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Estimating the Impacts of the Aging Population on Transit Ridership

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NCHRP 20-65 (4)

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1. Introduction

This report outlines the key demographic factors that affect public transportation use with a particular focus on how the aging demographics of the country will impact future transit ridership. In addition the report describes a spreadsheet tool that can be used to estimate the future effects of the aging population on public transportation use. The report is intended primarily for the use of public transportation agencies, including state departments of transportation that may provide public transportation service.

The issue of the aging U.S. population is important for all sectors of the economy, especially as the Baby Boomer generation ages. The changes in public transportation use that come with age are dictated by the most common effects of age, including disability, lack of car ownership, retirement from the work force, and reduced income. Nonetheless, people aged 65 and over are expected to use the transportation system in similar ways to their younger counterparts.

This report also includes a discussion of the relationship between ridership and demographic factors using data from the 2001 National Household Transportation Survey. This discussion explores specific mobility problems, examining predictors of staying home on a given day, and travel for non-institutionalized people with medical disabilities.

The ridership model developed under this project provides a way for public transportation agencies to estimate the effect that the aging population in their service area will have on overall ridership and costs. Using past transit behavior and information about population trends, the model illustrates the impact of the growth of the aging population on transit ridership. The older population will be both growing as a total number and as a share of the total population over time. Generally, a growth in older population causes a decrease in regular transit use relative to total population growth. Increased disability rates in the older population also lead to a predicted increase in paratransit ridership. In general, this implies that for a given population level, transit agencies can expect somewhat decreased ridership and increasing costs as the population ages.

Literature Review

1.1. Overview

The literature review below gives an overview of the characteristics associated with travel patterns in the older population. In general, the older population tends to parallel younger adults in its travel characteristics, albeit while traveling less overall. Older people have a higher incidence of disabilities and a lower rate of workforce participation, which may be the underlying reasons for a reduction in travel.

Besides the gross differences in travel patterns that emerge as people age, specific factors have been found to predict transit use within the older population. Residential location is highly significant in predicting transit use, as is availability of public transit service. Residential location variables used in recent studies reflect higher residential density, mixed use, and higher density of destinations as enabling trip-chaining by public transit users. Denser places also often have a higher level of public transit service.

Individual demographic characteristics are important, even controlling for location. Age, sex, and race appear to be correlated significantly with transit use decisions. Cultural values, habits, and social backgrounds are associated with modal choice. Employment status and income also figure significantly, both in trip generation and in modal choice. For the elderly, income becomes a less important predictor of ridership, as accumulated wealth and assets may substantially outweigh reported income.

Driver status – whether or not someone is still driving, irrespective of whether or not they hold a license – is important in determining the transportation options available to people at any time. However, it does not correlate completely with level of disability, which must be evaluated separately. Driver status may be due to long-standing habits or general lifestyle choices rather than any disability.

Level of disability is often the focus of studies on aging drivers. However, people who stop driving because of a disability do not necessarily begin riding transit instead. When they do use transit services they may face significant challenges and require paratransit and other special transportation services to meet their needs. Many do not use public transportation at all because they obtain rides or simply travel less.

The remainder of this chapter is organized as follows. Section 1.2 provides a discussion of the broader trends and demographic factors found in the literature to correspond with transit use. These trends have been documented in literature that focuses on specific areas such as disability and demographic change. Section 1.3 then discusses current travel patterns in the 65 and over population, looking at travel in general. Finally Section 1.4 provides an analysis of non-driving and transit use among older people, a detailed look at the literature's findings on factors affecting transit use.

1.2. Trends Affecting Driving and Transit Use

This section addresses some of the broader trends that may affect use of transit in the older population based on a review of the literature. In order to identify which demographic trends to examine, it is useful to first summarize the factors that the literature describes as potentially important in influencing ridership by older persons. The table below is expressed in terms of ridership rates (transit trips per year) for older persons. In general, the literature showed that the following trends may have an effect:

Table 1: Relationship between Trends in Older Population and Transit Ridership Rates
(Transit trips per year per older person)

Trend	Direction of Influence	Reason
Total number of older people: increasing	Neutral	A large portion of the overall U.S. population growth will be among persons 65 and over, meaning that the overall pool of potential riders will be larger, but the effect on ridership rates is ambiguous
Life expectancy: increasing	Ambiguous	The number of years drivers can expect to drive is shorter than average total life span, meaning that there will be more people living longer past their driving years. However, this may not imply that that they begin riding transit instead; also, longer life expectancy may be correlated with both working and driving more years.
Percentage of non-white 65 and over: increasing	Positive	Even when controlling for location and income, non-whites are more likely to ride transit than whites
Income and wealth increasing	Ambiguous	This could result in more elderly keeping their vehicles longer, absolute increases in trip rates (and thus transit trip rates), and increased relocation to urban housing.
Total number of "oldest old": increasing	Negative	Persons over 85 are generally less likely to ride transit than their "young old" peers
Women's licensing rates: increasing	Negative	Drivers tend to use transit at lower rates than non-drivers
Disability rates: decreasing	Probably negative	Persons who are not disabled are more likely to remain drivers; on the other hand, more of the "oldest old" may remain transit riders longer past their driving years, rather than being mobility isolated.
Poverty rate among older population: decreasing	Negative	Persons in poverty are less likely to own a car and more likely to ride transit.
Assisted living: decreasing; "Aging in place": increasing; Urban/down-sized housing: increasing	Ambiguous	Three changes in residential location trends for older persons will have confounding effects. A smaller percentage of older persons are moving to assisted living facilities that likely have decreased transit use. As the Baby Boomers enter retirement years they are more likely to stay in their current homes, largely in the suburbs, where they are less likely to have access to transit; however, housing tax code changes now have permitted many empty-nesters to down-size their housing, often including a move to a more urban locale.

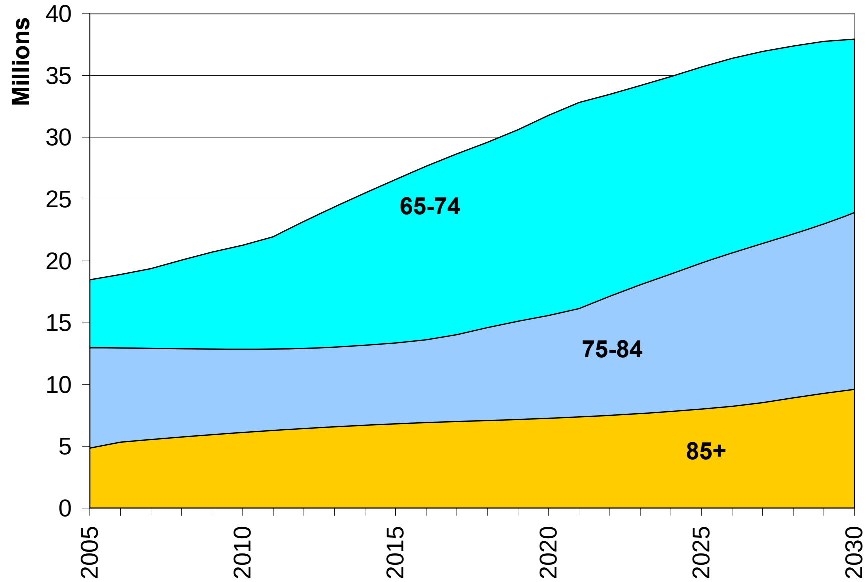
The following sections look at these trends and their potential impacts in more detail.

1.2.1. Total Number of People 65 and Over Increasing

The older population—defined here as people aged 65 and over—is expected to double over the next 30 years, from 35 million in 2000 to 71 million in 2030. This increase largely represents the Baby Boomers entering their 60s and 70s.[1] Although the total population will grow over the same period, the percentage of Americans 65 and over will increase from 12.4 to 19.7 percent.

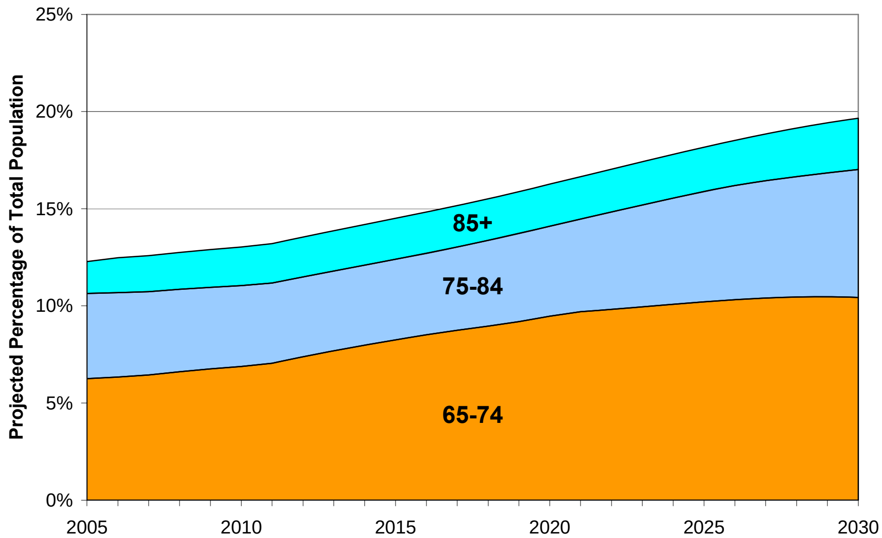
Figure 1, below, shows the changing proportion of those 65 and over with regard to the total U.S. population through 2030. As this figure and the next show, the largest single change occurs between 2010 and 2020, when the Baby Boom generation—generally defined as persons born between 1946 and 1964—begins turning 65. As they turn 65, the number of people in the cohort 65-74 will increase by 10 million.

Figure 1. Raw Population in 65 and Over Age Cohorts, 2005 - 2030



[1] All figures in this section from the U.S. Census, Population Projections Branch. *U.S. Interim Projections by Age, Sex, Race, and Hispanic Origin.* Released May 11, 2004.

Figure 2. Projected Share of Population in 65 and Over Cohorts, 2005 - 2030



Given that the older population in 2001 generated 1.3 million transit trips per day (a rate of 0.04 trips per person per day, or 14.3 trips per person per year), assuming that there is no change in their travel behavior they would generate 2.8 million trips per day in 2030.

Of course, this does not factor in what the trend for transit trips might be among the rest of the population. Certainly as the overall population increases we expect more transit trips. However, if the rate of transit trip-making is lower among the 65 and over population than among younger adults, there may be fewer transit trips made than if all segments of the population were increasing at the same rate because older adults will constitute a larger percentage of the population.

1.2.2. Life Expectancy Increasing

Tomorrow's older population is expected to live longer than their counterparts today. Compare the Baby Boom cohort to the one 20 years its senior in Table 2 (shaded columns). In 2000 there were 18.3 million people between the ages of 65 and 74. By 2010, there are expected to be 12.8 million people aged 75-84, meaning that 69.9 percent of that age group will survive. However, of the 31.8 million Baby Boomers who are 65-74 in 2020, 23.9 million will live to see 75-84. This represents a survival rate of 75.2 percent.

Table 2: Older Population by Age Cohort and Race/Ethnicity, 2000 to 2030

2000	65-74	75-84	85+	Total	%
White	14,991,907	10,649,127	3,708,389	29,349,423	83.7%
Black	1,641,505	913,860	317,556	2,872,921	8.2%
Hispanic	1,025,064	487,559	143,885	1,656,508	4.7%
Asian/Other	725,425	359,500	97,470	1,182,395	3.4%
Total	18,383,901	12,410,046	4,267,300	35,061,247	100.0%
%	52.4%	35.4%	12.2%	100.0%	

2010	65-74	75-84	85+	Total	%
White	16,594,814	10,413,239	5,163,299	32,171,352	79.9%
Black	1,965,104	1,062,192	477,987	3,505,283	8.7%
Hispanic	1,528,421	817,790	303,842	2,650,053	6.6%
Asian/Other	1,181,170	557,525	178,330	1,917,025	4.8%
Total	21,269,509	12,850,746	6,123,458	40,243,713	100.0%
%	52.9%	31.9%	15.2%	100.0%	
		Total % Increase from 2000:			*14.8%*

2020	65-74	75-84	85+	Total	%
White	23,820,993	12,129,540	5,797,949	41,748,482	76.4%
Black	3,190,792	1,340,567	633,122	5,164,481	9.5%
Hispanic	2,658,658	1,203,214	531,972	4,393,844	8.0%
Asian/Other	2,108,716	910,503	305,865	3,325,084	6.1%
Total	31,779,159	15,583,824	7,268,908	54,631,891	100.0%
%	58.2%	28.5%	13.3%	100.0%	
		Total % Increase from 2010:			*35.8%*

2030	65-74	75-84	85+	Total	%
White	26,424,646	17,883,167	7,365,659	51,673,472	72.3%
Black	4,274,988	2,268,106	864,737	7,407,831	10.4%
Hispanic	4,294,822	2,112,304	833,349	7,240,475	10.1%
Asian/Other	2,953,477	1,638,927	539,289	5,131,693	7.2%
Total	37,947,933	23,902,504	9,603,034	71,453,471	100.0%
%	53.1%	33.5%	13.4%	100.0%	
			Total % Increase from 2020:		*30.8%*

Shaded columns are Baby Boom cohort.

The numbers are even more dramatic for the oldest old. Of 12.4 million people aged 75-84 in 2000, 6.1 million can expect to live past age 85 in 2010 (49.3 percent). However, of 15.5 million people aged 65-74 in 2020, 9.6 million will live past 85 (61.2 percent).

Demographers distinguish between total life expectancy (TLE) and active life expectancy (ALE). TLE refers to the total number of years a person lives, while ALE refers to the number lived in relative health. While there is not a hard and fast line between the two, the divider is generally measured in a person's ability to perform six "activities of daily living" (ADLs): walking, dressing, eating, bathing, toileting, and getting in and out of bed. The literature on disabilities discusses the number of ADL limitations a person has. One generally indicates the ability to function more or less independently, with limited assistance, while six means relative dependence on others. Some literature also looks at "instrumental activities of daily living" (IADLs), which include tasks

such as grocery shopping, doing laundry, cooking, traveling, and managing money. Driving is not mentioned as an ADL or IADL.

