



## Research article

# Study on influence of walking experience on traffic safety attitudes and values among foreign residents in Japan

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## ABSTRACT

The most vulnerable user in road space is still an ordinary pedestrian even though the top fatalities by traffic mode differ in countries. Thus, prioritizing/protecting vulnerable road users is essential to improve road safety. People's safety perceptions toward vulnerable users are strongly associated with surrounding elements and their own experiences, especially as pedestrians. Therefore the attitude and values toward vulnerable users would vary due to culture and customs related to walking in each country. This study examines how a walking experience change reflects people with diverse backgrounds' traffic safety attitudes by conducting an online questionnaire survey for foreigners living in Japan for five years or less. As a result, 75% of respondents walk more frequently due to increased public transportation usage. For all the respondents, the increase in the walking frequency also drives the shift in the attitude toward vulnerable users and the values regarding travel safety and comfort indirectly intermediated by the shift in attitudes toward walkability, applying structural equation modeling. To focus on the structure of the shift according to nationality, people from Southeast/South Asia, where motorcyclists are the top fatalities in the road space and somehow regarded as vulnerable road users, the increased walking experience contributes significantly to the improvement of awareness of vulnerable road users and to the formation of safety and comfort values. Regarding people from Europe/North America, although their walking frequency increases after coming to Japan, there is a static causal relationship that does not influence their attitude toward walkability or safety and comfort values. Additionally, they already have an attitude of protecting/prioritizing pedestrians and placing more importance on safety and comfort. At the same time, people from Southeast/South lacks the attitude toward pedestrians due to much less frequency of walking in daily life. It suggests that establishing safe and having comfortable pedestrian spaces and public transport in developing countries where traffic infrastructure is at the development stage will encourage people to walk and likely help foster an attitude of placing importance on safety.

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## 1. Introduction

When it comes to road safety, 1.35 million deaths are the number of deaths in 2016 from road traffic accidents, and this number keeps rising continuously in the past decade [1]. Vulnerable road users, including all non-motorized road users and motorcyclists, are on top as far as traffic fatality is concerned. That's 54% globally and 59% in the South-East Asia region, according to the WHO report in 2018 in Table 1. Although this trend is roughly the same worldwide, each area has its own set of problems. 4-wheeler contribute the most significant fatality in western countries, i.e., 48% and 34% in Europe and Americas consecutively.

Simultaneously, 2-wheeler is the primary cause of death in the east, i.e., 43% and 36% in South-East Asia and the Western Pacific. This circumstance is likely due to the fact that cars and motorcycles are the primary modes of transport in each region. Although walking is not a primary means of transport in daily life, pedestrians alone still contribute a significant portion of deaths everywhere because they are exposed the most to other road users and have no little to none external protection in a collision [2]. It shows that pedestrians still need to be given priority and required protection since they are always vulnerable in road space [3]. Hammond's study in the UK [4] found that pedestrians don't feel confident in shared space due to having less priority over vehicles. Kaparias et al. [5] also confirmed that pedestrians do not feel comfortable in the space occupied by a lot of cars while they will thrive if some street protection and amenities are available. Moreover, prioritizing and protect the pedestrian as vulnerable road user get more important to make a city more human-centered [6] and to promote the usage of public transportation with safer walking access to stations [7].

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**Table 1**  
Percentage of worldwide traffic fatalities by mode (2016).

Fig. 1	Driver / Passengers of 4 wheeled vehicles	Motorized 2–3 wheelers	Cyclists	Pedestrians	Others / unspecified
Japan	32%	17%	15%	35%	1%
Western Pacific	22%	36%	6%	22%	14%
South-East Asia	16%	43%	2%	14%	25%
Europe	48%	11%	5%	27%	9%
Eastern Mediterranean	39%	15%	2%	34%	10%
Americas	34%	23%	3%	22%	18%
Africa	40%	9%	4%	40%	7%
World	29%	28%	3%	23%	17%

To improve pedestrian's situation, we need to explore how pedestrians become aware of their safety and behave safely. Many studies indicate that traffic safety is highly dependent on a variety of factors, including the behavior of road users themselves, vehicle performance, road infrastructure, and traffic regulations. Iversen and Rundmo [8] showed that, in Norway, there is a relationship between drivers' attitudes, risk behavior, and involvement in accidents or near-accidents. Furthermore, these driver attitudes are strongly related to driver personality [9]. Also, Chen [10] showed that personality, mediated by attitudes toward traffic safety, indirectly influences motorcycle driving behavior among young Taiwanese motorcyclists. Another study in Vietnam [11] showed the relationship between attitudes toward traffic safety and behavior, including both driving and walking ones. Ö. Şimşekoğlu [12] showed safer attitudes toward pedestrian violations are strong predictors of pedestrian behaviors. Doi et al. [3] mentioned that low awareness of vulnerable road users, especially elderly pedestrians, as parties concerned about traffic safety, leads to a reduction in safety in the road space. These researches have shown the relationship between safety attitude, personal trait, and traffic safety, and that safer walking behavior can lead to a reduction in traffic accidents.

Moreover, Bone and Mowen [13] found compound traits that arise from culture, sub-culture, the learning history of the individual influence on risky behavior. Nordfjærn and Şimşekoğlu [14] also showed cultural factors and attitudes toward safety are related to pedestrian behavior. Cultural factors might include daily travel habits. Cordelier et al. [15] revealed that motorcyclists are less concerned about the accident risk than car drivers, resulting in a more significant risk by motorcyclists. Similarly, the attitude toward safety is different between people who use public transportation more often than private and those who use private one more often [16]. Furthermore, pedestrian behaviors are different between drivers and non-drivers [17]. On the other hand, the relationship between walking frequency and safe behaviors and attitudes has not been shown.

