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Stroller Behavior and Road Characteristics on Walking Routes

by

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Abstract

Research on the behavior of strollers will contribute largely to the creation of high quality walking spaces. It is said that people can discover both the positive and negative aspects of their towns through daily strolls. For this study we selected two research areas, one rural and the other urban, in order to investigate and analyze stroll behavior in detail. The types of strolls, the walking distances, and the characteristics of road preferences selected in walking routes were analyzed based on data of the two areas. In addition, by comparing the analyses of the two areas, both the similarities and differences of stroller behavior between rural and urban areas were clarified.

Keywords: Pedestrian, Stroll behavior, Walking routes, Road characteristics

1. Introduction

It is thought that the importance of walking and of taking strolls for good health will increase in future societies in which comfortable lifestyles are desired. In such societies, it is desirable that walking spaces where citizens are able to walk not only safely and easily but also comfortably are enhanced further in both quality and volume. Moreover, constructing attractive walking spaces will help to reactivate stagnant shopping streets. Thus, it can be said that the maintenance of walking spaces will play an important role in improving town environments.

We have been researching preferable walking spaces from the idea that the stroll is one of the most basic and popular forms of walking behavior. As a result, we realized that it was

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important to know the spatial characteristics preferred by strollers as well as the characteristics of their behavior in order to be able to improve the networks of walking spaces. In this study, we investigated the realities of stroller behavior in Tanushimaru-cho in Fukuoka Prefecture, Japan, in October, 1994.

A number of notable findings were obtained through the analysis of the characteristics of walking routes relating to frequency, purpose, and time, etc. In addition, we investigated stroller behavior again in Nagaoka-Ooike, a residential area near the center of Fukuoka City, Japan, in October, 1997, to discover the points of similarity and difference between urban and rural areas. These series of findings were shown in Toi et al (1996, 1997, 1999 and 2000).

In this report, the realities of stroller behavior and the walking routes were analyzed, and the characteristics of the types of strolls and the routes preferred by strollers were clarified, paying attention to the points of similarity and difference in the two areas. Further, we compared the stroller behavior between the urban and rural areas.

2. Outline of Investigation

2.1 Investigation areas

Tanushimaru-cho is located in the countryside of Fukuoka Prefecture. The population of the town is about 22,000, but the recent aging of the population has caused this number to decline. Nagaoka-Ooike is a residential area in which about 18,000 people live. Geographically, the town abounds with many hills and slopes, and there are many waterside areas and trees even though it is adjacent to the center of Fukuoka City. The outline charts of both areas are shown in **Figs. 1** and 2.

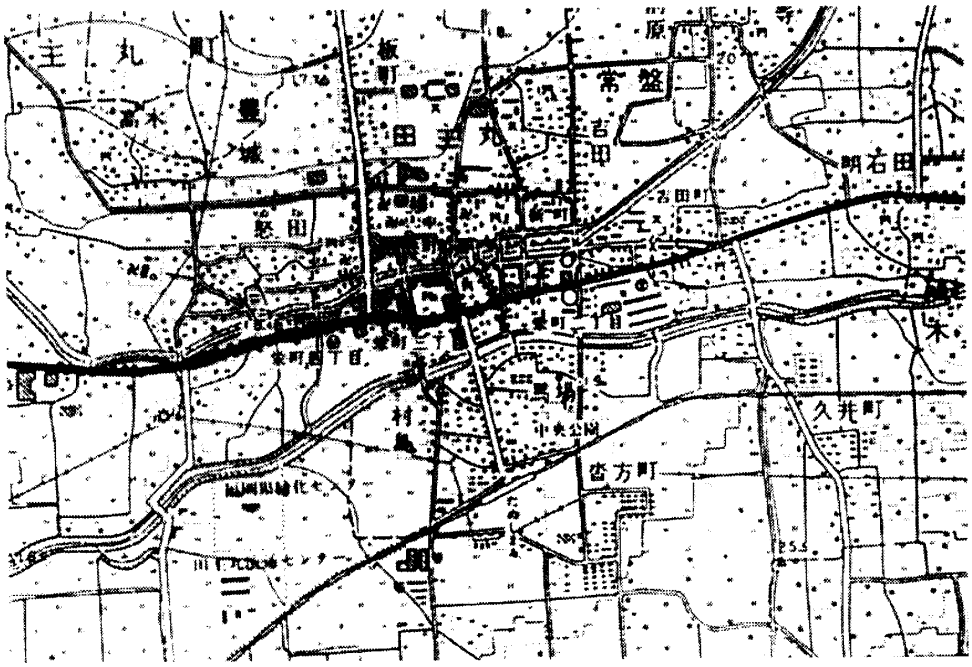

Fig. 1 The Tanushimaru Area.

