

**Title**

The impact of transportation alternatives on the decision to cease driving by older adults in Japan

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## **Abstract**

*Objectives.* This study investigated whether the availability of transportation alternatives for older drivers is a determinant of the decision to cease driving.

*Methods.* We recruited participants from a total of 7827 drivers aged 69 years or older living in Ibaraki Prefecture, Japan who were scheduled to renew their driving license between February and April 2011. In November 2010, we distributed questionnaires to collect data on predictors of driving cessation, and again in December 2012 to determine who had actually ceased driving. The relative impacts of factors related to driving cessation were then estimated.

*Results.* Of the 3089 respondents, 157 did not renew their license. The strongest determinants of this decision were having been advised to stop driving and if they had developed less confidence in their ability to drive safely. Even so, respondents were far more likely to have actually stopped driving if they were sure that someone else was available to provide a ride when they needed one.

*Discussion.* The final decision to stop driving is strongly influenced by personal convenience based on private transport, especially amongst drivers who have been advised to stop. The availability of public transport alternatives is not as important a factor in this decision.

**Keywords**

Driving cessation; Older drivers; Transportation alternatives; Epidemiological study

## Introduction

The proportion of older drivers is increasing in aging developed countries. For example, in Japan, 55% of men and 9% of women aged 75 years and older, and 87% of men and 46% of women aged 65–74 years, held a driving license as of 2012, and this proportion is even higher among pre-seniors (Cabinet Office, 2013). A disturbing effect of this is that the number of older drivers causing collisions is on the rise. Over the past decade, the proportion of at-fault drivers in motor vehicle collisions aged 65 years and older increased by 24% (NPA, 2013). Today, older drivers are more and more being encouraged to surrender their driving licenses, prompted by the National Police Agency and by local governments (Ohi, 2012), and as a result, the number of older drivers who might consider ceasing driving voluntarily may increase shortly. In a recent national survey of community-dwelling adults aged 60 years and older, 80% of current drivers suggested that they would consider ceasing driving when they perceived functional decline or had reached a certain age. In addition, 2 percent reported a wish to stop driving if public transportation were readily available (Cabinet Office, 2011).

Ceasing driving is, however, challenging for older people whose basic daily mobility solely depends on driving themselves. In Japan, the number of older adults living alone or living only with their older partner is also increasing (Cabinet Office, 2012). Moreover, the public transport network has been shrinking for the past 30 years across the country except within the major cities (MLIT, 2008). This means that many older drivers have fewer transportation alternatives, and once they are no longer able to drive, their daily life is significantly affected (Ikeda 2008; Mizuno, 2012). Therefore, older drivers, even if they wish to stop driving, may have to continue because of a lack of transportation alternatives. Thus, supporting older drivers who want to stop driving with feasible alternatives may be as important as supporting those who want to continue driving.

To support older drivers who want to stop driving, the determinants, and especially the enabling factors of driving cessation should be identified. To date, these determinants have been investigated in cohort studies of older adults but most of the previous studies have focused on intrinsic risk factors for driving cessation such as older age, poor health, and lowered cognitive function (Anstey et al. 2006; Edwards et al. 2008, 2010; Herrmann N et al. 2006; Sims et al. 2007). Little research has been carried out on extrinsic factors such as the availability of transportation alternatives, though some cross-sectional studies have suggested that driving cessation might be enabled by having family members or friends who can provide transportation support (Freund and Szinovacz, 2002; Johnson, 2008; Kington et al. 1994). Only recently did a cohort study identify that older adults with transportation support from their friends or neighbors were more likely to stop driving than those without (Choi et al. 2012a). A study employing a psychological experiment among current drivers revealed that the availability of other transport options and the cost of public transport would not influence their decision of driving cessation but low confidence in their driving ability and doctor's

advice (McNamara et al., 2013).

Choi et al. (2012b) proposed a conceptual model of the driving cessation process based on a stress-coping framework. Briefly, ceasing driving is prompted by health decline as a primary stressor, and driving-related problems such as difficulty in driving (internal stressor) and social pressure to stop driving (external stressor) are secondary stressors that might be induced by the primary stressor. To mitigate these stressors, coping strategies may be adopted, such as self-regulating driving patterns, using alternative transportation, attending driving safety programs, and/or emotional adjustment to the idea of not driving. Each of these behavioral and emotional modifications will in turn be influenced by social and physical environments as well as by transport policy.

