



# Elderly drivers' everyday behavior as a predictor of crash involvement—Questionnaire responses by drivers' family members

Yoshinori Nakagawa<sup>a,\*</sup>, Kaechang Park<sup>b</sup>, Yasuhiko Kumagai<sup>b</sup>

<sup>a</sup> Department of Management, Research Organization for Regional Alliance, Kochi University of Technology, Japan

<sup>b</sup> Research Organization for Regional Alliance, Kochi University of Technology, Japan

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## ABSTRACT

When or whether elderly drivers stop driving is concerning not only to the drivers themselves but also to their family members. Therefore, it is important for family members to take the initiative if they wish to obtain information on the likelihood of the drivers' involvement in crashes. On the basis of the older drivers' Everyday Behavior Questionnaire (EBQ) developed in this paper, we attempt to predict drivers' involvement in crashes using the responses given by their family members. The results revealed that this 14-item questionnaire has a sufficient level of internal consistency as well as a significant correlation ( $r=0.29$ ) with the experience of involvement in crashes in the last three years ( $p<0.01$ ). Although the EBQ is a proxy-reported questionnaire and does not include items directly related to driving behaviors, the correlation between the EBQ and crash involvement is stronger than that of the self-reported Driver Behavior Questionnaire reported in *deWinter and Dodou (2010)*, who conducted a meta-analysis and estimated the overall correlation among samples of earlier studies. In addition, logistic regression analysis showed that the EBQ score and the exposure to driving risks, measured by the frequency of driving, are significant predictors of involvement in crashes.

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## 1. Introduction

### 1.1. Background

Previous studies have shown that older drivers have higher crash rates per vehicle mile of travel (*McGwin and Brown, 1999; Retchin and Anapolle, 1993; Massie et al., 1995*). With the projected increase in the elderly driving population worldwide (*Parker et al., 2000; Lyman et al., 2002*), including Japan, the problem of an increasing number of crashes involving elderly drivers is attracting the attention of many researchers and practitioners.

When addressing this problem, it is important to note that driving restrictions and cessation threaten older adults' lives. According to *Stutts and Wilkins (2003)* and other authors, these conditions lead to consequences such as (i) loss of mobility (*Evans, 2001; Marottoli et al., 2000; Rosenbloom, 2001*), (ii) loss of identity and increased dependency (*Burkhardt et al., 1998; Carp, 1988; Culter, 1975; Eisenhandler, 1990*), (iii) physical and mental problems such as increased depression, heart disease, fractures, and stroke (*Bassuk et al., 1999; Fonda et al., 2001; Marottoli et al., 1997*),

and (iv) decreased social integration, as measured by number and frequency of social contacts (*Turano et al., 2009*).

It should also be noted that when or whether elderly drivers stop driving is of great concern to their family members for two reasons. First, if elderly drivers suffer the above-mentioned negative consequences on cessation of driving, their families are likely to be burdened psychologically, physically, and economically. Second, family members do not want their loved ones to be involved in crashes, and often hope for their driving cessation. Thus, it is important that family members take the initiative, if they wish, to obtain information on the likelihood of the elderly relatives getting involved in crashes and to gain a stance on driving cessation.

### 1.2. Objective

Against this background, this study develops an older drivers' Everyday Behavior Questionnaire (EBQ). This questionnaire, answered by older drivers' family members, attempts to predict drivers' involvement in crashes. This study also checks its internal consistency as well as the validity by calculating its correlation with the drivers' involvement in crashes in the last three years and with two factors of the proxy-reported Driver Behavior Questionnaire (DBQ), lapses and errors.

The EBQ has two characteristics. First, this questionnaire is answered by older drivers' family members who live with the

\* Corresponding author at: 185 Miyanokuchi, Kami City, Kochi Prefecture, Japan. Tel.: +81 887 57 2768; fax: +81 887 57 2124.

E-mail address: [nakagawa.yoshinori@kochi-tech.ac.jp](mailto:nakagawa.yoshinori@kochi-tech.ac.jp) (Y. Nakagawa).

drivers and observe their everyday lives. Thus, family members can independently answer the questionnaire without any technical know-how and within a short span of time. Second, as the EBQ consists of items not directly related to driving, respondents are not required to be regular passengers in the elderly drivers' cars.

### 1.3. Related earlier studies

Several lines of earlier research have aimed at predicting the performance of drivers, specifically those who are elderly. One line of research investigated the association between driving performance and requisite cognitive functions for driving which were assessed using various tests, such as the Ergovision test, the Useful Field of View (UFOV) test, a Complex Reaction Time Task, the Benton Line Orientation task, Clock Drawing, and the Trail Making test. Mathias and Lucas (2009) conducted a meta-analysis of these earlier studies and concluded that a variety of tests appear suitable for screening older drivers, the exact choice of which depends on the "gold standard" for determining driving ability (on-road driving, simulator performance, driving problems). It should be noted that although a combination of such ability measures can successfully identify risky drivers (e.g., McKnight and McKnight, 1999), these tests are burdensome to drivers, and may not be easy to adopt, especially when drivers are unwilling to retire from the roadways.