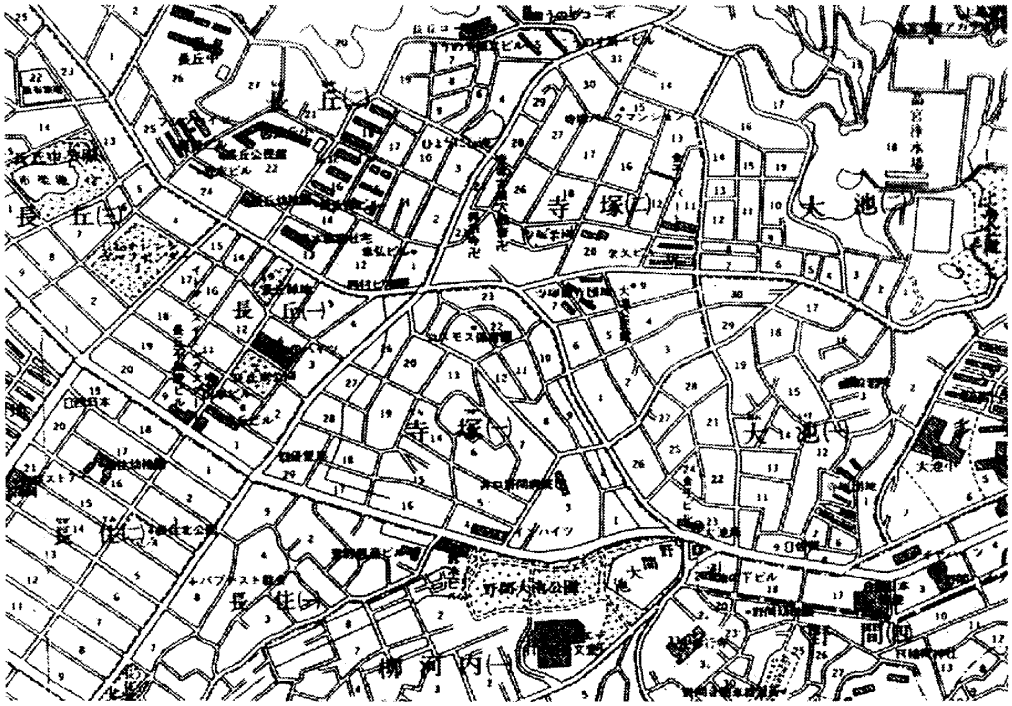

Fig. 2 The Nagaoka-Ooike Area.

2.2 Investigation method

Virtually the same method was adopted in both areas. Residents who were older than junior high school age were investigated. The items of the investigation consisted of their individual attributes, home attributes, strolling behavior including walking routes, and life environment, etc. The researchers visited many residents and distributed many questionnaires which were later collected. Cooperation of the residents for the investigation was received through the young men's office in Tanushimaru-cho and through the town chairman in the Nagaoka-Ooike area.

In Tanushimaru-cho, 464 homes were sampled in the center part of the town and 1130 questionnaires were distributed, of which 814 valid ones were collected. In the Nagaoka-Ooike area, 911 questionnaires were distributed, of which 511 valid ones were collected.

The age composition of respondents who returned valid questionnaires is shown in **Table 1**. The main difference in age composition between the two areas lies at the boundary of the 50 year old age group. That is, the age composition of the respondents was lower in Nagaoka-Ooike than in Tanushimaru.

Table 1 Age Composition of Valid Responses.

	Tanushimaru (rural area)	Nagaoka-Ooike (urban area)
Under 20	8.4%	9.2%
20～30	10.7	11.8
30～40	13.7	18.4
40～50	17.5	24.3
50～60	16.7	13.8
60～70	18.7	12.7
Over 70	14.4	9.9
Total	100.0	100.0

3. Total Results Concerning Stroll Behavior

The distribution of stroll frequencies is shown in **Table 2**. For Tanushimaru-cho, it was found that 42% of the respondents do not stroll at all, while 58% stroll more than several times a year. For the Nagaoka-Ooike area, on the other hand, 23% of the respondents do not stroll at all, while 77% stroll more than several times a year. Thus, the ratio of strollers to non-strollers is higher in Nagaoka-Ooike. The ratios of respondents who do not stroll frequently, such as only "2-3 times a month" or "several times a year," were high in both areas, though there were not many differences in the ratio of responses for "almost every day."

The frequencies of strolls for men and women are shown in **Table 3**. The frequency for women was higher than that for men in both areas. There are few differences in the stroll frequencies of men and women.

The stroll frequency of each age group is shown in **Fig. 3** and **Fig. 4**. The total percentage of responses of "almost every day" and "2, 3 times a week" increases with age in both areas. Moreover, the stroll frequency of the group over 70 years old is the highest.

This tendency is more prominent in the Nagaoka-Ooike area, and it is clear that stroll frequency rises with age. The percentage of respondents in the 40s age group who do not stroll at all is higher than both the younger and older age groups. Because this tendency is common to both areas, it seems that the middle age groups do not have room in their lives to stroll.

The reasons for taking strolls are displayed in **Table 4**. In Tanushimaru-cho, the reason of "Physical training and health" occupies almost half of the responses with 46.1%. This is higher than that of the Nagaoka-Ooike area, where the percentages of responses of "Physical training and health" and "Diversion of mind" were both 24.1%, and the percentage of the response of "Stroll while shopping" was 14.4%, which was also comparatively high in the Nagaoka-Ooike area. For the Tanushimaru-cho questionnaire, 8.9% of the respondents answered "Other" for their reason for taking a stroll. These reasons included "Stroll with

Table 2 Stroll Frequency.

	Tanushimaru (rural area)	Nagaoka-Ooike (urban area)
Almost every day	16.8%	17.4%
2, 3 times/week	14.7	16.9
2, 3 times/month	13.1	21.8
Several times/year	13.1	20.9
Not at all	42.1	23.0
Total	100.0	100.0

Table 3 Stroll Frequencies of Men and Women.

