Australasian Transport Research Forum 2011 Proceedings
28 - 30 September 2011, Adelaide, Australia
Publication website: http://www.patrec.org/atrf.aspx

Exploring mobility of older people: a case study of Adelaide

Long Tien Truong[1], Sekhar Somenahalli[2]

[1]University of Transport and Communications, Hanoi, Viet Nam

[2]University of South Australia, Adelaide, Australia

Email for correspondence: truongtienlong@gmail.com

Abstract

This paper explores mobility of older people in Metropolitan Adelaide using existing datasets together with data from a recent (2010) travel survey of older people (N=117). Findings derived from qualitative and quantitative methods suggest that older people's mobility, when measured by daily trip, distance travelled, and trip chain complexity, decreases with increasing age. Socio-economic characteristics, e.g. age, gender, income, driving licence, living alone, length of current residence, and mobile phone ownership as well as neighbourhood characteristics, e.g. population density, percentage shares of residential and commercial areas, and distance to the Central Business District (CBD) are found to be important factors underpinning travel patterns of older people. Medical services, shopping facilities and public transport are reported as being the three most important services/facilities influencing the residential location choice of older people. The need for smaller accommodation is the main driver of residential relocation. Concerns of older people about safety of motorised scooters and their needs of taxi concessions and designated senior parking spaces are also highlighted. Analyses of public transport usage among older Adelaide residents show an increase resulting from the Seniors FREE Travel initiative. Implications for transportation and urban development policy are also discussed.

Key words: Older people, Mobility, Adelaide

1. Introduction

In the 21st century, a rapidly ageing population represents one of the most formidable challenges for developed countries (Metz 2003; Rosenbloom 2005). Significant rises in both the absolute number and the percentage of older people are evident in developed countries (Tacken 1998; Metz 2000; Rosenbloom 2001; Schwanen and Páez 2010). Australian society, similar to Western societies, is ageing as well. In 2007 people aged 65 and above represent 13% of Australian's total population (ABS 2008). This proportion will be almost doubled, to 25%, in 2056 as the Baby Boomer generation ages.

South Australia has the oldest population in Australia, i.e. approximately one in six people aged 65 years and above (Hugo et al. 2009). This pattern will continue in the next 25 years. The pattern among the people aged 75 and above, who most intensively use health and aged services, is even more striking. In 2006, approximately 120,000 South Australians were aged 75 years and above, representing 7.8% of the population (Hugo 2008). The size of this group is expected to double in less than two decades, mainly due to the improved longevity of the older population.

The spatial distribution of the population aged 65 and above is also changing, i.e. the proportion of the people belonging to this group living outside metropolitan area is increasing. However, more than two thirds of the population aged 65 and above still live in Adelaide. Furthermore, as a result of the dramatic change of population structure, a significant shift in the distribution of older people is occurring within Adelaide. Between 1971 and 2006, the proportion of the people aged 65 and above living in outer suburbs has increased from

12.4% to 38.7% and the absolute number has increased sevenfold while the population aged 65 and above in inner city has remained relatively static. This is producing a growing spatial mismatch between the locations of aged services and aged residential accommodation (Hugo 2008).

Mobility of older people has increased when compared with earlier generations, e.g. more frequent and complex journeys are now made in old age. This can be attributable to a number of factors e.g. wider car use, an extended driving life, healthier older population, and a greater amount of disposable income (Rosenbloom and Morris 1998; Alsnih and Hensher 2003; Su 2007). Greater automobile dependency among the elderly is witnessed in developed countries e.g. the United State, Australia, Europe. However, mobility reductions become more evident as people reach 75 years of age (Giuliano et al. 2003). This can be explained by a number of factors, e.g. driving cessation and greater physical limitations. Older people therefore require more accessible alternatives, e.g. better public transport services or motorised scooters.

It is widely accepted in literature that mobility is closely related to older people's independence, well-being and quality of life. Banister and Bowling (2004) pointed out that in old age if mobility increases, so does the perception of quality of life, particularly in terms of participating in social activities and getting access to local services and facilities. Conversely, loss of mobility might contribute to social isolation which leads to lower health outcomes and even higher depression and morbidity rates (Bower 1997). Therefore better understanding of mobility of older people and the provision of transport options for them is essential.

This paper presents the findings from a recent (2010) travel survey of older people. The purpose of this paper is to explore mobility of older Adelaide residents by reporting on travel patterns, residential movement patterns, the use of motorised scooters and opinions about age-related transport issues. This paper also reveals their relationships with socio-economic, neighbourhood characteristics and opinions of older people.

2. Literature review

2.1 Travel pattern of older people

A growing body of literature, investigating travel patterns of an ageing population in developed countries, indicates that while older people today travel more than their comparable age groups several decades ago (Tacken 1998; Rosenbloom 2001; Hjorthol et al. 2010). Notwithstanding this, older people are less likely to travel than younger people, and the number of journeys made declines with increasing age and the trips get shorter (Collia et al. 2003; O'Fallon and Sullivan 2009; Schmöcker et al. 2010). Rather than employment-related activities, for example, most out-of-the home activities and associated travel engaged in by the elderly revolve around travel for shopping, entertainment, purchasing goods and services, or religious and volunteer organizations (Collia et al. 2003; Newbold et al. 2005; Somenahalli and Taylor 2007; van den Berg et al. 2010). In particular, travel for purposes of leisure and shopping is becoming more important to the elderly (Su et al. 2009). In addition, older people tend to travel less outside peak hours or at night (Hanson 1977; Scott et al. 2009). They tend to avoid driving in morning and evening peak hours, and at night, as they feel less safe to drive during these times (Somenahalli and Taylor 2007). Persuasive evidence shows that the elderly use non-car transport modes more frequently although private car still is main mode of travel (Rosenbloom 2000). Moving through the age groups, fewer and fewer trips are made as a car driver, and greater proportions are by walking or as a car passenger (Rosenbloom and Morris 1998; O'Fallon and Sullivan 2009).

2.2 Trip chaining

Trip chaining behaviour of older people recently has been of great research interest. Kim (2003) reported that older people are more likely to share a ride with others when chaining

trips and are less likely to use public transport for shopping or doing errands. Golob and Hensher (2007) used data from the Sydney travel survey to analyse the trip chaining activity of Sydney residents with a specific focus on older people. The results show that interaction between gender and marital status results in different mode preferences and tour frequencies. Other key results are that income does not have a significant influence on tour numbers and that reduced travel activity is especially pronounced for those aged over 85. The results also indicate that trip chaining peaks at ages between 45 and 54 and decreases after age 65. In a similar study, Hensher (2007) found that the key influences on the trip chain and modal behaviour of individuals over the age of 64, by gender, is currency of a driver's licence, living with a partner, and the specific age range over 64 years. Hensher (2007) argued that the loss of a driver's licence and a partner have the potential to be major contributors to social isolation in the absence of inadequate flexible public transport and support mechanisms that enable car sharing.

