ISSN: 2637-6067 DOI: 10.6918/IJOSSER.202103_4(3).0008

Research on the Choice Behavior of American Elderly Trip Chain Based on MNL

Shun Li[1, a]

[1]College of Transport & Communications, Shanghai Maritime University, Shanghai 201306, China

[a]1215828869@qq.com

Abstract

In order to study the travel behavior of the elderly, this article uses the data from the 2017 National Household Travel Survey in U.S., and select groups of people aged 65 years or older. Using Python to splice the travel data into a trip chain. According to the number of activities in the trip chain, the trip chain is divided into three types: simple trip chain, complex trip chain and super complex trip chain. The results show that more than half of the elderly have only one trip chain per day, and more than half of the trip chain is simple trip chain. Using Multinomial Logit Model to model and analyze the choice behavior of the elderly trip chain, the results show that the better health level of the elderly, the higher frequency of using smartphone on the Internet, the higher education level, and the more inclined to choose super complex trip chain; The higher frequency of using tablet on the Internet, the trip chain is more simple of the elderly; the trip chain of the elderly living alone is more complex; the trip chain of the elderly in low population density areas is more complex.

Keywords

Old people; Trip chain; Multinomial Logit Model (MNL); Python.

1. Introduction

The rapid development of medical and health standards has increased the average life expectancy of human beings to a certain extent, and the proportion of elderly people has also increased. Therefore, many countries have entered the elderly society. According to statistics, the number of people aged 65 and over was 53.2 million in America in 2019, accounting for 16.21% of the national population, which was an increase of 3.23% compared with 12.98% in 2010 [1]. In the past 10 years, the proportion of elderly people has risen linearly in America [2]. Statistics in the United States show that the proportion of the elderly in the number of travelers has increased, and the travel frequency of the elderly has also increased to a certain extent [3]. In order to enhance the happiness of the elderly and improve the quality of transportation services, it is necessary to conduct research on the travel behavior of the elderly.

Trip chain refers to a number of closed chain formed by connecting the traveler's daily trips in chronological order, starting from home [4]. For the definition of the complexity of the trip chain, some scholars think a trip chain that only contain one activity is called simple trip chain, and a trip chain that contain more than two activities is called complex trip chain [5]. Some scholars spliced all the activities of the day into a trip chain to form a more complex trip chain [6]. This article divides trip chain into three categories based on the number of activities contained in trip chain. Trip chain contains one activity is defined as simple trip chain, contains two activities is defined as complex trip chain, a travel chain with a number of activities more than or equal to three is defined as super complex trip chain.

ISSN: 2637-6067 DOI: 10.6918/IJOSSER.202103_4(3).0008

Scholars have achieved fruitful results in related research on trip chain all over the world. L.B. Li et al. used Binary Logistic regression to analyze and study trip chain choice behavior of residents in Xiaoshan District, Hangzhou [6]. M. Yang et al. also used Binary Logistic regression to analyze and study the selection behavior of commuting simple trip chain and complex trip chain [4]. L. Cheng et al. used the Mixed Logit model to model and analyze the trip chain choice behavior of low-income people [7].

In terms of travel research for the elderly, J. D. Schmocker et al. used the Ordered Probit model to analyze the complexity of the trip chain of the elderly in London [8]. Similarly, P. Pettersson et al. also used the Ordered Probit model to study the complexity of the trip chain for the elderly in Metro Manila [9]. Y.L.Q. Song et al. used the Logit model to model and analyze the travel mode of the elderly in Nanjing [10]. J. S. Hahn et al. modeled and analyzed the travel of the elderly in Seoul from the aspects of personal and family attributes [11].

Although the existing literature has achieved fruitful results, it still has the following shortcomings: (1) The data used in the existing researches are all travel survey data in a certain area; (2) The existing literature analyzes the choice behaviors of working people and low-income people in simple trip chain and complex trip chain, and analyzes and study the complexity of the elderly trip chain. However, there are few literatures that use the travel survey data of the elderly across the United States to analyze and study the choice of trip chain; (3) Existing research does not analyze the influence of different frequency on the Internet on the trip chain choice behavior of the elderly. Therefore, this article will use the travel data of elderly residents across the United States to study the influence of different devices on the Internet frequency, health level and family structure on the behavior of elderly trip chain choices. In order to provide information for transportation planning, improve the quality of existing transportation services, and enhance the happiness of the elderly.

