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IDENTIFYING CRASH INVOLVEMENT AMONG OLDER DRIVERS: AGREEMENT BETWEEN SELF-REPORT AND STATE RECORDS

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Abstract—Older drivers have a high crash rate per vehicle mile of travel. Coupled with the growth of the number of older drivers on the road, this has generated interest in the identification of factors which place older drivers at increased risk. However, much of the existing research on medical and functional risk factors for crash involvement has generally been inconsistent. Methodological differences between studies have been hypothesized as being partly responsible for such inconsistencies. The source of information used to identify crash-involved drivers has been identified as one such difference. This paper reports on the agreement between self-report and state record for identifying crash involved-older drivers. We also sought to determine whether the prevalence of visual and cognitive impairment differs across crash-involved drivers identified by either or both sources. Finally, we assessed whether risk factors for crash involvement differed when crash-involved drivers were identified by either self-report or state records. Results indicated that there was a moderate level of agreement between self-reported and state-recorded crash involvement (kappa = 0.45). However, we did find significant differences between crash-involved drivers identified via state records and/or self-report with respect to demographic (age, race), driving (annual mileage, days per week driven), and vision impairment (acuity, contrast sensitivity, peripheral visual field sensitivity, useful field of view). We also found that the possibility for biased measures of association is real. Useful field of view impairment was associated with both self-reported and state-recorded crash involvement; however, the magnitude of the associations was disparate. Moreover, glaucoma was identified as a significant risk factor when considering state-recorded crashes but not self-reported crashes. While validation of these findings is required, research designed to identify risk factors for crash involvement among older drivers should carefully consider the issue of case definition, particularly if self-report is used to identify crash-involved older drivers. © 1998 Elsevier Science Ltd. All rights reserved.

Keywords—Older drivers, Accidents, Accident records, Vision, Cognition, Methodology

INTRODUCTION

Driving is a complex task requiring visual, cognitive and physical skills. Impairment in these skills is increasingly common in the later decades of life (Katz, 1983; Tielsch et al., 1990; Whitehouse, 1993), and has been associated with increased risk of crash involvement in older drivers (National Highway Traffic Safety Administration, 1989). Chronic diseases (e.g. diabetes, cardiovascular disease) which engender these types of functional impairments have also been identified as increasing crash risk for older adults (National Highway Traffic Safety Administration, 1989). After 16–25-year-olds, persons aged 70 and older have the second highest rates of motor vehicle collisions and fatal and non-fatal crash injuries per vehicle mile of travel (National Safety Council, 1993). With the aging of the U.S. population, there is a pressing need to understand the causes of crashes by older drivers so that preventive strategies can be developed.

Although relatively sparse, much of the research on medical and functional risk factors for motor vehicle crashes in the elderly has not produced consistent results. For example, three studies have assessed diabetes as a risk factor for crash involvement among older drivers (Foley et al., 1994; Gresset and Meyer, 1994a; Koepsell et al., 1994). Among them, one

(Koepsell et al., 1994) found a significantly elevated, almost 3-fold risk, while the remaining studies (Foley et al., 1994; Gresset and Meyer, 1994a) found no such significant increase. Studies investigating medication use and crash risk among older drivers have also been equivocal. Although a number of studies have found elevated crash rates for drivers using benzodiazepines (Hemmelgarn et al., 1997; Honkanen et al., 1980; Neutel, 1995; Ray et al., 1992; Skegg et al., 1979), other studies have produced null results (Benzodiazepine/Driving Collaborative Group, 1993; Jick et al., 1981; Leveille et al., 1994). It has been suggested that these discrepancies may be partly methodologic in origin (Koepsell et al., 1994; Ray, 1992). Differences in study populations, data collection techniques (e.g. interview, medical record), and availability of information on potentially important confounding variables (e.g. driving exposure) have been identified as such methodological discrepancies. Another methodological issue relates to case definition (i.e. how crash-involved drivers are identified). Among previously conducted studies, case definitions have included self-reported crashes (Hoffstetter, 1976; Marottoli et al., 1994; Shinar, 1977), crashes involving injury to the driver (Koepsell et al., 1994; Leveille et al., 1994; McCloskey et al., 1994), and state-recorded crashes where the driver was found to be at-fault (Ball et al., 1993; Owsley et al., 1991). Several studies have also utilized a mixture of injury, fault and/or self-report when defining cases (Gresset and Meyer, 1994a,b; Marottoli et al., 1994). In the majority of studies conducted to date, the impact of case definition on study results has not been given due consideration (see Marottoli, 1997; Owsley, 1997 for discussion). When attempting to identify risk factors for any health problem, including cataract, neural tube defects and hypertension, heterogeneity among cases can potentially obscure or mask important determinants. Therefore, it is possible that discrepancies between prior studies utilizing different case definitions are attributable to the fact that risk factors are not uniform across different case definitions. For example, the use of self-report rather than state records for identifying crashes may only identify a fraction of all crashes. If this fraction is somehow different with respect to risk factors of interest, the end result will be measures of association that are biased.