In the study of trip chaining of public transport users in Melbourne, Currie and Delbosc (2011) showed that between 1994 and 1999 the complexity of trip chains was relatively stable and slightly decreasing, and was found to be larger for rail and tram than for car based trips. Most recently, Schmöcker et al.(2010) examined the trip chaining complexity of the elderly in London, finding that older people reduce total home-to-home tours by combining different trips into single tours. The analysis also shows that disabilities do not necessarily lead to reduced tour complexity, except when walking difficulties become so severe that independent travel is not possible. Moreover, trip chain and tour complexity of older people might further increase in the future. For example, the spread of mobile phone usage appears to increase tour complexity of the elderly.

2.3 The role of public transport

While cars are considered to be the most convenient mode for older people, continuous reliance on them may have negative impacts on the environment and on mental health if alternative modes are not considered (Currie and Delbosc 2010). Public transport trips are a very small proportion of all travel of older people (Rosenbloom and Morris 1998; Rosenbloom 2001). There is growing evidence that it may be possible to capture some ridership from older people, even from those who continue to drive (Rosenbloom 2001). Currie and Delbosc (2010) also suggested a future increase in public transport usage of older populations when the Baby Boomer generation ages. Car drivers also use public transit, occasionally or even regularly. Partially this is a function of land use patterns and the price of using the car; partially this is a result of better public transit options. Improved public transport services could offer viable travel alternatives for all older people but especially for those older drivers whose abilities to safely operate automobiles are deteriorating (Burkhardt 2003).

2.4 The use of motorised scooters

It is reported that the use of motorised scooters enhances quality of life by improving sense of freedom and self-esteem, facilitating social interaction (Department for Transport Energy and Infrastructure 2006; Pettersson et al. 2006). Arguably the health requirements for using a motorised scooter are less than for driving a car. Motorised scooters enable older people to transport small loads and travel short distances around their local community, ensuring continued access to shops and other facilities (Brandt et al. 2004; May et al. 2010). However, challenges and risks associated with the use of motorised scooters involve initial costs, difficulty in access to existing road infrastructure and community facilities, difficulty in learning how to use them and most importantly safety (Belcher and Frank 2004; Su 2007; Nitz 2008).

2.5 Residential location and travel

The relationship between land use and travel behaviour has been the subject of extensive research. In the study of the role of land use in travel of the elderly, Giuliano et al. (2003)

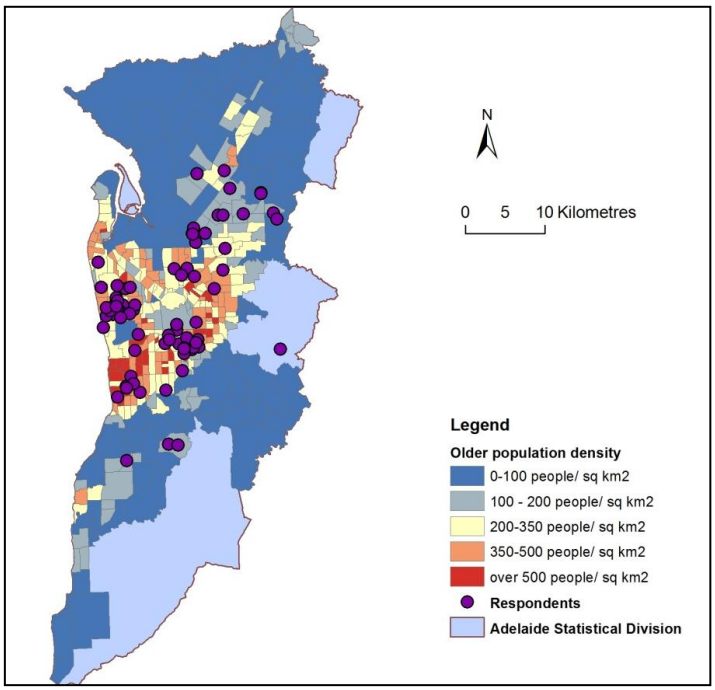
found that the travel distance declines with increasing population density and the number of trips increase with increasing density. The results show that the older elderly make fewer and shorter trips in low-density areas relative to the other age cohorts. It is also pointed out that the relationship between increased travel distance with increasing size of metropolitan area. In addition, older people's travel is sensitive to local accessibility. In the study of mode choice of older people, Kim and Ulfarsson (2004) revealed a negative effect of population density on the propensity to drive. The results also show that the elderly are more likely to use public transport if they live within five blocks of a bus stop.

In addition, the diversity within a neighbourhood, referred to as the spatial distribution of opportunities and services, affects travel behaviour in three different ways (Dieleman et al. 2002; Næss 2006). For instance, higher mix use leads to lower average travel distance; more diversity is associated with a larger share of walking/cycling thereby lowering car use; and a higher level of mixed use is associated with lower levels of vehicle ownership. Highly diversified and mixed land use patterns can provide better accessibility to various opportunities. In addition, car use rises with distance to the city centre (Best and Lanzendorf 2005).

3. Data and methodology

The focus of research in this paper is on Adelaide Statistical Division (ASD), which comprises of the entire metropolitan area of Adelaide and some rural areas, with about two thirds of the population of South Australia living in the ASD. The primary data is from the Adelaide Older People Travel Survey (AOTS). The AOTS survey, a self-administered questionnaire survey, was conducted in 2010 with the aim of recording travel behaviour, residential relocation after retirement and opinion about the use of motorised scooters and transport issues of older people who live in Metropolitan Adelaide. It also collected information about their socio-economic situation and households.

Figure 1: Spatial distribution of respondents



Sample size for a 95% confidence level and a 5% precision level was calculated. A total of 259 questionnaire sets were distributed to older people (aged 65 years and above) attending "Year Ahead" presentations for senior drivers, provided by the Royal Automobile Association (RAA). Since the majority of older people who came to these presentations are able to drive, the sample would have a bias in favour of healthy elderly. The sample was stratified equally into days of week. The response rate is about 31% based on the valid questionnaire sets only. The number of returned questionnaire sets with valid information of older couples, e.g. husband and wife, is 36. Therefore, the number of valid respondents is 117. As questionnaires are considered to be valid if household and travel information were completed, a few missing cases are expected for additional information such as mobile phone ownership and opinions. The spatial distribution of respondents is shown in (Figure 1). Travel information i.e. trip start and trip end locations was geo-coded

into ArcGIS. The total number of recorded trips is 376. The Network Analyst tool was used to estimate trip lengths and then distance travelled based on shortest paths.

