storey dwellings | 0.021 |
| Number of dwellings in one or two storey flats | 0.012 |
| *Sum:* | *0.293* |

c)

| Number of people aged 75-84 as percentage of suburb population | |
|---|---|
| Independent Variable | Correlation |
| Elderly Care Home Accesibility | 0.207 |
| Sum of Service Accessibility | 0.202 |
| Health Accesibility | 0.197 |
| Dinning Out Accesibility | 0.188 |
| Local Food Outlets Accesibility | 0.183 |
| *Sum:* | *0.976* |

d)

| Number of people aged 85 and over as percentage of suburb population | |
|---|---|
| Independent Variable | Correlation |
| Dinning Out Accesibility | 0.156 |
| Local Food Outlets Accesibility | 0.154 |
| Health Accesibility | 0.147 |
| Financial Institution Accesibility | 0.144 |
| Sum of Service Accessibility | 0.139 |
| *Sum:* | *0.739* |

*Note: "Correlation" in these tables refers to their coefficient of determination*

## 8. Further Analysis

The next phase of work will use principal component analysis (to summarise the data) and multiple regression (to establish links between the variables) to quantifiably translate the generalisations about the elderly migration decision process discovered by this paper into predictions of the current distribution of the elderly across the ASD and likely future migration patterns. To improve understanding of causality further variables may be examined. These may include descriptions of access to public transport as well as to community services that improve elderly mobility. Ethnicity, superannuation policy and migration to other states and countries will also be considered. The results of this next phase of work will be used to identify:

- Potential growth areas; where the right services are in place but elderly population density is currently low;
- Stressed areas where service provision is low and elderly population density is high;
- Suburbs that are ageing in place and will consequently have a future need for services different to those currently available.

From the above work a liveability index will be built to quantify the suitability of each suburb to elderly residence. Further research will then be needed so that the entire decision making process (as defined by Wiseman, 1980) is better understood.

This research will be policy relevant as it may guide future planning for social services, housing programs, and broader community issues. Understanding the processes leading to different population distributions will enhance our ability to plan assistance programs for the elderly and community response to changing population profiles.

# 9. Conclusion

This study has shown that:

- The distribution of the elderly around Adelaide is not even;
- There are links between the accessibility of some services and elderly population distribution;
- The propensity of recent retirees to reside in certain suburbs is affected more by socio-economic, housing and migration related variables than the accessibility of services;
- The distribution of people aged 75 years or over is explained better by access to services than socio-economic, migration or housing related data;
- The relocation of middle class households away from Adelaide city in recent years has resulted in a measurable degree of segregation between labour force and non-labour force populations. Employed middle income persons have moved away from the city leaving behind a population that is increasingly unemployed and service-dependent.

In the context of the findings of this paper the following predictions seem reasonable:

- A higher proportion of the elderly population will be concentrated close to the city centre, primarily as a function of increases in population in these areas;
- The number of suburbs with relatively high concentrations of elderly persons will increase;
- The older population living close to the centre of Adelaide will be spatially dispersed over an increasingly large suburban area.

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