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Research Article

How Do Sociodemographics and Activity Participations Affect Activity-Travel? Comparative Study between Women and Men

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Activity-travel behaviors of women and men are different because they have different social and household responsibilities. However, studies concerning gender differences are mainly limited in developed countries. This paper concentrates on gender role-based differences in activity-travel behavior in a typical developing country, namely, China. Using data from 3656 cases collected through surveys conducted in Shangyu, data processing, method choice, and descriptive analysis were conducted. Binary and ordered logistic regression models segmented by gender were developed to evaluate the mechanism through which individual sociodemographics, household characteristics, and activity participations affect the number of trip chain types and activities for women and men. The results show that women aged 30 to 50 perform less subsistence activities. However, the difference between the different age groups of men is not as significant. In addition, men with bicycles and electric bicycles have more subsistence and maintenance activities, whereas women do not have these attributes. Moreover, women with children under schooling age make more maintenance trip chains but less leisure trip chains and activities, whereas men are free from this influence. Furthermore, both women and men perform more subsistence activities if the duration increases, and men have less influences than women do.

1. Introduction

At the turn of the 21st century, China was in a revolution [1]. Since the "Reform and Opening-up" policy to the western world in the late 1970s, this revolution has brought rapid economic boom and continuous improvement of female social status and educational level. Consequently, gender differences have become more complex, requiring special attention and additional research. Women and men have varying roles in the society because of their different social and household responsibilities. As a result, gender differences exist in their activity-travel behavior concerning the influence of individual sociodemographics, household characteristics, and activity participations. Pas [2] found that gender is a significant factor for daily travel-activity behavior. Levinson and Kumar [3] assumed that the increase in trip chaining is an adjustment to higher family incomes and less time as women have already entered the workforce. Through statistical analysis, Elias et al. [4] concluded that demographic factors differently affect the tour frequency for women and men.

Various studies have been conducted in western countries, such as America and Germany, and in developed Asian countries, such as Japan and Korea, to determine the effect of individual/household sociodemographics and activity participations on daily activity-travel behaviors of women and men. McGuckin and Murakami [5] found that women, especially those with children in the household, are more likely to undertake chain household-sustaining trips when going to and from work. Based on the National Personal Transportation Survey, Strathman and Dueker [6] stated that women are more likely to form complex commutation and nonwork chains than men. Furthermore, Vance and Iovanna [7] found that employment status, age, number of children, automobile availability, and proximity to public transit exert significantly different effects on the probability

of nonwork car travel between women and men. In Japan, Kawase [8] disclosed that daughters are forced into long-distance commuting from their parents' homes because of the Japanese traditional idea that parents should not allow their daughters to live alone. In Korea, Jang [9] discovered that males prefer automobiles and females prefer public transportation and walking. Moreover, males have more activity time than females.

In developing countries, studies have focused on gender role-based differences in the activity-travel behavior of women and men. Yang et al. [10] analyzed gender-based differences in mode choice by comparing the interactions among sociodemographics, time-use patterns, and mode choices. Cao and Chai [11] concluded that males dominate outside work-related activities, whereas females dominate outside household-related activities. In addition, they jointly participate in nonwork activities. Yang et al. [12] assumed that male in-home activity participation has a positive effect on the length and number of female trip chains, and vice versa.

Previous studies have mainly focused on developed countries. Unlike in developing countries, gender differences in terms of activities and travel behaviors are relatively less emphasized. Although several studies dealing with gender have been conducted, most have merely focused on the travel itself. Limited research has been conducted on gender-based analysis to determine the influence of individual sociodemographics, household characteristics, and activity participations on the different types of trip chains and activities. Therefore, understanding and quantifying gender role-based differences in activity-travel behavior in developing countries are urgently needed. The present research will provide a deeper comprehension of the activity-travel behavior in China, thereby promoting contrastive studies between developed and developing countries.

Based on an activity-travel survey of Shangyu residents, the main objective of this paper is to explore gender-based differences in the following two aspects: first, analyze gender differences in various impact factor influences on subsistence number, maintenance, and leisure trip chains; and second, generate gender-based comparisons and analyses on how the influential variables affect the number of subsistence, maintenance, and leisure activities of women and men.

This paper consists of five sections. Section 2 presents the methodology of the binary logistic regression and ordered logistic regression. Section 3 discusses the data collection and processing methods. The criteria for the method evaluation are also explored, and descriptive analyses of the 13 independent and 6 dependent variables are made based on the gender differences. Section 4 presents the preliminary analysis and results, as well as the evaluation of relevant models. This section also mainly discusses the gender role-based differences in subsistence, maintenance, and leisure trip chains and activities. Finally, the conclusion and future directions are discussed.

2. Methodology

This study uses binary and ordered logistic regression models segmented by gender to evaluate how individual sociodemographics, household characteristics, and activity participations affect the number of trip chain and activity types of women and men.