The data used in this research also includes secondary data sources, e.g. Australian Bureau of Statistics (ABS) Census data (2006), South Australian Digital Cadastral Database (DCDB) data, and road network databases. Data was analysed using ArcGIS to produce characteristics of suburbs where respondents live. Distances from respondents' houses to services are represented by travel times by car, approximately calculated using shortest paths, road hierarchy, and speed limits. Selected neighbourhood characteristics are shown in Table 1.

Table 1: Neighbourhood characteristics

Variables	Unit
Population density	1000 people/km2
Percentage of older people aged 65+	%
Share of residential areas	%
Share of commercial areas	%
Travel time to the nearest shopping centre	minutes
Travel time to the nearest medical centre	minutes
Travel time to the CBD	minutes
Walking time to the nearest bus stop/train station*	minutes

*Walking time to the nearest bus stop/train station is reported by respondents in the AOTS

The methodology of this research includes both quantitative and qualitative approaches to better understand mobility of older people. Qualitative methods, e.g. descriptive statistics, are used to figure out interesting relationships. Quantitative methods are then used to examine the size and significance of relationships.

4. Results

4.1 Number of trips and distance travelled

There are significant differences among all three age groups for all measures of travel (Table 2). It is evident that travel decreases with increasing age. The oldest group has the lowest daily trip rate and has the largest share of those who did not travel on the survey travel day. Those aged 65-74 has the highest daily trip rate, which is 1.3 and 1.6 times of daily trip rates of those aged 75-84 and those aged 85+ respectively.

Table 2: Daily trips, distance travelled (km) by age group

Age Group	# persons	Average number of trips	Average distance travelled (km)	Persons made no trips
65-74	51	3.88	24.85	9.80%
75-84	33	3.03	15.76	6.10%
85+	33	2.36	12.46	24.20%

The One-way ANOVA test for differences among age groups is significant at $p < 0.01$

Table 3: Average number of trips by driving licence and age

		Age Group			
		65-74	75-84	85+	All
Driving licence	No	(1)	2.67 (3)	1.25 (4)	1.63 (8)
	Yes	3.96 (50)	3.07 (30)	2.52 (29)	3.33 (109)
	All	3.88 (51)	3.03 (33)	2.36 (33)	3.21 (117)

The t-test for driving licence is significant at $p < 0.05$. The figures in brackets show the number of persons.

Table 3 shows that there is a marginal difference in average trip rates for different age groups of older people who have a driving licence. However, there is a perceptible difference in average trip rates for the persons in the same age groups who do not have a driving licence.

Table 4: Average number of trips by mobile phone ownership and age

		Age Group			
		65-74	75-84	85+	All
Mobile phone ownership	No	2.50 (10)	2.89 (9)	2.00 (12)	2.42 (31)
	Yes	4.22 (41)	3.13 (23)	2.53 (19)	3.53 (83)
	All	3.88 (51)	3.03 (32)	2.36 (31)	3.21 (114)

The t-test for mobile phone ownership is significant at $p < 0.05$. The figures in brackets show the number of persons.

Table 5: Average number of trips by gross annual income and age

		Age Group			
		65-74	75-84	85+	All
Gross annual income	Under $10399	8.00 (1)	2.50 (4)	1.33 (3)	2.75 (8)
	$10400-$20799	3.39 (18)	3.58 (12)	1.54 (13)	2.88 (43)
	$20800-$31199	3.77 (22)	2.30 (10)	3.25 (8)	3.30 (40)
	$31200-$41599	4.25 (4)	3.67 (6)	3.13 (8)	3.56 (18)
	Over $41599	4.83 (6)	2.00 (1)	3.00 (1)	4.25 (8)
	All	3.88 (51)	3.03 (33)	2.36 (33)	3.21 (117)

The Pearson correlation between number of trips and gross annual income is significant at $p<0.05$. The figures in brackets show the number of persons.

Interestingly, older people who have a mobile phone make significantly more trips than those who do not (Table 4). The use of mobile phones among the elderly might increase social networking and therefore the number of social/recreation trips. This is especially true for the young elderly with 4.22 trips compared to 2.5 trips. A strong correlation between levels of income and daily trip rates is shown in Table 5. In general, trip rates increase with higher levels of income. However, patterns of three age groups seem to be inconclusive, possibly because of the small sample size. For example, referring to Table 5, the average number of trips of those belonging to the age group of 65-74 and with an income under $10399 may not actually represent the reality due to low sample size.

Table 6: Correlations between distance travelled and neighbourhood characteristics

	Distance travelled (km)		
	Pearson Correlation	Sig. (2-tailed)	N
Trip frequency	.515	.000	109
Population density	-.273	.004	109
Percentage of 65+	-.120	.213	109
Share of Residential	-.180	.061	109
Share of Commercial	.162	.093	109
Travel time to Shopping Centres	.152	.114	109
Travel time to Medical Centres	.016	.868	109
Travel time to Hospital	-.032	.738	109
Travel time to CBD	.258	.007	109
Walking time to the nearest bus stop	-.125	.194	109

Table 6 shows a proportional relationship between daily trip rate and daily distance travelled, provided by a positive correlation of .515, significant at p<0.001. It also indicates significant relationships between distance travelled and neighbourhood characteristics such as population density, shares of commercial areas, residential areas. There is a disproportional relationship between distance travelled and population density, indicated by a negative correlation of -.273, significant at p<0.01. Distance travelled tends to increase as distance to the CBD increase, represented by travel time to the CBD (significant at p<0.01). The relationships between distance travelled and shares of residential areas and commercial areas are significant at p<0.1. Accordingly, distance travelled tends to increase as the share of commercial areas increases or the share of residential areas decreases.

Mobile phone ownership also has a significant relationship with travel distance i.e. those who possess a mobile phone tend to make much longer distances when compared to those who do not have a mobile (Table 7).