2. Data

2.1. Data Sources

The data used in this article are obtained from the National Household Travel Survey conducted in the United States in 2017. The survey was conducted under the auspices of the Federal Highway Administration of the United States, and the survey lasted more than one year. Random sampling was used to investigate the daily trips of all residents in the United States. The data set contains abundant information, including family information, personal information, geographic location information, family vehicle information, travel purpose, travel mode, and travel distance. The data download URL is https://nhts.ornl.gov/.

2.2. Data Processing and Descriptive Statistical Analysis

The database used in this article has a huge amount of data, and the travel data table alone contains hundreds of thousands of rows of data, so the data processing mainly uses the programming software Python. This article selects travel data for people aged 65 years or older. There is a type of data in the obtained data, the travel purpose of the traveler is missing, and all travel data of the traveler whose travel purpose is missing are deleted. Encoding the travel purpose. The code with the original travel purpose "1" is "H", and the code with other travel purposes other than "1" is other non-"H" letters.

There are three types of data in the data table that completes the travel code: (1) In a day, the traveler’s starting point is "H" and the end point is not "H";(2) In a day, the traveler’s starting point is not "H", and the end point is "H"; (3) In a day, neither the start point nor the end point of the trip of the traveler is "H". Because the trip chain formed by these three types of data do not meet the definition of trip chain. Therefore, the “while” loop, “if else” nested structure and logical judgment statements in Python are used to identify and delete this type of data.

ISSN: 2637-6067 DOI: 10.6918/IJOSSER.202103_4(3).0008

The “while” loop, “if else” nested structure and logical judgment statements also are used in splicing of the trip chain. The splicing process is: starting from the first row of data, it is judged whether the travel destination is "H", and if the judgment condition is met, the travel start point and travel end point are sequentially connected to form a trip chain. If the judgment condition is not met, the travel destination of the next row of data is judged. This is repeated to complete the splicing of trip chain. After completing the splicing of trip chain, there is a "HH" chain similar to trip chain. Since this type of chain does not meet the definition of trip chain, such data is deleted. Then select variables and code them, and finally get 61,621 valid trip chains data for 41,390 residents.

The average daily number of trip chain for the elderly is 1.5 in the United States. The number of trip chain and the proportion of people are shown on Fig. 1. Fig. 1 shows that there are 25,877 people who have one trip chain in one day, accounting for 62.52% of the sample population. There are 11,606 people who have two trip chains in one day, accounting for 28.04% of the sample population; 3,214 people have three trip chains in one day, accounting for 7.77% of the sample population; 693 people who have 4+ trip chains in one day, accounting for 1.67% of the sample.

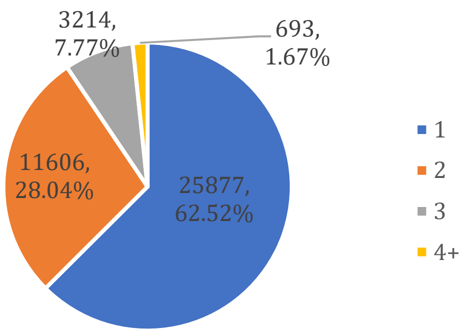

Fig 1. Distribution of the number of elderly trip chain

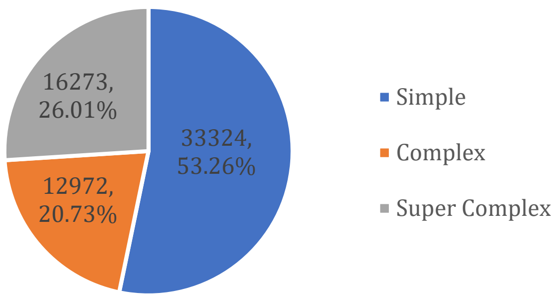

Fig 2. Distribution map of trip chain mode

The distribution of the complexity of the elderly trip chain and its proportion are shown on Fig. 2. Fig. 2 shows that the number of simple trip chains is 33,324, accounting for 53.26%; the number of complex trip chain is 12,972, accounting for 20.73%; the number of super complex trip chain is 16,273, accounting for 26.01%. In summary, more than half of the trip chains of American seniors are mainly simple trip chain, and American seniors only trip once a day.