	Tanushimaru (rural area)		Nagaoka-Ooike (urban area)	
	Men	Women	Men	Women
Almost every day	13.9%	19.1	13.6%	20.7%
2, 3 times/week	13.6	15.6	12.3	20.3
2, 3 times/month	12.3	13.8	22.6	21.0
Several times/year	12.5	13.6	21.8	20.0
Not at all	47.6	37.8	29.6	18.0
Total	100.0	100.0	100.0	100.0

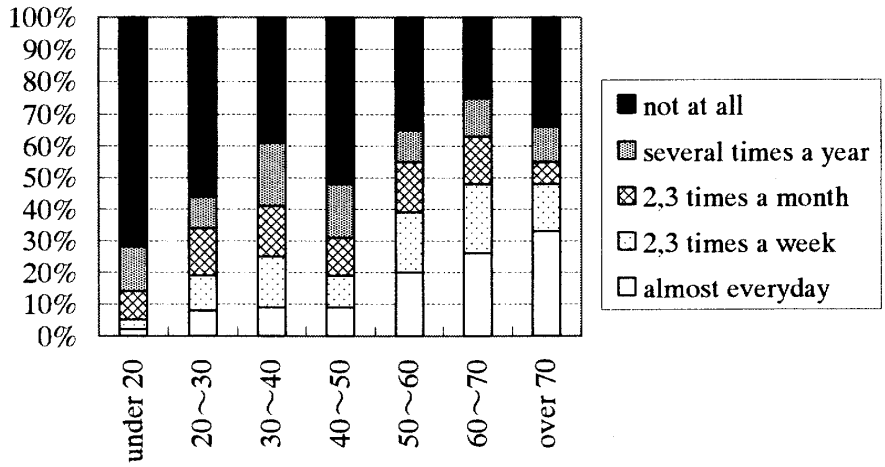

Fig. 3 The Stroll Frequency of Each Age Group (Nagaoka-Ooike Area).

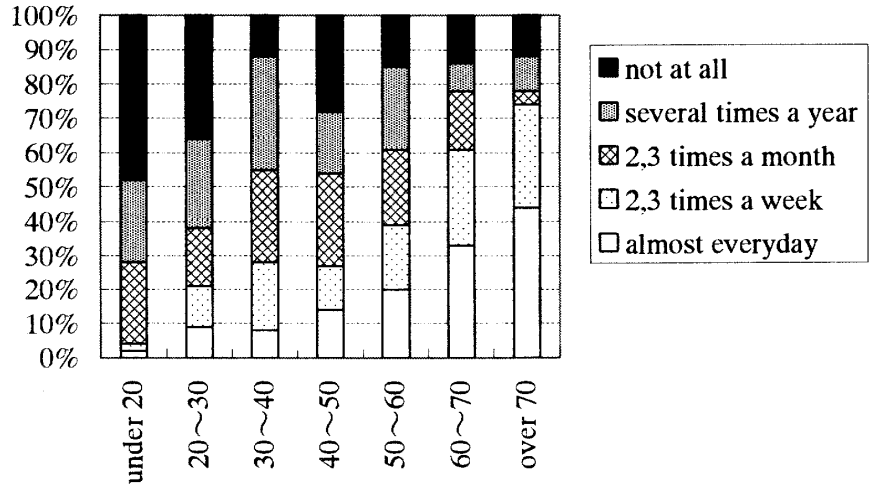

Fig. 4 The Stroll Frequency of Each Age Group (Tanushimaru-cho).

Table 4 Reasons for Taking a Stroll.

	Tanushimaru (rural area)	Nagaoka-Ooike (urban area)
Diversion of mind	25.9	24.1%
Physical training and health	46.1	24.1
As daily work	7.1	4.7
No reason in particular	12.0	5.5
Stroll with a dog	-	6.8
Stroll with a small child	-	7.5
Stroll while shopping	-	14.4
Stroll for passing time	-	3.9
Other	8.9	0.6
No answer	-	8.4
Total	100.0	100.0

a dog," "Stroll with a small child," "Stroll while shopping," and "Stroll for passing time." For the Nagaoka-Ooike area, however, the total of these other items totaled 33.2%, and therefore the reasons for strolls in this area seem to be more diverse.

The types of stroll are shown in **Table 5**. The ratio of "Walk around one's own house"

was 47.3% for the Nagaoka-Ooike area, and the ratio of "Consuming time in a park or at a waterside area" was 22.4%. In particular, this ratio in the Nagaoka-Ooike area is about twice that of Tanushimaru-cho, and the ratio of "Observing the scenery and the streets" is also greater than that of Tanushimaru-cho. Therefore, when compared with Tanushimaru-cho, the strollers in the Nagaoka-Ooike area seem to value rest and scenery more.

As shown in **Table 6**, for Tanushimaru-cho, the stroll duration of "Less than 30 minutes" was 47% while "30 minutes - 1 hour" was 45%. On the other hand, in the Nagaoka-Ooike area the ratio of "30 minutes - 1 hour" was 60% and the ratio of "1-2 hours" was also high. Thus, the stroll duration in the Nagaoka-Ooike area is, on average, longer than in Tanushimaru-cho. However, taking the above-mentioned feature regarding stroll type into consideration, this can be interpreted to mean that the time spent in a park or at a waterside area is included in the stroll duration.