Table 7: Average distance travelled (km) by mobile phone ownership and age

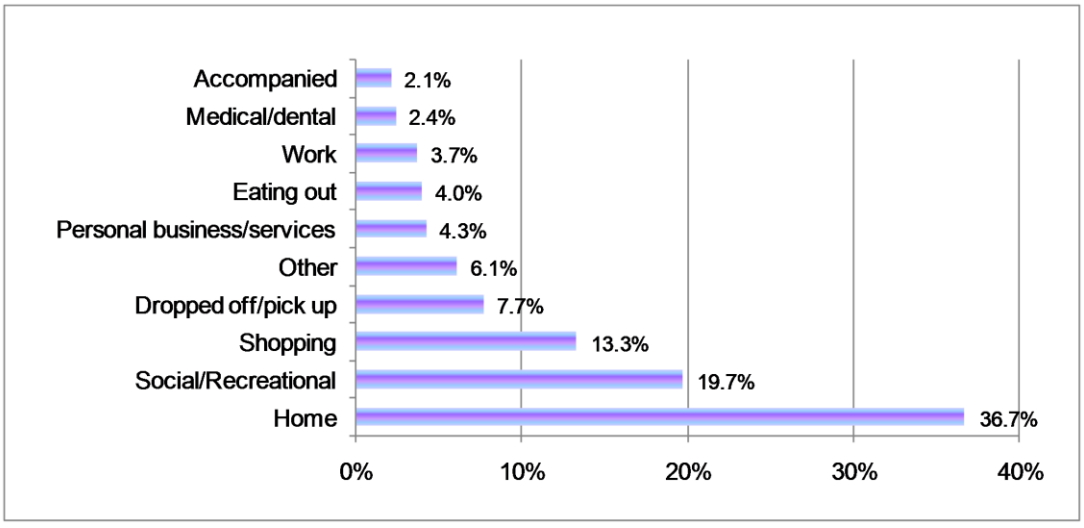
		Age Group			
		65-74	75-84	85+	All
Mobile phone ownership	No	13.02 (10)	10.38 (9)	8.28 (12)	10.41 (31)
	Yes	16.43 (41)	15.01 (23)	11.28 (19)	14.78 (83)
	All	15.67 (51)	13.86 (32)	10.88 (31)	13.50 (114)

The t-test for mobile phone ownership is significant at p <0.1. The figures in brackets show the number of persons.

4.2 Trip purpose

Trip purposes are categorised into ten groups, including home, social/recreational, shopping, dropped off/pick up, personal business/services, work, medical/dental, accompanied, and other. For instance, home, also referred to as return home, represents a trip from another location to home. Social and recreational trips include visiting people, community activities, active and passive participation in sporting activities, and all entertainment. Shopping trips are those to and from premises that sell goods. Work includes trips to the work place and trips related to work. Personal business/services include trips purchasing services, such as banking, haircuts. Figure 2 gives shares of trip purposes. A large proportion of daily trips are taken for social/recreational activities, shopping, dropped off/pick up and personal services. Apart from home trips, social/recreational and shopping trips account for the largest shares of daily trips of older people.

Figure 2: Trip purpose



4.3 Mode of travel

As shown in Figure 3, the private car is the dominant mode for older people, accounting for 82.72 percent of all trips. The use of the private car is categorised into two groups, as driver and as passenger. The share of car as driver is much higher than the share of car as passenger, 68.88 percent versus 13.83 percent. Walking accounts for 9.84 percent of all trips, followed by public transport, which is about 7.45 percent.

Figure 3: Mode of travel

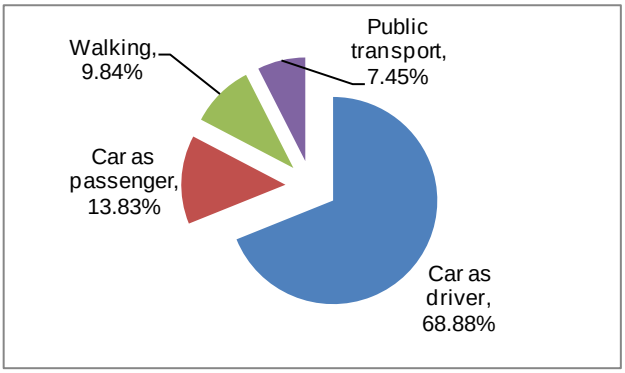


Table 8 indicates a statistically significant association between mode of travel and age groups. The share of car as driver increases with older age groups. Given that the number of trips decreases with age, a larger percentage of car sharing does not necessarily mean the number of car riding trips increases with age. At the same time, the share of car as passenger sharply decreases with older age groups. These trends could be attributed to the decline of support from family and friends in later age. For those aged 85+, walking constitutes only 2.56 percent of all trips, which is much lower than that of the younger elderly with 11.11 percent and 13 percent. The decline of physical capabilities in older age groups could be reason for this reduction of the share of walking trips. Public transport becomes more important as older people age. The share of public transport increases substantially with older age groups.

Table 8: Mode of travel and age group

		Mode of travel				
		Car as driver	Car as passenger	Walking	Public transport	Total
Age Group	65-74	131	35	22	10	198
		66.16%	17.68%	11.11%	5.05%	100.00%
	75-84	69	10	13	8	100
		69.00%	10.00%	13.00%	8.00%	100.00%
	85+	59	7	2	10	78
		75.64%	8.97%	2.56%	12.82%	100.00%
Total		259	52	37	28	376
		68.88%	13.83%	9.84%	7.45%	100.00%

The Pearson Chi-Square is significant at $p<0.05$

Table 9: Mode of travel and gender

		Mode of travel				
		Car as driver	Car as passenger	Walking	Public transport	Total
Gender	Female	129	35	20	20	204
		63.24%	17.16%	9.80%	9.80%	100.00%
	Male	130	17	17	8	172
		75.58%	9.88%	9.88%	4.65%	100.00%
Total		259	52	37	28	376
		68.88%	13.83%	9.84%	7.45%	100.00%

The Pearson Chi-Square is significant at $p<0.05$

Table 9 suggests that older females make a higher percentage of their trips in cars as passenger and in public transport, as compared to older males. Older men are more likely to drive a car as compared to older women. The percentage of walking trips is the same for both older females and males. For those who no longer drive, car passenger mode is the dominant mode while alternative modes become more important.

Not surprisingly, older people who live alone make a significantly lower percentage of their trips by car passenger mode, as compared to those who live with a spouse or other adults (Table 10). Four in five trips of those who live alone are taken by car driver mode.

Table 10: Mode of travel and Living alone

		Mode of travel				
		Car as driver	Car as passenger	Walking	Public transport	Total
Living Alone	No	178	49	27	20	274
		64.96%	17.88%	9.85%	7.30%	100.00%
	Yes	81	3	10	8	102
		79.41%	2.94%	9.80%	7.84%	100.00%
Total		259	52	37	28	376
		68.88%	13.83%	9.84%	7.45%	100.00%

The Pearson Chi-Square is significant at $p<0.01$

Table 11 presents mode shares by gross annual income. It is clear that older people in the lower income group (under $20800) are more likely to use public transport. When compared to the lower income group, higher income groups ($20800-$31199 and over $31200) have a higher percentage of trips made by car. Interestingly, the highest income group has the highest share of car passenger mode when compared to lower income groups.