A second line of research examined the association between driving performance and neurological disorders that older people are more likely to suffer, such as stroke, dementia, and mild cognitive impairment (e.g., Frittelli et al., 2009; Zuin et al., 2002). Many of these studies investigated the association between driving performance (on-road driving or simulator performance) and commonly used screening tests for detecting dementia and cognitive impairment, such as the Clinical Dementia Rating (CDR) and Mini Mental State Examination (MMSE). However, these two scores are not without limitations: the CDR is time-consuming and is rarely used outside of specialist clinics, and MMSE scores correlate poorly with driving performance (Wagner et al., 2011); the reason for this poor correlation is discussed by Frittelli et al. (2009).

A third line of research explored the association between drivers' involvement in crashes and their driving behavior patterns. Among the typologies of aberrant driving behaviors, the DBQ is one of the most popular instruments. A number of earlier studies have aimed to predict drivers' involvement in crashes using the questionnaire's subscales, such as errors (mistakes that have potentially dangerous consequences), lapses (primarily attentional failures), and violations (risky driving behaviors). In a meta-analysis of these studies, deWinter and Dodou (2010) concluded that the violation and error factors of the DBQ predicted crashes with an overall correlation of 0.13 and 0.10, respectively. Parker et al. (2000) applied the DBQ to drivers aged 50 and above, and found that, in an older sample, relatively high scores on the error and lapse factors were predictive of involvement in an active accident. It should be noted that these studies are based on a self-report questionnaire, and it is not clear to the authors of the present paper whether this approach is applicable to drivers who are suspected of having a certain degree of cognitive impairment.

It is expected that the proposed instrument will complement the above-mentioned existing measures in predicting aged drivers' performance.

## 2. Methods and materials

### 2.1. Participants

Data were collected via an internet research company, Cross Marketing, Inc., whose registered members were invited by to

participate in the preliminary survey. Potential participants were asked if they satisfied the following four conditions. Those who satisfied all four were invited to participate in the main survey.

**Condition 1:** He or she lives in the same house as the elderly family member aged 70 or more.

**Condition 2:** The elderly relative drives at least twice or three times per month.

**Condition 3:** He or she wants the elderly relative to cease driving.

**Condition 4:** He or she rides as a passenger in the car driven by the elderly family member at least once per two or three months.

Condition 3 was checked by the item "Do you want him/her to cease driving?", and the respondents were asked to choose from one of the five alternatives: 1 = *Agree*, 2 = *Agree to some extent*, 3 = *No opinion*, 4 = *Disagree to some extent*, and 5 = *Disagree*. Respondents who chose options 1 or 2 were considered to satisfy the given condition. Condition 4 was included to check the validity of the scale developed in this study, although the EBQ proposed in this study was designed such that respondents were not required to be regular passengers in elderly drivers' cars. If the scale exhibits validity, then scores should be associated with the frequency of lapses and errors reported by the elderly drivers' family who have been passengers.

Among those who qualified for the preliminary survey, 488 people agreed to participate in the main survey. There were 268 (54.9%) males and 220 (45.1%) females, with an average age of 50.0 (SD 14.8). The average age of their elderly family members was 76.3 (SD 4.6). More than half of them (55.7%) were the respondents' parents and 22.1% of them the respondents' spouses. The numbers of drivers with no, one, two, and three or more crash experiences in the last three years were 289, 116, 47, and 36, respectively.

### 2.2. Materials

#### 2.2.1. Characteristics of respondents and their elderly family drivers

Socio-demographic and other questions were included in the questionnaire to determine (i) respondents' age and gender, (ii) age, gender, and former and current employment status of the respondents' elderly family members, (iii) driving history of the elderly family members (in years), (iv) driving exposure or frequency of driving of the elderly family members (4 = *Every day*, 3 = *Twice or three times per week*, 2 = *Once per week*, 1 = *Twice or three times per month*), (v) frequency with which the respondents ride as passengers in the cars driven by the elderly family members (4 = *Once or more per week*, 3 = *Once per two or three weeks*, 2 = *Once per month*, 1 = *Once per two or three months*), and (vi) the elderly family member's involvement in crashes in the last three years (4 = *Three times or more*, 3 = *Twice*, 2 = *Once*, 1 = *None*).

Involvement in crashes was measured by the item "In the past three years, has your elderly family member caused crashes (incidents with other vehicles, pedestrians, cyclists, or objects, or more serious crashes) while driving a car?" Although the present study could have used a yes or no response, a four-point scale was adopted, ranging from 1 (*None*) to 4 (*Three times or more*), and respondents who answered "1" were regarded as having no crash experiences. This was expected to enhance the reliability of the item. With regard to driving exposure, most earlier studies asked drivers about kilometers (miles) driven in a specific period using a self-report questionnaire survey. We did not adopt this method of measuring exposure, because this study involved a proxy-reported survey, and reporting the total distance driven by their family members would be difficult for the respondents.

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