Data descriptive statistics are shown in Table 1. From Table 1, the number of adults in American elderly homes is mainly 1-2, which shows that the family structure of American elderly is mainly the elderly living alone and with their spouses. The number of motor vehicles in the family is mainly 1-2, which is consistent with the family structure. The devices used by the elderly are mainly smartphone and tablet in America. In terms of surfing frequency, 49.6% of

ISSN: 2637-6067 DOI: 10.6918/IJOSSER.202103_4(3).0008

Table 1 Data descriptive statistics table

Variable		Number	Proportion
Gender	Male	20175	48.7
	Female	21215	51.3
Age	65-69	16303	39.4
	70-74	11406	25.6
	75-79	6888	16.6
	80-84	4104	9.9
	85+	2689	6.5
Education	High school and below	10620	25.7
	Some college or associate degree	12311	29.7
	Bachelor's degree	8629	20.8
	Graduate degree or professional degree	9830	23.8
Driver	No	2401	5.8
	Yes	38989	94.2
Worker	No	33111	80.0
	Yes	8279	20.0
Household income($/year)	[0,25000)	7065	17.1
	[25000,50000)	11060	26.7
	[50000,75000)	8431	20.4
	[75000,100000)	5783	14.0
	[100000,150000)	5712	13.8
	≥150000	3339	8.0
Count of adult household members at least 18 years old	1	11079	26.8
	2	27110	65.5
	3+	3201	7.7
Count of household vehicles	0	1064	2.6
	1	12745	30.8
	2	18181	43.9
	3	6387	15.4
	4+	3013	7.3
Number of drivers in household	0	879	2.1
	1	13246	32.0
	2	25052	60.5
	3+	2213	5.4
Number of workers in household	0	27491	66.4
	1	10196	24.6
	2	3295	8.0
	3+	408	1.0
Urban/Rural indicator - Block group	Rural	11030	26.6
	Small town	10411	25.2
	City	19949	48.2
Population density (persons per square mile) in the census block group of the household's home location	<100	6323	15.3
	[100,500)	7393	17.9
	[500,1000)	4105	10.0
	[1000,2000)	5627	13.6
	[2000,4000)	7749	18.7
	≥4000	10193	24.5
Race	White	37609	90.9
	Black or Africa american	2046	5.0
	Asian	861	2.0
	Other	874	2.1
Frequency of smartphone use to access the Internet	Daily	20535	49.6
	A few times a week	3002	7.3
	A few times a month	1385	3.3
	A few times a year	746	1.8
	Never	15722	38.0
Frequency of tablet use to access the Internet	Daily	12191	29.5
	A few times a week	4376	10.6
	A few times a month	2758	6.7
	A few times a year	1633	3.9
	Never	20432	49.3

ISSN: 2637-6067 DOI: 10.6918/IJOSSER.202103_4(3).0008

the elderly use smartphone on the Internet every day, nearly half, and 38% of the elderly who never use smartphone on the Internet. The proportion of people who use tablet on the Internet every day is 29.5%, and the proportion of people who never use tablet on the Internet is 49.3%. By comparison, it can be found that the smartphone is the main device used by the elderly on the Internet, which may be related to the convenience of carrying the two devices, because the smartphone is smaller and more convenient to carry. The use of the Internet by the elderly is polarizing in the United States. Nearly half of the elderly on the Internet every day, and nearly half of the elderly never on the Internet.

3. Method

3.1. Basic Theory

The establishment of the discrete choice model is based on the theory of random utility. When a decision maker is faced with a choice set, the decision maker generally chooses the plan that can bring him the maximum utility. In other words, when decision-maker i faces J options, decision-maker i will choose j from the J options that can bring him the maximum utility. At the same time, the utility obtained by decision-maker i is U_{ij}. The utility U_{ij} can be expressed as: $U_{ij} = V_{ij} + \varepsilon_{ij}$, V_{ij} is a fixed utility, and ε_{ij} is a random error term. The fixed utility V_{ij} can be expressed as: $V_{ij} = a_0 + \sum_{n=1}^{N} a_n x_n$, a_0 is a constant term, $\sum_{n=1}^{N} a_n x_n$ is the sum of the utility brought by each factor x_n, and a_n is the coefficient of each factor. Assuming that the random error terms are independent of each other and obey the Gumbel distribution with a mean of 0, then the probability that the i decision maker chooses the j option is [12]:

$$P_{ij} = \frac{exp(V_{ij})}{\sum_{j=1}^{J} exp(V_{ij})} \tag{1}$$

The discrete choice model used in this paper is Multinomial Logit model. There are three options: simple trip chain, complex trip chain and super complex trip chain. In the model estimation, the super complex trip chain is used as the comparison benchmark. The influencing factors x_n mainly include personal attributes, family attributes, built environment attributes, health level, race, frequency of on the Internet and travel variables.

The comparison of model fitting results is done through Likelihood ratio test. The principle is: model 1 is formula (2) and (3), the int Log likelihood of the running result is $L(U)$, and K_U is the number of estimated parameters. Model 2 is formula (4) and (5), the int Log likelihood of the running result is $L(R)$, and K_R is the number of estimated parameters. The relationship between the two models is shown in formula (6). If $-2(\mathrm{L(R)} - \mathrm{L(U)})$ is less than $\chi^2_{(K_U-K_R)}$, the fitting result of model 2 is better than model 1.

$$U_{11} = a_0 + a_1 x_1 + a_2 x_2 \tag{2}$$

$$U_{12} = b_0 + b_1 x_1 + b_2 x_2 \tag{3}$$

$$U'_{11} = a'_0 + a'_1 x_1 \tag{4}$$

$$U'_{12} = b'_0 + b'_1 x_1 \tag{5}$$

$$-2(\mathrm{L(R)} - \mathrm{L(U)}) \sim \chi^2_{(K_U-K_R)} \tag{6}$$

ISSN: 2637-6067 DOI: 10.6918/IJOSSER.202103_4(3).0008

Table 2. Variable coding and coding meaning table

Variable	Variable description
X_{11}	Count of trip chain for everyone one day(from 1 to 6)
X_{21}	Gender(1=male, 0=female)
X_{22}	Age
X_{23}	1=high school and below, 0=other
X_{24}	1=some college or associates degree, 0=other
X_{25}	1=bachelor's degree, 0=other
X_{26}	1=graduate degree or professional degree, 0=other
X_{27}	Driver(1=yes, 0=no)
X_{28}	Worker(1=yes, 0=no)
X_{29}	Full-time or part-time worker (1=part-time, 0=other)
X_{31}	Opinion of health(1=excellent, 2=very good, 3=good, 4=fair, 5=poor)
X_{41}	Count of adult household members at least 18 years old(1=one adult, 0=other)
X_{42}	1=two adults, 0=other
X_{43}	1=three and more adults, 0=other
X_{44}	Number of workers in household(from 0 to 7)
X_{45}	Household income(1=[0, $25000), 0=other)
X_{46}	1=[$25000, $50000), 0=other
X_{47}	1=[$50000, $75000), 0=other
X_{48}	1=[$75000, $100000), 0=other
X_{49}	1=[$100000, $150000), 0=other
X_{410}	1=$150000 or more, 0=other
X_{411}	Number of drivers in household(from 0 to 9)
X_{412}	Count of household vehicles(1=zero vehicle, 0=other)
X_{413}	1=one vehicle, 0=other
X_{414}	1=two vehicles, 0=other
X_{415}	1=three vehicles, 0=other
X_{416}	1=four or more vehicles, 0=other
X_{51}	Urban/Rural indicator - block group(1=rural, 0=other)
X_{52}	1=small town, 0=other
X_{53}	1=city, 0=other
X_{54}	Population density (persons per square mile) in the census block group of the household's home location (1=[0,100), 0=other)
X_{55}	1=[100,500), 0=other
X_{56}	1=[500,1000), 0=other
X_{57}	1=[1000,2000), 0=other
X_{58}	1=[2000,4000), 0=other
X_{59}	1=4000 and more, 0=other
X_{61}	Race(1=white, 0=other)
X_{62}	1=black or African American, 0=other
X_{63}	1=Asian, 0=other
X_{64}	1=American Indian or Alaska Native ,etc. 0=other
X_{71}	Frequency of smartphone use to access the Internet(1=daily, 2=a few times a week, 3=a few times a month, 4=a few times a year, 5=never)
X_{72}	Frequency of tablet use to access the Internet(1=daily, 2=a few times a week, 3=a few times a month, 4=a few times a year, 5=never)