Table 11: Mode of travel and gross annual income

		Mode of travel				
		Car as driver	Car as passenger	Walking	Public transport	Total
Gross annual income	Under $20800	100	11	17	18	146
		68.49%	7.53%	11.64%	12.33%	100.00%
	$20800-$31199	106	12	8	6	132
		80.30%	9.09%	6.06%	4.55%	100.00%
	$31200 and over	53	29	12	4	98
		54.08%	29.59%	12.24%	4.08%	100.00%
Total		259	52	37	28	376
		68.88%	13.83%	9.84%	7.45%	100.00%

The Pearson Chi-Square is significant at $p<0.001$

Table 12 gives the relationship between mode of travel and length of current residence. It is evident that older people who have recently moved residence make significantly higher percentages of their daily trips by walking and public transport. This suggests that when older people relocate their home after retirement, they choose locations with a friendly walking environment and good public transport services so that they can use them more often. It appears that older people prefer to share a car or use public transport for long distance trips, as shown in Table 13. Average trip distances for shared car trips and public transport trips are 9.92 kilometres and 8.94 kilometres. Average trip distances for car driver mode and walking are 5.45 kilometres and 0.55 kilometres. It is noticeable that while the variation in car

driver trip distances among age groups is small, the variations of car passenger trip distance and public transport trip distance travelled by age groups are larger.

Table 12: Mode of travel and length of current residence

	Mode of travel				
	Car as driver	Car as passenger	Walking	Public transport	Total
Three years or less	20	3	10	8	41
	48.78%	7.32%	24.39%	19.51%	100.00%
Four to nine years	38	11	9	0	58
	65.52%	18.97%	15.52%	0.00%	100.00%
Ten to twenty years	87	21	11	2	121
	71.90%	17.36%	9.09%	1.65%	100.00%
More than twenty years	114	17	7	18	156
	73.08%	10.90%	4.49%	11.54%	100.00%
Total	259	52	37	28	376
	68.88%	13.83%	9.84%	7.45%	100.00%

The Pearson Chi-Square is significant at $p<0.001$

Table 13: Average trip distance (km) by mode of travel and age group

		Mode of travel			
		Car as driver	Car as passenger	Walking	Public transport
Age Group	65-74	5.21	12.55	.74	12.88
	75-84	5.71	4.65	.27	9.51
	85+	5.67	4.34	.36	4.55
Total		5.45	9.92	.55	8.94

The One-way ANOVA test for mode of travel is significant at $p <0.001$

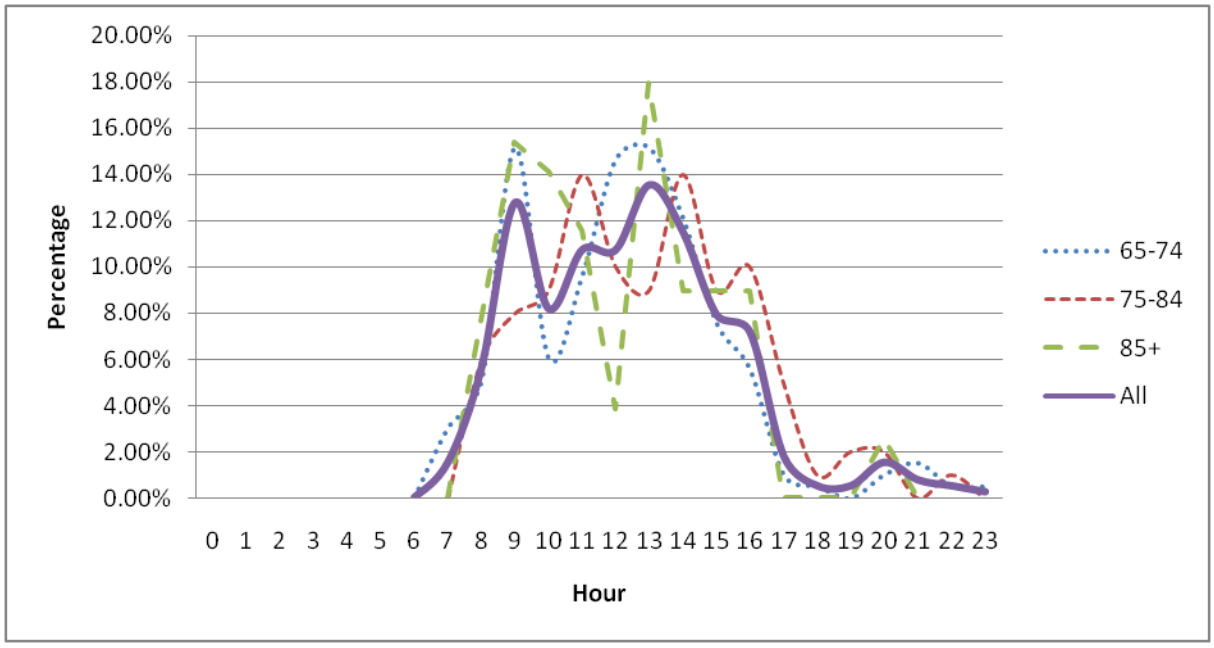
4.4 Time of travel

Trip rates on weekend are much lower than on weekdays. The highest trip rates are on Wednesday and the lowest trip rates are on Sunday for all age groups. Older people start their travel day anytime between 6 a.m. and 6 p.m. It appears that the majority of them start their travel in the morning. Especially, about 30 percent of them start their travel between 9 a.m. and 10 a.m.

The distribution of trip start times is shown in Figure 4. Over 67% of older people's daily travel is started between 9 a.m. and 4 p.m. In general, daily travel for older people shows two peaks: in late morning 9 a.m. and in early afternoon 1 p.m. By doing so, the elderly tend to avoid morning and afternoon peak traffic times when congestion is likely to be a problem. Daily travel for 75-84 age group shows two peaks at 11 a.m. and 2.p.m, which are a little later than those of the other two age groups. The percentage of trips start in the evening for all age groups is relatively small.

In general, daily travel by walking, car passenger and car driver mode has two peaks: one in late morning and one in early afternoon. The public transport trips seem to be concentrated in mid-day period (10 a.m. to 12 noon), where over 35 percent of public transport trips are performed. Social/recreational trips are more frequent in early morning, e.g. over 30 percent of social/recreational trips start between 9 a.m. and 10 a.m. Shopping trips of older people are more frequent in late morning and early afternoon, e.g. over 20 percent of shopping trips start between 1 p.m. and 2 p.m.