Table 7 shows the times of day for taking strolls. For Tanushimaru-cho, the two categories "Early morning" and "Time is not fixed" are 20.2% and 25.3%, respectively, and the percentages are relatively high. For the Nagaoka-Ooike area, they are 20.5% and 29.0%, respectively, and these percentages are also relatively high. Moreover, the percentages of strolls in the nighttime and early morning are less in the Nagaoka-Ooike area. The principal cause for this seems to be the differences in age composition of the two areas. However, it can also be suggested that there are fewer nighttime strolls in the Nagaoka-Ooike area

Table 5 Stroll Types.

	Tanushimaru (rural area)	Nagaoka-Ooike (urban area)
Walking around one's own house	51.7%	47.3%
Consuming time in a park or waterside area	9.2	22.4
Moving around from placeto place	14.9	9.2
Observing the scenery and the streets	9.4	12.2
Other	14.6	7.5
No answer	0.2	1.4
Total	100.0	100.0

Table 6 Stroll Durations.

	Tanushimaru (rural area)	Nagaoka-Ooike (urban area)
Less than 30 minutes	47.0%	20.9%
30 minutes – 1 hour	45.3	61.1
1–2 hours	7.3	15.6
Over 2 hours	0.4	2.4
Total	100.0	100.0

Table 7 Time of Day of Stroll.

	Tanushimaru (rural area)	Nagaoka-Ooike (urban area)
Early morning	20.2%	10.1%
Before noon	10.9	16.3
Lunch time	1.2	1.4
Afternoon	10.5	17.0
Evening	17.4	20.5
Nighttime	14.5	5.7
Time is not fixed	25.3	29.0
total	100.0	100.0

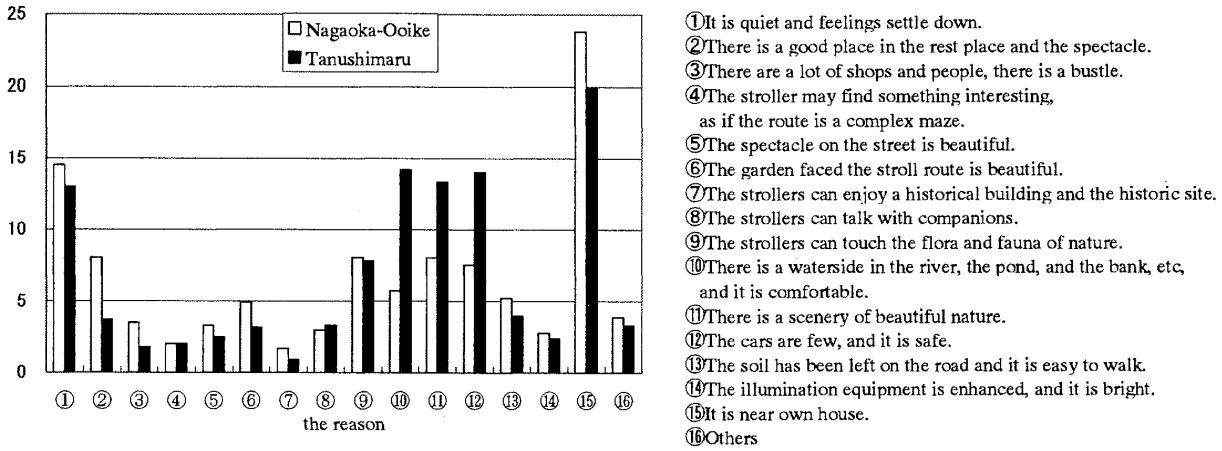

Fig. 5 Reasons for Choice of Route.

because of the precautions taken to avoid crime in urban areas.

The reasons why walking routes are selected are shown in **Fig. 5**. "It is near one's own house" represents the highest percentage in Tanushimaru-cho. Reasons such as "There are waterside areas such as rivers, ponds, and river banks, and they are nice and comfortable," "There is beautiful natural scenery" and "There are few cars and it is safe" were also high. Considering these reasons, it is understood that strollers primarily desire the element of nature.

The percentage of the reason "It is near one's own house" is also high in the Nagaoka-Ooike area. Reasons such as "It is quiet and relaxing," "There is beautiful natural scenery," "There is a good resting place and a nice view," and "One can be in contact with the area's flora and fauna" were also high. For both areas, a common tendency to seek nature and relaxing places could be seen in the distribution of responses. However, there is also a trend to prefer urban elements (2-6) in the Nagaoka-Ooike area, while the more countryside elements (10-12) are preferred in Tanushimaru-cho due to the environmental circumstances of each area.

4. Classification of Stroller Behavior

Stroller behaviors in both areas were categorized in order to get a clearer image of stroller behavior and to compare the two areas. The following procedure was executed in the analysis, and the number of valid data was 367 in Tanushimaru-cho and 398 in the Nagaoka-Ooike area.

First, the data from nine questionnaire items regarding stroll behavior were analyzed using multivariate analysis methods, and stroll behaviors were then classified into 12 groups.

Next, the concept of each group was examined concerning its relationship to the nine questionnaire items mentioned above using the following statistical methods. That is, when the percentage of a category for all data was assumed to be the population ratio, the statistical significance of the percentage of the category in each group was examined.