ISSN: 2637-6067 DOI: 10.6918/IJOSSER.202103_4(3).0008

3.2. Discussion of Result

The variable codes in the model and their meanings are shown in Table 2. Parameter calibration uses software STATA 16. The model optimization process is listed in Table 3. The model optimization is completed in 5 steps. Each step only deletes some variables, and each step forms a nested relationship with the previous step. That is, the next step considers that the parameter a_i of the partial coefficient x_i in the previous step is 0. The model own 86 final calibration parameters. The calibration results are shown in Table 4.

Table 3. Model optimization process

Int Log likelihood	Number of estimated parameters	Degree of freedom	$-2(L(R) - L(U))$	relationship	χ^2
-59445.523	102				
		6	0.332	<	12.69
-59445.689	96				
		6	11.508	<	12.69
-59451.440	90				
		2	1.820	<	5.99
-59452.360	88				
		2	0.282	<	5.99
-59452.501	86				

The following conclusions can be drawn from Table 4:

(1) The more trips in a day, the fewer activities involved in each trip. In Table 4, the parameter of the simple trip chain X_{11} is 0.818, and the parameter of the complex trip chain X_{11} is 0.438, which is about twice the relationship, which fully shows that the more trips there are, the fewer activities involved each time. If old person can only travel once in a day, travelers would prefer to complete more activities during this trip.

(2) With age increasing, the trip chain of the elderly will become more simple. Because with the increase of age, the physical functions of the elderly gradually degenerate and their physical strength is getting weaker and weaker. They cannot participate in a large number of activities in a trip, so they tend to be more inclined to the simple trip chain. This is consistent with the estimate of the health of the elderly. The model shows that the worse the health of the elderly, the fewer activities they participate in each trip.

(3) The lower the level of education, the more inclined to choose a simple trip chain. Under normal circumstances, the higher the level of education, the wider the social sphere, and the richer the types of activities involved in daily life, so each trip will participate in more activities. Therefore, as the level of education increases, they will be more inclined to choose complex trip chain and super complex trip chain.

(4) Those who is worker and those who work part-time will participate in more activities each time they travel. For worker, they usually carry out activities such as dining, shopping, or leisure and entertainment after finishing their work to relieve the pressure caused by work or purchase goods needed in life and work by the way. For people whose work attribute is part-time, they will have more free time, so they will have more free time. They will use this time to enrich their spare time and improve their happiness index in their later years.

(5) When there is only one elderly person in the family, the elderly will participate in more activities each time they travel. When there is only one elderly person in the family, it means

ISSN: 2637-6067 DOI: 10.6918/IJOSSER.202103_4(3).0008

that the elderly person is living alone. If a person stays at home for a long time, the feeling of loneliness and unhappiness will increase. Therefore, the elderly will be more inclined to more outdoor activities to enrich their lives, improve their quality of life, and increase their happiness.

(6) The trip chain of the elderly holding a driver's license is more complicated. People with a driver's license are more mobile than those without a driver's license, their travel is less restricted by means of transportation, and their dependence on public transportation is lower. People with a driver's license can travel almost at any time, and they can engage in more activities each time they travel. They will not be unable to participate in more activities due to restrictions on public transportation routes and departure schedules.

(7) The number of motor vehicles at home has a significant impact on the complexity of the trip chain. When there is no motor vehicle at home, the elderly is more inclined to simple trip chain. Because there is no motor vehicle, the elderly mainly rely on public transportation, walking or non-motorized vehicles to travel, and the travel range of these vehicles is reduced; coupled with the age factor of the elderly, their physical strength is limited, so they participate in fewer activities each trip. When there are two motor vehicles at home, the elderly is more mobile and less dependent on other means of transportation outside the private car. They can make multiple trips in one day, so the elderly participates in fewer activities each time they travel.