Background also shows its part in some studies. Through surveys in Norway and Ghana, Lund and Rundmo [18] and Nordfjærn et al. [19] examined cultural differences in risk perception and attitudes toward traffic safety and risks. These studies also found differences between the two

**Table 2**  
Summary of the previous study on traffic safety attitude, values, and behaviors.

Authors	Examined contents
Iversen and Rundmo [8]	Relationship between drivers' attitudes, risk behavior, and involvement in accidents or near-accidents is identified.
P. Ulleberg, T. Rundmo [9]	Driver attitudes are strongly related to driver personality.
Chen [10]	Personality, mediated by attitudes toward traffic safety, indirectly influences motorcycle driving behavior.
D. D. Dinh et al. [11]	The relationship between attitudes toward traffic safety and behavior, including both driving and walking ones, is revealed.
Ö. Şimşekoğlu [12]	Safer attitudes toward pedestrian violations are strong predictors of pedestrian behaviors.
International comparison	
Lund and Rundmo [18], Nordfjærn et al. [19]	Cultural differences in risk perception and attitudes toward traffic safety and risks are found comparing two countries.
McIlroy et al. [20,21]	Links between attitudes and behaviors differed according to the country. Fatalistic belief constructs influence the risk of pedestrian behavior differently.
Solmazer et al. [22]	Values have varying effects on pedestrian behavior in the five countries.

countries. McIlroy et al. [20] explored the relationships between attitudes toward traffic safety and pedestrian behaviors in six countries: Bangladesh, China, Kenya, Taiwan, the UK, and Vietnam. The results showed links between attitudes and behaviors in all countries; however, the relationships differed according to the country. Additionally, they reveal that fatalistic belief constructs influence the risk of pedestrian behavior differently among 6 countries [21]. Solmazer et al. [22] compared pedestrian behaviors in Estonia, Greece, Kosovo, Russia, and Turkey, and investigated the relationships between these behaviors and values in each country. Principal component analyses revealed that the four-factor structure applied to the Pedestrian Behavior Scale (PBS) developed by Granie et al. [23] was consistent across the five countries. PBS consists of 20 items on pedestrian behaviors, which have four sub-dimensions, namely "transgression," "lapses," "aggressive behaviors," and "positive behaviors." The covariance results showed significant differences in each country's PBS items and scale scores. Regression analysis results revealed that values have varying effects on pedestrian behavior in the five countries. As described above, a succession of international comparisons of the relationships between attitudes, behaviors, and values has revealed significant differences. However, these surveys were carried out in the respective countries, and the people in each country responded to the situation relating to traffic, such as the state of road infrastructure and education level, with that country in mind. Therefore, a bias of awareness of that country's traffic situation is considered to exist in the regional differences examined. In other words, there are certain limitations in that the causes of the significant differences observed are diverse and cannot necessarily be expressed.

According to the results of previous studies shown in Table 2, people's perceptions of safety are strongly related to factors around them and their own experiences, especially those from different cultures, countries, and regions. Many studies also focus on the impact of attitudes and values on behavior. However, the effects of behavior and experience on attitudes and values have rarely been examined. This study will examine how people from diverse backgrounds, including motorcycle-oriented countries and developed countries, transform their traffic safety awareness by walking in the same environment. Specifically, we will first survey a specific group of people whose daily commute has changed. We will then examine people's walking behavior and views before and after the change to better understand how people's attitudes change after living in a new, more protected environment. This study focuses on Japan because although the Japanese road safety record is reasonably good, pedestrians are exposed to higher risks in the road space than in other developed countries. In addition, Japan has one of the most developed public transportation systems in the world and relies almost exclusively on public transportation for daily travel in urban areas.

## 2. Methods

### 2.1. Data collection method

This study is based on an online questionnaire survey of foreigners living in Japan. Long-term residents were excluded from the survey

because their memories of before arriving in Japan are likely to be unclear. However, certain sample size was needed for the analysis, and so foreigners who had lived in Japan for <5 years were surveyed. Five years was considered to be a key juncture in programs such as study abroad and technical intern training based on people returning home. However, South Korea and the People’s Republic of China were not included in this survey because their traffic situations and culture are considered to be relatively close to Japan.

The online questionnaire survey was outsourced to a research company. The research company has foreign members as survey respondents and have their attributes such as gender, age, nationality, the date they came to Japan etc., collected when they were registered. These registered foreigners who have been in Japan for <5 years were asked to respond to the questionnaire via e-mail in December 2018. Then 500 responses were collected in the order of earliest response. Note that the respondents receive a small amount of payment. The research company collected only complete responses. Five hundred responses don’t include incomplete or contradictory responses by asking the period in Japan. However, one response by people born in Japan but has foreign nationality was collected, and so there were 499 valid responses. There were 2.3 million foreigners in Japan, excluding permanent residents, as of December 2018. Therefore, the data has a 4.39% of margin error under the 95% confidence level. Also, note that the responses are biased because the survey was carried out in English.

2.2. Survey contents

The authors constructed the survey contents referring to previous studies. A pre-survey (administered to 30 international students) was then conducted and modified based on the respondents’ opinions. This study intended to capture the change in attitudes toward walking and values toward mobility due to changes in experiences and behaviors before and after coming to Japan. Firstly, personal attributes such as nationality, age, and duration of stay in Japan were asked.

Secondly, for travel behaviors, we initially asked separately about the frequency of use of public transportation, private cars, motorcycles, and walking before coming to Japan and the behaviors after coming to Japan. However, the respondents were confused when asked the frequency before coming to Japan because the survey didn’t identify when among the period. Therefore, in this study, we decided to ask the difference between the two-time points directly. The changes in behavior and frequency of use of public transportation, private cars, motorcycles, and walking after coming to Japan were evaluated in six levels: “decreased,” “decreased a little,” “same as before,” “increased a little,” “increased,” and “don’t know”. Note that the behavioral change captured in this study does not represent an actual frequency but a self-reported behavioral change.