The following mathematical symbols were used:

S_j : number of all data of item (j)

T_{jk} : number of all data of item (j), category (k)

p_{jk} : ratio of item (j), category (k) $(= T_{jk}/S_j)$

G_{ij} : number of data of item (j), group (i)

X_{ijk} : number of data of item (j), category (k), group (i)

When the number of data of item (j), group (i) (G_{ij}) are extracted from all data (S_j) at random, the probability that the number of data will come under category (k) is (X_{ijk}), and can be shown by the following binominal distribution:

$$P(X_{ijk})={}_{G_{ij}}C_{X_{ijk}}\cdot {p_{jk}}^{X_{ijk}}\cdot(1-p_{jk})^{(G_{ij}-X_{ijk})} \tag{1}$$

If the number of data is as large as that of this data, binominal distribution is approximated to normal distribution with the expectation of $G_{ij}\cdot p_{jk}$ and the variance of $G_{ij}\cdot p_{jk}\cdot(1-p_{jk})$.

Therefore, X_{ijk} can be standardized by the following expression Z_{ijk}

$$Z_{ijk}=(X_{ijk}-G_{ij}\cdot p_{jk})/\sqrt{\{G_{ij}\cdot p_{jk}\cdot(1-p_{jk})\}} \tag{2}$$

When the significance level (α) is assumed to be 5%, only if the next formula is satisfied can it be judged that item (j) category (k) is significant in group (i):

$$Z_{ijk}>Z(\alpha/2)=1.96 \tag{3}$$

Finally, the group name was decided by referring to the significant categories in each group.

The classification results are shown in **Table 8**. Comparing the classifications of the two areas, we observed some differences between them. An overwhelming percentage is occupied by "Keep one's health type" in Tanushimaru-cho, while "Diversion of mind type" is high in the Nagaoka-Ooike area. The main axis in the subdivision in the Nagaoka-Ooike area is who the companion is, and its structure is more comprehensible than the classification of Tanushimaru-cho. On the other hand, a lot of common types also exist in the two areas, such as "Diversion of mind type," "Dog stroll type," "Time consuming type," and "Shopping type."

As also shown in **Table 4**, the percentage of respondents who take a stroll for diverting themselves or for promoting their health are equally high in the Nagaoka-Ooike area, and the reason for this is that diverting oneself is a main characteristic of stroll-taking behavior in the Nagaoka-Ooike area.

Table 8 Comparison of Stroll Classifications Between the Two Areas.

Tanushimaru (rural area)			Nagaoka-Ooike (urban area)		
Communication type		23	Diversion of mind type	Husband & wife type	92
	Time consuming type	23		Around the house type	114
Enforcing type		17		Friends' company type	14
	Moving around type	32		Free and easy type	16
Keep one's health type		77		Shopping type	15
Diversion of mind type		29		Parents type	6
Dog stroll type	(nighttime)	36		Other	6
	(day work)	24	Keep one's health type		74
Observation type		24	Dog stroll type		29
Free and easy type		71	Baby-sitter type		28
Shopping type		6	Time consuming type		3
Lunch time/visiting type		5	Other		1
Total		367	Total		398

5. Characteristics of Walking Routes

This chapter describes the respondents' preferred road characteristics, walking distances, and walking routes.

5.1 Length of walking route

The distribution of the walking distances obtained from the walking route data is shown in **Fig. 6.**

The average walking distance of Tanushimaru-cho was about 2860m, while that of Nagaoka-Ooike was about 1920m. Therefore, there is about a 1km gap between the two average distances. For Tanushimaru-cho, there are many strolls taken for their health benefits, and thus the elements of the countryside are preferred in the walking routes. For the Nagaoka-Ooike area, however, the ratio of the time passing type is high, and thus walking routes that contain urban elements are preferred. These features are also reflected in the walking distances. That is, even if the walking times are long, the walking distances are not necessarily long in the Nagaoka-Ooike area.

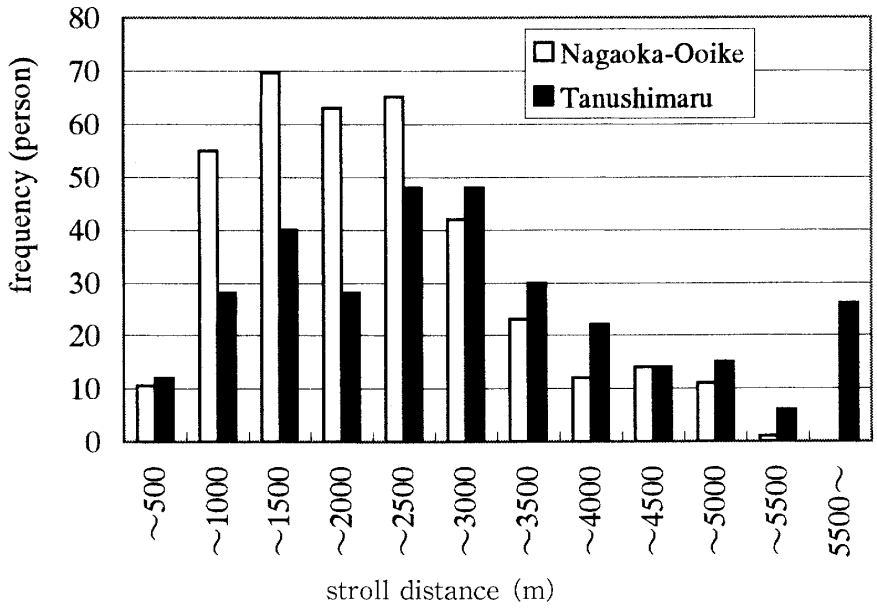

Fig. 6 Distribution of Walking Distances.

