Predictors of driving outcomes including both crash involvement and driving cessation in a prospective study of Japanese older drivers

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ARTICLE INFO

ABSTRACT

The first aim of this study was to investigate predictors of future traffic crash involvement, taking into account bias in the handling of data for former drivers. The second aim was to compare characteristics of former drivers and crash-involved drivers in order to gain an understanding of appropriate driving cessation among older drivers.

In all, 154 drivers aged 70 years or older participated in the baseline interview and the follow-up survey conducted two years later. In the baseline interview, participants were asked to respond to a questionnaire, take the Useful Field of View test® (UFOV), and complete the Mini-Mental State Examination. In the follow-up survey, participants were asked by mail or telephone whether they had stopped driving. Participants reporting that they still drove were invited to participate in a subsequent interview. Based on the information obtained in the follow-up survey, participants were classified as follows: driving cessation group ($n = 26$); crash-involved group ($n = 18$); and crash-free group ($n = 110$). A multinomial logistic regression was then used to analyse the data.

Contrary to the results of previous studies, we found older age to be associated with crash involvement but not with driving cessation. The cessation group had more decreased cognitive processing speed than the crash-involved and crash-free groups. Crash history was also predictive of crash involvement. Participants who were subject to license renewal between baseline and follow-up had a greater tendency to continue driving.

Results suggested that age and crash history could potentially identify high-risk older drivers. The predictive power of cognitive processing speed is reduced under certain conditions. License-renewal procedures may induce Japanese older adults to continue driving. Future studies should use a large national sample to confirm the results of the present study.

1. Introduction

As the population of older adults has grown and the numbers of older drivers have increased in most developed countries, it is expected that fatal crashes involving older drivers will continue to rise (Charlton et al., 2006; Lyman et al., 2002). Because the number of driving license holders aged 65 years and older has rapidly increased in Japan, the number of crashes involving such individuals has also risen sharply (National Police Agency Bureau of Traffic, 2016).

To identify high-risk older drivers, make them aware of age-related functional impairment, and protect public safety in Japan (Ichihara, 2008; National Police Agency, 2009), the following measures have been implemented for older drivers. First, the procedure for driving license renewal for individuals under 70 years of age is different from that for those 70 years or older (Saitama Prefectural Police, 2016). As a prerequisite to license renewal, drivers under 70 years of age are required to take one of three types of lessons, depending upon their history of traffic violations and crashes. Drivers 70 years or older are required to take a lesson for older drivers before renewal. This lesson consists of a lecture, a driving operation evaluation, tests of vision (including kinetic visual acuity, night vision, and horizontal visual field), and on-road driving instruction (Higuchi, 2009). Renewal applicants are informed of their test results, and the on-road driving instruction is based on those results. In addition, drivers aged 75 years or older need to undergo cognitive screening before license renewal. Examinees are informed of the test result, which consists of three grades. Those identified as having cognitive impairment additionally have to undergo a medical examination by a physician specializing in dementia (Higuchi, 2009).

Second, licenses for drivers with a history of certain violations or crashes are valid for only three years regardless of the driver's age. However, for drivers aged 72 years or older, the term is three years even if there is no history of violations or crashes.

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Third, Japanese authorities have conducted campaigns to encourage older adults to relinquish their driving license. For example, older adults who surrender their license in exchange for an identification certificate may receive coupons for buses or taxis as well as discounts at local businesses such as restaurants, department stores, and museums (Arima, 2011).

Fourth, drivers aged 70 years and older are required by law to display a sign at the front and rear of their vehicles indicating that they are senior drivers. There is no penalty for non-compliance; however, nearby vehicles are obliged by traffic law to take special care to ensure that vehicles displaying such a sign can pass safely.

It is unclear whether such measures for older individuals can identify high-risk drivers or play a role in the decision of older people no longer fit to drive to cease doing so. Studies from various countries, including Japan, have largely failed to demonstrate that license-renewal procedures reduce the involvement of older drivers in crashes (Grabowski et al., 2004; Hakamies-Blomqvist et al., 1996; Ichikawa et al., 2015; Langford et al., 2004a,b; Mitchell, 2008; Siren and Meng, 2012). On the other hand, a number of studies have shown that license-renewal procedures are associated with driving cessation (Hakamies-Blomqvist et al., 1996; Langford et al., 2004a; Mitchell, 2008; Siren and Meng, 2012).

There is thus a pressing need worldwide to identify high-risk older drivers who are likely to be involved in future crashes. Many previous studies have examined predictors of future crash involvement among older drivers. Recent studies employing a prospective research design have revealed various predictors of future crash involvement, including the following: crash history (Emerson et al., 2012; Owsley et al., 1998; Sims et al., 2000); cognitive processing speed measured by means of the Useful Field of View® (UFOV®) test (Ball et al., 2006; Cross et al., 2009; Owsley et al., 1998; Sims et al., 2000); history of falls (Ball et al., 2006; Cross et al., 2009); and Trail Making Test performance (Ball et al., 2006; Emerson et al., 2012). Age (Ball et al., 2006), gender (Ball et al., 2006; Cross et al., 2009), driving exposure (Hu et al., 1998), and medical condition, including stroke (Sims et al., 2000) and diabetes (Leproust et al., 2007), have also been shown to be associated with future crash involvement.