Marottoli et al. (1997) recently discussed the issue of the agreement between self-report versus state records for the identification of crashes among older drivers. These authors concluded that self-report and state records provide complementary information and that the former may provide a reasonable alternative to state records. Others have been less sanguine about the agreement between self-report and state records (Ball et al., 1993; Owsley et al., 1991). For example, in their study of older drivers in Alabama, Ball et al. (1993) found a low correlation ($r = 0.11$) between the raw number of self-reported and state-recorded crashes during a 5-year period. However, when subjects were categorized into groups according to none versus one or more self-reported crashes and none versus one or more state-recorded aggregate crashes, the level of agreement between self-report and state records was moderate (kappa = 0.40). Thus, the apprehension on the part of some researchers may be partly related to the manner in which sources of information on crash involvement are compared. Nevertheless, agreement between sources is only part of the issue. Of greater concern is the potential for important risk factors to be over- or under-represented among crash-involved subjects identified via self-report or state records. To our knowledge, no studies to date have directly addressed this issue.

The objective of this report is three-fold. First, we estimate the level of agreement between self-reported and state-recorded crashes among a sample of older drivers. Second, we evaluate whether the prevalence of visual and cognitive impairment differs across three groups of older crash-involved drivers: those with crashes that were both self-reported and state-recorded, self-reported but not state-recorded, and not self-reported but state-recorded. Third, we assess whether risk factors for crash involvement differed when crash-involved drivers were identified by either self-report or state records. We focus on visual and cognitive factors, because driving is a complex task obviously involving visual and cognitive skills for its successful execution, and impairment of these skills has been associated with increased risk of crash involvement in older drivers (Ball et al., 1993; Cooper et al., 1993; Decina and Staplin, 1993; Johansson et al., 1996; Johnson and Keltner, 1983; Kahneman et al., 1973; Marottoli et al., 1994; Owsley et al., 1991; Transportation Research Board, 1988).

METHODS

Subjects

This sample was originally assembled for the purposes of a case–control study on older drivers with a history of crash involvement (Ball et al., 1993). The source for the sample was all licensed drivers in Jefferson County, Alabama, age 55 years and older ($N = 118{,}553$). Ultimately, the goal was to enroll a sample of approximately 300 drivers that was balanced with respect to two variables: crash frequency during the previous 5-year period, and age. To identify these 300 individuals, the source population of older drivers in Jefferson County was first sorted into 21 cells, representing three crash categories (0, 1–3 and 4 or more, over the prior 5 years) and seven age categories (55–59, 60–64, 65–69, 70–74, 75–79, 80–84, and 85+ years old). Seventy-five drivers were selected randomly from each cell, and contact letters were sent to those listed in the local telephone directory. The goal was to enroll approximately 300 older adults in a 6-week period in the summer of 1990. Enrollment was terminated when 302 subjects were successfully recruited, even though there were additional names to contact for scheduling. Six of the 302 subjects who enrolled were excluded from analysis because they did not drive, even though they maintained a current driver's license, and two additional subjects were excluded because they did not complete the protocol. It was necessary to exclude 16 additional subjects who did not provide information on self-reported crashes. Thus, the final sample consisted of 278 older drivers. Thirty-three percent of the overall sample had 0 crashes on record, 49% had 1–3 crashes and 18% had 4 or more, over the prior 5 years. For the purposes of this paper, subjects were classified as either having 0 or 1 or more state-recorded crashes. The mean age of the study subjects was 71 years (SD = 9, range 56–90); 54% were male and 81% were white.