In binary logistic regression, y is usually coded with values of 0 and 1, representing a binary choice or state. Several independent variables or predictors are included and defined as $x_1, x_2, \ldots, x_n$. Thus, the binary logistic model can be expressed as follows:

$$p\left(y = 1 \mid x\right) = \frac{1}{1 + \exp\left[-\left(\alpha + \sum_{i=1}^{n} \beta_i x_i\right)\right]}, \tag{1}$$

where p is the predicted probability when $y = 1$ and α and β are the intercept parameter and slope parameter, respectively [13].

Odds express the likelihood that an event would occur. Odds can be calculated using the following equation:

$$\text{Ln (odds)} = \text{Ln}\left(\frac{p}{1-p}\right) = \alpha + \sum_{i=1}^{n} \beta_i x_i. \tag{2}$$

Through this logit function, the model can be constructed and the variables can be estimated via an iterative maximum likelihood procedure and then used to analyze the influence of various impact factors by comparing the odds and odds ratio output [13].

Unlike the binary logistic regression, the ordered logistic regression is generally used for categorical responses with three or more values. The definition is as follows:

$$y^* = \alpha + \sum_{i=1}^{n} \beta_k x_k + \varepsilon, \tag{3}$$

where y^* is the exact but unobserved dependent variable and β $(\beta_1, \beta_2, \ldots, \beta_n)$ is the vector of regression coefficients that we wish to estimate [14].

Although directly observing y^* is impossible, its categories of y^* can be examined through the following:

$$y = \begin{cases} 0, & y^* \le 0 \\ 1, & 0 < y^* \le \mu_1 \\ \cdots & \\ N, & \mu_{N-1} < y^*, \end{cases} \tag{4}$$

where μ represents the cut-off score set by the model [14].

By observing y, the ordered logit technique could be used to fit parameters α and β. It can also be used to analyze the influence of impact factors.

3. Data and Descriptive Analysis

3.1. Data Collection and Processing. The selected city in this study is Shangyu, which is a typical small city located in the hinterland of the Yangtze River Delta and is one of the fastest growing regions in Eastern China. The city has a population of about 204,900 (average town population in China is 930,475) and covers an area of 111 square kilometers with a central district of 18.2 square kilometers. The survey was implemented to formulate an overall transportation plan

in Shangyu, and the plan was implemented in areas where the urbanization level has reached a considerably high degree. Data collection was conducted through questionnaires, random sampling method (sampling rate is approximately 3%), and face-to-face interviews. The response rate of the 5550 distributed forms is 89.7%. After the preliminary test, 4761 forms became available after the data were uploaded into the access database. With household as a unit, the survey involves all members in a household, except children under school age. The survey has three sections, namely, household characteristics, individual sociodemographics, and travel-activity attributes [10].

Two test rules have been set to remove the incorrect data.

(1) Considering that not all respondents thoroughly understand the survey, this test rule includes the following three common mistakes in the database.

   (i) Several items or attributes, such as job and family income, were left out in the form.

   (ii) Several attributes are incorrectly filled. For example, in the original questionnaire, the job is coded with values from 1 to 6, which represent the different levels of family income status. In several cases, the value of family income is 0. These items should be deleted from the database.

   (iii) Several attributes in an individual's daily activities contradict each other. For instance, we consider two typical mistakes. First, an individual's trip purpose is to go home but his/her destination for the same trip is the shopping mall. Second, the destination of an individual's last journey does not agree with the source of his/her next journey.

(2) The number of an individual's total activities should be more than or equal to the total number of his/her trip chains. In addition, an individual should have more subsistence activities than her/his subsistence trip chains; the same should be the case for his/her maintenance and leisure activities.

Students were excluded from this study because they always routinely travel. Finally, 3656 valid cases that can be used for further analysis were selected based on the above criteria.

The different types of activities and trip chains were then classified. Pas [15] placed all out-of-home activities in the three broad categories of subsistence, maintenance, and leisure. He defined work and school as subsistence, and shopping and personal businesses as maintenance [16]. This study excludes students and naturally categorizes work and several work-related affairs as subsistence activities; this research views shopping, picking up the children, and other personal business as maintenance activities. Bowman [16] defined leisure as optional activities for enjoyment. In this study, sports and other leisure entertainments were regarded as leisure activities.

A trip chain or tour is defined as the travel from home to one or more activity locations and back to home [17]. Each of these tours visits a number of stops or destinations. Within these destinations, several rankings of importance could be assumed [18]. In this study, the trip chain type was defined based on the type of primary destination, identified as "the destination at which the longest amount of time was spent" [18]. When focusing on a trip chain with multiple activities, we refer to a count of tours. That is, as all tours can be regarded as round-trip journeys, we need to calculate the number of complete home-based trip chains an individual has made in a day. The result is viewed as the number of his/her trip chains.

After classifying the different types of trip chains and activities, the dependent variables are processed as follows. First, personal trip chains should be removed from survey records. That is, based on the purpose of an individual's trip, the records per day are treated as different types of trip chains, such as H-W-H or H-S (shopping-) H. Then, the number of the trip chains and activities is calculated. Finally, all the dependent variables are coded with the proper values based on their distribution frequency (original values of these variables and detailed processing method are discussed in the next section).