On the other hand, questions remain about the reliability of recalling the past. Falkner et al. [24] compared the interview data of 30 years ago with the interview data of recalling 30 years ago regarding the frequency of exercise in the past. The results show that, given the length of time between the first interview and the recall, the intraclass correlation coefficients for weekday (occupational) and free time (leisure) physical activity found in this study are about 0.4, which is close to the result in other studies with recall intervals of 10 years or less. In this study, light and moderate activity on weekdays were recalled more than intense activity on weekdays and in free time. Falkner et al. [24] discussed that the better recall of less vigorous weekday activity might be due to its routine nature. Since the frequency of use of public transportation, private cars, motorcycles, and walking is related to daily life, recall of up to 5 years is not a significant problem. Note, however, that recall errors are usually more underreported than overreported [25].

Thirdly, we constructed question items on attitudes toward walking for attitudes assumed to be influenced by behavior change. Regarding walkable road space, Appolloni et al. [26] suggested the 12 indices in

**Table 3**  
Question items on attitude toward walking corresponding to previous research.

12 indexes in T-WSI [xx4]	Question items on attitude toward walking in this study
Sidewalk surface, Obstacles, and Slope.	Barrier-free sidewalks
Safeguard from vehicles	Separation of pedestrians and cyclists on sidewalks, and Pedestrian-vehicle separation
Road lighting, Safe Crossing, and Traffic	The existence of pedestrian traffic lights on routes when walking, Waiting time at traffic lights when crossing at crosswalks, and The existence of crosswalks at appropriate locations
Sidewalk width	Width of sidewalk allowing safe/comfortable walking
Street furniture	Abiding by traffic lights when walking and The existence of street-side rest places
Activity, Building stock	Liveliness of street-side areas Streetscape
Vegetation	The existence of greenery along the street

the Walking Suitability Index of the Territory-T-WSI; Sidewalk surface, Obstacles, Slope, Safeguard from vehicles, Road lighting, Safe Crossing, Sidewalk width, Street furniture, Activity, Traffic, Building stock, and Vegetation. Then the authors constructed the question items corresponding to the indexes, as shown in Table 3. Regarding the above attitudes toward walking, the change in attitudes toward safety and comfort when walking was evaluated on three levels: “I am more aware,” “Same as before,” and “I am less aware”.

Finally, we surveyed the changes in the level of importance of “convenience,” “safety,” “comfort,” “environment,” and “entertainment” in terms of values related to transportation in three levels: “I have become more aware of them,” “same as before,” and “I have lost awareness of them”.

2.3. Attributes of respondents

Table 4 shows the respondents’ gender, age, and duration of stay in Japan, respectively. Of the respondents, 40% were male, and 60% were female. Respondents aged between 25 and 34 years made up 76% of the total, while foreigner aged between 25 and 34 living in Japan account for 27%. For those who have been in Japan <5 years, the percentage of aged 25 to 34 may be smaller. However, their data are not available. Then this point is a limitation of this study. For the duration of stay in Japan, the proportion of respondents in each item (from <1 year to 4–5 years) was roughly the same at approximately 20%. The most commonplace of residence was Tokyo at 42%. Among the respondents, 80% were residents of three major Japanese metropolitan areas,

**Table 4**  
Characteristics of the respondents (n = 499).

Gender	
Male	40.28%
Female	59.72%
Age	
-19	2.40%
20–24	12.42%
25–29	34.47%
30–34	30.66%
35–39	9.82%
40-	10.22%
Duration of stay in Japan	
-1 years	17.03%
1–2 years	18.24%
2–3 years	21.44%
3–4 years	24.05%
4–5 years	19.24%

**Table 5**  
Nationality of respondents.

Nationality	No	Nationality	No	Nationality	No	Nationality	No
<b>Asia</b>		<b>Europe</b>		<b>America</b>		<b>Africa</b>	
Philippines <sup>*SEA</sup>	69	United Kingdom	26	U. S.	62	Egypt	4
Indonesia <sup>*SEA</sup>	30	France	21	Canada	17	South Africa	4
Malaysia <sup>*SEA</sup>	18	Germany	13	Mexico	2	Cameroon	3
Thailand <sup>*SEA</sup>	15	Italy	11	Brazil	5	Nigeria	3
Singapore <sup>*SEA</sup>	13	Spain	10	Colombia	3	Morocco	3
Vietnam <sup>*SEA</sup>	7	Russia	7	Argentina	2	Gabon	2
Myanmar <sup>*SEA</sup>	3	Poland	6	Venezuela	1	Zambia	2
India <sup>*SA</sup>	32	Ukraine	3	Peru	1	Zimbabwe	2
Nepal <sup>*SA</sup>	10	Switzerland	3	Jamaica	6	Tunisia	2
Bangladesh <sup>*SA</sup>	5	Greece	2	Cuba	1	Kenya	1
Pakistan <sup>*SA</sup>	4	Iceland	1	Guatemala	1	Senegal	1
Sri Lanka <sup>*SA</sup>	1	Netherlands	1	Trinidad and Tobago	1	Mauritania	1
China	7	Sweden	1	Haiti	1		
Hong Kong	5	Serbia	1	Barbados	1		
Taiwan	3	Finland	1				
Mongolia	2	Bulgaria	1	<b>Oceania</b>			
Syria	2	Belarus	1	Australia	18	Asia total	232
Afghanistan	1	Belgium	1	New Zealand	2	*SEA: South East Asia	155
UAE	1	Portugal	1			*SA: South Asia	52
Israel	1	Moldova	1			Europe total	115
Iran	1	Lithuania	1			America total	104
Turkey	1	Romania	1			Oceania total	20
Lebanon	1	Europe other	1			Africa total	28

including Tokyo, Kanagawa, Saitama, Chiba, Osaka, Hyogo, and Aichi, and most lived in urban areas with well-developed public transport networks. The aggregate results for country/region of origin are shown in Table 5.

An examination of the structure of change in attitudes and values by region of origin was attempted; however, it was not possible to secure a sufficient sample size to perform an analysis by nationality. Therefore, the groups shown in Table 6 were taken as the targets of the comparative analysis.