Protocol

The protocol was approved by the Institutional Review Board at the University of Alabama at Birmingham. Before participation, written informed consent was obtained from each subject after the nature of the study was explained. The protocol was completed in a single visit to the clinic in 1990, and consisted of assessments of visual sensory function, visual attention/processing speed, eye health, a questionnaire about driving exposure, cognitive function, as well as a review of demographic and health information. The order of these assessments was counterbalanced across subjects, except for the eye examination which was always last because it involved eye dilation. These evaluations are summarized below. The examiners were unaware of the crash histories of all subjects tested.

Data collection and measurements

The following visual sensory tests were administered because they represent major aspects of visual sensory function, are commonly used screening tools, and have been linked in varying degrees to driving problems in prior studies. All vision tests were performed under photopic conditions (100 cd/m^2), except where noted. Letter acuity was measured using the ETDRS chart (Ferris et al., 1982) and expressed as log minimum angle resolvable (logMAR). Impaired acuity was defined as worse than 20/40 acuity, the legal limit for licensure in many states. Contrast sensitivity was measured using the Pelli–Robson chart (Pelli et al., 1988) and expressed as log contrast sensitivity. Impaired contrast sensitivity was defined as a score of 1.5 or worse. Stereoacuity ('depth' perception) was measured using the TNO-test (Simons, 1981) and expressed as arcseconds. Impaired stereoacuity was defined as 500 arcseconds or worse. Disability glare was measured with the MCT-8000 (VisTech) and defined as the difference in letter acuity (logMAR) under conditions of glare versus no glare. Impairment was defined by values greater than 0. Visual field sensitivity was measured with the Humphrey Field Analyzer's 120-point screening program for the central 60° radius field using the quantify defects option. A pre-set initialization value of 34 dB (both central and peripheral) was used, which served as a baseline, 'normal' visual field against which performance was compared. This standard was based on the normal visual field sensitivity for adults in their 50s who are in good eye health (Brenton and Phelps, 1986). Background luminance was 10 cd/m^2. For each eye, visual field defect for the central 30° and the peripheral 30–60° field was expressed as the average defect depth of all points in the region. The eye with the smaller defect depth ('better' eye) was used in all subsequent data analysis. The standard protocols for all above tests were followed as described in the manufacturers' manuals. All tests were administered binocularly, except the visual field tests in which each eye was tested separately. For all tests except visual field testing, subjects wore their habitual correction because their everyday visual performance capabilities were of primary interest. With respect to visual field testing, the Humphrey Field Analyzer's validity rests upon use of optimal optical correction for the near target distance, so this was implemented in the protocol. Impaired visual field sensitivity (for both the central and peripheral visual fields) was a loss of sensitivity of more than 1 log unit (10 dB).