Ultimately, independent variables should be processed based on their types. For the discrete independent variables, this paper uses several statistical characteristics that code these variables with proper values. The results are presented in Table 1. With respect to the continuous independent variables, this paper uses the total time an individual spends on a certain activity ("activity duration" equals "departure time" minus "arrival time").

3.2. Method Choice. The procedure for coding the dependent variables with specific values is an essential step for the final method selection. Figure 1 shows the frequency distributions of each variable. In terms of the number of subsistence trip chains, most people have no or only one trip chain (more than 99%); therefore, combining the second and third groups becomes a necessity. Considering the number of maintenance trip chains, individuals who undertake two or more trip chains do not account for an adequate proportion to separate them from the second group. Focusing on the number of leisure trip chains, the case is the same as the maintenance trip chain. That is, two groups are naturally classified. However, results change because the three parts of these numbers evidently occupy the majority of the number of subsistence activities. Therefore, individuals that have no trip chain, those that have one or two trip chains, and those that have three or more trips are coded with values 1, 2, and 3, respectively. For the number of maintenance activities, although individuals who have three or more maintenance activities do not have the proportion to separate them from the others, careful calculation will result in changes as the ratio of women becomes 14.4% and that of men becomes 7.8%. For women, 14.4% is a relatively large proportion. Men usually have only a few maintenance activities, so 7.8% is also a relatively large ratio. This factor is truly significant for the analysis of the men who have more "unexpected" trip chains. Finally, by

Table 1: Classification and description of independent variables.

Attributes		Classification	Description	Female	Male
Individual sociodemographics	Job	None	1, 0 otherwise	42.7%	24.8%
		At least one	Reference category	57.3%	75.2%
	Age	Under 30	1, 0 otherwise	10.9%	7.8%
		30–50	1, 0 otherwise	58.6%	60.0%
		Over 50	Reference category	30.5%	32.2%
	Driving license	Has not held	1, 0 otherwise	92.0%	60.8%
		Already held	Reference category	8.0%	39.2%
	Educational level	Low	1, 0 otherwise	44.8%	30.3%
		Middle	1, 0 otherwise	38.3%	40.0%
		High	Reference category	17.0%	29.7%
Household characteristics	Bicycles and electric vehicles	None	1, 0 otherwise	12.9%	13.5%
		At least one	Reference category	87.1%	86.5%
	Motorcycles	None	1, 0 otherwise	74.0%	71.7%
		At least one	Reference category	26.0%	28.3%
	Cars	None	1, 0 otherwise	88.2%	81.8%
		At least one	Reference category	17.8%	18.2%
	Annual family income	Under 20,000¥	1, 0 otherwise	22.9%	22.7%
		20,000-50,000¥	1, 0 otherwise	44.1%	44.8%
		Over 50,000¥	Reference category	33.0%	32.5%
	Children under school age	None	1, 0 otherwise	76.4%	76.1%
		At least one	Reference category	23.6%	23.9%
Activity participations	Duration of subsistence activities				
	Duration of maintenance activities				
	Duration of leisure activities				

concentrating on the number of leisure activities, the number can be divided into two because individuals who have no leisure activities account for most of the sample (more than 80%).

All the dependent variables have been coded with specific values, so we can now discuss the method selection. The number of subsistence, maintenance, and leisure trip chains is coded with 0 (none) and 1 (one or more). In this sense, they can be viewed as binary variables (whether an individual "has" or "does not have" a trip chain). Therefore, binary regression is the best choice for these variables. The same principle applies to the dependent variable "number of leisure activities." The number of subsistence and maintenance activities is coded with 1 (none), 2 (one or two), or 3 (three or more). Therefore, we can group the three categories as none, usual number, and greater number. Ordered logistic regression is suitable to group these variables.

3.3. Descriptive Analysis. In Table 1, the 13 independent variables are divided into two groups, namely, discrete and continuous groups. The discrete groups have two general types, namely, individual sociodemographics and household characteristics.

Considering the individual sociodemographics, 49.5% of women participated in the survey compared with 50.5% of men. Notably, 42.7% of the women do not have jobs, whereas 24.8% of the men are working, indicating that men might have higher levels of formal work engagement. Considering the ages, about three-fifths of the women and men are aged 30 to 50 years, revealing slight gender differences in the age distribution. Another evident difference can be observed in their driver's license. About 39.2% of men and only 8.0% of women have a driver's license, making it necessary for the latter to rely on other transportation modes, such as buses and "electric bicycles," which is a form of transportation in China that resembles a bicycle in appearance but uses electric batteries. In addition, the education level of women is lower compared with that of men, but the gap decreases, especially in the middle education level.

In terms of household characteristics, most women and men have at least one bicycle or electric bicycle, but only about one-fourth of these individuals have motorcycles. Moreover, cars are not widely used, with a ratio of 18%, although the annual family income is relatively high. Nearly 24% of the families have school-aged children, so parents face larger constraints on travel.