(8) Elderly people living in low-density population areas are more inclined to choose super complex trip chain. In Table 4, the coefficients of the variables X_{51}, X_{52} and X_{54} are all less than 0, and the variables X_{51} and X_{52} can reflect from the side that the population density of the area where they live is low. If the population density of the residential area is low, the infrastructure construction of the residential area is not perfect, the bus line network density is low, the departure interval is longer, and the comprehensive utilization of land is low. Many purposes of the elderly cannot be achieved nearby. Therefore, the elderly generally choose super complex trip chain to reduce travel cost.

(9) Compared with other races, White, Black or African American and Asian travel are more inclined to choose simple trip chain and complex trip chain.

(10) The Internet access frequency has a significant impact on the complexity of the trip chain, and the Internet access frequency of different devices has different effects on the complexity of the trip chain. The lower the frequency of using smartphone on the Internet, the older people are more inclined to choose simple trip chain and complex trip chain. The lower the frequency of on the Internet using table, the older people are more inclined to choose super complex trip chain. This may be because smartphone is small in size and easy to carry. The higher the frequency of the smartphone for the elderly, the wider the social range, and the better physical condition of such elderly people. Therefore, their trip will participate in more activities. The tablet is large in size and inconvenient to carry, but it is more convenient to use. Activities such as shopping, video and file processing can be completed on the tablet. Therefore, the more frequently this type of elderly people use tablet on the Internet, the more they tend to choose simple trip chain and complex trip chain.

4. Conclusion

This article uses 2017 U.S. National Household Travel Survey data and uses programming software Python to generate elderly trip chain data. Through the analysis of the travel behavior of the elderly, the results show that the average number of trips of the elderly per day is less. About 62.52% of the elderly only travel once a day, and the elderly travel 1.5 times a day on average. In terms of trip chain complexity, 53.26% of trip chain are simple trip chain.

ISSN: 2637-6067 DOI: 10.6918/IJOSSER.202103_4(3).0008

Table 4. Estimation result of Multinomial Logit Model for Trip Chain Model Choice

Explanatory variables	Simple trip chain			Complexity trip chain		
	Coef.	Std. Err	P	Coef.	Std. Err	P
Constant	-2.045	0.193	0.000	-1.967	0.230	0.000
X_{11}	0.818	0.014	0.000	0.438	0.016	0.000
X_{21}	0.170	0.021	0.000	0.056	0.025	0.025
X_{22}	0.016	0.002	0.000	0.010	0.002	0.000
X_{23}	0.194	0.033	0.000	0.033	0.039	0.396
X_{24}	0.068	0.029	0.021	-0.044	0.035	0.208
X_{25}	0.094	0.030	0.002	0.017	0.036	0.628
X_{26}	base			base		
X_{27}	-0.342	0.068	0.000	-0.112	0.081	0.168
X_{28}	-0.178	0.048	0.000	-0.227	0.058	0.000
X_{29}	-0.016	0.045	0.725	0.142	0.055	0.010
X_{31}	0.077	0.011	0.000	0.080	0.013	0.000
X_{41}	-0.194	0.081	0.017	-0.116	0.096	0.226
X_{42}	-0.010	0.055	0.850	-0.022	0.065	0.733
X_{43}	base			base		
X_{44}	0.043	0.026	0.103	-0.027	0.032	0.382
X_{45}	0.076	0.026	0.144	0.087	0.062	0.156
X_{46}	-0.021	0.045	0.637	0.014	0.054	0.788
X_{47}	-0.054	0.044	0.218	-0.045	0.052	0.389
X_{48}	-0.087	0.045	0.055	-0.034	0.054	0.530
X_{49}	-0.030	0.045	0.496	-0.090	0.054	0.093
X_{410}	base			base		
X_{411}	0.073	0.039	0.058	0.068	0.046	0.141
X_{412}	0.360	0.098	0.000	0.108	0.119	0.364
X_{413}	-0.003	0.049	0.951	0.031	0.059	0.605
X_{414}	0.071	0.042	0.093	0.104	0.051	0.042
X_{415}	0.024	0.045	0.600	0.039	0.055	0.481
X_{416}	base			base		
X_{51}	-0.115	0.052	0.028	-0.138	0.062	0.025
X_{52}	-0.081	0.035	0.022	-0.124	0.042	0.003
X_{53}	base			base		
X_{54}	-0.164	0.061	0.007	-0.147	0.072	0.041
X_{55}	-0.064	0.051	0.211	-0.034	0.060	0.569
X_{56}	-0.071	0.048	0.138	0.027	0.057	0.635
X_{57}	-0.004	0.038	0.912	0.017	0.045	0.704
X_{58}	0.038	0.032	0.225	0.019	0.038	0.618
X_{59}	base			base		
X_{61}	0.238	0.069	0.001	0.239	0.084	0.004
X_{62}	0.144	0.083	0.082	0.196	0.099	0.048
X_{63}	0.338	0.102	0.001	0.292	0.122	0.016
X_{64}	base			base		
X_{71}	0.018	0.006	0.005	0.022	0.008	0.004
X_{72}	-0.012	0.035	0.022	-0.018	0.008	0.015