In framing the present study then, we were concerned that older drivers, even if they find difficulty in driving safely or are advised to stop driving, might not be able to stop because of a lack of transportation alternatives. These internal and external stressors and their interactions were not fully taken into account in previous studies. Therefore, the objectives of the present study were to estimate the relative effects of driving-related stressors on the decision to cease driving in a cohort of older drivers, and to investigate whether the availability of transportation alternatives enabled this to happen, particularly among those who have little or no confidence in their ability to drive safely and those who have been advised to stop driving.

## **Methods**

### *Study design and setting*

We conducted a cohort study of older drivers in Ibaraki Prefecture. The study area is located in the central part of Japan's main island of Honshu and its capital city is situated about 100 km away from Tokyo. Ibaraki Prefecture has a population of about 3 million, and 22% of the population are adults aged 65 years or older. Ethical approval for the study was obtained from the Research Ethics Committee at the Faculty of Medicine of the University of Tsukuba.

In Japan, driving license holders have to renew their license regularly, every 5 years when they renew it at age 69 years or younger, and every 3 years when they renew it at age 71 years or older. The license will be valid for 4 years when they renew it at age 70 years. In the case, where drivers have committed a traffic violation prior to the renewal, the license will be valid for 3 years only. Renewal has to be made between 1 month before and 1 month after the date of birth.

### *Participants*

Eligible participants in this study were the 7827 driving license holders in Ibaraki aged 69 years or older, who were scheduled to renew their license between February and

April 2011. In line with prefectural ordinances relating to the protection of personal information, questionnaires were mailed to the participants through the Ibaraki Prefectural Police. Random sampling of the participants by month was not possible, so we therefore purposively chose to survey those license holders born in March. Of the 7827 license holders, 5920 (76%) and 5946 (76%) were males and aged 75 years or older, respectively, according to the Ibaraki Prefectural Police.

### *Data collection*

Self-administered questionnaires were distributed in November 2010 as a baseline survey, and again in December 2012 as a follow-up survey. A total of 3188 participants replied to both surveys, giving a response rate of 40.7%, and the 3089 of these who reported whether they renewed or did not renew their driving license were included in the analysis.

### *Measures*

In the baseline survey, we obtained participants' information on their demographics (age, sex, marital, and co-resident status), health and functional status (subjective health, hospitalization in the past 12 months, activities of daily living (ADL), instrumental ADL (IADL)), and depressive symptoms, car driving patterns, and the availability of transportation alternatives.

Subjective health was rated on a 4-point scale, and those who rated "poor" or "fair" were defined as having a lower health status. The ADL measure included bathing, dressing, toileting, transfer, feeding, and walking in the neighborhood, and was assessed from "no difficulty" to "unable to do" on a 5-point scale. They were also asked whether they are incontinent partially or totally. The participants were considered to be independent if they have no difficulty in these ADL measures. IADL was measured using the Tokyo Metropolitan Institute of Gerontology Index of Competence (TMIG-IC) (Koyano et al. 1991; Fujiwara et al. 2003). The subscale of instrumental self-maintenance assesses IADL, consisting of five items such as "Can you go out using a bus?" with a yes/no response. The participants were considered to be independent if they could perform all of these IADL.

Depressive symptoms were measured using the short version of the Geriatric Depression Scale (GDS), which consisted of 15 items such as "Do you often feel helpless?" with a yes/no response (Sheikh and Yesavage, 1986; Yatomi, 1994). The total number of symptoms gives a scale score in the range of 0–15. Those with a score of 6 or greater were considered as being positive for depression because the cutoff score of 6 yields reasonable sensitivity and specificity among the Japanese population (Schreiner et al. 2003).

Regarding car driving, we asked questions on the frequency of car driving in the previous month, whether they had ever been advised to stop driving by family/relatives or by medical personnel, and on their level of confidence in their ability to drive safely, which was

self-rated on a 4-point scale. Those who rated “not at all” or “a little” were defined as having less confidence.

Regarding transportation alternatives, we asked about the availability of someone who can provide alternative transportation, and about the availability of “demand responsive transport”. Demand responsive transport is an intermediate form of transport between bus and taxi, which picks up and drops off passengers according to their needs but in a shared-ride manner. To assess the accessibility of public transportation, we asked about the time taken to walk from home to a bus stop, and about the time from taxi call to taxi arrival at home.