Figure 4: Distribution of trips start times by age group



4.5 Trip chaining

This paper defines a trip chain as a sequence of trip segments that start and end at home. Accordingly, the total number of recorded trip chains is 138. Table 14 presents a significant relationship between trip chain complexity and age groups. The younger elderly tend to make a higher percentage of 3-stop or more trip chains. Those aged 75-84 have the highest share of 1-stop trip chains, followed by those aged 85+ and then those aged 65-74. Relationships are found between trip chain complexity and mobile phone ownership and income, but they are not statistically significant. Those who possess a mobile phone are more likely to take 3-stop or more trip chains.

Table 14: Trip chain complexity and age

		Chain complexity			
		1 Stop	2 Stops	3 Stops or more	Total
Age Group	65-74	33	15	17	65
		50.77%	23.08%	26.15%	100.00%
	75-84	33	3	7	43
		76.74%	6.98%	16.28%	100.00%
	85+	20	7	3	30
		66.67%	23.33%	10.00%	100.00%
Total		86	25	27	138
		62.32%	18.12%	19.57%	100.00%

The Pearson Chi-Square is significant at $p<0.05$

4.6 Residential movements

Figure 5 shows perceived importance of facilities and services to relocation decision-making processes of older people. Nine facilities and services are examined. The respondents gave highest importance to public transport with 38% rating it as “very important”. Similarly, the two other services that are highly rated include “access to medical services” and “access to shopping”. Place of worships and parks and recreational facilities are considered as “not

important" by about 40% of respondents. The results also indicate that older people living alone are statistically more likely to consider 'community/library' as very important. Similarly, older people who have children living nearby are more likely to consider 'family/friends' as very important.

Figure 5: Rating of facilities and services

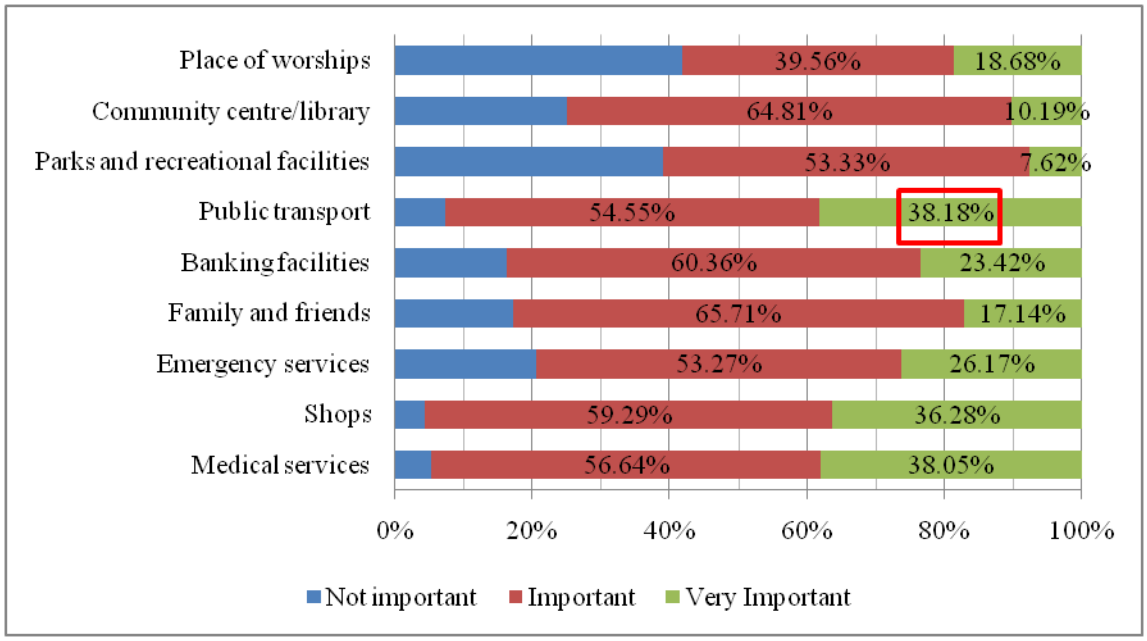
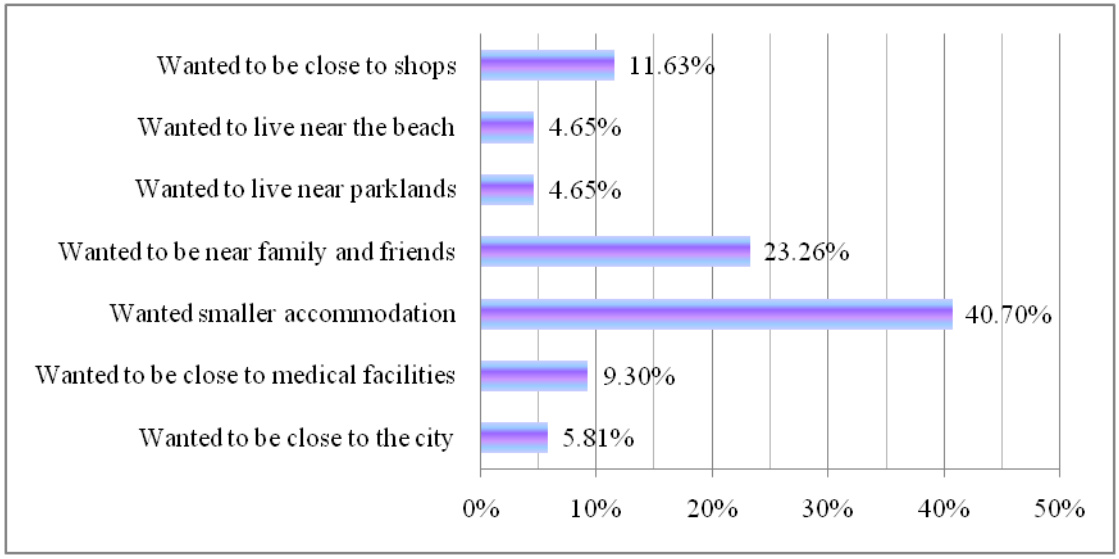


Figure 6 shows reasons for residential movements of older people who moved. Smaller accommodation is the main reason, followed by family and friends, shops, medical facilities and closeness to the city. In addition, re-marriage is also mentioned as reason for residential movements. It is also recorded that some older people moved to retirement villages because they wanted smaller accommodation and wanted to be near friends. Some said they moved because of being unable to look after gardens.