Visual attention/visual processing speed was assessed with the useful field of view test (Ball et al., 1990; Ball and Owsley, 1993). The useful field of view (UFOV) is defined as the visual field area over which one can use rapidly presented visual information (Sanders, 1970; Ball and Owsley, 1993). Unlike conventional measures of visual field which assess visual sensory sensitivity, the UFOV test additionally relies on 'higher-order' processing skills such as selective and divided attention, and rapid processing speed. The test consists of a radial localization task in which a subject must identify the radial direction of a target (a silhouette of a car) presented up to 30 degrees in the periphery, while simultaneously discriminating two targets presented in central vision (a silhouette of a car vs a truck). By varying the eccentricity of the peripheral target (at 10, 20, or 30°), the visual field area over which a subject can acquire information can rapidly be estimated. In some trials the peripheral target is embedded in distracting stimuli. Thus, the task has both divided-attention components (i.e. the subject must perform a central discrimination task at fixation while localizing a simultaneously presented target), and a selective-attention component (i.e. the subject indicates the radial direction of the peripheral target even though it is embedded in other distracting stimuli in the periphery). Another variable manipulated is the duration of the test display, which varies from 40 to 240 milliseconds. Performance is expressed as a function of three variables—the minimum target duration required to perform the central discrimination task (subtest 1), the ability to divide attention between central and peripheral tasks successfully (subtest 2), and the ability to filter out distracting stimuli (subtest 3). Performance in each of the three subtests is scaled from 0 to 30. In addition, performance in the three subtests is non-independent, since speed of processing is relevant to all three tests, and attention abilities are relevant to subtests 2 and 3. Performance in the overall useful field of view task is expressed as a composite score expressed as percent reduction (range 0–90%) of a maximum 30 degree field size (maximum field size of the test apparatus' screen at the viewing distance). Using a prior established cutpoint (Ball et al., 1993), impaired useful field of view was defined as a 40% reduction or greater.

All subjects received a comprehensive eye examination by an ophthalmologist, which included direct and indirect ophthalmoscopy after dilation, biomicroscopy, applanation tonometry, a refraction for distance and as assessment of external health. The primary diagnosis of each subject (other than refractive error) was noted (e.g. cataract, age-related maculopathy, glaucoma, diabetic retinopathy).

Mental status was evaluated by the Mattis Organic Mental Syndrome Screening Examination (MOMSSE) (Mattis, 1976), specifically designed to assess cognitive function in the elderly. This test, lasting about 20 minutes, provides a composite score of cognitive function that summarizes performance in several domains, including general information, abstraction, attention, orientation, verbal memory, visual memory, speech, naming, comprehension, sentence repetition, writing, reading, drawing and block design. Composite scores range from 0 to 28, with lower scores representing higher functioning. Using a prior established convention, a score greater than 9 indicated cognitive impairment (Simons, 1981).

To estimate driving or 'on-the-road' exposure, subjects were asked to fill out a brief questionnaire asking how many days per week they drove and how many miles per year they drove. Subjects were also asked how many accidents they had had over the past 5 years where the police were called to the scene; subjects were instructed to report only those crashes wherein they were the driver. For purposes of this paper, subjects were categorized as having reported either none or one or more crashes in the prior 5 years.

Using this information, subjects were cross-classified with respect to self-reported and state-reported crashes, thus allowing for the creation of four mutually exclusive groups: no self-report or state record, self-report but no state record, no self-report but state record, and self-report and state record (Fig. 1). To determine whether the prevalence of visual and cognitive impairment differs across the three groups of older crash-involved drivers, we made two comparisons: (1) we compared those drivers with crashes that were self-reported but not state-recorded to drivers with both self-reported and state-recorded crashes; and (2) we compared those drivers with crashes that were not self-reported but state-recorded to drivers with both self-reported and state-recorded crashes. Note that the drivers with both self-reported and state-recorded served as the common comparison group. To determine whether differences in the prevalence of visual and cognitive impairment had an impact on the identification of risk factors for crash involvement, the three groups of crash-involved drivers were split into two groups: self-reported crashes and state-recorded crashes. Drivers whose crashes were both self-reported and state-recorded were included in both groups. When crashes were limited to self-report, the reference group consisted of drivers who neither reported a crash nor had one recorded plus drivers whose crashes were state-recorded only. Similarly, when crashes were limited to state records, drivers who had a crash neither reported nor recorded plus drivers whose crashes were self-reported only served as the reference group.