One group is Southeast/South Asia, and the motorcycle is established as the means of transport in people's daily lives in most of the countries that fall into this group. These countries are also characterized by motorcyclists accounting for a high proportion of traffic fatalities compared to the world average. This might be because motorcyclists are less concerned about the accident risk than car drivers [15]. According to the study on walkability and pedestrian facilities in Southeast and South Asian Cities [27], the pedestrian road space is thought to be “bad” by South East and South Asia people. Moreover, the study also revealed that 67% of the respondents would shift their walking trips to motorized modes of transport if the walking environments in their cities do not improve. A walkable street is related to pedestrian behavior and attitudes [28]. At the same time, the authors reveal the Southeast drivers lack the attitude of prioritizing the vulnerable road user comparing to Americans and East Asians [29]. Through this discussion, the influence of the walking experience in Japan, where the walkability is better than that of Southeast and South Asia, on the attitudes and the values toward pedestrians and safety were examined.

Regarding South East and South Asia, the nationality distribution differs between the sample and the foreign residents in Japan in December 2018. Vietnamese and Nepali, which account for the 3.4% and 4.8% of the

South East and South Asian respondents, rank first and second in the percentage of the South East and South Asian residents [30], while the Philippines, Indian, and Indonesia, which account for the 9.2%, 4.5%, and 7.3% of the South East and South Asian residents, are representative of this group: the percentages are 33%, 16%, and 15%. The samples did not reflect the nationality distribution of the South East and South Asian residents in Japan. However, This research aims to identify the different influences of the walking experience on the traffic safety attitude and values among motorcycle-oriented countries and developed countries. Therefore, the samples are practical to use in this research.

On the other hand, a developed country group referred to as Europe/North America was selected for comparison. In these countries, public transport networks and sidewalks are well established compared to the rest of the world, and the use of public transport and walking are common. The top 5 of this group are the US, UK, France, Canada, and Germany, account for 32%, 14%, 11%, 8.8%, and 6.7% of Europe and North America representatives. The US, UK, France, Canada, and Germany are also at the top 5 countries among Europe and North America countries regarding the residents in Japan. The US accounts for 36% of the Europe and North American residents in Japan, UK does 12%, France does 11%, Canada does 6.7%, and Germany does 6.2%. The distribution of nationalities of the samples is almost the same as European and North American residents.

#### 2.4. Analysis method

First, we need to understand the changes in the frequency of use of public transport and walking before and after coming to Japan. Japan has one of the most well-developed public transport systems in the world. Further, the legislative system and operation and maintenance

**Table 6**  
Classifications of target groups compared in this study.

Regional classification	Sample size	Description
Southeast/South Asia	197	A group made up of Southeast/South Asian countries (207 samples in total), plus Taiwan (3 samples) where the use of motorcycles is widespread, excluding Singapore (13 samples), where the economic level is high.
Europe/North America	194	North America (2 countries: U.S., Canada), UK and EU countries (as of April 2020)
All samples	499	All the countries collected in this study shown in Table 1

costs make it difficult for foreigners to drive cars. The frequency of use of public transport among foreigners is therefore expected to increase after they start living in Japan. When using public transport, it is necessary to walk to and from the boarding/alighting location, and therefore, the frequency of walking is also expected to increase with the increased frequency of use of public transport. We examine the correlation between these two. Subsequently, we compare Southeast/South Asia and Europe/North America and examine the differences regarding changes in attitudes toward safety/comfort when walking and changes in the importance placed on convenience, safety, comfort, environmental friendliness, and entertainment when traveling.

Finally, we perform a structural equation modeling (SEM) to examine the relationships between changes in travel behavior and changes in attitudes/values toward traffic among foreigners living in Japan. SEM is a statistical technique that is the combination of factor analysis and regression models. This is used to understand the complex structure by testing the relationship between observed variables and latent constructs [31]. Regarding the frequency of use of public transport and walking before and after coming to Japan, the answers were replaced with integers from -2 to 2, with "Has decreased" being -2 and "Has increased" being 2. However, four samples in which the response to the frequency of use of public transport and walking was "Don't know" were excluded from the analysis. Similarly, for the questions about attitudes and values where a three-point rating scale was used ("I have become more aware/Has become of greater importance," "Same as before," and "I have become less aware/Has become of less importance"), the answers were replaced with integers from -1 to 1. The lavaan package (0.6-3) in software R was used in the analysis.

### 3. Results

#### 3.1. Changes in frequency of use of public transport and walking after coming to Japan

Table 7 shows a cross-tabulation of changes in the frequency of use of public transport and walking after coming to Japan. Respondents for whom the frequency of both use of public transport and walking increased after coming to Japan accounted for 75% of the total. It might be because high public transportation density promotes walk commuting [32]. Excluding the four samples in which the respondents did not know their frequency of use of public transport before and after coming to Japan, the Spearman's rank correlation coefficient of these items was calculated as 0.42 (0.1% significance), demonstrating a certain positive correlation.

#### 3.2. Changes in attitudes toward protecting vulnerable road users after coming to Japan

Table 8 shows the results for changes in attitudes toward the separation of pedestrians and cyclists on sidewalks and pedestrian-vehicle separation. Approximately 60% of the respondents answered that they had become more aware since coming to Japan in response to both questions. However, the distribution of each group is different. To examine the statistical difference, chi-square tests of independence were calculated by

comparing the awareness toward protecting vulnerable road use among the group. As a result, significant relations of the group and both "awareness of separation of pedestrians and cyclists" ( $X^2 = 25.90, p < 0.01$ ) and "Pedestrian-vehicle separation" ( $X^2 = 77.02, p < 0.01$ ) were found. Therefore the proportion of people from Europe/North America who had become more aware was statistically lower than all samples, and the proportion of people from Southeast/South Asia who had become more aware was statistically higher than all samples.