In the follow-up survey, we asked whether participants had or had not renewed their driving license. Of those who renewed their driving license, 97.2% actually drove a car in the month before the follow-up survey, i.e., those who renewed their driving license were mostly current drivers. Therefore, non-renewal of driving license is a valid indicator of ceasing driving, the outcome variable of the present study.

### *Analysis*

First, we compared the characteristics mentioned above between those who renewed and those who did not renew their driving license, using chi-square tests. Next, based on the conceptual model of the driving cessation process (Choi et al. 2012b), we conducted a logistic regression analysis to examine the relative effects of having less confidence in safe driving (intrinsic stressor) and having been advised to stop driving (extrinsic stressor) as well as transportation alternatives (coping strategy), on non-renewal of a driving license (driving cessation). The analysis controlled for age, sex, and self-rated health status which represents other health-related variables. Among transportation alternatives, the availability of someone who can provide a ride was only related to driving cessation, so we further assessed whether the availability modified the effects of the intrinsic and extrinsic stressors by including interaction terms along with main-effect terms. The relative effects of the variables in the multivariate models were shown by odds ratios and 95% confidence intervals. The fit of the models was assessed with Hosmer-Lemeshow goodness-of-fit test. The specification of the models was checked by performing a link test with the *linktest* command in the Stata 13 software (StataCorp, 2013). To identify specification errors in the models, the link test examines the consistency of the real and predicted values by using a simple linear regression.

### **Results**

Table 1 compares the characteristics of the 2932 respondents who renewed their driving license and the 157 who did not. The latter group tended to be older, female, with a lower health and functional status, to be infrequent drivers, to have a lower level of

confidence in their ability to drive safely, to have been advised to stop driving, or to be those who did not have someone who could provide transport alternatives as necessary. There was, however, no significant difference between the two groups in their self-assessment report on the availability of demand responsive transport and public transportation accessibility.

Multivariate logistic regression analysis indicated that having been advised to stop driving is the strongest influence on whether a respondent ceased driving or not, followed by them having less confidence in safe driving (Table 2). Age, sex, self-rated health, and the availability of someone who can provide a ride were also related to driving cessation. The models 2 and 3 which included interaction terms suggests that, if they have someone who can provide a ride, those who had been advised to stop driving were far more likely to have stopped driving than their counterparts, as their interaction term was significant. This was not the case if respondents have a better access to bus stop (< 5 min) or a taxi (< 10 min) or are able to use demand responsive transport (data not shown). The model 3 showed no significant effect of having someone who can provide a ride for those who had less confidence in safe driving to cease driving. The fit of the models was reasonable since the Hosmer-Lemeshow test was not significant in all the models. Besides, the link test showed that all the parameters of trend were almost 1.2 (all  $p < 0.001$ ) and those of their least square error were 0.46–0.53 (all  $p > 0.05$ ), so all the models are admissible.

## **Discussion**

Our cohort study thus showed that the availability of someone who can provide an alternative enables a driver to cease driving, particularly amongst older drivers who have been advised to stop driving, but also showed that the existence of other transportation alternatives is not related to the decision to cease driving. This implies that older drivers face difficulties in deciding to stop driving when they are advised to stop driving, unless they have someone who can give them a ride when necessary.

We should bear in mind that there will be an increasing number of older drivers giving up their car keys in the near future, but that it will become harder for them to have someone who can provide a ride within their household because of changing household composition and lifestyle. This is anticipated not only in Japan but also in other developed countries (Hanson & Hildebrand, 2011; Deka, 2014). Therefore, older drivers who cannot secure this assistance in their family or neighborhood might continue driving even against their will. To avoid this situation, we recommend that the responsible authorities prepare alternative transportation systems that can satisfy the needs of people who cease driving, paying particular attention to the possible barriers to the use of existing transportation alternatives as discussed below.

Access to public transportation such as buses and taxis was found not to be related to the decision to cease driving. This was possibly because the study did not take into

account the impact of other barriers to public transportation use, such as inappropriate timetables, routes and connections of bus services, a lack of knowledge of how to use buses, difficulties with entering and exiting buses, and/or that bus drivers can be unfriendly or unhelpful to older people (Broome et al. 2009). In addition, taxis might be too expensive for frequent use, especially in remote areas.