Activity participation includes information on frequency, intensity, and duration of physical activities in all main domains [19]. This paper considers the duration of subsistence, maintenance, and leisure activities as three continuous independent variables that reflect the influence of the activity participations on the trip chains and activities. Table 2 shows that the average time of subsistence activities for women is about 0.28 h less than that of men, although 39.1% of women have no subsistence activities, which is consistent with the above-mentioned job ratio. This finding also suggests

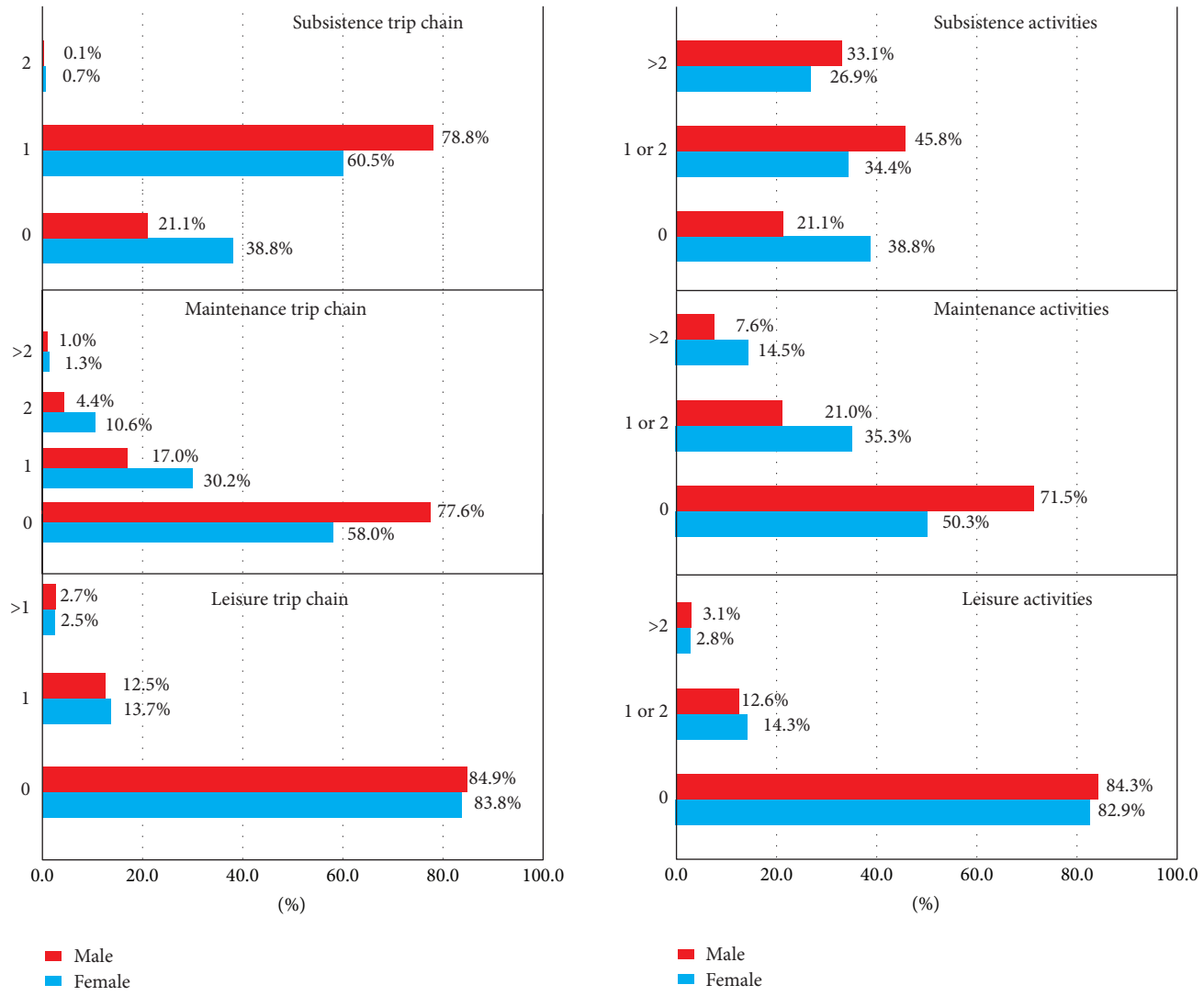

Figure 1: Distribution of trip chain numbers and activities between male and female.

that men are more burdened with formal work engagements than women. Furthermore, the durations of the maintenance and leisure activities are significantly lower than that of the subsistence activities. However, the number of women who have no maintenance activities is nearly 20% lower than that of men, indicating that women have more important roles in nonwork household activities than men.

We now focus on the six dependent variables that include the number of subsistence, maintenance, and leisure trip chains, and the number of subsistence, maintenance, and leisure activities. Table 3 shows that men have 17% more subsistence trip chains and activities than women. However, in the maintenance trip chain and activities, women are 20% higher. This finding indicates that men have more work engagements, whereas women are burdened with more household responsibilities. In addition, no significant gender difference in the leisure trip chain and activities is observed partly because most people in the city engage in minimal leisure activities, and the small figure fills up the gap. This finding is distinct from the situation in developed countries. Data from the 2000 Behavioral Risk Factors Surveillance System suggest that only 27% of adults in the US are not engaged in any leisure physical activity [20].