Figure 6: Reasons for residential movements

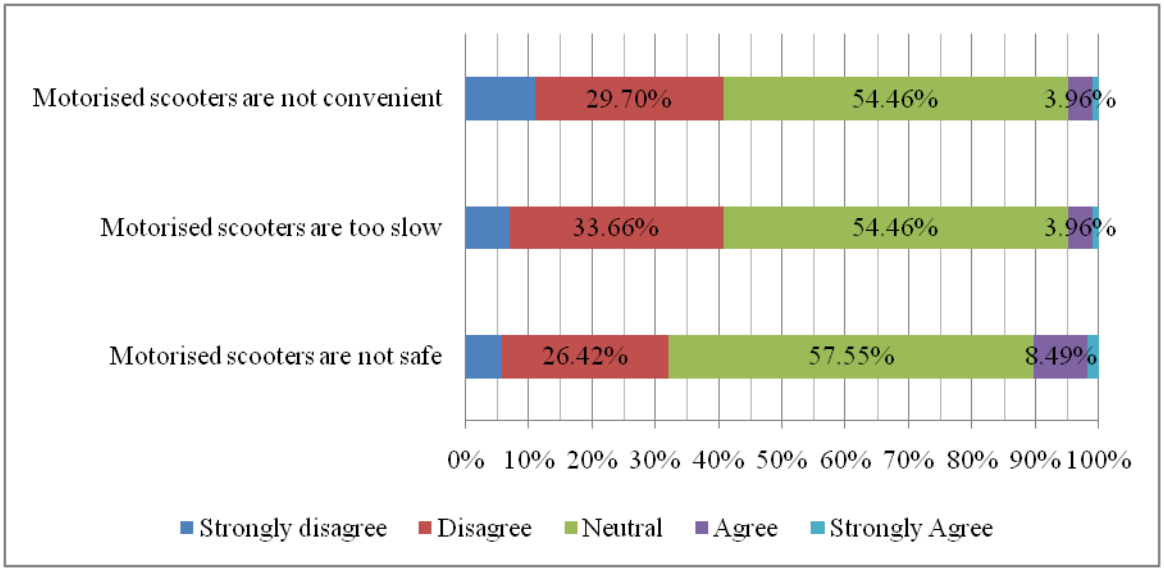


4.7 Motorised scooters

Figure 7 gives older people's opinion about convenience, speed and safety of motorised scooters. More than half of older respondents have a neutral opinion about these issues

(54.46%, 54.46%, and 57.55% respectively). Safety of motorised scooters is of greater concern to older people, as compared to convenience and speed. For example, 8.49% of older respondents consider that motorised scooters are not safe. Many respondents agree that motorised scooters can provide independent travel to older and disabled people. However, many indicate a need for training of motorised scooter drivers.

Figure 7: Opinion about motorised scooters



4.8 Public transport usage

A relatively small percentage of respondents have decreased their use of public transport when compared to last year (Figure 8). A decline in walking ability is reported as the main reason for this reduction. However, more than 30 percent of them have increased their use of public transport, as compared to last year.

Figure 8: Public transport usage compared to last year

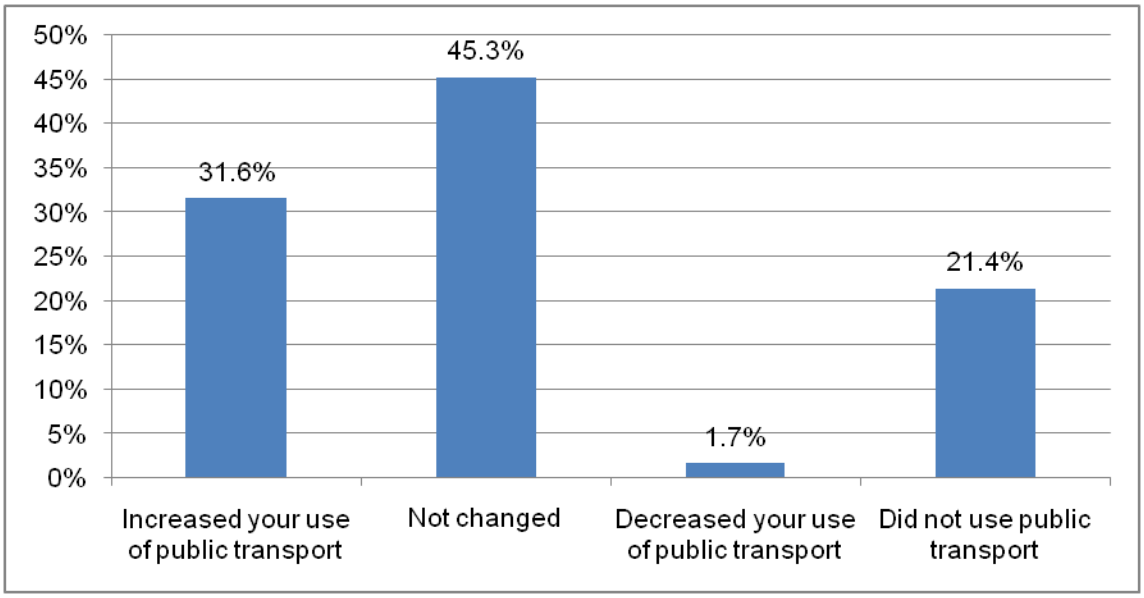
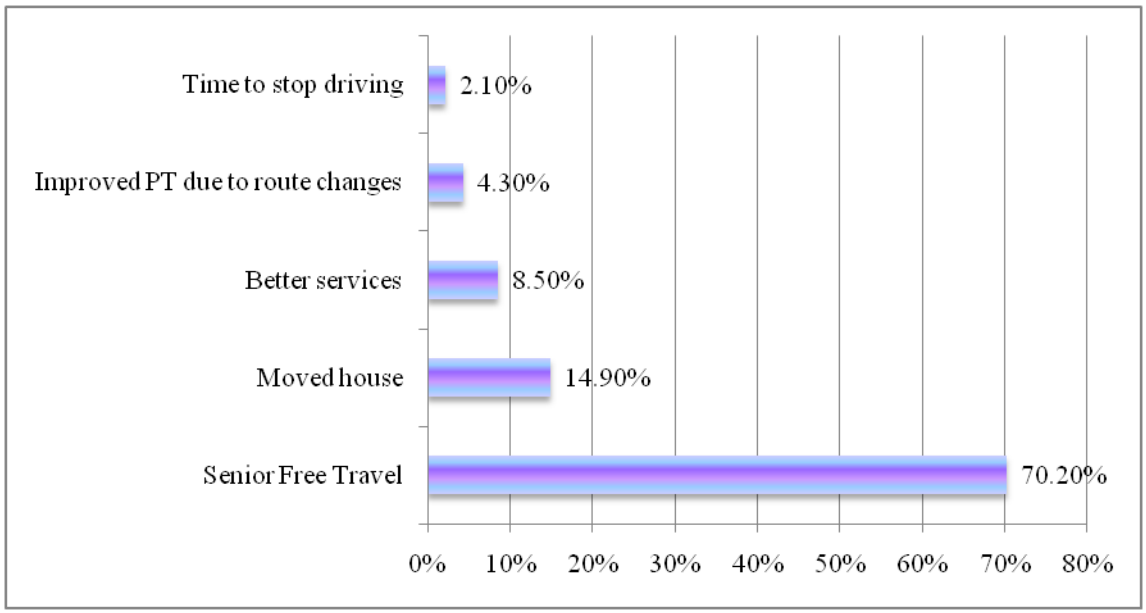