Demand responsive transport, which could be an alternative mode of transportation as it costs less than taxi but is more convenient and flexible than a bus, was found not to be related to the decision to cease driving either. Because about half of the participants reported it possible to use this service from their house, knowing that such a service was available does not prompt older drivers to replace their private car use even if they have been advised to stop driving, or have no confidence in their safe driving ability. To enable a modal shift from private to public transport, mobility management or specific interventions to prepare older drivers for a life after ceasing driving may play an important role (Liddle et al. 2013; Taniguchi and Fujii, 2007).

Nevertheless, being advised to stop driving or having a lower level of confidence in safe driving ability do appear to be major predictors of driving cessation, suggesting that drivers stop driving more or less as a result of social pressure, as shown in the model of the driving cessation process (Choi et al. 2012b). Women and those respondents from older age groups are more likely to stop driving than men and those of a younger age. This finding might be explained by different patterns of daily activities between genders and age groups (Cabinet Office, 2011). Men are more likely to go out by car than women, while more women tend to be driven by other family members or use public transportation compared with men. Of course, frequency of going out reduces as age advances for both men and women.

Finally, it is important to note that driving cessation might increase the risk of adverse social and health outcomes such as decreased out-of-home activity levels (Marottoli et al., 2000), reduced network of friends (Mezuk & Rebok, 2008), physical and social functional decline (Edwards et al., 2009a), increased depressive symptoms (Marottoli et al., 1999; Windsor et al., 2007), entry into long-term care (Freeman et al., 2006), and increased three-year mortality risk (Edwards et al., 2009b). Therefore, averting such consequences is another challenge after driving cessation (Windsor & Anstey, 2006). If these consequences would be alleviated by securing transportation alternatives, the importance of mobility support for older adults is two-fold: supporting older drivers to stop driving when they decide it, and preventing possible adverse outcomes from driving cessation.

To effectively design alternative transportation systems for older drivers, future research should investigate their travel patterns and how their travel needs could be met, considering heterogeneity in their preferences and resources for mobility options as well as in their health and functional status (Hanson & Hildebrand, 2011; Mercado et al., 2010). Given the heterogeneity, a different level and type of assistance would be required to overcome the

aforementioned barriers to the use of transportation alternatives. On the other hand, it is also important to reconsider current land use and housing patterns which necessitate trips by private vehicles (Deka, 2014). Because this situation is increasingly unfit for aging society, the effort of minimizing motorized travel is inevitable in future community design.

While the strength of the current study lies in its determination of the important factors in ceasing driving in a longitudinal design, it had some limitations. First, the response rate was just 41%. While sex composition of the respondents was almost the same as that of eligible participants, we possibly had more responses from relatively healthier individuals than from those who should be considering giving up driving because of health questions. In fact, younger eligible participants responded more than older ones, and nearly 90% of the respondents rated their health as good or very good. Again, among the non-responding older drivers, there could be more individuals who had been advised to stop driving and/or had a lower level of confidence in their safe driving ability who did not renew their driving license but did not want to be interviewed about this decision. If they had responded, the impact of the provision of transportation alternatives on the decision to cease driving might have been more prominent. We were, however, unable to obtain information on the non-respondents' characteristics to compare with the respondents. Second, the survey results may not be generalizable to older adults living in those metropolitan areas or underpopulated rural areas that are different from our study setting with regard to the availability of alternative transportation facilities and to the patterns of using these resources.

In conclusion, our study has identified the importance to a driver who is about to cease driving of the availability of someone who can provide alternative private transport, particularly amongst older drivers who have been advised to stop driving. The existence of other transportation alternatives was not found to be related to the decision to cease driving. Older drivers should therefore be assisted to cease driving when they are advised to by the authorities, through the agency of someone who can provide alternative transportation. However, the number of people who can provide this service may also change in an aging society, and this situation calls for the development of sustainable alternative public transportation options for older adults.

**Acknowledgments**

We thank Ibaraki Prefectural Police for their help in sending out baseline questionnaires.

**Funding**

This work was supported by JSPS KAKENHI Grant Number 22790486; and the Mitsui Sumitomo Insurance Welfare Foundation Research Grant.