#### 3.3. Changes in attitudes toward walking after coming to Japan

Table 9 shows the aggregate results for changes in the attitudes of people from Southeast/South Asia and Europe/North America toward walking after coming to Japan. The top six items in Table 9 are questions related to safety, while the bottom four items are questions related to comfort. Regarding safety, for each of the six questions, the percentage of people who replied that they had become more aware was approximately 70%, and only about 40% of those from Southeast/South Asia and Europe/North America, respectively. Similarly, regarding comfort, the percentage of people from Southeast/South Asia who replied that they had become more aware was greater than that of people from Europe/North America. These differences were found to be significant by applying the statistical tests: chi-square test or Fisher's exact test when more than one values are smaller than five, as shown in Table 9.

#### 3.4. Changes in values relating to travel after coming to Japan

Table 10 shows the aggregate results for changes in the values of people from Southeast/South Asia and Europe/North America in terms of travel after coming to Japan. In both groups, the highest percentage is that of people who replied that convenience had become of greater importance. Over 70% of Southeast/South Asia people replied that safety, comfort, and environmental friendliness had become of greater importance. Meanwhile, less than 50% of people from Europe/North America replied that safety, comfort, and environmental friendliness had become of greater importance, and a larger percentage replied that their values were the same as before.

To compare the gap of the proportion, chi-square tests and Fisher's exact tests were conducted. As a result, the relations of nationality and the change in values relating to travel were found, as shown in Table 10. The results also statistically implied that Southeast/South Asia people tend to change in values more than Europeans/North Americans. Regarding the number of respondents who reply "has become of greater," safety showed the largest gap between Southeast/South Asians and Europeans/North Americans. Additionally, in both groups, the percentage of respondents who replied that entertainment had become of greater importance was smaller compared to those of the other items.

#### 3.5. Examination of influence structure of walking experience on attitudes/values

To examine the relationships between changes in travel behavior and changes in attitudes/values toward traffic among foreigners living

**Table 7**  
Changes in frequency of use of public transport and walking.

		Change in frequency of use of public transport before and after coming to Japan					
		Has increased	Has increased a little	Same as before	Has decreased a little	Has decreased	Don't know
Change in frequency of walking before and after coming to Japan	Has increased	268	36	16	2	5	1
	Has increased a little	49	21	10	4	4	1
	Same as before	14	16	20	2	2	1
	Has decreased a little	8	3	3	0	4	1
	Has decreased	4	0	1	0	3	0

The Spearman's rank  $R = 0.42$  ( $t = 10.2, p < 0.0001$ ),  $N = 495$  (the answers "Don't know" are eliminated).

**Table 8**  
Attitudes toward protecting vulnerable road users.

	Separation of pedestrians and cyclists on sidewalks			Pedestrian-vehicle separation			N
	Have become more aware	Same as before	Have become less aware	Have become more aware	Same as before	Have become less aware	
Europe/North America	51.5%	36.1%	12.4%	36.1%	53.6%	10.3%	194
Southeast/South Asia	73.1%	24.9%	2.0%	79.7%	18.3%	2.0%	197
All samples	64.7%	28.3%	7.0%	59.9%	34.3%	5.8%	499
Chi-square test	$\chi^2 = 25.90, df = 2, p < 0.01$			$\chi^2 = 77.02, df = 2, p < 0.01$			

**Table 9**  
Changes in attitudes toward walking.

	Southeast/South Asia (N = 197)			Europe/North America (N = 194)			Independence test
	Have become more aware	Same as before	Have become less aware	Have become more aware	Same as before	Have become less aware	
Abiding by traffic lights when walking	81.2%	18.3%	0.5%	42.8%	55.7%	1.5%	F.T. $p < 0.01$
The existence of pedestrian traffic lights on routes when walking	76.6%	22.8%	0.5%	35.1%	64.4%	0.5%	F.T. $p < 0.01$
Waiting time at traffic lights when crossing at crosswalks	77.2%	21.8%	1.0%	44.3%	54.1%	1.5%	F.T. $p < 0.01$
The existence of crosswalks at appropriate locations	78.7%	20.3%	1.0%	37.6%	59.3%	3.1%	F.T. $p < 0.01$
Width of sidewalk allowing safe/comfortable walking	81.7%	14.7%	3.6%	32.5%	46.4%	21.1%	$\chi^2 = 98.2, p < 0.01$
Barrier-free sidewalks	74.1%	23.4%	2.5%	33.0%	49.5%	17.5%	$\chi^2 = 71.2, p < 0.01$
Liveliness of street-side areas	66.0%	27.9%	6.1%	54.1%	39.2%	6.7%	$\chi^2 = 6.0, p < 0.05$
The existence of street-side rest places	61.4%	25.4%	13.2%	31.4%	44.8%	23.7%	$\chi^2 = 35.3, p < 0.01$
The existence of greenery along the street	67.0%	28.9%	4.1%	35.6%	46.9%	17.5%	$\chi^2 = 43.6, p < 0.01$
Streetscape	72.1%	22.8%	5.1%	37.6%	47.4%	14.9%	$\chi^2 = 47.5, p < 0.01$

FT means Fisher's exact test. This test is used when more than one values are smaller than five on behalf of the chi-square test.

in Japan, “attitude toward walkability,” “attitude toward protection of vulnerable road users,” and “values regarding safety/comfort” were established as latent variables. An exploratory analysis of the latent variable paths and the manifest variables corresponding to the latent variables was conducted to improve the goodness of fit of the model. As manifest variables for “attitude toward walkability,” awareness of width of sidewalk allowing safe/comfortable walking, awareness of barrier-free sidewalks, awareness of street-side rest places, and awareness of streetscapes were adopted. Please note that “change in pedestrian behavior” is given as a latent variable in the figures below in order to clearly express the relationships; however, it is, in fact, a manifest variable of change in walking frequency before and after coming to Japan.