In one analysis of TLE and ALE (Manton and Land), researchers used data from four National Long Term Care Surveys performed in 1982, 1984, 1989, and 1994 to develop models of ALE for older people in different age cohorts. The table below, extracted from this study, uses zero limitations in ADLs as the basis of ALE, even though persons may still be relatively independent with a mild disability.

Table 3: Comparison of Total Life Expectancy with Active and Driving Life Expectancy by Age Cohort

	Men		Women	
Age	**Total Life Expectancy**	**Active Life Expectancy (No disability)**	**Total Life Expectancy**	**Active Life Expectancy (No disability)**
65	15.7	13.6	22.2	15.7
70	12.0	10.0	18.3	11.7
75	9.7	7.7	14.8	8.3
80	8.0	5.9	11.8	5.4
85	6.4	4.2	9.3	3.1

	Total Life Expectancy	**Driving Life Expectancy**	**Total Life Expectancy**	**Driving Life Expectancy**
70-74	17.7	11.5	20.6	11.2
75-79	13.5	8.0	16.2	7.9
80-84	9.8	5.0	12.2	5.0
85+	6.0	2.0	7.9	1.8

Sources: Active life expectancies from Manton and Land, Table 2 and 3. Driving life expectancies from Foley, et al, Table 3.

In another study (Foley, et al), researchers used data from the Asset and Health Dynamics Among the Oldest Old study conducted in 1993 and 1995 to determine probable driving life expectancy, or the number of years drivers could be expected to keep driving. Note, however, that this survey concerns *only* the life expectancy of those still driving at age 70. Those who do not drive are not included; to the extent that part of the reason they do not drive is poor health, their exclusion may cause the TLE in the study to be higher than for the general population.

While women have longer TLE, men will spend a greater percentage of their remaining years in good health. These differences are especially pronounced in terms of driving life expectancies; women can generally expect to spend less than half their remaining years able to drive, while men will generally spend more than half. This may point to a great demand among women for transit or paratransit services.

1.2.3. Total Number of Oldest Old Increasing

As shown in Table 2, the total number of people over age 85—the “oldest old”—will increase from 4.3 million in 2000 to 9.6 million in 2030. This age cohort is the fastest-growing in the U.S. (Giuliano). As a percentage of the overall 65 and over population, their proportion will increase slightly, from 12.2 to 13.4 percent.

While this age cohort is less likely to drive than younger old—as shown in Figure 5, below, about 70 percent of persons aged 85 and over do not drive—they are also less likely to ride transit. Less than 10 percent of people in this age cohort are transit riders. Probably the most common reason for this is health-related. According to 2001 NHTS figures, while 23.8 percent of all people 65 and over have a medical condition that affects their ability to travel, nearly half of those over 85 have such a condition. See Table 4, below.

Table 4: Percent of Age Group with a Medical Condition Limiting Travel

	Men	Women	Total
65-70	12.9%	16.7%	15.1%
71-75	18.1%	21.7%	20.1%
76-79	26.8%	29.2%	28.2%
80-84	29.4%	35.5%	33.1%
85+	37.3%	53.4%	48.0%
All	20.4%	26.3%	23.8%

Source: 2001 NHTS, ICF Consulting analysis

1.2.4. Percentage of Non-White Older Population Increasing

As shown in Table 2, the number and percentage of non-white older people is increasing. From 2000 to 2030, the white percentage in this population will decrease from 83.7 to 72.3 percent. The largest growth will be among Latinos; this percentage will increase from 4.7 percent in 2000 to 10.1 percent in 2030. The percentage of Asian/other will also more than double, from 3.4 percent in 2000 to 7.2 percent in 2030. The African-American population will increase from 8.2 to 10.4 percent.

Figure 3: Demographic Profile of Older Population, 2000

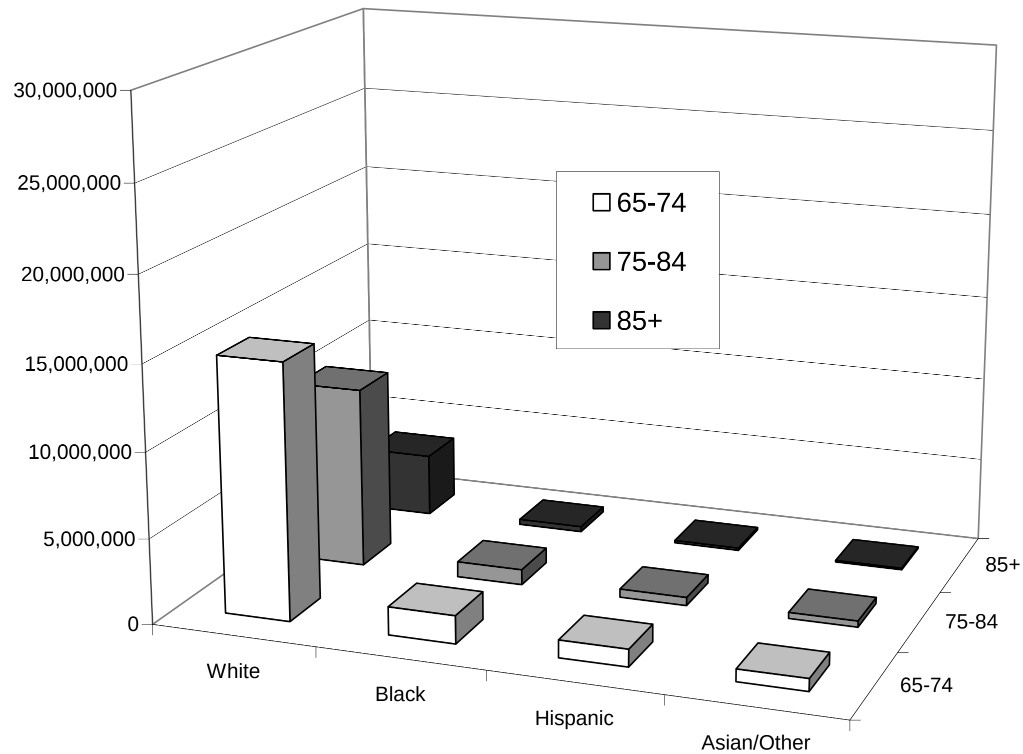
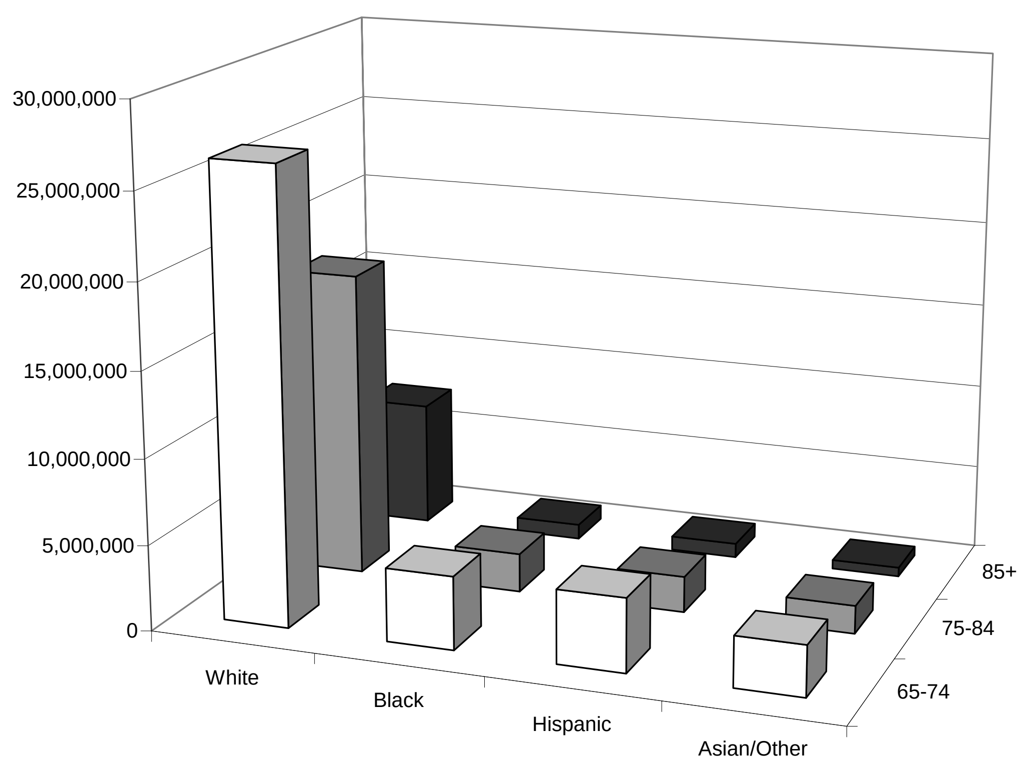


Figure 4. Demographic Profile of Older Population, 2030



This has implications for travel behavior among those 65 and over because even when taking into account location and income, two important determinants of travel, non-whites are still more likely than whites to ride transit. A paper by Waldorf (2003) analyzing 1995 NPTS data found that for African-Americans and whites, there were differences depending on gender, location, and income. For all trips—whether driver or passenger—white men and women made trips in cars about 95 percent of the time in “second city” and suburban areas, and about 85 percent of the time in urban areas. These travel patterns were fairly constant regardless of income. For African-Americans, trip patterns were similar to whites’ at middle and higher incomes, but for lower incomes they were less likely to use a car as a driver or passenger, even in suburban areas. African-American men with income under $10,000 used cars only 63 percent of the time in urban areas, compared with 85 percent of white men with income under $10,000. This may be related to wealth (as opposed to income) as well as culture.

A separate analysis looked only at trips where the person was a driver. Women of both races were less likely to drive than men. Income also played a stronger role in African-American travel behavior than in whites’. However, African-Americans in urban areas at all income levels were less likely to drive than whites. In the most striking difference, African-American men with income under $10,000 in urban areas drove only 37 percent of the time, while white men in urban areas with income under $10,000 drove 80 percent of the time.

In Rosenbloom and Waldorf’s 2001 paper, also using 1995 NPTS data, the authors looked specifically at transit use by racial and ethnic category. In urban areas, while older African-Americans and Asian-Americans used transit for about 20 percent of trips, older whites used it for only five percent and older Latinos for less than one percent. While they analyzed the data several ways, because there was such a small sample in some categories many of their findings were not statistically significant.

Waldorf speculates that the differences may be attributable to factors such as:

- The proportion of non-white households without a car (substantially larger than the number of white households without a car);
- Cultural norms such as perceived need for a license or car, how appropriate it is for women to drive, and whether alternative modes are safe;
- Differences in the amount of caregiving performed by family members as opposed to paid caregiving, and whether providing transportation is seen as part of caregiving.

1.2.5. Women’s Licensing Rates Increasing

One truism of travel behavior among those 65 and over, that women are less likely to hold a driver’s license than men, seems likely to disappear during the next 30 years. Women are quickly catching up to men in terms of the percentage holding a driver’s license. According to Rosenbloom and Waldorf, in 1997, 92 percent of older men had a driver’s license, while only 67 percent of women did. By 2012, they predict that almost 100 percent of men and over 90 percent of women will hold a license. According to Spain, if Baby Boom women keep their licenses at the same rates that men currently do, by 2030, 84 percent of women over 75 will have a driver’s license.

Spain also looks at some other trends among Baby Boom women that will affect their travel behavior as they reach their later years. Their share as a percentage of the overall older population will probably decrease as men’s life expectancies catch up. According to Census 2000, the share of women among the population 65 and over was 58.8 percent in 2000; this will decline to 56.1 percent by 2030. The percentage of women who live alone will probably rise,

they will have higher educational attainment (on a par with men), higher labor force participation, head a greater percentage of households, and be less likely to live in households without vehicles. Most of these indicators are associated with increased use of cars. In general, it seems likely that travel behavior between older men and women will become more similar than it is today.

1.2.6. Disability Rates Decreasing

More severe disabilities are associated with both not driving and lesser use of transit. As noted above, disabilities are generally measured in terms of ADLs and IADLs, neither of which directly addresses ability to drive. However, as Figure 8 shows (several pages below), an older person with two or more limitations in ADLs is less likely to ride transit than someone with none or only one. The rate of non-driving also rises with every limitation in ADLs

However, the rate of disabilities among the older population is decreasing. A study by Manton and Gu using data from the National Long-Term Care Survey (1982, 1984, 1989, 1994, and 1999) showed that the overall disability rate for the older fell from 26.2 percent in 1982 to 19.7 percent in 1999. The rate of decline increased slightly in the 1990s. They defined disabled as any limitation in IADLs or ADLs, meaning that some persons classified as disabled could have fairly slight limitations and still be able to drive. The rate of more severe disabilities—ranging from three limitations in ADLs through being institutionalized—fell from 13.5 to 10.6 percent over the same time period. Also, the disability rate for African-Americans, which was substantially higher than the rate for whites in 1982, fell at a greater rate.

While Manton and Gu do not speculate about whether disability rates might continue to decline further, they suggest that the current trend is probably due to the slowing rates of progression in major illnesses.

Rosenbloom, in *Mobility Needs of Older Americans*, points out that it is a misconception that older people progress steadily from driving to riding transit to walking to being homebound. Many older people find driving easier physically than riding transit or walking. She also notes that driving is not either/or; many older people reduce their driving gradually, perhaps driving only during the day, on familiar roads, or in good weather. Finally, many disabilities are temporary; while Manton and Gu looked at chronic disability, this is defined as lasting over 90 days. Therefore losing the ability to drive due to disability is not necessarily permanent.