Statistical analysis

The kappa coefficient was calculated to determine the agreement between self-reported crash involvement and state-recorded crash involvement. For continuous variables, differences in visual and cognitive impairment between the groups of subjects were tested using the t-test; for categorical variables, the chi-square statistic was calculated. Fisher's exact test was also used when expected cell counts of

	State Recorded Crash Involvement		
Self report	No	Yes	TOTAL
No	Self - / State - N=89	Self - / State + N=64	153
Yes	Self + / State - N=14	Self + / State + N=111	125
TOTAL	103	175	278

Fig. 1. Drivers cross-classified by self-reported and state-recorded crash involvement.

contingency tables were less than 5. A number of continuous variables were collapsed into binary variables categorizing impaired and non-impaired subjects (see Data collection and Measurements). For variables where this was the case, we assessed differences between groups of subjects using both the original continuous variables and the binary variables. For all variables, the results were consistent and thus will be presented using the latter. Logistic regression was used to calculate odds ratios (ORs) and 95% confidence intervals (CIs) for the association between self-reported crashes and state-recorded crashes and measures of visual and cognitive impairment.

RESULTS

Of the 278 study subjects, 175 had crashes recorded by the state during the 5-year period of interest (Fig. 1). During the same time period, 125 subjects reported having been involved in at least one crash where the police were called to the scene. For 111 subjects there was agreement between self-report and state-recorded crash events. There were 64 subjects who did not report that they had been involved in a crash, but for whom one was recorded by the state. Only 14 subjects reported a crash that was not also recorded by the state. The remainder of the subjects ($N=89$) neither reported a crash nor had one recorded in state records. There was moderate agreement between the two information sources (kappa = 0.45). When considering the agreement between the number of self-reported crashes and the number of state-recorded crashes, the level of agreement was reduced (kappa = 0.25). This was mostly attributable to subjects recalling fewer crashes than were recorded in the state records.

Tables 1–3 compare the demographic, driving, health, visual and cognitive characteristics for study participants according to self-reported and state-recorded crash involvement. Table 1 lists the demographic, driving and health characteristics for the three groups; several differences are of note. The mean age (in years) of drivers with both self-report and state-record crashes was 70.3. This was significantly lower than the mean of drivers with state-record only crashes (72.8). No significant difference was observed when compared to drivers with self-report only crashes. Among those with self-report only crashes, the proportion of black subjects was lower (7.1%) compared to drivers with both self-report and state-record crashes (23.4%). No significant difference was observed for those with state-record only crashes. The gender distribution was not significantly different across the three groups of subjects. The proportion of subjects driving $<10{,}000$ miles per year was significantly greater among those with self-report only (85.7%) and with state-record only (76.2%) compared to those with crashes that were both self-reported and state-recorded (57.7%). A similar pattern was observed for days per week driven. No significant differences were observed for chronic medical conditions or cognitive impairment.

Table 2 presents the visual characteristics of study subjects by self-reported and state-recorded crash involvement. The prevalence of impaired letter acuity (worse than 20/40) was significantly higher among subjects with both self-report and state-record (12.6%) compared to those with subjects with self-report only crashes (0.0%). Drivers involved in state-record only crashes were significantly more likely to have impaired contrast sensitivity (25.0%) as compared to those with both self-reported and state-recorded crashes (11.7%). No significant differences

Table 1. Demographic, driving and health characteristics of drivers by self-reported and state-recorded crash involvement

Characteristics	(Self+/State−)† N=14	(Self−/State+)† N=64	(Self+/State+)† N=111
Age (years)			
Mean (SD)	67.4 (7.9)	72.8* (9.0)	70.3 (9.4)
Race (%)			
White	92.9	73.4	76.6
Black	7.1*	26.6	23.4
Sex (%)			
Female	57.1	51.6	40.5
Male	42.9	48.4	59.5
Annual miles driven (%)			
10,000+	14.3	23.8	42.4
⩽9,999	85.7*	76.2*	57.7
Days per week driven (%)			
7	42.9	46.0	59.5
<7	57.1	54.0*	40.5
Chronic diseases‡ (%)			
0	28.6	12.5	18.0
⩾1	71.4	87.5	82.0
Cognitive score‡,§ (%)			
⩽9	85.7	76.6	75.7
>9	14.3	23.4	24.3