4. Analysis of Gender Role-Based Differences in Activity-Travel Behavior

4.1. Preliminary Tests. This paper used binary and ordered logistic regression methods. Testing the significance of the discrete and continuous independent variables is important. Using the Pearson chi-square test, we can determine the significance of the discrete variables and decide whether they are potential candidates as independent variables. Moreover, by using the logistic regression for single variables and by determining the Wald value, we can select the candidates as continuous independent variables for subsequent models.

After selecting the candidates for the discrete and continuous independent variables, a combined stepwise method is

Table 2: Statistical descriptions of continuous independent variables.

	Mean (h)				Std. deviation				Percentage of zero	
	Female		Male		Female		Male		Female	Male
	*	**	*	**	*	**	*	**		
Duration of subsistence activities	4.85	7.96	6.44	8.24	4.21	2.08	3.90	2.15	39.1%	21.8%
Duration of maintenance activities	0.80	1.68	0.71	2.67	1.79	2.29	2.11	3.38	52.4%	73.3%
Duration of leisure activities	0.28	1.70	0.28	1.87	0.86	1.46	0.95	1.74	83.3%	84.9%

*: Total cases are included, **: only nonzero cases are included.

Table 3: Classifications and values of independent variables.

Dependent variables	Classification	Values	Female	Male
Number of subsistence trip chains	None	0	38.8%	21.1%
	One or two	1	61.2%	78.9%
Number of maintenance trip chains	None	0	58.0%	77.6%
	One or more	1	42.0%	22.4%
Number of leisure trip chains	None	0	83.8%	84.9%
	One or more	1	16.2%	15.1%
Number of subsistence activities	None	1	38.8%	21.1%
	One or two	2	34.4%	45.8%
	Three or more	3	26.8%	33.1%
Number of maintenance activities	None	1	50.3%	71.5%
	One or two	2	35.3%	21.0%
	Three or more	3	14.4%	7.5%
Number of leisure activities	None	0	82.9%	84.3%
	One or more	1	17.1%	15.7%

used to pick the final variables needed in the model. Tables 4 and 5 show the results. The gender-based differences and policy applications related to the subsistence, maintenance, and leisure trip chains and activities are discussed in the following sections.

4.2. Gender Differences in Number of Subsistence, Maintenance, and Leisure Trip Chains. Table 4 shows that among the individual sociodemographics variables, nonwork negatively affects the subsistence trip chain, suggesting that nonworkers have less subsistence trip chains than employed individuals. In addition, jobs are more significant predictors for women, with odds ratios of –3.584 (women) and –2.720 (men). This finding can be attributed to the fact that females account for a relatively small proportion of the total number of workers and therefore are more sensitive to this variable. When considering age, women aged 30 to 50 years have less subsistence than those less than 30 years. However, the difference between the age groups of men is not as significant. This observation can be attributed to women who have more nonwork responsibilities after marriage. Another significant gender difference lies in the educational level. This predictor is positive for women who reached low and middle education levels but is insignificant for men in the maintenance trip chain. This finding can be explained through the two following aspects. First, the number of women who receive higher education is increasing. Thus, we can deduce that highly educated women have substantially more different lifestyles and after-work schedules compared with those who achieved lower education levels. This difference is naturally considered into the maintenance trip chain. Meanwhile, most of the men with low and middle education level still undertake more financial responsibility than women and, thus, focus on their work rather than their maintenance trip chain.

Considering household characteristics, low annual family incomes indicate that men with low or middle income tend to have less subsistence trip chains, whereas women with the same income have a different subsistence trip chain. In other words, the subsistence trip of women is not significantly affected because the increasing household income will make them stay at home and care more about their family affairs. However, for men, an increasing income is usually related to an increasing workload and, consequently, more subsistence trips. Moreover, when the family income increases, the life standard will also increase, resulting in the need to work harder for a better salary and cope with the new living standard. Children under school age do not significantly influence men in terms of all the three types of trip chains because they are relatively free from the responsibility to take care of the children. However, childless women are negatively affected in the maintenance trip chain. This finding indicates that women seem to make less maintenance trip chains before they have a child. However, as their responsibilities for raising children increase, women deal with more affairs regarding their children's everyday life. Therefore, they make more maintenance trip chains, such as shopping, to better raise

Table 4: Binary logistic regressions for number of subsistence, maintenance, and leisure trip chains.