Fig. 1 and Table 11 show the estimated result of SEM for all the obtained samples. The fit of the SEM was examined by calculating commonly used fit indexes: comparative fit index(CFI), the Tucker

Lewis Index (TLI), and root mean square error of approximation (RMSEA) [33]. The model was a good fit, with a CFI of 0.971, TLI of 0.959, and RMSEA of 0.044. The numbers inside the model indicate standardized estimates, and all paths were significant at a 5% level. This model suggests that the attitude toward walkability changes due to a change in frequency of walking associated with the frequency of use of public transport. Moreover, the attitude toward walkability changes directly influences the change in “values regarding safety/comfort” and indirectly influences it intermediated by a change in “attitude toward protection of vulnerable road users.” It was indicated that walking experience in Japan or the increase in walk frequency could cause the attitude toward walkability and vulnerable road user and finally built up the values regarding safety and comfortable travel. Alfonso [34] mentioned that pedestrian needs hierarchically consist of convenience, safety, comfortability, and enjoyment from the top.

**Table 10**  
Changes in values relating to travel.

	Southeast/South Asia (N = 197)			Europe/North America (N = 194)			Independence test
	Has become of greater importance	Same as before	Has become of less importance	Has become of greater importance	Same as before	Has become of less importance	
Entertainment	54.8%	37.1%	8.1%	33.5%	57.2%	9.3%	$\chi^2 = 18.6, p < 0.01$
Environmental friendliness	78.2%	20.3%	1.5%	33.5%	62.9%	3.6%	F.T. $p < 0.01$
Comfort	81.2%	16.8%	2.0%	50.0%	45.4%	4.6%	$\chi^2 = 42.3, p < 0.01$
Safety	84.3%	13.2%	2.5%	37.6%	53.1%	9.3%	$\chi^2 = 89.5, p < 0.01$
Convenience	90.4%	8.1%	1.5%	68.0%	29.9%	2.1%	F.T. $p < 0.01$

Note: F.T. means Fisher's exact test. This test is used when more than one values are smaller than five on behalf of the chi-square test.

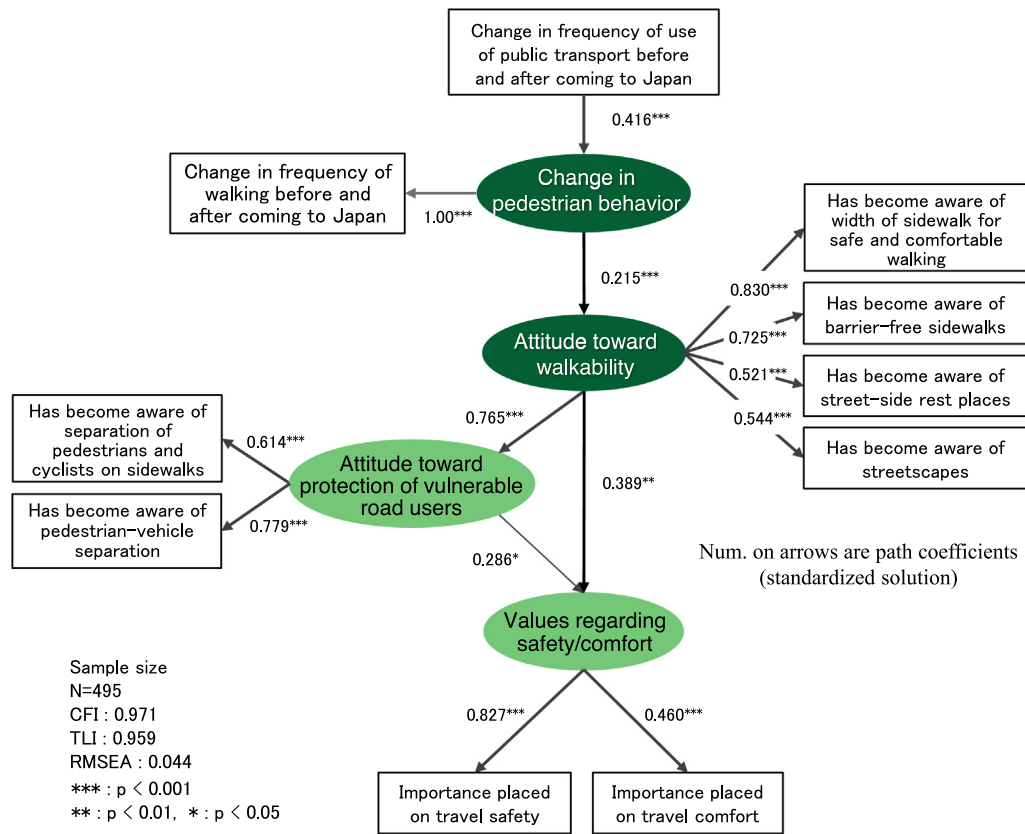


Fig. 1. SEM of walking experience on attitudes/values of all samples.

3.6. Differences in structure of change in attitudes/values according to region of origin

To verify that the structure of change in attitudes/values described in Section 3.5 differs according to the region of origin, the same model was estimated for the sample of people from Southeast/South Asia and

Europe/North America, respectively. Here, the manifest variables for the latent variables were taken to be the same as those in Fig. 1, and attempts were made to estimate a model with higher goodness of fit by changing the paths between the latent variables on an exploratory basis.

With regard to people from Southeast/South Asia, when the same structure as the one in Fig. 1 was used, the paths from “attitude toward

Table 11  
The result of SEM on all samples.