5.2 Analysis concerning road characteristics preferred as walking routes

(1) Analysis method

The following two kinds of composition rates were used to extract the road characteristics preferred on stroll routes.

① Real route composition rate

This is calculated by dividing the extension of each characteristic that appears on the real routes by the total extension of walking routes.

② Possible route composition rate

Possible routes have the same origin and destination of the real route, and their lengths are almost equal to the real route. A lot of possible routes are searched at random by a computer network simulation. The possible route composition rate is calculated using the

extension of each road characteristic of possible routes as well as the real route composition rate.

The real route composition rate indicates the road characteristics that strollers actually walked. But it should be standardized based on the average characteristics because it can be influenced easily by the road characteristics in the area.

Regarding the possible road composition rate, each walking route is calculated as a basic unit. Therefore this composition rate shows the average road characteristics around a stroller's residence. The influence of the road characteristics around the residence can then be removed through comparing and contrasting the real route composition rate with the possible road composition rate.

Here, the statistical significance of a certain road characteristic is determined based on the idea that the possible routes constitute the population, and the real routes are the specimens extracted from the population. The following expression can be used:

$$Z_j=(x_j-np_j)/\sqrt{np_j(1-p_j)} \tag{4}$$

Where,

x_j : average link length conversion value of road extension of characteristic (j) in real routes (This means the occurrence frequency of characteristic (j)).

n : average link length conversion value of real routes (This means the trial frequency).

p_j : ratio of road characteristics (j) in possible routes (This means the generation rate of characteristic (j) in population).

x_j is formulated as the probability variable according to binominal distribution. And Z_j of expression (4) is the approximated probability variable according to the standard regular distribution. The road characteristics (j) of real routes can be significant at the 5% level only if $|Z_j|$ is more than 1.96.

(2) Result of analysis

The possible road composition rate, the real route composition rate, and the value of Z_j of the two areas are indicated in **Table 9**. Comparing the two composition rates of Tanushimaru-cho, it is understood that the ratio of the following road extensions are high: good state of pavement, smooth and straight road lines, no sidewalks, two-way traffic, little automobile traffic, and no lighting.

It is thought that the road characteristics are preferred when the composition rate of the real route is higher than that of the possible routes. Here, if Z_j is positive and $|Z_j|$ is large, it means that the composition rate of the road characteristics (j) is significantly high. The characteristics that satisfy these conditions are preferred in walking routes. They are, regarding the road structure, good state of the asphalt pavement, slopes, gradual curves and winding roads, 5m widths, and sidewalks on at least one side. Moreover, regarding the roadside conditions, the characteristics are flowery plants, farms and fields, rivers, schools or hospitals, no buildings, two-way traffic, and less urbanization. These are features of the countryside. In Tanushimaru-cho, many strollers seem to prefer roads where nature is abundant.

Next, the real route composition rates in **Table 9** (the Nagaoka-Ooike area) show that the ratios of the following road extensions are high: good asphalt pavement, smooth or gradual slopes, straight, 5m-10m in width, no sidewalks, two-way traffic, good scenery, and no lighting. The characteristics with a high composition rate judged by Z_j are as follows: (regarding the road structure) roads with tile and brick pavement or soil surfaces, flat, gradual curves, wide width, and sidewalks; and (regarding the route surroundings) roadside

Table 9 Composition Rate and Significance of Road Characteristics in Stroll Routes.

(Tanushimaru-cho)

Road characteristic and category		Composition rate of routes		Significance (Z_i)
		Possible route	Real route	
Pavement	Asphalt (good condition)	78.6	86.1	14.8
	Asphalt (bad condition)	10.8	8.4	-6.1
	tile-brick	2.3	1.0	-7.0
	Soil surface	8.3	4.5	-11.3
Slope	Slop	3.5	12.5	38.9
	Flat	96.5	87.5	-38.9
Line	Straight	69.2	60.2	-15.7
	Mild curve	26.5	32.7	11.3
	Steep curve	4.3	7.1	11.0
Width	Under 2m	7.8	3.5	-12.9
	2mk~3m	18.9	16.5	-4.9
	3m~4m	24.0	15.9	-15.3
	4m~5m	20.0	19.8	-0.4
	5m~6m	10.6	15.9	13.9
	6m~8m	7.6	17.4	29.6
	Over 8m	11.0	10.9	-0.2
Roadside	Trees or woods	0.6	0.3	-4.9
	Fields	0.1	0.9	32.7
	Park·Square	9.1	6.3	-11.8
	Flowers	5.7	10.7	25.7
	Chikugo river·Kose river	6.8	11.8	24.1
	Hibari river	3.2	1.2	-14.0
	Brooks	3.1	3.6	3.7
	Farms	3.6	6.2	16.7
	Cultivated fields	11.0	13.5	9.4
	Buildings	40.3	28.4	-29.6
	Irrigation channel	6.8	4.8	-9.2
	Weeds	9.6	12.4	11.3
Sidewalk	Both sides	8.2	6.9	-3.7
	One side	10.6	13.4	7.2
	None	81.2	79.7	-3.1
Regulations	Two way traffic	92.3	96.0	11.4
	One way traffic, etc.	7.7	4.0	-11.4
Degree of urbanization	Almost 100% urbanized	40.2	26.3	-22.8
	75% urbanized	6.9	4.1	-8.9
	50% urbanized	26.4	21.4	-9.1
	25% urbanized	10.0	14.0	10.6
	Not urbanized at all	16.4	34.1	38.7
View	Good	44.7	68.1	37.9
	Not good	55.3	31.9	-37.9
Traffic volume	Frequent	14.9	14.6	-0.8
	Middle	26.3	30.9	8.3
	Few	58.7	54.5	-6.8
Lighting	Well equipped	25.1	14.8	-19.1
	Not well equipped	4.9	5.6	2.7
	None	70.0	79.6	16.8