1.2.7. Poverty Rates among Older Population are Decreasing

This literature review, focused mostly on travel behavior, ability to drive and ride transit, and demographic change, did not incorporate many sources focusing on income. However, TCRP Report 82 included the following projections, based on the 1999 Administration on Aging Report, *Aging into the 21st Century* (http://www.aoa.gov/prof/Statistics/future_growth/aging21/intro.asp):

> Projections to the year 2020 suggest that the number of elderly persons who are poor will decrease sharply. The percentage of the non-disabled elderly population below the poverty level will decrease from 17 percent in 1990 to 7 percent in 2020, a drop of more than 50 percent. The percentage below 150 percent of the poverty level is expected to decrease from 35 percent in 1990 to 16 percent in 2020, a decrease of more than 50 percent. The percentage of disabled elderly persons living below the poverty level is projected to drop from 27 percent in 1990 to 11 percent in 2020, a decrease of nearly 60 percent. The percentage of elderly disabled persons at less than 150 percent of the

poverty level is projected to drop from 49 percent in 1990 to 23 percent in 2020, again a decrease of more than 50 percent (AoA, 1999).

1.2.8. "Aging in Place" Increasing

One of the main reasons that older people do not use transit frequently is the same as for younger adults: they live in areas where transit is sparse or not available at all. In 2000, according to an analysis of 2000 Census data by Frey, 69 percent of all persons over age 65 lived in suburban areas of large metropolitan areas. This is likely to continue to be true for the Baby Boom generation; already by 2000, their growth in the suburbs was outpacing their growth in central cities. Frey points out that:

> In large measure, this "graying" of the suburbs resulted not from migration to the suburbs in the 1990s, but from residential location decisions made long ago. As the "first suburban generation," most Boomers were born in the suburbs, and continue to live there today. At the same time, Boomer parents, who helped to create port-war suburbia, have stayed in the suburbs as they aged into their late 50s, 60s, and beyond.

He also notes that while the older population in suburbs grew by 20 percent from 1990 to 2000, the older population in center cities grew by only 2.4 percent. He further divides metropolitan areas based on geographic location and demography, resulting in five broad categories: Melting Pot metros, north (largely black/white), north (largely white), south (largely black/white), and south and west (largely white). Their populations are aging at different rates for different reasons, as shown in Table 5:

Table 5: Growth in and Share of 55-64 and 65+ Age Cohorts in Suburban Metropolitan Areas, 1990-2000

	Melting Pot	North (Black/White)	North (White)	South (Black/White)	South and West (White)
Growth in 55-64 age cohort, 1990-2000	53.0	42.4	44.4	60.9	63.6
Share of all residents 55-64, 2000	8.3	8.9	9.0	8.6	8.8
Growth in 65+ age cohort, 1990-2000	37.6	19.9	22.4	47.2	46.8
Share of all residents 65+, 2000	10.9	13.2	13.4	10.1	13.3

Source: Frey, Appendix A.

While all areas experienced large growth in the 55-64 age cohort as Baby Boomers reached their 50s, suburban areas in the south and west experienced greater growth than the other types of regions because they had higher rates of in-migration. As Frey puts it, "This suggests that these areas may be attracting some pre-retiree migrants who are part-time or partially retired workers, and are anticipating retirement in those locations as they advance into their senior years." The northern cities had more stable populations, while the Melting Pot suburbs show less growth in that age cohort because they had higher rates of immigration, which tends toward a younger population. Growth rates in the over 65 age cohort tended to mirror those of the Baby Boom, with Sunbelt cities gaining the largest proportions. Of the 20 suburban areas

with the fastest-growing older populations, only three were in either Florida or Arizona, the traditional “retirement magnets.” However, all were in the South or West.

A review of literature by Giuliano et al found evidence that older people tend to “age in place;” that is, they prefer not to move. Data from the American Housing Survey (AHS) of 2001 showed that only 4.6 percent of people 65 and over had moved in the previous year, as compared to 18.5 percent of younger adults. The AHS data also showed that 80 percent of those 65 and over own their own home, which provides a strong reason not to leave, especially when mortgages are paid off. Table 6 shows the residential patterns and transit access for this population:

Table 6: Residential Patterns and Transit Access, 65 and Over

	Urban	Suburban	Rural	Total
Share of Older Population	28%	48%	24%	100%
Percent with Access to Transit in each Area	80%	51%	25%	53%

Source: American Housing Survey 2001, as quoted in Giuliano, et al.

Census data show that of the older people who do move, 25 percent of moves are from one MSA to another and seven percent are from MSAs to non-MSAs. As these proportions are higher than those of the total population, and the older population is less likely to move within an MSA (47 percent as compared to 54 percent of the total population), this suggests that when they do move they tend to move farther away, perhaps in search or warmer climates or lower costs of living. However, housing tax code changes regarding capital gains now have permitted many empty-nesters to down-size their housing, often including a move to a more urban locale. Whether this trend becomes more important is as yet undetermined.

1.3. Current Travel Patterns in the 65 and Over Population

In a 2003 article, Collia, et al, analyzed the travel patterns of older Americans based on the 2001 National Household Travel Survey. Overall, they compare to younger adults in the following ways:

- Their general travel patterns are similar in modal distribution.
- They take fewer and shorter trips.
- Fewer older people drive, and the gender gap is larger than for younger adults.

The fact that people 65 and over take fewer and shorter trips than younger adults is due in part to the fact that as a group they take fewer work trips. In the 65 and over population, 3.1 percent of trips are taken for work, compared to 16.1 percent for younger adults. In addition, while trip rates and lengths tend to be more similar for men and women under 65, there is more divergence among older men and women (Collia et al.).

Table 7: Daily Trips and Trip Length for Men and Women Under and Over 65

	Age 19-64			Age 65+		
	Men	**Women**	**Total**	**Men**	**Women**	**Total**
Daily Trips	4.3	4.6	4.4	3.9	3.2	3.4
Total Travel Distance in Miles	42.1	25.0	-	27.2	9.5	-
Average Trip Length in Miles (Trips Divided by Distance)	9.8	5.4	-	7.0	3.0	-

Note: Dash (-) indicates not available.
Source: Adapted from Tables 6 and 7, Collia et al[2]. Data from NHTS 2001, Daily Trip File and Person File, U.S. DOT

In terms of mode choice, travel behavior in the 65 and over population is very similar to that of younger adults. For both groups, almost 90 percent of all trips are taken via private car. With regard to the remainder of trips, older people walk about 10 percent more often and use transit about one-third less.

The main difference between younger and older adults in automobile use is whether they are drivers or passengers. Older people are slightly more likely to be passengers.

Table 8: Travel Mode for Persons –Over and Under 65

	Age 19-64	Age 65+
Personal vehicle	89.5	89.3
Single occupant	48.2	44.4
Multiple occupants	41.3	44.9
Transit	1.8	1.2
Walking	7.5	8.4
Other	1.2	1.2

Source: Collia, et al.

Compared to younger adults, people 65 and over are less likely to drive. About 20 percent of older people do not drive, as compared to only seven percent of adults aged 19-65. The gender gap for driving is far larger among the older population, with nearly thirty percent of older women not driving. See Table 9.

Table 9: Percent of Adults Who Do Not Drive

	Age 19-64	Age 65+
Men	5.2	10.0
Women	8.5	27.6
Total	6.9	20.2

Source: Collia, et al.

[2] Collia et al use the NHTS 2001 national sample data for their analysis, which was available before the complete data set and includes add-on areas appropriately weighted. ICF Consulting uses the complete data set in its analyses later in this paper. Results are similar but there are slight differences.

From the transit agency perspective, people 65 and over currently make 7.4 percent of all transit trips. They are proportionately the most underrepresented age category relative to other cohorts as shown in Table 10 below. Baby Boomers, those who will be 65 and over in 2030, are represented in close proportion to their population. (ICF Consulting analysis, NHTS 2001 data)

Table 10: Age Cohorts as Percent of Population and of Public Transit Riders

	18 and under	19 to 35 years	36 to 55 "Baby Boomers"	56 to 64 years	65 and over
Percent of Public Transit Riders	18.9%	38.8%	28.7%	6.1%	7.4%
Percent of Population	28.3%	20.9%	29.6%	8.9%	12.4%
Ratio: transit use to population	0.67	1.86	0.97	0.69	0.60

Ages are as of the time of the NHTS 2001 survey. ICF Consulting analysis of NHTS 2001 data, Census population estimates for 2001.

Variations in the characteristics of where people live and their personal backgrounds are strong predictors of transit use. Rosenbloom and Waldorf (2001) found a person's neighborhood characteristics to be the largest variable predicting mode choice, followed by effects associated with race and ethnicity. This was true even controlling for age, driver status, income, sex, and transit availability. They found that living in an urban environment significantly increased the odds of using public transit.

These findings were contradicted to some extent by Giuliano et al (2003), who found that density was only significantly correlated with transit use at fairly high densities. The two studies also used differing definitions of residential location type, which may have contributed to the contradictory findings. Giuliano's findings are not surprising, however, as housing development density alone, without accounting for usage mix, proximity to other destinations, walkability characteristics at the origin and destination, and similar factors, has been generally shown to have low explanatory power.

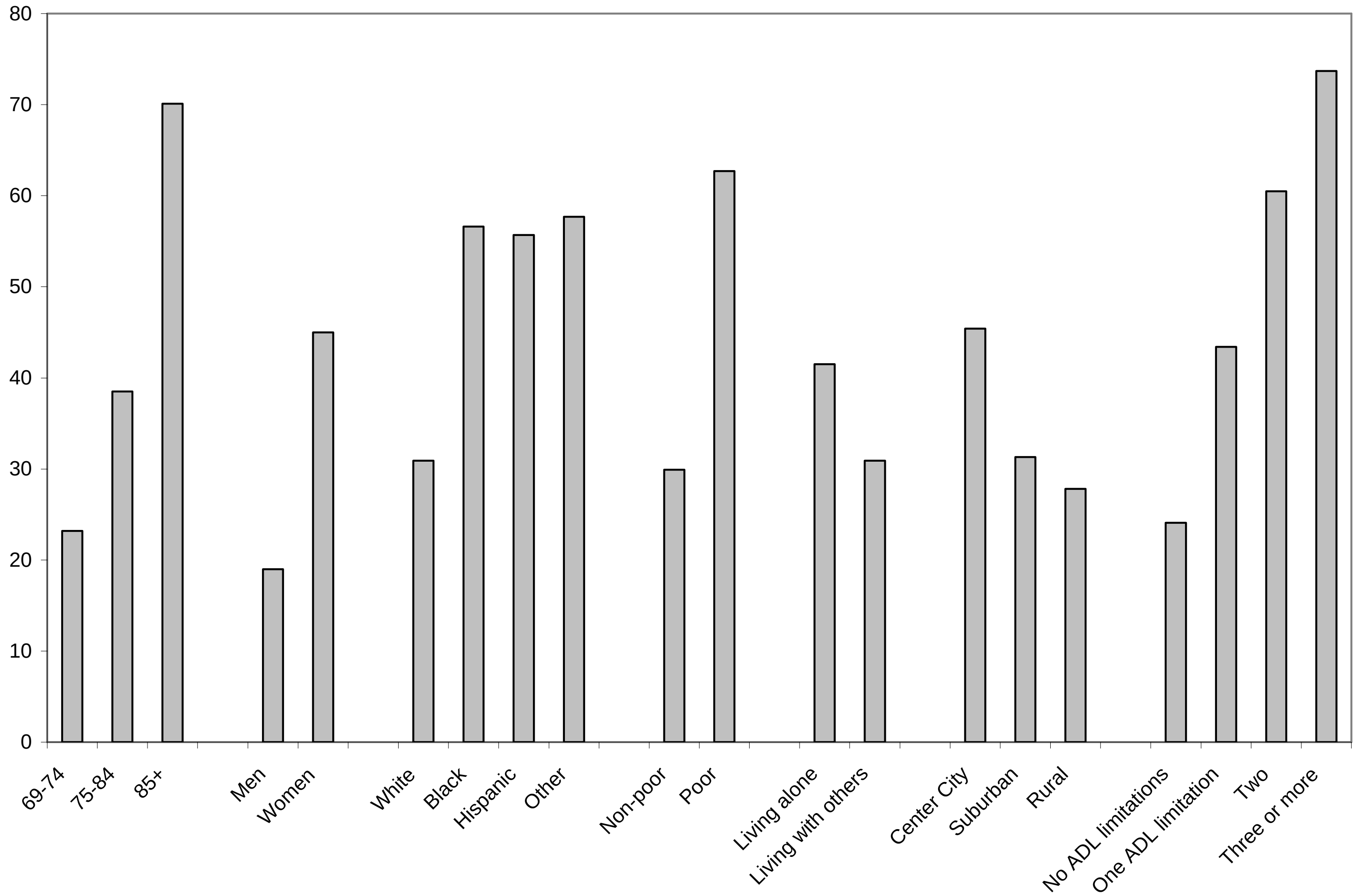
1.4. Analysis of Non-Driving and Transit Use among Older People

The following explores the demographic and health-based characteristics that correlate with variations in travel behavior. Most of this section is based on analysis in TCRP Report 82, *Improving Public Transit Options for Older Persons,* which uses data from the 1994-95 National Health Interview Survey on Disability, Supplement on Aging, conducted by the National Center for Health Statistics (NHIS SOA II).

1.4.1. Non-Driving

As noted above, just over 20 percent of the 65 and over population do not drive. This average masks wide variation not only between men and women, but a number of different categories. Figure 5, below, shows the proportion of older people who do not drive by a number of different criteria.

Figure 5: Variations in Non-Driving Among Older People



Source: TCRP Report 82, based on data from the National Center for Health Statistics, 1994-95.

The non-driving population figures shown in Figure 5 are based on data collected in 1994-5, which explains in part the fact that they do not match those reported in the 2001 NHTS. Another important difference is that the overall figures are for people over 69, not 65. The share of non-drivers in the different age groups from the 2001 NHTS are still lower, but similar in pattern to those shown above: 14.1 percent for those aged 69-74, 24.8 percent for those aged 75-84, and 55.8 percent for those 85 and over. The NHIS SOA II also focused especially on inclusion of people with disabilities, using face-to-face interviews, while NHTS 2001 used only telephone interviews; NHIS SOA II may have more accurate data on older people with disabilities, who are less likely to drive, and may have more difficulty communicating by telephone.