*$p<0.10$ compared to Self+/State+.
†Self-report only crashes=Self+/State−; state record only crashes=Self−/State+; self-report and state-record crashes=Self+/State+.
‡Higher values represent greater impairment except for contrast sensitivity, where lower values represent greater impairment.
§Score on Mattis Organic Mental Status Syndrome Examination (range: 0–28).

were noted for stereoacuity, disability glare, and central visual field sensitivity impaired. The prevalence of peripheral visual field sensitivity impairment was significantly higher among subjects with state-recorded only crashes (48.4%) and significantly lower among those with self-reported only crashes (14.3%) compared to those with both self-reported and state-recorded crashes (35.1%). The proportion of drivers with useful field of view impairment was significantly lower among those with self-report only crashes (21.4%) as compared to those with self-reported and state-recorded crashes (72.1%). Among those with state-recorded crashes, there was no significant difference in useful field of view impairment by self-report status.

For the three eye conditions considered (glaucoma, cataract, macular degeneration), prevalence differed little across the three groups (Table 3).

To determine whether differences in the prevalence of visual and cognitive impairment had an impact on measures of association, we calculated ORs and 95% CIs for the association between the prevalence of visual and cognitive impairment and self-reported and state-recorded crash involvement. As discussed in detail in the Methods section, we collapsed the three groups of crash-involved drivers into two groups: those with self-reported crash involvement ($n=125$) and those with state-recorded crash involvement ($n=175$). We constructed separate multivariable logistic regression models for each group, attempting to identify the most parsimonious model. All variables in Tables 1–3 were simultaneously included in a multivariable logistic regression model and the −2 log likelihood statistic for this model was obtained. Then, individually, each variable was removed from the model and the −2 log likelihood statistics for each reduced model was obtained. The −2 log likelihood values were used to compute likelihood ratio tests (LRTs) to determine which of the variables demonstrated significant, independent associations.

In general, the results for the two models were similar (Table 4). When the case definition was limited to self-reported crashes, useful field of view was the only impairment variable identified as having a significant, independent association with crash risk. When cases were defined on the basis of state-recorded crash involvement, two variables were identified: useful field of view impairment and glaucoma. The OR for useful field of view impairment was larger than that obtained using self-report (13.7 vs 3.4). Finally, when the case definition included all

Table 2. Prevalence of visual processing impairment of drivers by self-reported and state-recorded crash involvement

Visual characteristics	(Self+/State−)† (%) $N=14$	(Self−/State+)† (%) $N=64$	(Self+/State+)† (%) $N=111$
Letter acuity			
20/40 or better	100.0	82.8	87.4
Worse than 20/40	0.0*	17.2	12.6
Log_{10} contrast sensitivity‡			
>1.5	92.9	75.0	88.3
≤1.5	7.1	25.0*	11.7
Stereoacuity‡			
<500 Arcseconds	78.6	60.3	73.9
≥500 Arcseconds	21.4	39.7	26.1
Disability glare‡,§			
≤0	50.0	43.7	59.5
>0	50.0	56.3	40.5
Central 30° visual field sensitivity‡,‖			
0 to 10	92.9	82.8	89.2
>10	7.1	17.2	10.8
Peripheral 30–60° visual field sensitivity‡,‖			
0 to 10	85.7	51.6	64.9
>10	14.3*	48.4*	35.1
Useful field of view‡,¶			
<40.0	78.6	26.6	27.9
≥40.0	21.4*	73.4	72.1

*$p<0.10$ compared to Self+/State+.
†Self-report only crashes = Self+/State−; state record only crashes = Self−/State+; self-report and state-record crashes = Self+/State+.
‡Higher values represent greater impairment except for contrast sensitivity, where lower values represent greater impairment.
§LogMAR acuity with glare minus LogMAR acuity without glare.
‖Average defect depth (dB)
¶Percentage reduction in useful field of view.

Table 3. Prevalence of eye conditions of drivers by self-reported and state-recorded crash involvement

Eye conditions	(Self+/State−)† (%) $N=14$	(Self−/State+)† (%) $N=64$	(Self+/State+)† (%) $N=111$
Glaucoma	7.1	12.5	9.0
Cataract	42.9	56.3	46.0
Macular degeneration	7.1	9.4	7.2

†Self-report only crashes = Self+/State−; state record only crashes = Self−/State+; self-report and state-record crashes = Self+/State+.