(Nagaoka-Ooike Area)

Road characteristic		Composition rate of routes		Significance
		Possible route	Real route	
Pavement	Asphalt (good condition)	92.7	82.3	-41.3
	Asphalt (bad condition)	0.9	1.7	8.7
	tile-brick	1.8	5.3	27.4
	Soil surface	3.5	10.5	39.0
	Others	1.1	0.2	-8.6
Slope	Steep slope	24.9	16.1	-21.0
	Mild slope	39.0	36.5	-5.3
	Flat way	30.8	41.8	24.5
	Stairs	5.3	5.6	1.6
Line	Straight	70.3	66.3	-8.7
	Mild curve	20.4	25.7	13.2
	Right angle	3.4	2.3	-5.8
	Steep curve	5.1	5.5	1.7
Width	Under 5m	14.4	16.1	4.9
	5m~10m	76.3	60.5	-37.5
	10m~15m	6.7	16.9	41.3
	15m~20m	0.9	2.9	21.4
	Over 20m	1.4	3.4	17.4
Roadside	Trees	4.1	6.0	12.6
	Woods	12.0	15.0	11.6
	Park	2.9	9.3	47.7
	Cemetery park	1.7	1.2	-5.0
	Ponds	1.3	4.0	31.2
	Brooks	0.0	0.1	3.3
	Fields	0.2	0.1	-3.0
	Buildings	57.2	51.4	-14.9
	Walls	14.1	8.5	-20.2
	Open space	5.4	3.7	-9.6
	Others	1.0	0.6	-5.3
Sidewalk	Both sides	22.7		21.0
	One side	20.2	24.9	11.7
	None	57.0	43.7	-27.3
Traffic regulations	Two way traffic	83.0	84.8	4.9
	One way traffic	8.2	6.3	-7.1
	Entrance prohibited	8.7	8.8	0.6
	Others	0.1	0.0	-1.5
Degree of urbanization	Almost 100% urbanized	53.5	46.7	-13.7
	75% urbanized	15.5	12.9	-7.3
	50% urbanized	17.6	20.5	7.8
	25% urbanized	2.7	3.6	5.0
	Not urbanized at all	10.7	16.3	18.4
View	Good	54.4	60.4	12.2
	Not good	45.6	39.6	-12.2
Traffic volume	Frequent	9.2	15.4	21.6
	Middle	23.3	23.0	-0.7
	Few	67.5	61.6	-12.7
Lighting	Well equipped	13.9	22.9	26.3
	Not well equipped	25.5	21.1	-10.1
	None	60.6	56.0	-9.6

trees and forests, parks, ponds, brooks, and less urbanization. From the above-mentioned analysis, there is a tendency that the elements of nature are preferred over the elements of urbanization. It is understood that roads with wide widths, heavy traffic, and safety features such as sidewalks and lighting are also highly preferred in the Nagaoka-Ooike area.

Here we will compare the two areas and clarify their differences and similarities.

Regarding pavement, slope, and lighting, the two areas have opposing preferences. That is, urban roads are preferred in the Nagaoka-Ooike area, while roads surrounded by nature are preferred in Tanushimaru-cho.

On the other hand, the residents of both areas seem to prefer gradual curves, waterside areas, and good views, while buildings and urbanized roadsides are not preferred, and roads with little traffic are not preferred as much.

5.3 Road characteristic preferences based on road group classifications

In the previous section, the preferences of road characteristics were individually analyzed. However, road characteristics seldom appear independently from other characteristics in the real road network. Many characteristics are mutually related, such as pavement, width, traffic volume, roadside conditions, level of urbanization, and lighting. Therefore, in this research, road links in the two areas were classified based on the combination of road characteristics, a feature was given to each road group, and the preferences of each road group in the walking routes were analyzed.

First, the roads where the respondents walked and the roads around them were extracted from the road network, and the characteristics of those roads were investigated. These characteristics data were analyzed with quantification methods. Then 17 road groups in Tanushimaru-cho and 18 road groups in the Nagaoka-Ooike area were extracted using cluster analysis. Next, the road characteristics that appeared frequently in each group were extracted, and the features of each road group were clarified. Finally, referring to those features, the groups were named in order to express the character of each road group. The same method as in the previous section was used to determine which road groups were preferred by strollers.