The NHIS SOA II data above show that those least likely to drive consist of the “oldest old” (85 and over), women, non-whites, the poor, persons living alone and in the center city, and persons with disabilities. “ADL” (activities of daily living) limitations refer to whether people can perform the six activities associated with independent living: walking, dressing, eating, bathing, toileting, and getting in and out of bed. (See Trends Affecting Driving and Transit Use; Life Expectancy Increasing for a more detailed discussion of measuring disability.)

Why do non-drivers not drive? Figure 8 gives some indications, but unfortunately none of the documents reviewed here addressed this question in its entirety. For example, while NHTS asks respondents whether they drive, it does not ask whether they have ever driven. Presumably, some number of older people—particularly women—have never driven, and they have retained those habits over the years. People who have never driven, and have instead used public transit, are more likely to continue use alternatives to driving as they age.

In some cases, people's driver status may be related to their economic status. Older people living in poverty drive far less than average and their poverty may coincide with not owning a car or never having owned a car. Poverty also generally correlates with poorer health, which may in turn cause driving cessation. Economics may also help explain the reason that non-whites are more likely to be non-drivers than whites.

A main cause of driving cessation, as opposed to never driving, is poor health. According to Collia, et al, the 2001 NHTS found that 23.5 of all those 65 and over reported a "medical condition that makes it difficult to travel outside the home." These conditions were self-reported, and do not necessarily correlate with limitations in ADLs.

Of those 23.5 percent, there was a wide variation in the impact of the disability, as shown in the table below:

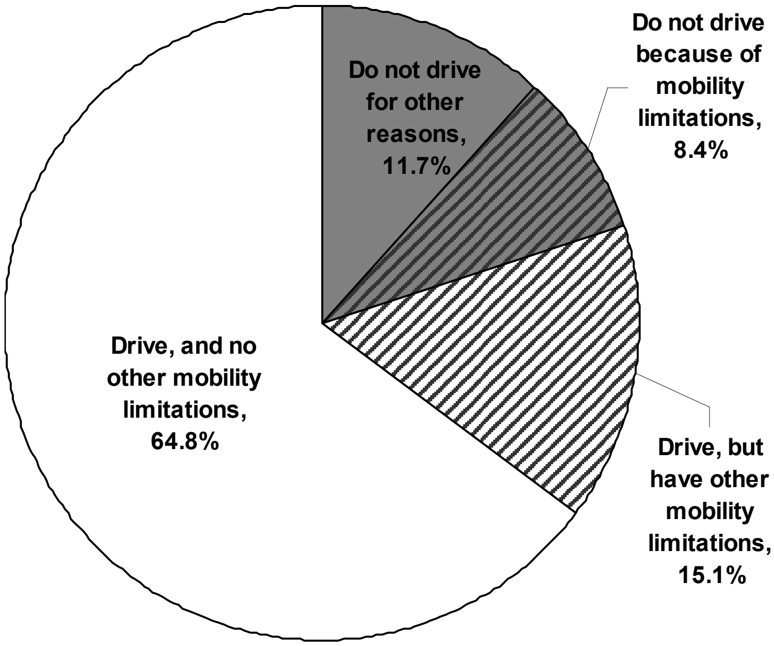
Table 11: Response of Older People to Mobility Limitations

Because of this condition, have you:	**% Yes**
Reduced your day-to-day travel?	84.6%
Asked others for rides?	52.3%
Limited your driving to daylight hours?	47.5%
Given up driving altogether?	35.8%
Used special transportation services?	12.0%

Source: Collia, et al, adapted from Table 13.

Table 11 shows not only that there are many responses to mobility limitations, but that only about one-third of older people with self-reported disabilities that affect mobility stop driving. Figure 6, below, shows the figures on not driving and self-reported disability in another way. There is some overlap between older people who do not drive and those with mobility limitations, but people who do not drive because of health reasons represent only 8.4 percent of the total older population. Two-thirds of those 65 and over have no medical limitations on their ability to travel.

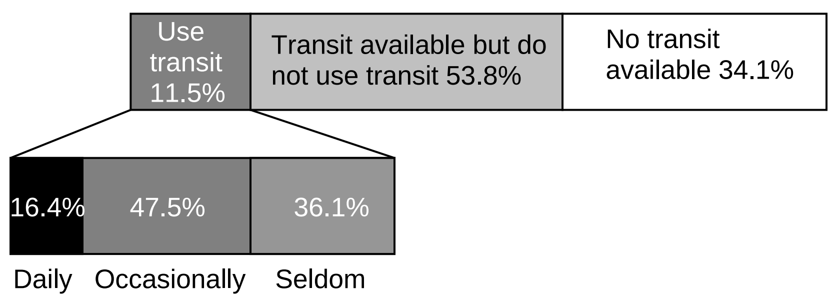
Figure 6. Relationship of Driving and Self-Reported Disability



The rate of non-driving in the older population varies widely across the U.S. While almost one third (29.8 percent) of those 65 and over are non-drivers in the Middle Atlantic region—comprising the Eastern seaboard from Maryland to Florida—only one in seven (15.1 percent) of those 65 and over are non-drivers in the rural area of the West North Central region, which includes Kansas, Iowa, Minnesota, Missouri, Nebraska, and the Dakotas (ICF Consulting analysis of NHTS 2001 data).[3]

1.4.2. Transit Use

Figure 7: Use of Transit among Older People, 1994-1995



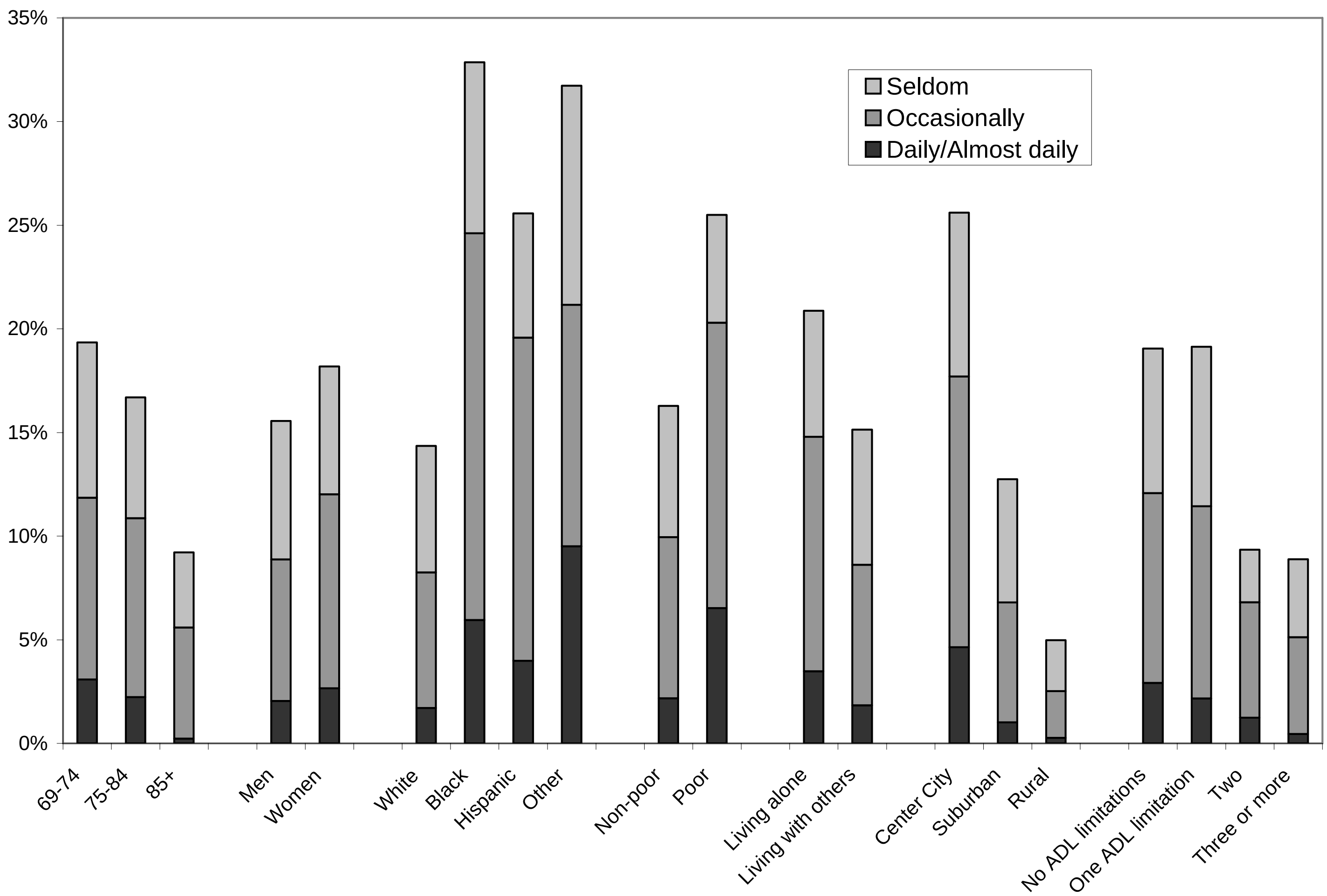
Only 11.5 percent of older people (over 69) had used transit in the past 12 months, according to the National Center for Health Statistics NHIS SOA II study. 34.1 percent do not report having transit available where they live (likely, many are not considering paratransit), and the other 53.8 percent did not ride for other reasons. Of those 11.5 percent of older transit users, 13.7 percent ride daily or almost daily, 47.5 percent ride occasionally, and 36.1 percent ride seldom. Thus of those with access to transit, about 17.6 percent rode it at least once per year (11.5 percent divided by 65.3 (11.5 plus 53.8) percent).

Figure 8 shows the percentage of various categories of older people with access to transit who report riding it. Those more likely to ride transit were non-white and living in a center city. The

[3] 2001 NHTS data are not sufficiently detailed to allow a breakdown by state or metropolitan region.

least likely to ride transit were the oldest old, rural and persons with two or more ADL limitations. Of older people who have access to transit, there is no group with over a third of its members using transit. The most likely frequent riders are the poor and the “other” racial category (NHIS SOA II study).

Figure 8: Variations in Transit Use among the Elderly with Transit Access



Source: TCRP Report 82, based on data from the National Center for Health Statistics, 1994-95.

Of those older people who have access to but do not ride transit, 15.3 percent said it was because of a health problem or other impairment. The groups most likely to have such impairments were those over 85 (37.1 percent) and with two or more ADL limitations (for two, 40 percent, for three or more, 62.1 percent).

Table 12: Relationship of Transit Use and Driving Among Older People with Access to Transit

	NHIS SOA II study, 1994-5			**NPTS, 1995**		
	Transit Riders	**Non-Riders**	**Total**	**Transit Riders**	**Non-Riders**	**Total**
Drivers	7.3%	54.0%	61.4%	8.8%	65.1%	73.9%
Non-Drivers	10.3%	28.4%	38.6%	8.4%	17.8%	26.1%
Total	17.5%	83.4%	100%	17.1%	82.9%	100%

Source: TCRP Report 82, Table 14. Columns and rows may not add to 100% due to rounding

Table 12 compares the results of two surveys regarding the relationship of transit use and driving among older people. The results from both show that around 17 percent of older people with access to transit ride it and those riders are fairly evenly divided between drivers and non-drivers. HIS SOA II found that over one-quarter (28.4 percent) of all older people are non-drivers who also do not use public transit, while NPTS shows this figure at 17.8 percent. The most obvious reason for this difference is the age range selected – NHIS SOA II uses over 69, while NPTS uses 65 and over, a population that is younger and generally healthier. People who do not drive due to health reasons are also less likely to use public transit. NPTS also shows a higher percentage of drivers within this population, 73.9 percent as compared to 61.4 percent, which is also likely due to the age range selection and interviewing technique.

Table 13, below, uses more recent figures from the 2001 NHTS to look at the percentage of older people using transit. This is not directly comparable to Table 6, above, since this looks at transit use by all people 65 and over, not just those with transit access.

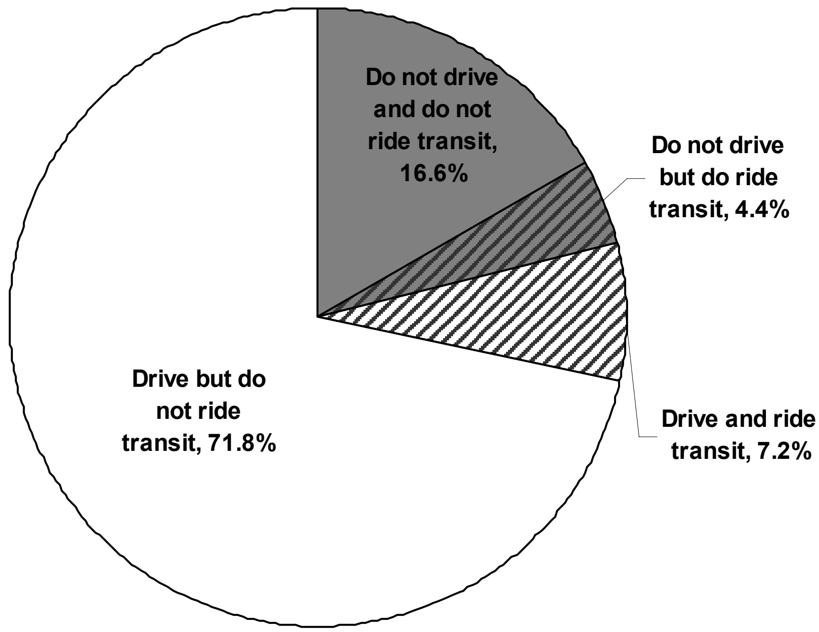
Table 13: Relationship of Transit Use and Driving Among ALL Older People (65+)

	NHTS, 2001				
	Transit Riders	Non-Riders	Total	Percent of all drivers who ride transit	Percent of all non-drivers who ride transit
Drivers	7.2%	71.8%	79.0%	9.1%	
Non-Drivers	4.4%	16.6%	21.0%		20.9%
Total	11.6%	88.4%	100.0%		

Source: 2001 NHTS data analyzed by ICF Consulting.