	Number of subsistence trip chain				Number of maintenance trip chain				Number of leisure trip chain			
	Female		Male		Female		Male		Female		Male	
	B	Wald	*B*	Wald	*B*	Wald	*B*	Wald	*B*	Wald	*B*	Wald
Job-none	−3.584	263.391	−2.720	123.034	—	—	—	—	—	—	—	—
Age	57.583		46.300		12.72		7.750		8.106		21.219	
Under 30	2.884	25.320	1.540	6.975	−1.035	7.232	−0.631	2.166	−1.346	6.662	−1.750	4.888
30–50	1.528	46.832	1.801	44.193	−0.168	0.622	−0.590	7.266	−0.633	6.998	−1.439	19.245
Driving license-Has not held	—	—	—	—	—	—	—	—	1.279	6.549	—	—
Educational level	50.883		19.916		9.819		—		5.318		6.772	
Low	−2.842	37.221	−1.565	19.762	0.854	9.322	—	—	−1.304	3.965	−0.825	5.046
Middle	−1.771	14.253	−1.285	13.401	0.530	3.957	—	—	−0.347	0.520	−0.825	5.256
Bicycles and electric bicycles-none	—	—	−0.658	5.332	—	—	−0.303	4.433	—	—	—	—
Cars-none	0.729	4.371	—	—	—	—	0.309	4.572	—	—	—	—
Annual family income	—		8.842		—		—		—		—	
Under 20,000¥	—	—	−0.978	8.767	—	—	—	—	—	—	—	—
20,000-50,000¥	—	—	−0.575	3.536	—	—	—	—	—	—	—	—
Children under school age-none	—	—	—	—	−0.368	6.993	—	—	1.246	7.593	—	—
Duration of subsistence activities	—	—	—	—	−0.295	137.471	−0.254	89.400	−0.144	8.799	−0.392	6.023
Duration of maintenance activities	−1.256	95.551	−1.340	138.619	2.346	211.291	2.361	208.790	—	—	—	—
Duration of leisure activities	−0.847	32.149	−1.015	70.220	—	—	—	—	5.924	240.154	5.380	227.134
Constant	4.232	56.310	5.012	126.814	−0.495	4.119	−0.432	5.284	−4.346	20.770	−1.784	25.264
Nagelkerke R^2	0.831		0.789		0.797		0.682		0.818		0.807	

The omitted parameter is set to zero because it is treated as reference category.

the children. For the leisure trip chain, Tillberg Mattsson [21] stated that an essential impact of children on women's leisure trips is that the norm of organized child leisure results in a high degree of time-space adaptation on the part of the parents, especially the mothers. In this study, this impact appears as a positive predictor for women with no children. Based on these findings, we can conclude that women put less time and effort on the leisure trip chain when they have a child.

We now focus on the variables reflecting activity participations. The duration of the subsistence activities shows negative effects on the number of leisure trip chains for both women and men. However, the influence level differs between women and men, with odds ratios of −0.144 and −0.392, respectively. In other words, when the duration of the subsistence activities increases by 1 h, the likelihood for a leisure trip chain will decrease by 14% (1 − exp(−0.144)) for women and by 32% (1 − exp(−0.392)) for men because men usually work longer than women do. As a result, longer working hours for men decrease the time spared for the leisure trip chain, indicating that subsistence activities have a higher effect on men by making them devote more time for work. Therefore, men should weigh and balance work and leisure.

4.3. Analysis for Gender Role-Based Subsistence, Maintenance, and Leisure Activities. Table 5 shows the impacts of the sociodemographic variables. Age is a positive impact factor for both middle-aged women and men in the subsistence activities but has a different influential degree with odds ratios of 1.109 and 0.432. This finding suggests that middle-aged women are more likely to perform subsistence activities compared with men, with odds of 3.03 (women) and 1.54 (men). Considering the educational level, the likelihood of low-educated women who undertake subsistence activities is less than that of men. This finding can be attributed to the fact that men are burdened with more financial responsibilities and, therefore, would always try to perform more subsistence activities to better support the family despite their low education level. This observation is consistent with findings in the subsistence trip chain analysis.

Among the household characteristics, men without bicycles and electric bicycles notably have a negatively affected subsistence and maintenance activities. This mode is

Table 5: Logistic regressions for number of subsistence, maintenance, and leisure activities (binary).

	Number of subsistence activities				Number of maintenance activities				Number of leisure activities			
	Female		Male		Female		Male		Female		Male	
	Estimate	Wald	Estimate	Wald	Estimate	Wald	Estimate	Wald	*B*	Wald	*B*	Wald
Job-none	−1.516	85.099	−1.595	99.451	1.564	91.747	1.690	113.168	—	—	—	—
Age-under 30	1.014	19.620	0.176	1.756	−1.080	22.257	0.160	1.599	−2.629	7.078	−2.290	6.046
Age-30 to 50	1.109	40.594	0.432	10.804	−1.168	45.580	−0.459	12.374	−0.997	6.638	−1.741	23.493
Educational level-low	−0.624	15.226	−0.552	14.885	0.607	14.490	0.549	14.916	−0.997	4.043	−1.237	9.333
Educational level-middle	−0.208	4.114	−0.339	7.765	0.192	2.802	0.370	9.376	−0.227	1.240	−0.877	51.186
Bicycles and electric bicycles-none	—	—	−0.351	5.608	—	—	−0.351	5.715	—	—	—	—
Annual family income-under 20,000¥	—	—	−0.397	6.693	—	—	−0.365	6.977	—	—	—	—
Annual family income-20,000-50,000¥	—	—	−0.084	1.508	—	—	−0.170	4.363	—	—	—	—
Children under school age-none	—	—	—	—	−0.161	5.672	—	—	2.736	5.215	—	—
Duration of subsistence activities	0.219	107.581	0.067	12.858	−0.231	122.596	−0.102	32.542	−0.209	5.826	−0.117	8.657
Duration of maintenance activities	−0.391	34.092	−0.658	98.864	0.364	31.269	0.586	87.155	—	—	—	—
Duration of leisure activities	−0.353	12.070	−0.479	37.950	—	—	—	—	7.979	40.745	6.791	176.224
Evaluation of the model												
Valid cases	1810		1845		1810		1845		1810		1846	
Nagelkerke *R* square	0.681		0.574		0.638		0.656		0.911		0.844	