Table 4. Odds ratios and 95% confidence intervals for significant variables from multiple logistic regression models for state-recorded and self-reported crash involvement

	State-recorded crash involvement		Self-reported crash involvement		All crashes	
Variables	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)
Useful field of view†,‡						
<40.0	1.0	(Referent)	1.0	(Referent)	1.0	(Referent)
≥40.0	13.7	(6.7, 28.3)	3.4	(1.9, 6.0)	10.6	(5.2–21.9)
Glaucoma§	3.0	(0.8, 11.0)	—		3.5	(0.9–14.5)

†Higher values represent greater impairment.
‡Percentage reduction score in useful field of view.
§Referent group is those without glaucoma.

crashers, regardless of the source of information, the resulting logistic regression model was consistent with the latter set of results.

DISCUSSION

The objective of this report was to estimate the agreement between self-reported and state-recorded motor vehicle crash involvement among older drivers. We also sought to determine whether visual and cognitive impairment differed across three groups of drivers cross-classified with respect to self-reported and state-recorded crash involvement.

We found a moderate level of agreement between self-reported and state-recorded crashes. The kappa statistic (0.45) was consistent with that of Marottoli et al. (0.40) in their study of self-report and state records for identifying crashes among older drivers in New Haven, CT (Marottoli et al., 1997). It should be noted that while the present study used a 5-year time window for crashes, that of Marottoli et al. used a 1-year window. We also found the level of agreement in this study consistent with work previously conducted by us among a smaller sample of older drivers in Alabama (Ball et al., 1993; Owsley et al., 1991). Szlyk et al. (1992, 1993, 1995) reported that self-report identified many more crashes than state records. However, they did not report the level of agreement or correlation between these two sources of information.

There are several possible explanations for the two discordant (i.e. self-reported but not state-recorded crash involvement and not self-reported but state-recorded crash involvement) groups of older drivers in this sample. First, regarding subjects who reported a crash that was not found in state records, it is possible that these crashes occurred prior to the time period covered by the state records used in this study, even though the 5-year time frame was emphasized when the subject was asked the question. Another possible explanation is that, although subjects were asked to recall only crashes where a police-officer came to the scene, they improperly recalled incidents where an officer was not present. Although no information on crash severity was obtained in the questionnaire, in general, crashes reported by the subject but not recorded in state records tended to be minor, as the proportion involving injuries was less than that in the other groups. Marottoli et al. (1997) suggest other explanations for this group of drivers, namely, that the crash occurred out of the state or recording inefficiencies by the state cause police reports not to make it into official records. Subjects who had state-recorded crashes that were not self-reported may have failed to recall these events or were unwilling to divulge this information. It is also possible that these subjects incorrectly recalled when the crash occurred and therefore failed to identify it as having occurred in the proper time-frame. In contrast to prior studies, we identified more crash-involved subjects by state record than self-report (Marottoli et al., 1997; Szlyk et al., 1992, 1993, 1995). Most prior studies used a shorter time period over which drivers were to recall crash involvement. Therefore, it is possible that crashes occurring earlier in the 5-year time period of interest were simply forgotten. However, there was no indication that state-record only crashes were more likely to have occurred earlier within the 5-year time period.

To our knowledge, only three prior studies have compared the characteristics of drivers involved in self-reported and state-recorded crashes. Of these, only one focused specifically on older drivers. No study has evaluated characteristics beyond standard demographics (age, race and gender). We found that drivers with state-recorded crashes (with and without self-report) tended to be older than those with self-report only. McGuire (1973) reported that males were more likely to have state-recorded crashes among mostly younger drivers in Mississippi. However, he did not find any differences with respect to age or race. Marottoli et al. (1997) reported no substantial differences in demographic features. They did note a higher proportion of males among those with both self-reported and state-recorded crashes compared to those with no events, a result consistent with our data.