Figure 13 shows the same data in chart form. The overall group of transit riders is drawn slightly more from the ranks of drivers than non-drivers. A far larger group, 16.6 percent, neither drives nor uses transit.

Figure 9. Relationship of Driving and Transit Use, 65 and Over



Giuliano, et al analyzed 1995 NPTS data by population density, and found that only at the highest densities (over 10,000 persons per square mile, or approximately 6.8 dwelling units per acre) do older people use transit in any appreciable level. These data seem to suggest that at the highest densities, people shift from drive-alone trips to transit and walking; the share of trips as a passenger remain relatively constant. For all ages and density levels, walking has far larger mode share than transit. The age cohort 55-64 is included in Table 14 to show the similarity in travel patterns to the older population.

Table 14: Mode Share, Percent of All Trips by Density and Age Cohort

Age Cohort	Density in Persons per Square Mile	Driver	Passenger	Transit (Bus/Rail)	Walk
55-64	Under 500	77.8	19.3	0.1	2.2
	500 – 2,000	78.2	18.8	0.6	1.9
	2,000 – 10,000	76.8	17.2	1.1	4.2
	Over 10,000	56.3	16.5	8.5	17.9
65-74	Under 500	74.8	21.6	0.2	3.0
	500 – 2,000	75.4	19.9	0.4	3.3
	2,000 – 10,000	72.4	19.9	1.2	6.0
	Over 10,000	48.4	21.1	11.7	17.9
Over 75	Under 500	60.7	32.0	0.9	6.0
	500 – 2,000	64.8	29.1	0.7	4.6
	2,000 – 10,000	65.7	25.9	1.9	6.2
	Over 10,000	42.2	24.8	9.0	22.1

Source: Giuliano, et al, Table 4-5.

The 1995 NPTS data show that older people are more likely to live near transit—probably as a function of living in older neighborhoods—but they are less likely to be transit riders than younger adults. As Giuliano, et al put it:

> The elderly are less likely to be regular transit users, even when transit is accessible…and when land use patterns are more favorable to transit. In addition, the older elderly are more likely to be transit users when transit stops are close to home [the model found a major difference between one-half mile and one-tenth mile] and when local access to goods and services is likely to be high.

Rosenbloom and Waldorf (2001), looking at the same data, found significant effects of residential location and racial category in predicting modal choice for people 65 and over. Using five basic location categories developed by Miller and Hodges (1994), and controlling for other factors such as transit availability, they found that older people living in an urban setting were much more likely to be public transit users than their rural counterparts. They also found that older African-Americans and Asian-Americans were more likely than older whites to use public transit, even controlling for income and other characteristics. This suggests that cultural values may have a strong effect on modal choice.

1.4.3. Travel of Non-Drivers and Non-Transit-Riders

If many older people neither drive nor ride transit, how do they travel? One important point is that non-drivers take fewer trips than drivers. Table 15, below, shows the rate of trip-making for all adults, broken out by age, gender, and driving status. (This section draws on an ICF Consulting analysis of NHTS data, as well as reports by Linda Bailey, formerly of the Surface Transportation Policy Project and now at ICF Consulting, and *Freedom to Travel*, a report based on a Bureau of Transportation Statistics survey of the disabled.)

Table 15: Daily Trips by Age, Gender, and Driving Status

	Drivers			Non-Drivers			All Adults		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
19-64	4.4	4.7	4.5	2.7	2.8	2.8	4.3	4.5	4.4
65+	4.1	3.7	3.9	1.3	1.6	1.5	3.8	3.1	3.4
Total	4.4	4.5	4.4	2.4	2.3	2.3	4.2	4.2	4.2

Source: 2001 NHTS, analysis by ICF Consulting

On the whole, drivers average 4.4 trips per day, while non-drivers average only 2.3. Younger adults average 4.4 trips per day, while older people average only 3.4, but the difference in trip making is more pronounced among non-drivers. When non-drivers are older, they take just over half as many trips as their younger counterparts, with 1.5 trips per day compared to 2.8. They take less than half the number of trips of their driving peers, who take almost 4 trips daily. For older drivers, the gender roles reverse; older women make fewer trips than older men. However, non-driving older men make the fewest trips of any group: only 1.3 trips per day.

As Table 16 below shows, older drivers take a very high proportion of their trips by car. Older men who drive are more likely to be behind the wheel than older women who drive; for women, about one-third of their car trips are as passengers. However, even non-drivers take two-thirds of their trips by car, as passengers.

For non-drivers, the second-most frequently used mode is walking, accounting for 22 percent of all trips by non-drivers. Transit use among non-drivers is higher than among drivers, but far behind walking with around eight percent.

Table 16: Mode Share by Gender and Driving Status, 65 Years and Over

	Drivers			Non-Drivers			All		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
Car	91.3%	91.6%	91.4%	61.5%	66.4%	65.4%	90.2%	88.0%	89.0%
Driver	82.2%	63.1%	72.7%	-	-	-	79.2%	54.1%	66.0%
Passenger	9.2%	28.5%	18.8%	61.5%	66.4%	65.4%	11.1%	33.8%	23.0%
Transit	0.5%	0.4%	0.4%	8.0%	8.4%	8.3%	0.7%	1.5%	1.1%
Walk	6.9%	7.2%	7.1%	26.6%	21.7%	22.6%	7.7%	9.3%	8.5%
Bike	0.5%	0.2%	0.3%	2.3%	0.0%	0.4%	0.5%	0.2%	0.4%
Other	0.8%	0.6%	0.7%	1.7%	3.6%	3.2%	0.8%	1.1%	1.0%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Source: 2001 NHTS, analysis by ICF Consulting

Bailey looked at the prevalence of travel among non-drivers and found that isolation—defined as not traveling at all on a given day—was common among those 65 and over, in particular among those who do not drive. Of all older non-drivers, 54 percent do not leave their home on a given day, while only 17 percent of drivers stay home. An analysis of trip purpose found that non-drivers went out for social, family, and religious purposes on average three times per week, while drivers made such trips on average eight times per week.

Isolation among non-drivers was more common in rural areas (with 60 percent of non-drivers staying home on a given day) and small towns (63 percent) than urban and suburban areas (51 percent). In areas with a population density over 25,000 persons per square mile, only 43 percent of older non-drivers stay home on a given day. The impacts also varied with race; since whites are far less likely to be non-drivers (only 16 percent), they are also less likely to stay home on a given day (22 percent) than Latinos (34 percent), African-Americans (36 percent) and Asian-Americans (38 percent). (This analysis was not provided by non-driver.)

According to Bailey's analysis, older non-whites are also much more likely to be public transportation users. About one fifth (21 percent) of older African-Americans and Latinos use public transportation at least occasionally, and 16 percent of older Asian-Americans do so, compared to only 10 percent of older whites.

According to *Freedom to Travel*, 3.5 million persons never leave their homes at all. Of these, 1.9 million are persons with disabilities; the average age of this population is 65. However, the report did not discuss what percentage of the total 65 and over population are homebound.

Older people use specialized transportation services for very few of their trips, proportionately. According to Table 11 (above), only 12 percent of those with mobility limitations have used specialized transportation services. However, of those who have a medical condition and use specialized transportation, over a quarter (27.3 percent) say they use public transportation at least occasionally (ICF analysis of 2001 NHTS).

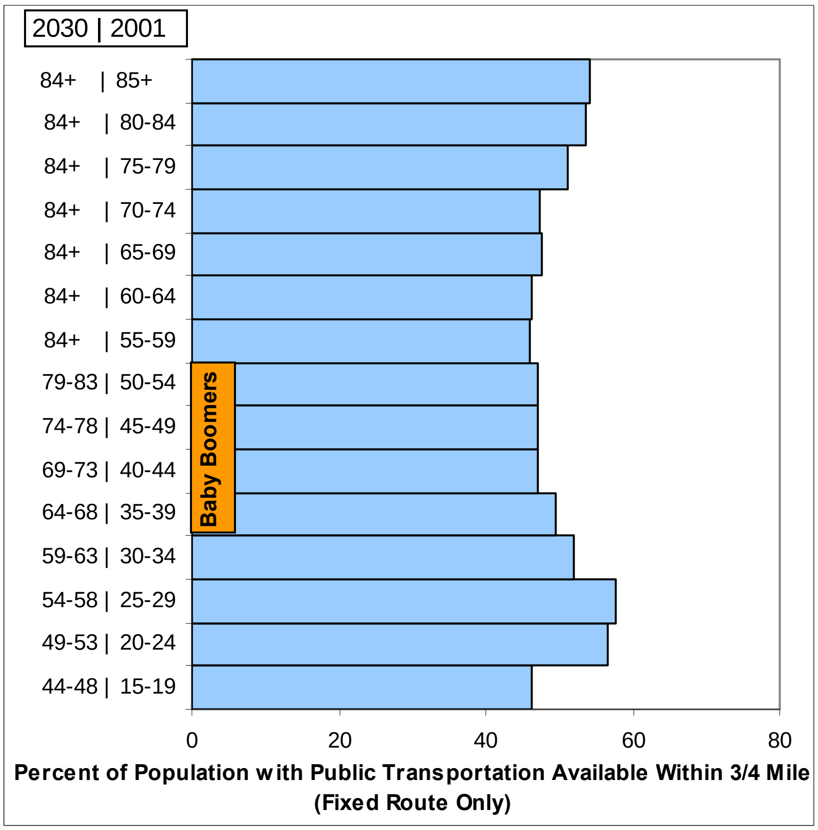
Of the entire disabled population (not just those 65 and over), *Freedom to Travel* reports that only 3.5 percent had used a service provided by a human services agency in the previous month. 5.5 percent reported having used paratransit provided by a transit agency. The report did not indicate whether there might be overlap between these two groups.

2. Public Transit Availability and Use by Age in 2001

In addition to findings from the literature, ICF Consulting conducted an analysis of both aggregate (population group) and disaggregate (individual person) data. This chapter provides the results of the analysis of aggregated data from the 2001 NHTS.

2001 data on public transportation use is available and provides a window into the relationship between age and public transportation use. A prerequisite to public transportation use is typically availability. The graph below illustrates availability of fixed-route transit within a ¾ -mile buffer.[4] In the following graphs, the Baby Boomer population is highlighted to illustrate potential effects of aging in place, as well as their current patterns of public transportation use.

Figure 10. 3/4 Mile Public Transit Available By Age Cohort, 2001

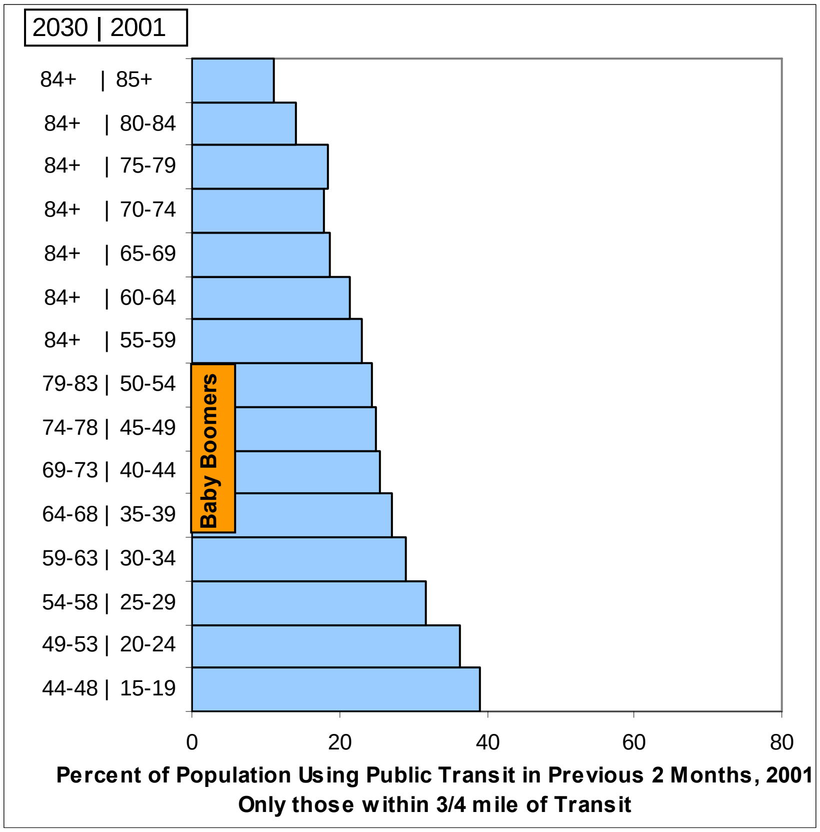


As shown above, there is relatively little variability in public transit availability between age groups. However, the Baby Boomer population is located in a slight trough of reduced availability, possibly due to increased suburbanization. However, they are not dissimilar to the 65-74 population.

The graph below shows the percentage of each age cohort that reported using public transportation within the previous two months from the 2001 NHTS.

[4] New data on proximity to public transportation (rail stops and fixed bus routes) was made available by the National Household Transportation Survey staff in 2005 for this study.