Figure 9 shows reasons for increasing the use of public transport. Not surprisingly, the major reason is Senior Free Travel, introduced in Adelaide in July 2009 with free public transport for senior card holders between 9 am and 3 pm weekdays and all day on weekends and public holidays. It can be seen that older people who had just moved to a new home are

likely to use public transport more often. This is consistent with findings in the analysis of mode of travel.

Figure 9: Reasons for increasing the use of public transport



4.9 Age-related transport issues

Overall, respondents agree with all of the statements listed below in Table 15. A 1-to-5 rating scale is applied to concern expressed by older people (1 for the least and 5 for the most important). Taxi concessions are viewed as being the most important area of improvements for older people, followed by upgrading footpaths, senior parking spaces, improvements of pedestrian walk time in traffic lights, street lighting and subsidised car pooling. The need for taxi concessions also was the case in an earlier study by Somenahalli and Taylor (2007).

Table 15: Opinion about age-related transport issues

Rank	Transport issues	N	Mean	Std. Dev
1	Need taxi concessions for people aged 70+	106	3.97	0.749
2	Footpaths urgently need upgrading	109	3.83	0.837
3	Need designated parking space (senior stops)	104	3.8	0.863
4	Pedestrian walk time in traffic lights to be lengthened	105	3.54	0.821
5	Street lighting is poor and inadequate	101	3.45	0.806
6	Need subsidised car pooling	99	3.19	0.724

The results also indicate that concerns about pedestrian walk time and senior parking increase with increasing age. The Spearman‘s rho is significant at $p<0.01$ and $p<0.05$ respectively. For instance, a much lower percentage of those aged 65-74 strongly agree about the need to lengthen green walk times, compared with two older age groups. When compared to two younger age groups, the 85+ age group has a significant higher percentage of those who strongly support the need for senior parking.

5. Summary and conclusions

Overall travel by older people decreases with increasing age, when measured by daily trips and distance travelled. This is consistent with findings in elsewhere (Rosenbloom 2001; Tacken 1998). The results also indicate that having a driving licence and higher income are

associated with higher trip making while possessing a mobile phone is associated with both higher trip making and longer distance travelled. Moreover, neighbourhood characteristics were found to be highly related to distance travelled. As distance to the CBD or share of commercial areas increases, distance travelled increases. Conversely, as population density or share of residential areas increases, distance travelled decreases. Social/recreational activities constitute the highest shares of trip purpose, followed by shopping trips. Especially, the share of social/recreational trips increases with age.

Car mode, including car driver and car passenger, still is the dominant mode. It is found that age, gender, income, living alone, length of current residence, and trip distance are closely related to mode of travel. With advancing age, the shares of car driving and public transport increase while the shares of car passenger and walking decrease. While older women are more likely to travel by public transport and by car as passenger, older men tend to travel by car as driver. Older people who live alone tend to travel more as car drivers and less as car passengers. Lower income was found to be associated with greater public transport use. Older people who moved to current residence three years ago or less tend to take more walking and public transport trips. The results also show that older people prefer to share a car or use public transport for long distance trips. The vast majority of travel of older people are taken during the mid day period. However, their temporal patterns are slightly varied in different age groups, trip purpose, and mode of travel.

Trip chaining analysis finds that older people, who are younger or have a higher income level, are likely to take more complex trip chains. In terms of gender, trip chaining complexity is comparable for older males and females. The relationship between mobile phone ownership and travel behaviour of older people is noted, as those who possess a mobile phone are likely to make more complex trip chains.

Medical services, shopping facilities and public transport are reported as being the three most important services/facilities influencing the residential location choice of older people. This result suggests further roles of public transport in providing mobility options for older people. Residential movements are also documented. The need for smaller accommodation is the main driver of decisions to move. A trend of moving from outer suburbs to middle and inner suburbs is evident.

Many older people consider motorised scooters as having potential for increasing independent travel in later age. However, concerns about safety and the need for driver training are highlighted. The results suggest that the use of motorised scooters is likely to increase in near future. In addition, older people's needs of lengthening the walk time for pedestrians and designated senior parking spaces are highlighted. Evidence also shows an increase in public transport usage among older Adelaide residents, resulting from the Free Senior Travel.

The findings suggest several implications for transportation policy. For instance, free public transport to older people in other time periods of a day e.g. early morning and evening would attract more patronage from older people. Providing more designated senior parking at shopping centres, senior citizens' centres and council facilities would benefit older people, especially those who rely on the private car due to physical disabilities e.g. walking disabilities. Taxi concessions are viewed as being very important to older people, who have no transport, or are unable to use public transport for any reasons, to attend medical appointments, go shopping, participate in social activities or simply get out of the house. In addition, safety of motorised scooters could be improved by training of motorised scooter drivers and by increasing visibility of motorised scooters. The findings also have implications for urban development policy. For instance, downsizing of accommodation and wanting to get closer to certain services/facilities, trend of moving to inner-middle suburbs and negative effect of density on distance travelled suggest a more compact and mixed use development in inner-middle suburbs.

There are limitations with regard to the small sample size and the bias of choosing participants in favour of those who are able to drive a car. However, participant's partners also filled out the forms and they may not be in a position to drive a car. The methodology and the data used could be refined by expanding the sample of the older people travel survey; distributing the questionnaire survey spatially in the study area; and employing techniques to increase response rates of the questionnaire survey. There are several areas where further research is required. State-of-the-art modelling methods should be applied to examine mode of travel and trip chaining complexity in relation to socio-economic, neighbourhood characteristics and age-related opinions of older people in order to shed further light on this important research area. Possibility of using multivariate analysis should also be explored.

Acknowledgements

The authors would like to thank Ben Haythorpe and Belinda Maloney from the Royal Automobile Association, for their support in conducting the older people travel survey. The authors would also like to thank two anonymous reviewers for their helpful suggestions on improving the quality of the paper.

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