The omitted parameter is set to zero because it is treated as reference category.

an insignificant impact factor for women. This special case only occurs in several specific areas in China. To be exact, as motorcycles are regulated and cars are not widely used (18%) in Shangyu, bicycles, especially electric bicycles, have become the major transportation mode in this city. As a result, men are more inclined to perform subsistence and maintenance activities using electric vehicles, whereas women might use buses, thereby causing different influential degrees on these two types of activities for women and men. Concerning children under school age, having no children is a positive predictor for women in terms of their leisure activities, whereas it has no substantial effect on men. This finding can be explained by the fact that childless women have more free time to undertake leisure activities, whereas those who have children are committed to raising their kids. This finding is in good agreement with the influence of leisure trip chain.

With respect to the variables reflecting activity participations, the longer duration of subsistence activities indicates that the individual could perform more subsistence activities. Moreover, men seem to be less influenced by the additional time compared with women, having odds ratios of 0.067 and 0.219, respectively. This finding can be explained by the fact that most men shoulder a large part of the household financial responsibility, and numerous men already have one or more jobs to support their families. Therefore, an increase or decrease in the duration of the subsistence activities will not significantly increase the likelihood of having more subsistence activities for men. Another gender difference lies in the duration of the maintenance activities. This difference shows a more evident negative effect on men in terms of their number of subsistence activities. This finding indicates that men are less likely to perform subsistence activities than women when their time for maintenance activities increases.

5. Conclusions and Future Directions

This research focuses on the gender role-based differences in activity-travel behavior in developing countries, such as China. Using the travel data obtained from a survey in the city of Shangyu, data processing, descriptive analysis, and rigorous significance tests were conducted. Binary and ordered logistic regression model segmented by gender were developed to evaluate the mechanism through which individual sociodemographics, household characteristics, and activity participations affect the number of trip chain types and activities of women and men.

The major findings for the gender differences in the activity-travel behaviors are as follows.

(1) Individual sociodemographics: unemployed workers make less subsistence trip chains, and this finding is especially evident among women because of their smaller proportion in the total number of workers. Women aged 30 to 50 years make less subsistence trips

than those younger than 30 years. However, the differences between the age groups of men are insignificant. Education level is not related to men's maintenance trip chain, but women with higher education levels will make less maintenance trip chains. Men with lower education level have more subsistence activities than women who achieve the same level.

(2) Household characteristics: men with lower household income tend to have less subsistence trip chains, whereas women with the same income perform differently. Men with bicycles and electric bicycles have more subsistence and maintenance activities compared with women. Women with children under school age have more maintenance trip chains but less leisure trip chains and activities. By contrast, men are not influenced by this attribute.

(3) Activity participations: a longer duration for the subsistence activities leads to fewer leisure trip chains. This factor is more significant among men. Both women and men perform more subsistence activities if the duration increases, but men are less influenced than women. Men are less likely to perform subsistence activities than women when their time for maintenance activities is increased.

Several of our findings show potential implications for traffic demand management (TDM) policies. One of the most important aims of TDM programs is to directly or indirectly persuade travelers to change their schedules, thus affecting traffic congestion. For instance, the government in Eastern China usually adjusts commuters' work schedules to ease road congestion. However, according to the findings in this study, women with children under school age have to deal with more affairs involving their children's everyday life and would naturally make more maintenance trips, such as shopping, to better raise their children. Therefore, for working women, domestic needs might decrease their abilities to adapt to their expected work schedules, thereby seriously affecting their normal lives. Another implication lies in the quantity of the subsistence activities. By analysis, men respond less significantly to changes in the duration; therefore, men will show lower time or propensity to cut down or change their subsistence activities if the duration is decreased. Based on different degrees of influences of the strategy, we can formulate different TDM policies to decrease relevant working hours for women and men for more flexible maintenance and leisure trips. In addition, this proposal suggests that policy makers should be more oriented toward women because they can easily change their subsistence activities. Finally, this TDM strategy can result in fewer regular and concentrated trips to avoid traffic jams.