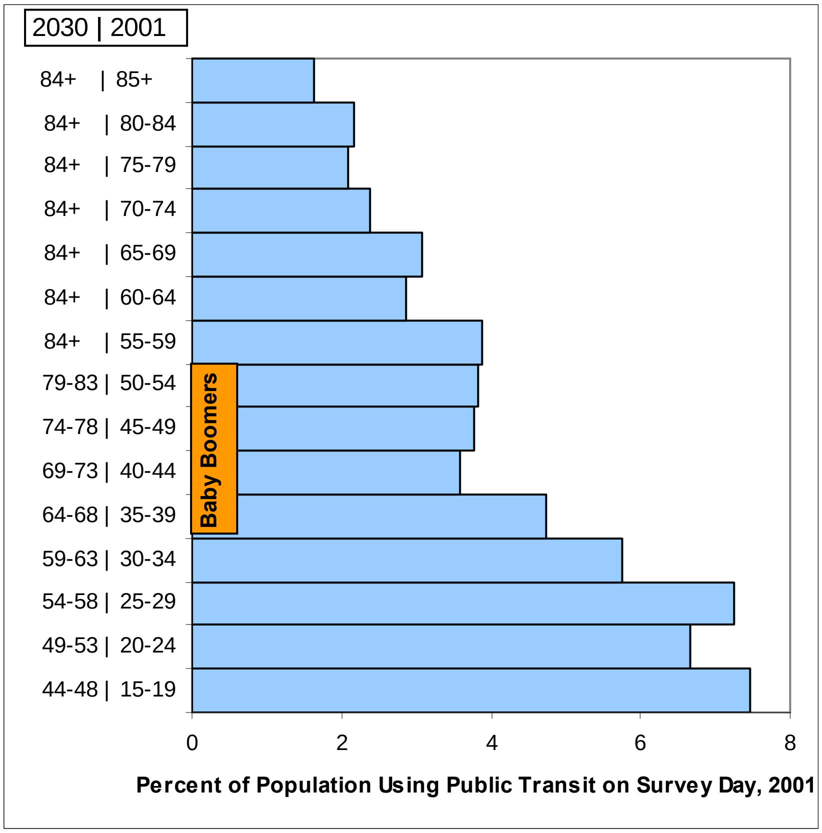
Figure 11. 3/4 Mile Buffer: Public Transit Users by Age Cohort, 2001



This graph shows the steady decline in public transportation use in the age cohorts. However, it also shows that a significant portion of the Baby Boomer generation occasionally or regularly uses public transportation where it is available – between 25 and 27 percent. This graph shows only the population with public transportation available within ¾ mile of their home.

Finally, the regularity of public transportation use typically declines with age. The graph below shows that public transportation use on a given day declines in the older age cohorts significantly, again among the population within ¾ mile of transit.

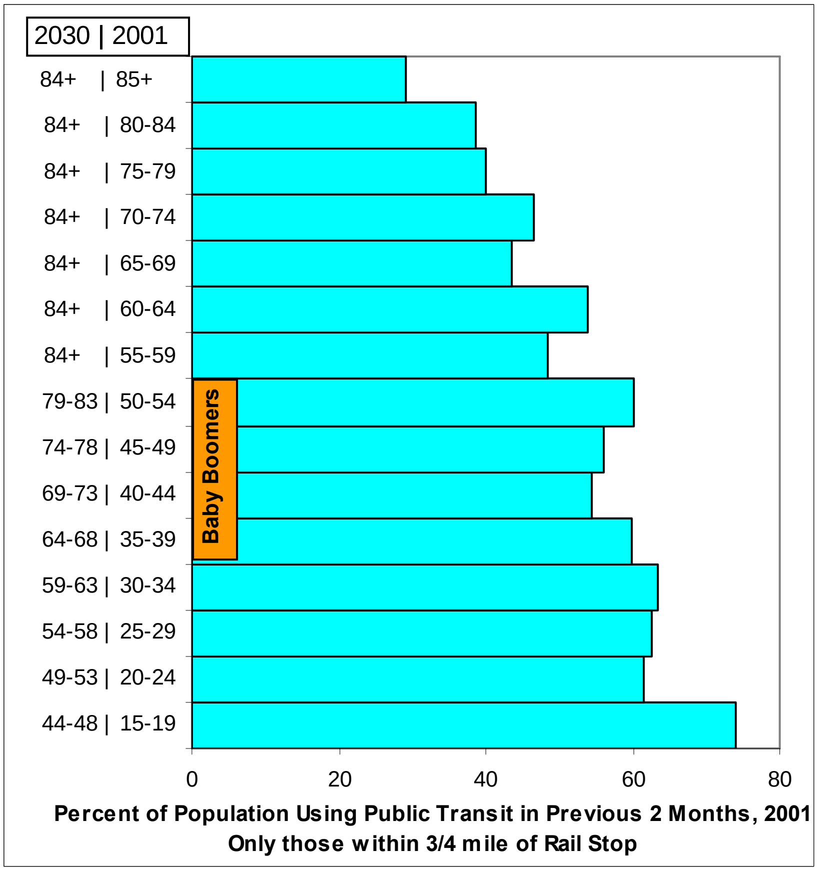
Figure 12. Public Transit Users on Survey Day by Age Cohort, 2001



This illustrates that people in older age cohorts who do use public transportation may be infrequent riders. The same holds true for paratransit service, which often has many registered users in the 65 and over category, but provides relatively few rides for the 65+ population. Younger disabled people, who are more likely to be in the work force or engaged in other daily activities, typically take more trips than those who are 65 and over.

It is important to note here that rail transit availability has a significantly higher correlation with use than bus and rail combined. The graph below shows public transportation users, occasional or regular, among the population living within ¾ mile of a rail stop.

Figure 13. 3/4 Mile Buffer - Rail Stop: Public Transit Users by Age Cohort, 2001



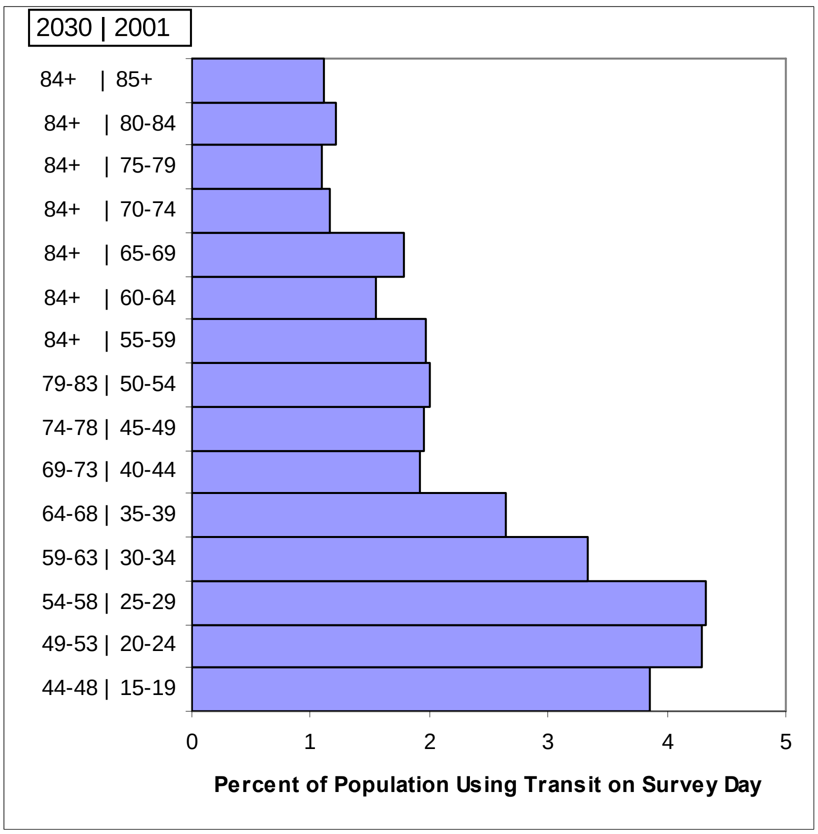
3. Discussion: Associations Between Age and Public Transit Use

3.1. Introduction: Predicting Public Transportation Use in Individuals

This chapter provides the results of disaggregate-level (individual person) statistical analysis of data from the 2001 NHTS. It differs in approach from chapter 2, which produces the average characteristics of population groups using straightforward arithmetic means or percentages. This chapter instead uses statistical analyses to predict transit usage by a given individual based on multiple variables.

Using the 2001 NHTS (National Household Travel Survey), individual use of public transportation was predicted using demographic and geographic characteristics. The predicted variable, individual public transportation use on the survey day, is illustrated below for different age cohorts, regardless of public transportation availability (availability is one of the independent variables explored below).

Figure 14. Public Transit Users on Survey Day by Age Cohort, 2001



3.2. Methodology

National data, including add-on areas, were analyzed from the 2001 NHTS. The model took into account the stratified sample and clustering from multiple respondents in a household to establish the statistical significance of each independent variable. In addition to existing data, ICF staff was provided new data from the NHTS staff that indicated the distance of each respondent's residence to a fixed-route bus line or rail stop.

A logistic regression was conducted to predict using public transportation on the travel day as a binary variable. Descriptive statistical procedures showed that the average number of trips per day for public transportation users is approximately two, so in essence only the first trip was modeled.

Some of the survey questions used in the analysis were only asked of adults. Therefore, those 15 and under were excluded from the analysis presented.

3.3. Results

The logistic model presented below is globally significant, with a Chi-square value of less than 0.0001. All of the variables presented below have a statistically significant correlation with public transportation use (as denoted with asterisks), with the exception of residence in a metropolitan statistical area with a population below 1 million, and sex. Each of the variable associations is described further below.

A positive estimated beta value indicates a positive relationship between the variable and public transportation use, while a negative value indicates a negative relationship. The odds ratio factor, in the second column, gives a factor for computing the odds ratio for any given individual. This is useful for comparing the effects implicated by each of the different factors.

Table 17. Results of Predicting Public Transportation Use on a Given Day

	Estimated Beta (β)	Odds Ratio Factor (exp^β)	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept	**-5.42****	**0.004**	0.30	336.63	<.0001
Public Transportation Available within 3/4 mile	**1.07****	**2.91**	0.17	40.91	<.0001
C/MSA under 1 million population	**0.09**	**1.10**	0.30	0.09	0.7584
C/MSA from 1 million - 3 million	**0.82****	**2.27**	0.27	9.02	0.0027
C/MSA over 3 million population	**1.05****	**2.87**	0.26	16.01	<.0001
Dwelling units per square mile (thousands)	**0.20****	**1.22**	0.03	48.34	<.0001
Driver status (driving)	**-1.10****	**0.33**	0.14	63.82	<.0001
Medical condition making travel difficult	**-0.36****	**0.70**	0.17	4.34	0.0371
Worker status (working)	**0.54****	**1.72**	0.13	18.60	<.0001
Female	**0.07**	**1.08**	0.09	0.69	0.4058
No vehicles available in household	**1.48****	**4.41**	0.15	99.31	<.0001
65 and over age group	**-0.79****	**0.45**	0.16	24.70	<.0001

**Significant at p > .01.
ICF Analysis of NHTS 2001 data

3.3.1. Location

Availability of a fixed-route service within ¾ mile correlates significantly with public transportation use, raising the odds by an estimated factor of 2.91, or 191 percent higher than someone who does not have access within a ¾ mile. This factor may seem low, considering the fact that most people access bus or rail by walking, and most prefer not to walk more than a ¾ mile in order to do so. However, the model also includes two other measures of geographic

location that correlate with public transportation use as well as availability. Living in a metropolitan statistical area has a large effect on public transportation use - it increases the odds by a factor of 2.27 for areas with a population of one to three million, and by a factor of 2.87 for areas with a population over three million. This effect is in comparison to those living outside of metropolitan statistical areas.

The effect of living in a larger metropolitan area, controlling for public transportation availability, is an indication of two major effects not captured simply by availability. One is the size and coverage of the public transportation system, which corresponds typically with size of a city and its suburbs. Second, the size of a metropolitan area may be a proxy for land use patterns near destination rail stations or bus stops. Research on predicting public transportation use has shown a significant effect of destination land use, showing that the destination can have an equal predictive value to land use at trip origin.

Residential density, which serves as a proxy for other land use measures, has a significant positive effect on public transportation use, independent of metropolitan area size and public transportation availability. It increases the odds of using public transportation by a factor of 1.22, or an increase of 22 percent, for every additional thousand households per square mile in the respondent’s neighborhood. The geographic area used here is actually census block groups, which are a relatively fine level of differentiation among residential locations.

3.3.2. Driving and Medical Conditions

As part of this survey, respondents were asked whether they have a medical condition that makes travel difficult. Controlling for membership in the 65 and over cohort and driver status, a medical condition reduces the odds of using public transportation by a factor of 0.70, in effect reducing the odds by 30 percent. Because of the control on the driver status of the respondent, this odds factor is showing the effect of health conditions aside from their effect on ability to drive. For example, someone may use public transportation throughout their life but have difficulty traveling due to a medical condition. In examining the effects of medical condition with these data, it is important to note that the 2001 NHTS does not survey the population in institutions such as nursing homes, and conducts all interviews by telephone, which reduces responses from older individuals with health problems.

Being a current driver also reduces the odds of using public transportation significantly, by a factor of 0.33, or 67 percent. The question asked in the NHTS 2001 is different than some surveys in that respondents are asked about whether they “currently drive,” not whether they have a driver’s license. Many people stop driving but retain their driver’s licenses.

3.3.3. Vehicle Ownership

Independent of driver status, vehicle ownership has a large effect on the odds of using public transportation. The independent variable here is binary, indicating whether any vehicles are available in the respondent’s household. Respondents with no vehicles available in their homes had more than four times higher (4.41) odds of using public transportation than others in their category, controlling for all other influences mentioned here including driver status. While vehicle ownership shows a very significant correlation, it is important to note that this may not be a causal relationship, especially in the 65 and over population. People who use public transportation may have no need for a vehicle, and vice versa.

Although vehicle ownership has a very strong predictive power in this regression, it is important to note that even controlling for vehicle ownership, the other factors discussed here have significant predictive power as well. This would indicate that aside from vehicle ownership, other factors can predict public transportation use as a choice.

3.3.4. Sex

While sex was included in the model and shows a slight effect (women being more likely to use public transportation than men), the effect is not statistically significant. Other factors that may make women more likely to use public transportation, such as decreased workforce participation, vehicle ownership, and driver status, are controlled for in this analysis. Sex does not have a significant effect beyond those factors.

3.4. Factors Predicting Public Transportation Use over Time

In addition to the analysis of the 2001 NHTS, four preceding national surveys (formerly known as the National Personal Transportation Survey, NPTS) were examined for relationships between demographic factors and public transportation use. Because of changes between the five surveys, comparability is extremely limited. Inconsistencies range from questions asked in the survey, such as driver licensure vs. currently driving, to changes in sampling techniques and interview methods. Nevertheless, major factor shifts over time are reported here to give a window into changes public transportation use over time.