Of course, some older adults tend to cease driving of their own accord. In prospective studies about predictors of crash involvement, the proportion of participants who had participated in a baseline survey but then stopped driving before the follow-up survey was 3% over a five-year period (Sims et al., 2000) and 20% over seven years (Emerson et al., 2012); however, such proportions do vary in different studies. In those studies, individuals who stopped driving before the follow-up were identified as dropouts (Ball et al., 2006) or as crash-free drivers (Cross et al., 2009; Owsley et al., 1998; Sims et al., 2000). However, as Ball et al. (2006) pointed out, the decision to cease driving and crash involvement may not be mutually independent.

For example, poor UFOV® performance has been found to be associated with subsequent driving cessation (Ackerman et al., 2008; Edwards et al., 2010, 2008b). Some studies have shown UFOV® performance to be associated with future crash involvement (Ball et al., 2006; Cross et al., 2009; Owsley et al., 1998; Sims et al., 2000); however, other studies have failed to support this finding (Emerson et al., 2012; Friedman et al., 2013). If most drivers with impaired UFOV® performance were aware of their poor cognitive processing speed and then decided to cease driving, the relationship between UFOV® performance and crash involvement might be underestimated. Thus, if there is some overlap in predictors of crash involvement and driving cessation, the impact of those predictors on crash involvement might not be correctly estimated owing to the bias involved in handling the data of older adults who cease driving.

In addition to individual characteristics such as age (Anstey et al., 2006; Brayne et al., 2000; Edwards et al., 2010; Emerson et al., 2012; Jette and Branch, 1992; Marottoli et al., 1993; Unsworth et al., 2007), gender (Freeman et al., 2005; Jette and Branch, 1992; Kington et al., 1994; Lafont et al., 2008; Marottoli et al., 1993; Unsworth et al., 2007), and UFOV® impairment (Ackerman et al., 2008; Edwards et al., 2010, 2008b), driving license-renewal procedures for older drivers have been frequently regarded as possibly affecting driving cessation (Hakamies-Blomqvist et al., 1996; Langford et al., 2004a; Mitchell, 2008; Siren and Meng, 2012). For example, Siren and Meng (2012) found that after the 2006 introduction of cognitive screening for license renewal for older drivers in Denmark, fatal crashes involving unprotected older road users increased; while there was no reduction in fatal crashes involving older drivers. The authors attributed this finding to the fact that the change in license-renewal procedures might have increased driving cessation and a modal shift from driving to unprotected means of travel among older drivers. As a previous study pointed out, illnesses which do not impair driving ability were associated with driving cessation (Siren et al., 2004), meaning that some older people give up even though they can still drive safely.

It is important to recognise that driving cessation can lead to many negative consequences, including increased depressive symptoms (Fonda et al., 2001; Marottoli et al., 1997), increased risk of entry into long-term care (Freeman et al., 2006), reduced network of friends (Mezuk and Rebok, 2008), decreased out-of-home activity levels (Marottoli et al., 2000), and increased risk of three-year mortality (Edwards et al., 2009). Ideally, then, driving cessation should be encouraged only for older adults who are no longer fit to drive (while older adults who are fit to drive continue driving). To understand whether older drivers make the driving cessation decision appropriately, it is necessary to simultaneously investigate who tends to decide to cease driving and who tends to be involved in a crash before driving cessation.

1.1. Purposes of present study

This study had two purposes. First, given that the predictors of future crash involvement have not hitherto been correctly evaluated owing to bias in the handling of the data of former drivers, this study sought to overcome the problem by including both crash involvement and driving cessation as outcome measures and more accurately identifying predictors of crash involvement.

Second, this study aimed to obtain information regarding whether older drivers made the driving cessation decision appropriately (that is, they decided to cease driving only if it was best that they do so) by examining predictors of outcome categories that combined two factors: whether one stopped driving or not and whether one was involved in a crash or not. This could not be properly determined by comparing former drivers and active drivers or by comparing a crash-involved group and a crash-free group, as in previous studies. Furthermore, in Japan, older drivers are not required to renew their license at the same age, which means the age at license renewal varies for each driver. Thus the impact of license-renewal procedures on driving cessation can be examined independently of the effect of age itself. Accordingly, using an appropriate sample of older Japanese drivers would allow an examination of the impact of both factors on driving cessation.

In this study, both crash involvement and driving cessation were included as outcome measures. We classified participants into three categories according to their status in a follow-up survey and identified these categories as outcomes. The three categories were as follows: (1) individuals who had stopped driving after baseline, (2) individuals who had continued driving and had no crash history after baseline, and (3) individuals who had continued driving and had a crash history after baseline. We also investigated the prospective association between characteristics at baseline and outcome categories using multinomial logistic regression analysis.