Several future research directions can be deduced from this study. First, many models, such as multinomial logit, probit, and negative binomial regression models, can be developed to compare the activity-travel behaviors investigated in this study. Second, Shangyu is a typical small city in China, so the research could be improved if other city scales and types can be utilized to enhance and increase available data. Third, along with gender, the sample population can also be divided into workers and nonworkers to achieve better comparison. Finally, more relevant investigations should be designed and conducted to verify and discover potential policy implications based on the analysis of gender-based activity-travel behavior.

Conflict of Interests

The authors declared that they have no conflict of interests to this work. They declare that they do not have any commercial or associative interest that represents a conflict of interests in connection with the work submitted.

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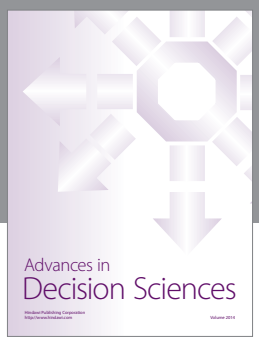

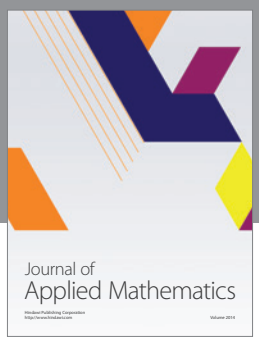

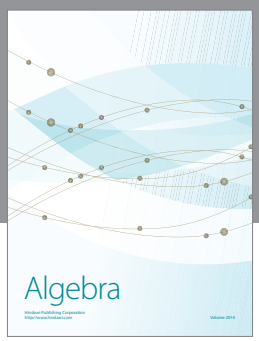

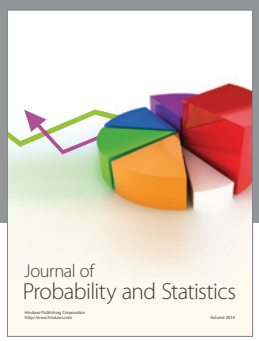

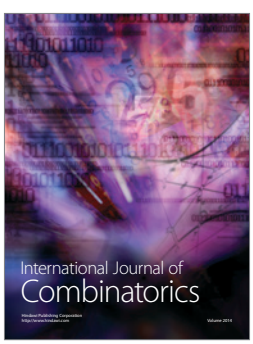

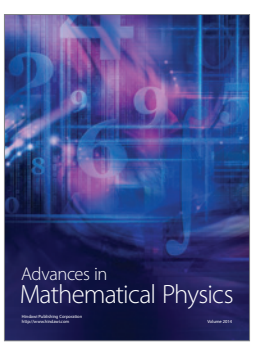

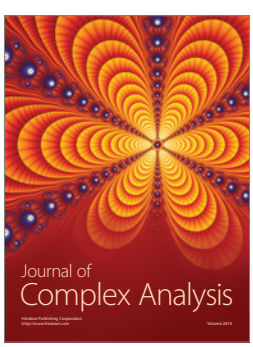

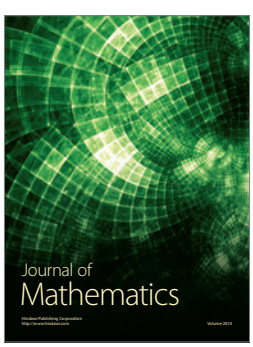

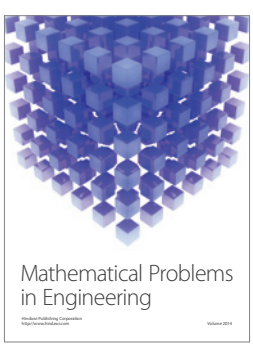

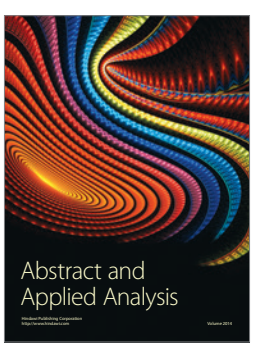

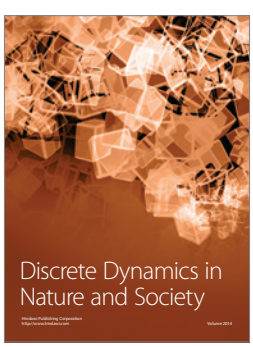

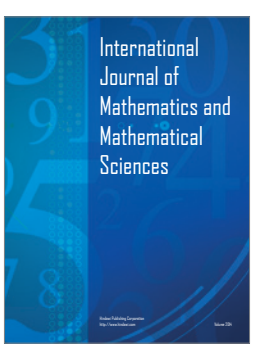

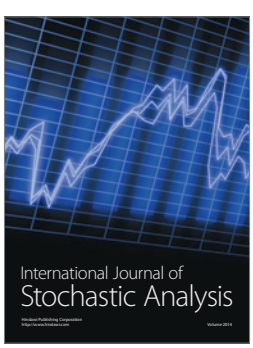

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