The models reported here are much simpler than the models reported above because they use only variables that were available in all five years of the survey analyzed, 1977, 1983, 1990, 1995, and 2001.[5] Each model represents a separate logistic regression to predict public transportation use on the travel day.

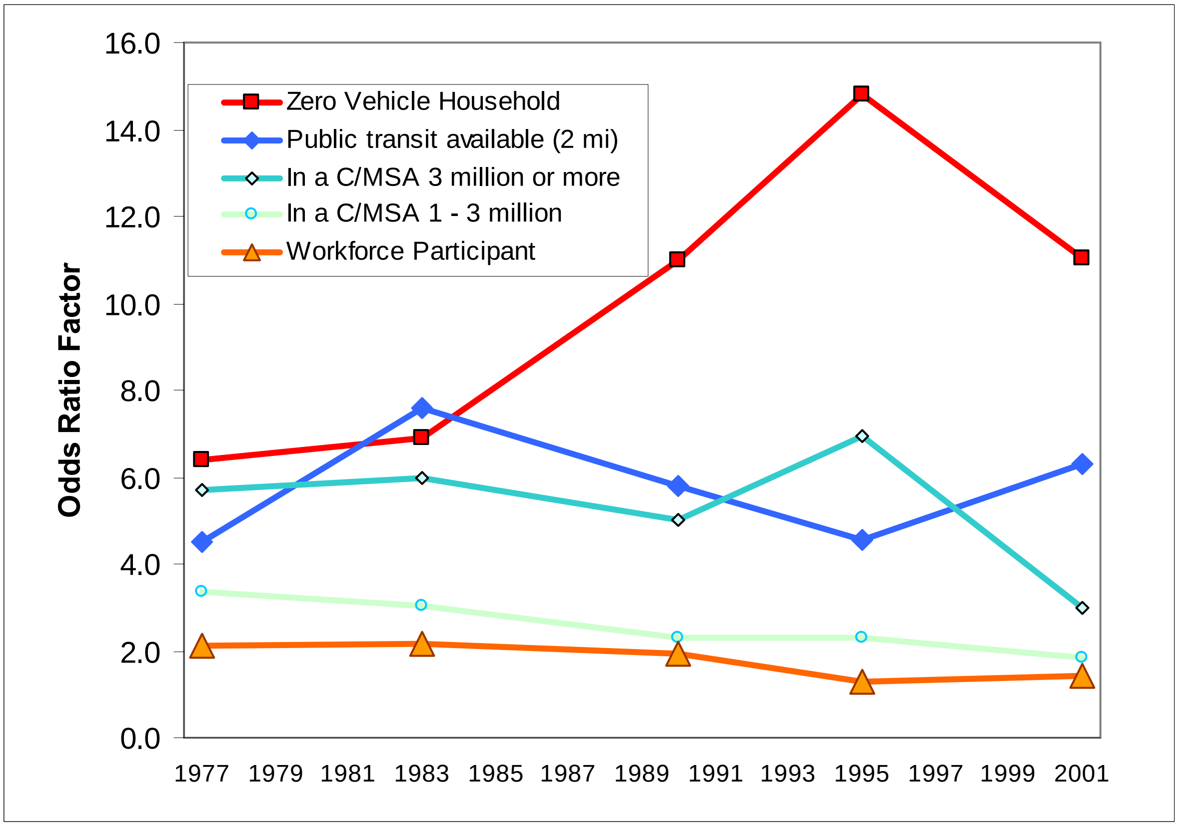
The following independent variables were included:

- 65 and over age group
- Zero vehicle household
- Workforce participant
- In a C/MSA less than 250,000'
- In a C/MSA 250,000 - 499,999'
- In a C/MSA 500,000 - 999,999'
- In a C/MSA 1 - 3 million'
- In a C/MSA 3 million or more'
- Public transit available within 2 miles

The estimated odds ratio factor results for selected variables from the five NPTS/NHTS are illustrated in the graph below.

[5] A 1969 NPTS was also completed, but the data have not been made available due to records damage.

Figure 15. Factors Predicting Transit User on a Given Day, Controlling for Age



3.4.1. Zero-vehicle households

Of the trends visible in this graph, one of the most noticeable is the growing effect of living in a zero-vehicle household. This reflects the increasing rate of automobile ownership in the population, resulting both in more vehicles available per household and a decrease in zero-vehicle households. Thus, those who use public transportation are more likely to have made a long-term plan to not use a vehicle, and do not purchase one. In effect, being a public transportation user has become more and more closely linked to living in a zero-vehicle household.

Noticeably, however, the importance of the zero-vehicle household declines in 2001, which was the first year to use objectively-measured public transportation availability. In previous years, the survey had asked respondents about their knowledge of public transportation availability near their homes. The results suggest that respondents who were unaware of available public transportation biased the results in previous years.

3.4.2. Other effects

The positive effect of living in a high-population metropolitan area has been fairly consistent over time, with some ups and downs over the years. Working also has a positive effect on the odds of using public transportation, though smaller than the effects of residence in large metropolitan areas. Public transportation availability within two miles has a significant positive effect on public transportation use.

3.5. Isolation and Public Transportation

As urban planners and social service providers prepare for the aging of the Baby Boomer generation, a major concern is providing those with health problems with adequate transportation so that they can age in place. A complete assessment of the provisions for aging in place across the country is beyond the scope of this project, but a statistical model was run for 2001 to assess current services for the non-institutionalized population. Looking only at this population, a logistic regression was conducted to predict the odds of staying home on a given day.

The model results are shown below:

Table 18. Predicting Staying Home in NHTS 2001

	Estimated Beta	Standard Error	Wald Chi-Square	Pr > ChiSq	Odds Ratio Factor (exp^β)
Intercept	-1.7636**	0.0393	2016.442	<.0001	0.17
Public transportation available within 3/4 mile	-0.1514**	0.0384	15.5133	<.0001	0.86
Medical condition that makes travel difficult	1.118**	0.0436	657.0559	<.0001	3.06
Zero-vehicle household	0.6407**	0.0708	81.8423	<.0001	1.90
Worker status	-0.9253**	0.0421	482.7938	<.0001	0.40
65 and over age group	0.4267**	0.0424	101.4389	<.0001	1.53

As above, this analysis was conducted controlling for the stratification in the sample procedure and household clustering. All five variables were found to be statistically significant in predicting staying home on a given day.

The single largest predictor of staying home on a given day is having a medical condition that makes travel difficult, which increases the odds of staying home by a factor of more than three (3.06). As expected, being 65 and over increases the odds of staying home by more than 50 percent (factor of 1.532), and working decreases the odds of staying home by 60 percent.

Transportation-related factors also play a key role. Public transportation availability makes a significant but smaller contribution, reducing the odds of staying home by 14 percent. Living in a zero-vehicle household increases the odds of staying home by 90 percent, controlling for all other factors in the model.

A separate model was run just for those with medical conditions that make travel difficult.

Table 19. Of those with Medical Conditions: Predicting Staying Home on a Given Day

	Estimated Beta	Standard Error	Wald Chi-Square	Pr > ChiSq	Odds Ratio Factor (exp^β)
Intercept	0.0411	0.0916	0.201	0.6537	1.042
Public transportation available within 3/4 mile	-0.2855**	0.0777	13.497	0.0002	0.75
Driver status	-0.9607**	0.0773	154.580	<.0001	0.38
Worker status	-0.8593**	0.1187	52.424	<.0001	0.42
65 and over age group	0.539**	0.0814	43.863	<.0001	1.71

In the population of those with medical conditions making travel difficult, work status and age group have the expected effects. Older people are 71 percent more likely to stay home on a given day, and workers are 58 percent less likely to stay home.

Public transportation availability and driver status both significantly reduced the odds of staying home on a given day in the population with medical conditions. Being a driver reduced the odds by over 60 percent (factor of 0.38). Having public transportation available within ¾ mile reduced the odds of staying home by 25 percent (factor of 0.75).

4. Model Description

4.1. Model Overview

The Aging Effects on Transit (AET) model created as part of this project is a Microsoft Excel spreadsheet that calculates future transit ridership and costs based on demographic forecasts. It provides default demographic data used to predict ridership, and also allows the user to input any of the component demographic, ridership, or cost variables. Users are especially encouraged to input future population and employment projections for their service area, more current ridership data for the base year, and estimates of transit operating costs per rider. The user interface is explained in more detail below.

The underlying data analysis uses urbanized areas as the unit of analysis. Forecasts are based on a multivariate regression that models growth in transit ridership based on growth in demographic factors, extrapolated into the future. The 1990-2000 growth rates for specific urbanized areas are also used as a factor in forecasting, but these are both smoothed and adjusted to bring predicted national trends into local areas. Because there are relatively few rail transit systems (and the six largest represent about 90 percent of rail transit ridership), the model is less statistically robust for rail, and generally functions best for cities without a rail transit system.

While the AET model can be used as a stand-alone tool, it will perhaps be most useful as an exploratory tool to understand the magnitude of the influence that the increasingly older population will have on future ridership. Generally, the model shows that an increased older population depresses regular transit ridership (especially for buses), while increasing paratransit use.

4.2. User Guide

The user generally only will be interacting with the first worksheet in the AET model, named “User Input.” The model screen is depicted on the next page.

In the upper, “Base Year” section of the model, the green column represents default values for the selected urbanized area for the year 2000. Users should begin by selecting their urbanized area from the drop-down menu, accessed by selecting the city name in the yellow “Your input” column (cell D4). Default values for 2000 are provided for 307 urban areas (plus one generic “non-urban area”) based on Census and National Transit Database data.

The yellow column (“Your Input”), where the user selected their urbanized area, is for the user to fill in updated base year data. The user should first select a baseline year from 2000 to 2005 in which they can fill in their most recent information to update the default values. The next step is to fill in data for the current or most recent year for the agency’s service area, if it is available. The data you input in the model will require some forethought. Demographic data should be internally consistent. For example, if the urbanized area total population is 100,000 in 2006, the age group populations should add up to 100,000. The model will show an error message if you enter both the population age groups and the total and they do not match. Alternatively, in the Base Year Data section (for the current year), you may enter each population age group separately, and the total will calculate automatically. The model will help make adjustments in a number of categories to try to keep the data values consistent (for example, keeping a stable share of zero-vehicle households), but the user still should check all values to be sure of a robust result.

The blue “Base Year Data” column provides full results for the base year, filling in values for variables not entered by the user. These are filled in by the model using a combination of those

user inputs which were made, local growth rates from 1990-2000, and national trends and growth rates.

Figure 16. Base Year Inputs, AET Model

Please enter the data for your Base Year in the yellow area below. Default values have been provided in green to assist you. Make all of your entries in the yellow area only; the blue area will automatically update to include your data with default values where needed:

	Default Values	Your Input	Base Year Data
Urban area[1]:	Tallahassee, FL	Tallahassee, FL	Tallahassee, FL
Base year:	2000	2002	2002
Unlinked bus trips:	3,922,150		4,011,783
Unlinked rail trips:	-		-
Unlinked demand response trips:	49,180		51,166
Unlinked other transit trips:	-		-
Unlinked total transit trips:	**3,971,330**		**4,062,949**
Population aged 0-15:	36,847		38,465
Population aged 16-64:	150,865		158,189
Population aged 65+:	17,145		17,952
Urban area population:	**204,857**		**214,606**
Population aged 65-74:	8,998		9,165
Population aged 75-84:	5,965		6,397
Population aged 85+:	2,182		2,390
Workers:	126,781		135,599
Households:	83,596		87,574
Zero-vehicle households:	6,361		6,481
$Operating Cost/bus unlinked trip	$ 2.69		$ 2.69
$Operating Cost/rail unlinked trip	$ 2.48		$ 2.48
$Operating Cost/DR unlinked trip	$ 24.20		$ 24.20
$Operating Cost Bus	$ 10,545,700		$ 10,786,700
$Operating Cost Rail	$ -		$ -
$Operating Cost DR	$ 1,189,954		$ 1,238,017
Total operating costs	**$ 11,735,653**		**$ 12,024,717**

Notes:

1. Use the pull-down menu to select an urban area. Note that choices include "Non-urban area" and
2. All costs are expressed in 2003 dollars

In the bottom, "Forecast Year" section, the green "Default Forecast Year Values" provides one set of estimated values for the variables to assist the user in data inputs. This section extrapolates the Base Year Data to the forecast year, using a combination of smoothed local growth rates from 1990-2000 and national trends and growth rates (the former become less important and the latter become more important in the extrapolation the further in the future the forecast year is). The default values are fairly robust for the demographic data, although local adjustments will undoubtedly still need to be made by the user. The default values for transit ridership are fairly simplistic and should generally be discounted in favor of users' own models or the blue Modeled Forecast Results.

Data entry in the yellow Your Input column is only slightly different than for the Base Year. Enter either data for population segments or for all segments and the total, making sure that they are internally consistent. When altering population forecasts, one must be careful to keep realistic ratios between the different age groups (or just enter total population and let the model handle the age breakdown). Similarly, increases in the 16-64 age group should be approximately in parallel with changes in workers (a typical ratio is 3 workers for every 4 persons in this age cohort) and zero-vehicle households (look at the specific ratio for your urbanized area in the Default Values section). The model will immediately update the ridership projections based on the demographic inputs, using the factors described in detail below.

While you are free to enter transit ridership projections from other models, doing so will negate the effects of this model on those modes (although you may still gain insights about any of the transit modes not entered). You may benefit more from examining the magnitude of the change in this model and comparing it to the current results of alternative models.

It is especially important that you input the agency's individual cost estimates for transit service in the forecast years. The figures used in the AET model are national cost averages, which vary widely, especially for demand-response service.

As an example, the screen shot below shows a completed forecast year model with ridership results.

Figure 17. Forecast Year Values, AET Model

Please enter the data for your Forecast Year in the yellow area below. Default values have been provided in green to assist you. The green default values represent extrapolations combined from 1990 to 2000 trends in your urbanized area and in the U.S. We recommend using local predicted values if they are available. Population figures you enter should be calculated to add to the total, and must be complete (or omitted). Make all of your entries in the yellow area only; the blue area will automatically update to include your data with default values where needed. The blue area shows the results of the model, taking into account the changes in the aging population in the second blue column, as indicated.