ISSN: 2637-6067 DOI: 10.6918/IJOSSER.202103_4(3).0008

Using Multinomial Logit Model to model and analyze the choice behavior of the elderly trip chain, the results show that: (1) The better the health of the elderly, the trip chain is more complex; (2) The higher the frequency of using smartphone on the Internet, the trip chain is more complex; (3) The higher the frequency of using a tablet on the Internet, the trip chain is more simple; (4) The trip chain of the elderly living alone is more complicated; (5) The trip chain of the elderly with lower population density in residential areas is more complicated.

To some extent, this research reveals that the influence of the health of the elderly and using different devices on the Internet on the complexity of the travel chain. This research findings have the following guiding significance for future related research:(1) In-depth analysis of the impact of physical health and mental health on the complexity of the trip chain of the elderly; (2) Exploring the deep-seated reasons for the different effects of different device Internet access frequencies on the complexity of the elderly trip chain; (3) Exploring the influence of family structure on the complexity of the elderly trip chain.

References

[1] Information on: https://data.worldbank.org.cn/region/north-america?view=chart

[2] Information on: https://www.kylc.com/stats/global/yearly_per_country/g_population_65above_perc/usa.html

[3] Information on: https://nhts.ornl.gov/publications

[4] M. Yang, X.W. Chen, W. Wang, et al. Behavior Analysis of Simple/complex Trip Chaining, Journal of Wuhan University of Technology (Transportation Science & Engineering), Vol. 32(2008) No.2, p.191-194.

[5] X. Zhao, H.Z. Guan, S.X. Liu. Study on Combined Mode Choice Behavior in Holiday Based on Trip-chain, Journal of Wuhan University of Technology (Transportation Science & Engineering), Vol. 35(2011) No.6, p.1139-1142.

[6] L.B. Li, M.F. Cao, J.J. Yin, et al. Observing the Characteristics of Multi-Activity Trip Chain and Its Influencing Mechanism, KSCE Journal of Civil Engineering, 2020

[7] L. Cheng, X.W. Chen, C. Feng, et al. Daily Trip Chain and Its Influencing Factors of Low Income Residents, Journal of Wuhan University of Technology (Transportation Science & Engineering), Vol. 39(2015) No.2, p.273-278.

[8] J. D. Schmocker, F.M. Su, R.B. Noland. An Analysis of Trip Chaining Among Older London Residents, Transportation, Vol. 37(2010), p.105-123.

[9] P. Pettersson, J.D. Schmocker. Active ageing in developing countries? – trip generation and tour complexity of older people in Metro Manila. Journal of Transport Geography, Vol. 18(2010), p.613-623.

[10] Y.L.Q. Song, Z.Y. Wang. Study on the Characteristics of Activity-travel Behavior of Urban Elderly and the Impact of Related Built Environment. Journal of Southwest Jiaotong University (Social Sciences), Vol. 19(2018) No.6, p.77-89.

[11] J.S. Hahn, H.C. Kim, J.K. Kim, et al. Trip making of older adults in Seoul: Differences in effects of personal and household characteristics by age group and trip purpose. Journal of Transport Geography, Vol. 57(2016), p.55-62.

[12] H.Z. Guan: Disaggregate Model—A Tool of Traffic Behavior Analysis (China Communications Press, China 2004)