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**Table 1** The demographics, health status, driving, and transportation alternatives of the 2932 older drivers who renewed and the 157 older drivers who did not renew their driving license\*

Baseline characteristics	Those who renewed		Those who did not renew	
	n	%	N	%
<u><i>Demographics</i></u>				
Age group (years)				
69–74	1503	51.4%	62	39.7%
75–79	853	29.2%	34	21.8%
80–84	475	16.3%	30	19.2%
85+	92	3.1%	30	19.2%
Sex				
Male	2257	77.1%	90	57.7%
Female	669	22.9%	66	42.3%
Marital status				
Married	2413	83.1%	112	74.2%
Widowed	471	16.2%	38	25.2%
Not married	19	0.7%	1	0.7%
Co-resident status				
Lives with other(s)	2688	92.6%	146	94.8%
Lives alone	214	7.4%	8	5.2%
<u><i>Health status</i></u>				
Self-rated health				
Very good	639	22.0%	19	12.1%
Good	1951	67.3%	80	51.0%
Fair	286	9.9%	51	32.5%
Poor	23	0.8%	7	4.5%
Hospitalization in the past year				
Yes	371	12.8%	33	21.3%
No	2537	87.2%	122	78.7%
Activities of daily living (ADL)				
No difficulty	2436	85.1%	103	66.0%
Any difficulty	425	14.9%	53	34.0%

Instrumental ADL				
5 full scores	2547	88.5%	103	65.6%
< 5 scores	330	11.5%	54	34.4%

Geriatric Depression Scale				
6+	239	8.5%	27	18.0%
< 6	2583	91.5%	123	82.0%

Driving

Frequency of car driving in the previous month				
2 days a week or more	2578	91.4%	36	26.3%
1 day a week or less	244	8.6%	101	73.7%

Self-rated confidence in safe driving				
Not at all	43	1.5%	43	33.6%
A little	766	27.4%	46	35.9%
Quite a bit	1583	56.5%	34	26.6%
Extremely High	408	14.6%	5	3.9%

Ever advised to stop driving by family/relatives				
Yes	127	4.5%	75	55.1%
No	2710	95.5%	61	44.9%

Ever advised to stop driving by medical personnel				
Yes	18	0.6%	14	10.7%
No	2805	99.4%	117	89.3%

Transportation alternatives

Someone who can provide a ride				
Available	2100	73.2%	127	84.1%
Not available	767	26.8%	24	15.9%

Demand responsive transport				
Available	1427	52.4%	67	46.2%
Not available	390	14.3%	24	16.6%
Don't know	904	33.2%	54	37.2%

Time taken to walk from home to a bus stop				
< 5 min	1117	42.9%	61	44.9%
5–10 min	752	28.9%	41	30.1%

10–20 min	404	15.5%	17	12.5%
20–30 min	160	6.1%	9	6.6%
>30 min	170	6.5%	8	5.9%

Time from taxi call to taxi arrival at home

< 10 min	1413	49.8%	81	53.3%
10–20 min	885	31.2%	42	27.6%
20–30 min	292	10.3%	12	7.9%
>30 min	44	1.6%	3	2.0%
Don't know	201	7.1%	14	9.2%

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\* Baseline characteristics were identified at a baseline survey in 2010, and license renewal was identified at a follow-up survey in 2012.

**Table 2** Relative effects of driving-related stressors and other factors on driving cessation: adjusted odds ratios (OR) and 95% confidence interval (CI) were estimated using multivariate logistic regression analysis

	Model 1			Model 2			Model 3		
	OR	95% CI		OR	95% CI		OR	95% CI	
Advised to stop driving	11.92	7.58	— 18.76	4.64	1.73	— 12.40	5.01	1.87	— 13.46
Have less confidence in safe driving	4.23	2.67	— 6.71	4.39	2.75	— 6.99	2.66	1.03	— 6.89
Someone who can provide a ride is available	1.99	1.15	— 3.45	1.25	0.65	— 2.38	0.85	0.35	— 2.07
Age	1.12	1.07	— 1.17	1.12	1.07	— 1.18	1.12	1.07	— 1.18
Sex (female)	2.54	1.58	— 4.10	2.63	1.62	— 4.25	2.61	1.61	— 4.24
Self-rated lower health status	3.75	2.36	— 5.94	3.72	2.34	— 5.91	3.75	2.35	— 5.96
Interaction term 1				3.32	1.10	— 10.00	3.10	1.02	— 9.38
Interaction term 2							1.90	0.64	— 5.58
Hosmer-Lemeshow test, p value		0.48			0.42			0.48	

Interaction term 1: Advised to stop driving, and someone who can provide a ride is available.

Interaction term 2: Have less confidence in safe driving, and someone who can provide a ride is available.