	Default Forecast Year Values	Your Input	Modeled Forecast Result without Aging	Modeled Forecast Result with Aging
Urban area[1]:	Tallahassee, FL	Tallahassee, FL	Tallahassee, FL	Tallahassee, FL
Forecast year:	2010	2010	2010	2010
Unlinked bus trips:	4,391,322		4,059,972	4,042,892
Unlinked rail trips:	-		-	-
Unlinked demand response trips:	58,981		76,414	78,815
Unlinked other transit trips:	-		-	-
Unlinked total transit trips:	**4,450,303**		**4,136,387**	**4,121,707**
Population aged 0-15:	43,662		43,662	43,662
Population aged 16-64:	185,225		185,225	185,225
Population aged 65+:	21,213		21,213	21,213
Urban area population:	**250,100**		**250,100**	**250,100**
Population aged 65-74:	9,994		9,994	9,994
Population aged 75-84:	7,852		7,852	7,852
Population aged 85+:	3,366		3,366	3,366
Workers:	167,382		167,382	167,382
Households:	104,810		104,810	104,810
Zero-vehicle households:	6,979		6,979	6,979
$Operating Cost/bus unlinked trip	$ 2.69		$ 2.69	$ 2.69
$Operating Cost/rail unlinked trip	$ 2.48		$ 2.48	$ 2.48
$Operating Cost/DR unlinked trip	$ 24.20		$ 24.20	$ 24.20
$Operating Cost Bus	$ 11,807,189		$ 10,916,270	$ 10,870,346
$Operating Cost Rail	$ -		$ -	$ -
$Operating Cost DR	$ 1,427,094		$ 1,848,916	$ 1,906,988
Total operating costs	**$ 13,234,283**		**$ 12,765,186**	**$ 12,777,334**

Notes:

1. All costs are expressed in 2003 dollars

4.3. Underlying Analysis and Assumptions for the AET Model

In order to predict future ridership, we combined demographic projections and demonstrated associations between demographic characteristics and transit ridership. The following describes the analysis and the external data inputs to the model.

4.3.1. Association between Demographics and Transit Ridership

The AET model is based in part on a regression analysis of the relationship between change in transit ridership in urbanized areas from 1990 to 2000 and growth in several demographic categories. Urbanized areas were chosen as the geographic basis for the analysis because their area is most representative of regional settlement patterns and often of transit agency service areas. Urbanized areas are designated by the decennial U.S. Census, which defines urbanized areas as a core city and the surrounding areas that are settled at a minimal density. Generally, this includes both cities and their suburbs. The data for the analysis is compiled from U.S. Census and the National Transit Database, summed by urbanized area.

A first difference model was used for the regressions, meaning the model attempted to predict the change in ridership from 1990 to 2000 based on the changes in the independent variables For the base forecast model, which does not include the effects of the aging population, the following independent variables were included: zero-vehicle household growth, growth in worker population, and overall population growth. Growth was expressed in absolute numbers of the respective variable, for each transit mode. The results of the regular bus service model are shown below in Table 20.

Table 20. Regression on Bus Ridership Growth (No Rail), 1990 – 2000

	Coefficients	Standard Error	T Statistic	P-value
Change in Zero-Vehicle Households, 1990 – 2000	1187.982	114.687	10.358	0.000
Population Growth, 1990 – 2000	-30.373	8.592	-3.535	0.000
Change in Worker Population, 1990 – 2000	30.459	9.721	3.133	0.002

Source: ICF analysis based on data from NTD and U.S. Census

Bus growth rates differ in urbanized areas with rail service, and are analyzed in a separate regression, as is ridership for the other modes. It is important to note that the coefficients from these regressions are not strictly used to determine the direction (negative or positive) of the effect of each factor, but rather must be interpreted jointly. For example, in the above case, it would be a misinterpretation to hypothetically add 1000 people to the population and interpret this as meaning a 30,373 decrease in annual ridership would occur. Rather, using national urban averages, one must add 1000 persons, 543 workers, and 46 zero-vehicle households. The results would then be (1187.982 * 46) + (-30.373 * 1000) + (30.459 * 543) = 41,359 new trips created.

For rail systems, the data is significantly more limited than for bus and demand-response services. Model users working with rail ridership predictions are encouraged to use in-house models for the baseline ridership data.

Regression factors show up in the equations for each of the two forecasts (with and without aging data) as factors in the final growth rate.

For the forecast including aging data, the model uses only the 75-84 and the 85+ population growth to model changes according to age. These are increasingly important age segments because of the increase in disability and decrease in workforce participation after age 75. The effects of the population of those aged 65-74 was less clear in the modeling, possibly because of greater variability in health and working status in this age category.

4.3.2. Future Estimates

For future years, data baselines are calculated individually for each urbanized area. The values are smoothed to avoid over-application of change values from 1990 – 2000, and calibrated to mirror national trends in specific values such as growth in the age groups listed in the model. Users who have data on local demographic trends in the age cohorts listed should fill them in to improve on the calibrated estimates that are the default values in the AET model.

The final calculation of transit ridership in the model uses the demographic estimates in the far-left column (light green) or the user's input values, calculating the change in each population segment, and multiplying that change by one-tenth of the coefficient from the regression analysis, discussed above. This moves the total ridership in the correct direction (negative or positive) relative to the growth in that figure.

The final column of the forecast year box in the model shows modeled transit ridership taking the aging population into account. As noted above, this model takes into account only changes in the 75 and over population, not those in the 65 to 74 age population. These age groups are more consistently statistically related to transit ridership than the younger, 65-74 population segment.

4.3.3. Forecast Costs

The forecast years include total cost estimates. The user should, however, input agency-specific values for the average costs of transit service in their area. The costs shown here, as noted above, are national averages per unlinked trip in 2003 dollars.

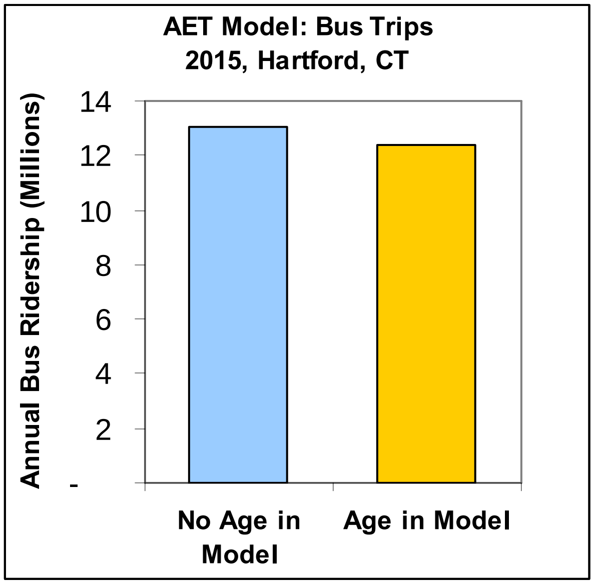
In general, costs are more significantly affected by increases in demand response than in the other two modes. Demand responsive service is typically several times more expensive than regular transit service per trip.

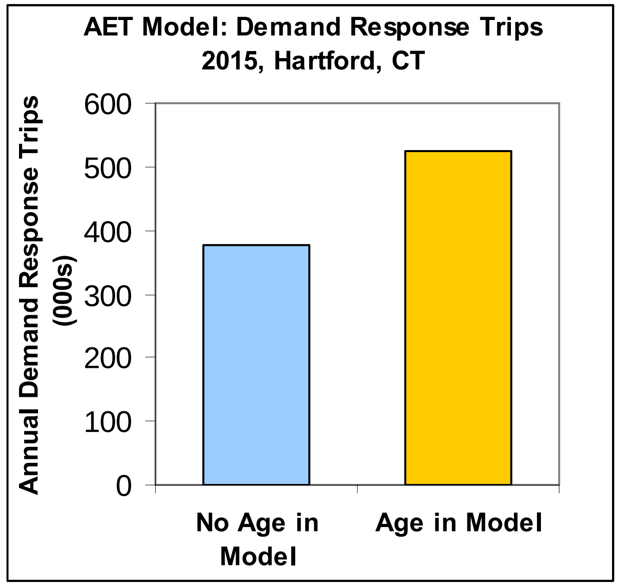
5. Conclusions

5.1. What Modeling Tells Us about Aging and Transit Use

The analysis and modeling described here conclusively shows that older people are less likely to travel in general and take fewer trips on public transportation than their younger counterparts. Growth in the older (75 and over) population corresponds to increased use of demand-response service, and decreased regular transit use.

Figure 18. AET Model Results for Hartford, CT, Showing Effects of Aging

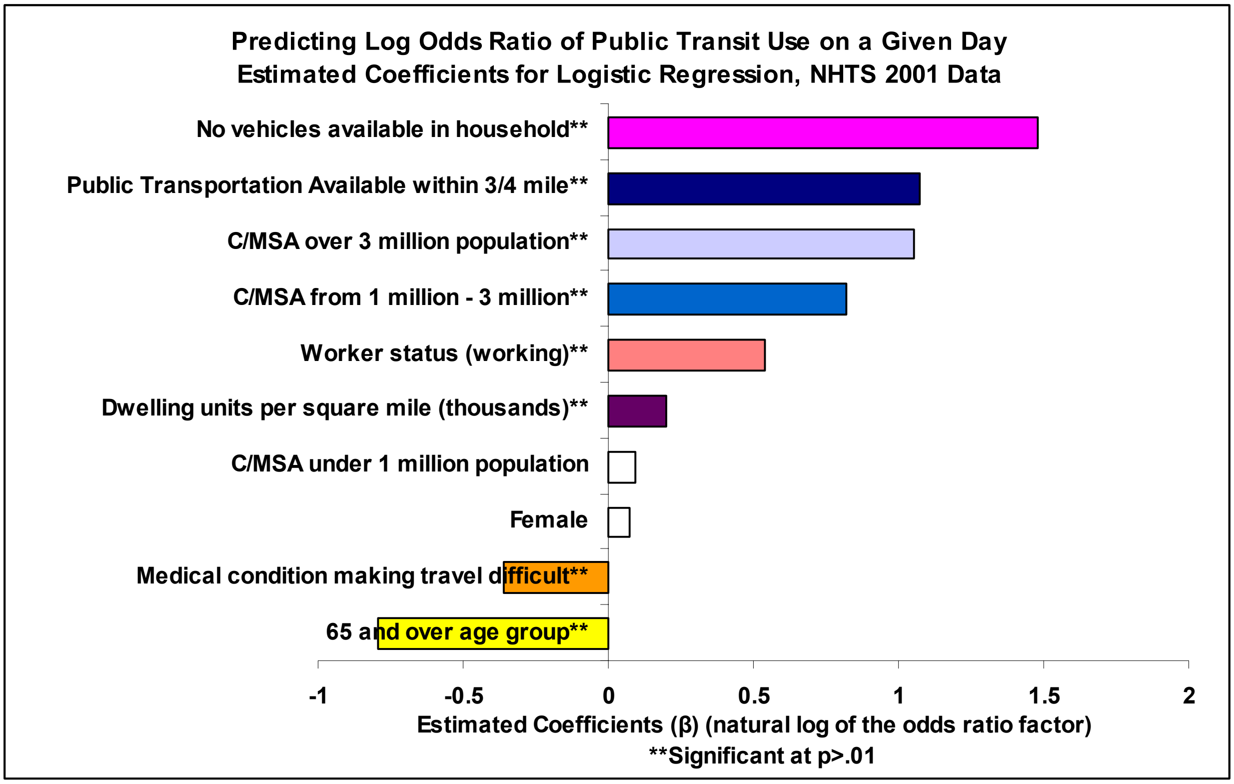




With the growth in this age segment, transit agencies must take into account the effects it will have both on regular transit and demand-response systems. Events in 2005 have shown that external factors (such as fuel prices, public transit quality, and availability) can have significant effects on public transportation demand. These external shifts may swamp the predicted demographics shown in the AET model.

However, the 2001 statistical analysis shows that while much of the effect of aging on transit use in the urbanized area-level model is related to workforce participation and disability, transit use also varies with age when controlling for these factors. There may be other life cycle factors not included here, such as financial assets (or lack thereof) and participation in social and family activities. These other aspects contribute to the significant correlation between aging and transit use. The relative effect of each of the individual characteristics identified in the statistical analysis is illustrated below.

Figure 19. Coefficients of 2001 NHTS Logistic Regression Model



Most of the model discussion above comes from the transit agency perspective, where the main concern is predicting actual transit use for the service area. An alternative view is explored at the end of Section 3, where we find a correlation between mobility and public transit availability. This gets at the question that planning agencies and state departments of transportation may have as to how much public transit is needed to allow residents to age in place. This is just one of the many research questions raised by this study - how does actual behavior relate to quality and type of service provided? Also, what type of destination service is required to support regular transit use? There is a wide variability of regional accessibility to transit, apart from access to transit near one's home. Still, the model shows a significant effect of transit availability near one's home (within ¾ mile) on the mobility of persons with medical conditions that make travel difficult.

This area of research will likely grow in importance as local and state governments across the U.S. prepare to provide a place for the aging Baby Boomers – one that will attract, retain, and support them in their life as they move into their 60s, 70s, 80s, and beyond. Transit agencies will need to adjust their expectations of ridership as well as future needs for demand-response service to complement regular transit service.

Annotated Bibliography

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Frey, William H. Boomers and Seniors in the Suburbs: Aging Patterns in Census 2000. Center on Urban and Metropolitan Policy, The Brookings Institution. January, 2003.

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The study uses data from four National Long Term Care Surveys (1982, 1984, 1989, and 1994) to look at active life expectancy for men and women. At age 65, men have 13.7 years of ALE, while woman have 15.7 years; however, at older ages, men have more remaining ALE than women, who have longer total life expectancy (TLE) but spend more time institutionalized.

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Using 1995 NPTS data, the study concludes that there are important differences in mode choice among the elderly linked to race and location, even when other variables are held constant. Residential location is considered the most important factor influencing mode choice.

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