	Std.lv	Std.Err	z-value	P(> z )
Change in pedestrian behavior				
Change in frequency of walking	1.000	0.029	31.464	0.000
Attitude toward walkability				
HBAo width of sidewalk for safe and comfortable	0.830	0.040	20.110	0.000
HBAo barrier-free sidewalk	0.725	0.042	16.993	0.000
HBAo street-side rest place	0.521	0.045	11.384	0.000
HBAo streetscapes	0.544	0.044	11.971	0.000
Attitude toward protection of vulnerable road users				
HBAo separation of pedestrians and cyclists on sidewalks	0.614	0.041	9.681	0.000
HBAo pedestrian-vehicle separation	0.779	0.054	9.319	0.000
Values regarding safety/comfort				
Importance placed on travel safety	0.827	0.050	7.625	0.000
Importance placed on travel comfort	0.460	0.069	7.380	0.000
Change in frequency of use of PT				
→Change in pedestrian behavior	0.416	0.047	9.682	0.000
Change in pedestrian behavior				
→Attitude toward walkability	0.215	0.046	4.336	0.000
Attitude toward walkability				
→Attitude toward protection of vulnerable road users	0.765	0.150	7.740	0.000
→Values regarding safety/comfort	0.389	0.177	2.773	0.006
Attitude toward protection of vulnerable road users				
→Values regarding safety/comfort	0.286	0.121	1.971	0.049
CFI = 0.971, TLI = 0.959, RMSEA = 0.044				

Note: HBAo-Has become aware of; Std.lv-Standardized loading value; Std.Err-Standardized error.

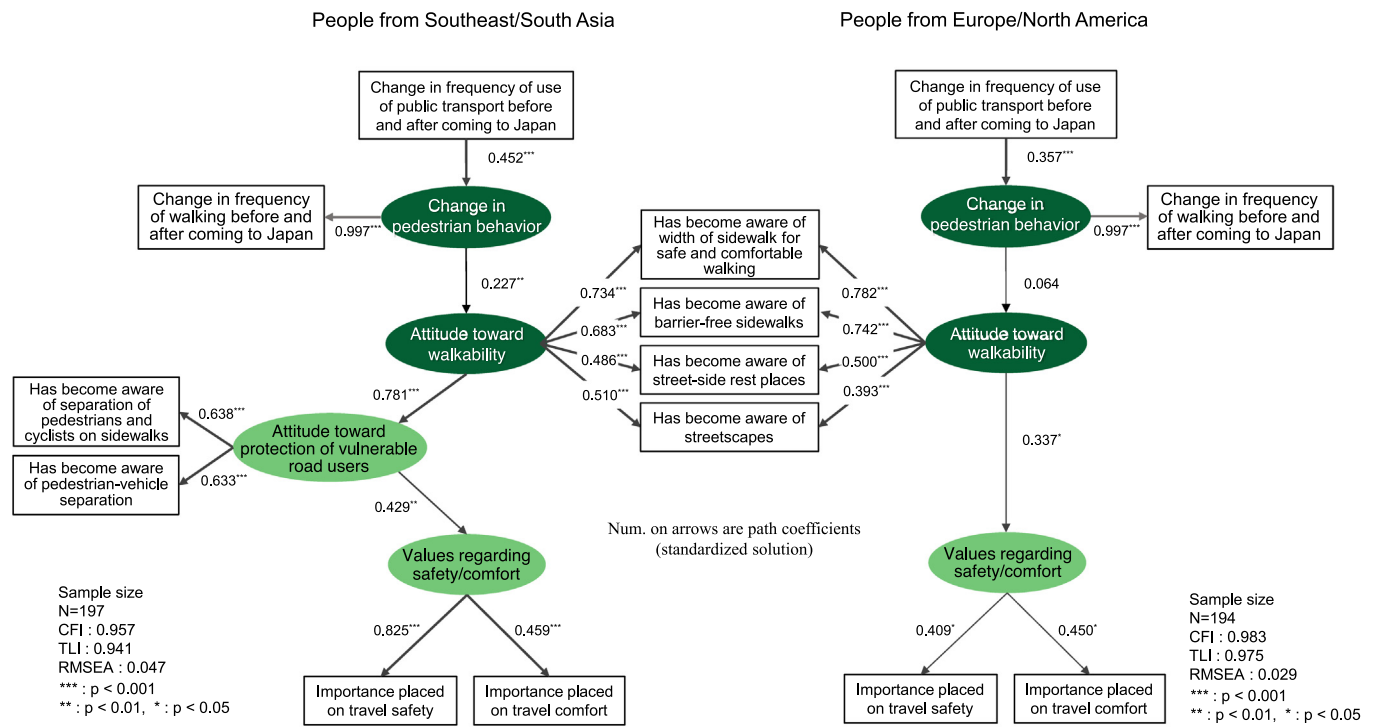


Fig. 2. SEM of walking experience on attitudes/values of people from Southeast/South Asia and those from Europe/North America.

walkability” to “values regarding safety/comfort,” and from “attitude toward protection of vulnerable road users” to “values regarding safety/comfort” were found to be not significant. Therefore, a structure in which the path coefficients were significant and the model’s goodness of fit improved was determined on an exploratory basis. As a result, the model shown on the left-hand side of Fig. 2 was estimated to be the model with the highest goodness of fit among those explored. In

this model, the path from “attitude toward walkability” to “values regarding safety/comfort,” which had a small path coefficient, was removed. The model indicated largely satisfactory goodness of fit, with a CFI of 0.957, TLI of 0.941, and RMSEA of 0.047, as shown in Table 12. Although the model for people from Southeast/South Asia had lower goodness of fit than the model for all samples, the path coefficients between latent variables were larger, suggesting that the influence

Table 12 The result of SEM on people from Southeast/South Asia and those from Europe/North America.