That is, the two composition rates of each road group were compared, and it was determined which road groups were likely to be chosen as walking routes. The result of the analysis is shown in **Table 10**. It shows that for Tanushimaru-cho, Z_j values of T2, T4, T5, T9 and T14 are large, and T1, T3, T6, T7, and T8 are negative. In other words, road groups such as the waterside areas and the countryside are more likely to be chosen as walking routes, while the road groups in the trunk roads and in urban areas are less likely to be chosen. **Table 10** also shows that for the Nagaoka-Ooike area, Z_j values of M1, M4, M9, M10, M15, M16, M17 and M18 are large, while M2, M5, M7, M11, M12, M13, and M14 are negative. That is, the pedestrian roads surrounded by popular shopping streets, waterside roads, and roads in the park are more likely to be chosen, while division roads enclosed by buildings and roads with unnatural lines are less likely to be chosen.

Comparing the results of the above-mentioned analysis with the previous section, natural elements such as waterside areas, parks, and the countryside are generally preferred in both

Table 10 Stroller Preferences of Road Groups.

(Tanushimaru-cho)

	Name of roads groups	possible	real	Z
T1	Trunk roads in urabn area	5.0%	1.9%	-11.5
T2	Roads along the River with flowers	7.7	13.3	17.0
T3	Non-paved narrow paths	3.4	2.1	-6.1
T4	Country roads apart from the town	3.8	9.7	25.1
T5	Roads along the River with flowers	1.7	7.1	34.0
T6	Town roads along and across the river	12.2	7.2	-12.4
T7	Resident roads apart from the town	18.4	11.9	-13.5
T8	Non paved small paths in open space	6.6	2.2	-14.2
T9	Crooked roads along the farm	3.5	12.0	36.9
T10	Roads in the urban park with trees	9.1	7.4	-4.7
T11	Trunk roads in urabn area with shops	14.2	13.5	-1.6
T12	Narrow paths in the field	7.6	6.7	-3.0
T13	Non-paved narrow paths in the park	1.5	0.6	-6.1
T14	Crooked paths in open space	1.2	2.4	8.4
T15	Roads in the temple or shrine	0.4	0.4	0.1
T16	Central shopping street	2.3	1.0	-7.0
T17	Slightly narrow roads with trees	1.3	0.7	-4.2

There is significance in the case of $|Z_j|>1.96$

(Nagaoka-Ooike Area)

	Name of roads groups	possible	real	Z
M1	Shopping mole with crowd	6.4%	12.3%	24.3
M2	Access roads in urban area	70.7	54.8	-35.4
M3	Wide trunk roads for through traffic	1.7	2.0	2.8
M4	Trunk roads with stores	0.9	2.9	21.4
M5	Undulating access roads in rural area	3.4	2.5	-5.2
M6	Roads around the big pond	1	1.1	1.0
M7	Narrow roads with bad surface	0.4	0.1	-5.3
M8	Road near the school with sidewalk	2.3	2.4	0.9
M9	Cemetery roads prohibited car traffic	3.3	4.4	6.2
M10	Pedestrian roads in the park	2.3	2.9	3.9
M11	Cemetery roads	1.3	0.9	-2.9
M12	Cemetery roads with right angled line	0.3	0.1	-2.9
M13	Stairs in residential area	1.2	0.2	-9.2
M14	Right angled roads in residential area	2.5	1.8	-4.7
M15	Pedestrian roads using bricks and soil	0.7	1.5	8.8
M16	Roads around the park with lighting	0.0	0.3	12.6
M17	Narrow pedestrian roads in the park	0.5	5.5	71.1
M18	Wide roads around big pond	1	4.3	32.8

There is significance in the case of $|Z_j|>1.96$

urban and rural areas. In addition, in urban areas, busy roads and roads properly maintained for pedestrians are preferred.

6. Conclusion

In this research, the stroller behaviors in a rural area (Tanushimaru-cho) and an urban area (Nagaoka-Ooike) were investigated, and the patterns of stroller behavior and stroller walking routes were analyzed based on the data. The results of the analyses were as follows:

(1) As for stroller behavior, firstly, the overall percentage of strollers is high at 50%-60%, and the frequencies of women and elderly strollers are high. The frequency of strollers is higher in urban areas than in rural areas. Moreover, there are many strolls taken around one's own house both in urban and rural areas, and the percentage of strolling times of 30 minutes to 1 hour is especially high in urban areas. The percentages of evening strolls and longer stroll times in urban areas are higher than in rural areas.

(2) As for the reason why strollers choose their routes, the tendency to prefer elements of nature in the walking space is high not only in urban areas but also in rural areas. However, the tendency to prefer urban elements is stronger in urban area than in rural area.

(3) Regarding the classification of stroller behavior, some common groups were extracted, and it became clear that strolls of the "diversion of mind type" are more common than strolls of the "healthy promotion type" in urban areas.

(4) From the analysis of walking distances, it became clear that the average walking distance in urban areas was about 1km shorter than that of rural areas, and there were many strolls of the "time consuming type" in urban areas.

(5) From the analysis of road characteristics, it was clarified that, common to both areas, roads where there are gradual curves, waterside areas, the countryside, and nice views are preferred, and artificial structures such as buildings, etc., are disliked along walking routes, while busy and well-maintained pedestrian roads are preferred in urban areas. Analyzing the appearance frequencies of each road group based on the road classifications, it became clear that busy shopping streets and pedestrian roads along waterside areas and in parks are preferred in urban areas. However, waterside areas and the countryside are preferred more in rural areas than in urban areas.

Finally, when walking road networks are planned based on these results, it is necessary to make the best use of the area characteristics that take into consideration the basic features common to stroller behavior.

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