That self-report or state records provide a non-biased sample of crash-involved drivers has not been adequately assessed in the literature. If potentially important risk factors for crash involvement are over- or underrepresented among drivers identified using either of these techniques, it is possible that measures of association will be biased. For example, if self-report is used to identify crash-involved drivers and those who self-report are less likely to have diabetes, then one will obtain a measure of association that is biased towards the null. The converse situation is also possible where measures of association will be biased away from the null. In order to address this issue, we compared the prevalence of visual and cognitive impairment among three groups of crash-involved drivers; those with self-report but no state records, no self-report but state records, and both self-report and state records.

In general, we found the prevalence of visual and cognitive impairment to be similar across the three groups of older drivers; however, for a few variables there were significant differences. Compared to older drivers with both self-reported and state-recorded crashes, drivers with state-recorded only crashes were significantly more likely to have contrast sensitivity and peripheral visual field sensitivity. Drivers with self-reported only crashes were significantly less likely to have letter acuity, useful field of view and peripheral visual field sensitivity impairment compared to drivers with crashes noted by both sources. It should be noted that this group of older drivers was small ($N = 14$) and, therefore, prevalence estimates may be spuriously elevated or reduced.

When we attempted to identify significant, independent predictors of crash involvement using two case definitions (self-report versus state record), the results obtained were generally consistent. Whether defined by self-report or state record, impaired useful field of view was identified as being significantly associated with crash involvement. However, the strength of the association was different. The OR for state-recorded crashes was over four-times that for self-reported crashes (13.7 vs 3.4). In addition, when the case definition was limited to state-recorded crashes, glaucoma was identified as a potentially important predictor of crash involvement. If one were to include both useful field of view impairment and glaucoma in the multivariable logistic regression model for self-reported crashes, the OR would be 1.1. This is markedly reduced compared to the state-recorded crash model where the OR for glaucoma was 2.9. In a field where researchers are still attempting to identify risk factors for crash involvement among older drivers and interpret results across existing studies, we feel that such differences are not unimportant. This is particularly true for self-reported crashes where the magnitude and statistical significance of certain measures of association were obscured.

It is difficult to compare these results with those of other published studies, as few other studies have assessed useful field of view impairment as a risk factor for motor vehicle crash involvement among older drivers. Glaucoma has been identified as a potentially important factor in motor vehicle crashes among the elderly. A case–control study in Washington state found that older drivers involved in state-recorded injurious crashes were 50% more likely to have glaucoma than those who were not crash involved (McCloskey et al., 1994). A prospective study by Foley et al. (1994) on state-recorded crashes regardless of injury also found an unadjusted elevated crash risk among older drivers with glaucoma. Unfortunately, studies of motor vehicle crashes in the elderly using self-reported crashes have not assessed glaucoma as a risk factor.

The choice of self-report versus state records for identifying crash-involved older drivers is often not open to investigators. In many states it is difficult or not possible to obtain driving records. Some researchers have suggested that the resources necessary to procure such information may not be necessary, as self-report provides information equivalent to that obtained from state records. Additionally, some have suggested that self-report may, in fact, be more desirable as it yields more crashes than state records for a given time period of interest. We found the converse to be true with the present data. The results of this study indicate that such recommendations may be suspect. Our results, as well as those of others, have found only moderate agreement between self-reported and state-recorded crashes. This suggests that there are a non-trivial number of subjects identified as having been involved in a crash via one source and not the other. Should the distribution of risk factors among these discrepant groups differ, it is possible that the resulting risk estimates will be biased. We did find this to be the case in the present study. What was also remarkable is that using one case definition, namely self-report, we also failed to identify glaucoma as a significant risk factor for crash involvement among our sample of older drivers. Thus, our concern for the use of self-report for the identification of crash-involved older drivers is heightened. The failure to identify potentially important risk factors is disconcerting given that the literature on risk factors for crash involvement among older drivers is small. Although our findings need to be validated, it is clear that caution is necessary when using self-report for the identification of crash-involved older drivers.

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