	People from Southeast/ South Asia				People from Europe/North America				
	Std.lv	Std.Err	z-value	P(> z )	Std.lv	Std.Err	z-value	P(> z )	
Change in pedestrian behavior									
Change in frequency of walking	0.997	0.045	19.698	0.000	0.997	0.047	19.698	0.000	
Attitude toward walkability									
HBaO width of sidewalk for safe and comfortable	0.734	0.071	10.065	0.000	0.782	0.077	10.151	0.000	
HBaO barrier-free sidewalk	0.683	0.072	9.303	0.000	0.742	0.077	9.671	0.000	
HBaO street-side rest place	0.486	0.075	6.310	0.000	0.500	0.077	6.516	0.000	
HBaO streetscapes	0.510	0.074	6.669	0.000	0.393	0.078	5.010	0.000	
Attitude toward protection of vulnerable road users									
HBaO separation of pedestrians and cyclists on sidewalks	0.638	0.082	4.869	0.000					
HBaO pedestrian-vehicle separation	0.633	0.081	4.870	0.000					
Values regarding safety/comfort									
Importance placed on travel safety	0.825	0.185	4.037	0.000	0.409	0.162	2.372	0.018	
Importance placed on travel comfort	0.459	0.094	4.388	0.000	0.450	0.179	2.360	0.018	
Change in frequency of use of PT									
→Change in pedestrian behavior	0.452	0.076	6.622	0.000	0.357	0.075	5.127	0.000	
→Attitude toward walkability	0.227	0.076	2.753	0.006	0.064	0.077	0.782	0.434	
→Attitude toward protection of vulnerable road users	0.781	0.299	4.075	0.000					
→Values regarding safety/comfort	0.429	0.106	2.799	0.005					
CFI = 0.957, TLI = 0.941, RMSEA = 0.047					CFI = 0.983, TLI = 0.975, RMSEA = 0.029				

Note: HBaO-Has become aware of; Std.lv-Standardized loading value; Std.Err-Standardized error.

between latent variables is large for the people from Southeast/South Asia. In other words, the causal relationship leading to the formation of values regarding safety/comfort through the change in attitude toward walkability and change in attitude toward protection of vulnerable road users was shown to be more pronounced in people from Southeast/South Asia.

Meanwhile, estimating a model for people from Europe/North America using the same structure as the model for all samples (Fig. 1) resulted in insufficient goodness of fit. Therefore, the model was changed on an exploratory basis, and the structure shown on the right-hand side of Fig. 2 was found to have the highest goodness of fit. The model was a good fit, with a CFI of 0.983, TLI of 0.975, and RMSEA of 0.029. “Attitude toward protection of vulnerable road users” was removed from this structure, and the path from “change in pedestrian behavior” to “attitude toward walkability” was found to be not significant. In other words, in people from Europe/North America, although “attitude toward walkability” was found to influence “values regarding safety/comfort,” no influence from “change in pedestrian behavior” was found, and no relationships were found between “attitude toward protection of vulnerable road users” and “attitude toward walkability” or “values regarding safety/comfort.” This shows that attitudes toward the protection of vulnerable road users of people from Europe/North America were already at a certain level before coming to Japan, and there is a static relationship that does not change with attitudes and values.

#### 4. Conclusion

This study conducted an online questionnaire survey of foreigners living in Japan to determine changes in their travel behaviors and attitudes/values toward traffic safety after coming to Japan. For most of the respondents, the usage of public transport and walking frequency had increased after coming to Japan. The frequency of use of public transport is considered to have increased because there are certain hurdles to getting a car and acquiring a driver's license for foreigners in Japan, and the majority of the samples reside in urban areas with well-developed public transport and so can live without relying on a private car. Further, when using public transport, it is necessary to walk to a bus stop or station, so the frequency of walking is considered to have increased with the use of public transport.

The SEM regarding changes in attitudes/values for all nationalities suggested that an attitude change toward becoming aware of walkability occurs due to an increase in walking frequency associated with an increase in the use of public transport, and this leads to a change in attitude toward protection of vulnerable road users and values regarding safety/comfort. Significant results in this study are that the experience changes the attitude and values, and the influence of experience differs in people's previous experience, although previous studies mainly focus on the influence of attitude and the values on the behaviors.

The results also suggest that the walking experience in better walkable conditions provides a new educational framework, unlike conventional traffic safety education, that promotes better safety awareness. In other words, encouraging the use of public transport, which necessarily involves the physical action of walking, improves people's awareness of the environment based on bodily sensations, and generally speaking, leads to people gaining the perspective of a vulnerable road user as a potential concerned party, beyond other people's perspectives. We confirmed that this causes a change in values such that people seek safety and comfort concerning traffic.

However, our study indicated that the structure of this change is not common to all people but differs according to nationality. It suggested that for people from Southeast/South Asia, where motorcyclists are regarded as vulnerable road users, improved awareness of the protection of vulnerable road users contributes significantly to the formation of values regarding safety and comfort. While for people from Europe/

North America, although their frequency of walking increases after coming to Japan, there is a static causal relationship that does not influence their attitude toward walkability or values regarding safety/comfort. It is assumed that people from Europe/North America already have an attitude of protecting/prioritizing pedestrians and place more importance on safety/comfort. At the same time, in Southeast/South Asia, the frequency of walking in daily life is low, and an attitude of protecting/prioritizing pedestrians is lacking, based on the comparison of the SEM results. This suggests that establishing safe and comfortable pedestrian spaces as well as public transport in developing countries where traffic infrastructure is at the development stage will encourage people to walk and could help foster an attitude of placing importance on safety. Additionally, a walkable road environment promotes active and public transport [35,36], which can cause synergy impacts. This strategy can contribute to realizing the traffic safety culture in Southeast and South Asia and the countries facing the same situation.

Japan was the target analysis area in this study. Although road improvements are being made in Japan and the developed legislation aims to protect and prioritize pedestrians, pedestrians still account for a high proportion of the total number of traffic fatalities. It is possible that greater effects would be obtained in Europe, where there is a more deeply rooted culture of protecting and prioritizing pedestrians, but this paper does not go as far as examining this. Further, in Japan, although legal reform is underway, cyclists still ride on the sidewalks, and it is possible that the experience of walking under this condition contributed to the recognition of pedestrians as vulnerable road users.

This study has limitations in that the samples from each nationality were not large enough to represent that country/region. The analysis was conducted using Europe/North America and Southeast/South Asia classifications but did not encompass all the common traits in these classifications. Additionally, the data was collected not by longitudinal surveys but by a single survey due to project duration and budget. Then the shift in behavior, attitude, and values in this study was self-reported and recalled. A longitudinal survey should be conducted to improve the reliability and validity of the data, which is a future challenge.

#### Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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