

# A Preliminary Assessment of the Medical and Functional Factors Associated with Vehicle Crashes by Older Adults

Richard V. Sims, MD,<sup>1,2</sup> Cynthia Owsley, PhD,<sup>1</sup> Richard M. Allman, MD,<sup>1,2</sup> Karlene Ball, PhD,<sup>2</sup> and Tonya M. Smoot, PhD<sup>3</sup>

**OBJECTIVES:** To examine associations between medical and functional variables and at-fault car crashes in a cohort of older drivers.

**DESIGN:** A case-control study.

**SETTING:** A tertiary care medical center.

**PARTICIPANTS:** Older drivers (ages 55–90 years) residing in Jefferson County, Alabama (n = 174). Cases were drivers who had at least one at-fault crash in the previous 6 years; controls were crash-free during the same period.

**MEASUREMENTS:** Self-reported medical conditions, reported and observed functional measures, and urinary drug screens. The occurrence of one or more at-fault car crashes in the 6 years preceding the 1991 assessment date represented the outcome measure.

**RESULTS:** Ninety-nine older drivers experienced between one and seven at-fault vehicle crashes during the period 1985 through 1991, whereas 75 drivers did not. Logistic regression models indicated that the following variables were independently associated with crash involvement: A 40% or greater reduction in the useful field of view (OR = 6.1; 95% CI, 2.9 to 12.7;  $P < 0.001$ ), black race (OR = 6.6; 95% CI, 1.7 to 26.2;  $P = .007$ ), a history of falling in the previous 2 years (OR = 2.6; CI, 1.1 to 6.1;  $P = .025$ ), and not taking a beta-blocking drug (OR = 4.3; CI, 1.2 to 15.0;  $P = .023$ ).

**CONCLUSIONS:** Functional assessments, such as a comprehensive test of visual processing, a falls history, and a review of current medications may be of greater relevance than specific medical conditions in the identification of older at-risk drivers. If prospective studies determine that falling and crashing share risk factors, a unified approach to the prevention of these mobility disorders could result. The finding of an independent association of black race with at-fault crashing is in need of further clarification because of the low represen-

tation of black drivers in this sample. *J Am Geriatr Soc* 46:556–561, 1998.

Compared with other age groups, older drivers experience among the highest crash, injury, and mortality rates per mile driven.<sup>1–3</sup> Functional impairments, chronic diseases, medications, and age-related physiologic changes are believed to underlie these findings.<sup>1–14</sup> Recent work suggests that a composite measure of visual sensory function, processing speed, and attention, the useful field of view (UFOV), has a stronger relationship to older driver crashes than other visual or cognitive measures.<sup>5,6</sup>

Although the literature has converged on the finding that visual and cognitive impairments contribute to unsafe driving, there is little agreement across studies about which medical conditions and functional impairments elevate crash risk.<sup>15–17</sup> This lack of consensus may stem, in part, from differing research designs, definitions of outcome variables, and the validity and reliability with which exposure variables have been measured.<sup>15,16</sup>

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By evaluating both medical and functional associations of vehicle crashes within the context of an older driver sample that has also undergone assessments of visual and cognitive function, the relative strengths and independence of all these factors with crash-involvement can be estimated. This article describes an exploratory study using this approach. Older drivers with a history of one or more state-recorded at-fault crashes were compared with older drivers who remained crash-free during the preceding 6 years. A strength of this study is the use of state-recorded crash records, which have been shown to be more reliable than self-reported crash involvement in this population.<sup>6</sup>

## METHODS

### Study Participants

In this case-control study, cases were defined as Jefferson County, Alabama, drivers, who were at least 55 years old and had experienced one or more police-investigated at-fault crashes in the 6 years preceding 1991. Control subjects were crash-free during this period. Crashes were determined to be “at-fault” if three independent raters, who studied the state

From the <sup>1</sup>Division of Gerontology and Geriatric Medicine, Department of Medicine; <sup>2</sup>Department of Ophthalmology; <sup>3</sup>Departments of Psychology and <sup>4</sup>Biostatistics, Center for Aging, University of Alabama at Birmingham, and <sup>5</sup>Birmingham Department of Veterans Affairs Medical Center, Birmingham, Alabama. This study was supported by a Research Supplement for Minority Investigators to the Edward Roybal Center for Research in Applied Gerontology from the National Institute on Aging (P50 AG11684), and the UAB Minority Comprehensive Faculty Development Program.

A preliminary version of this paper was presented at the annual meeting of the Transportation Research Board, January 1996, Washington, DC. Address correspondence to Richard V. Sims, MD, 219L CHSB-19th, 933 South 19th Street, Birmingham, AL 35294-2041.

### Data Analysis

Pearson's chi-square statistic and Student's *t* tests verified the significant relationships between categorical and continuous variables, respectively, and the outcome of crash group (crashers vs non-crashers). Fisher's exact test was used to test the significance of categorical variables, when the cell sizes in the  $2 \times 2$  tables were less than 5. Multiple logistic regression models were constructed using all the variables found to be statistically significant at the  $P < .1$  level in the univariate analyses.<sup>33</sup> Among highly collinear variables, the most biologically plausible factor was selected and used in the models. To determine the most parsimonious multivariable model, likelihood ratio tests were performed.<sup>33,34</sup> Regression diagnostics (i.e., *df*-beta, *c*-bar, and residuals), and Hosmer and Lemeshow goodness of fit tests were performed on the final model to identify influential observations and to measure how well the model fit the data.<sup>33</sup>

### RESULTS

One to seven at-fault crashes were sustained by 99 subjects (cases), whereas 75 subjects (controls) were crash-free in the 6 years preceding 1991. The average age of study enrollees was 71.1 years (range, 57–91), slightly more than half were men, and 26 of 174 (14.9%) study participants were black. More than 80% of the sample reported being in good or excellent health, and 19% described being admitted to hospital in the previous year. On average, approximately one in six older adults recounted difficulty walking one block (18.4%), getting out of a chair or bed (18.4%), performing heavy housework (17.9%), or climbing 10 stairs (16.9%). Few older people reported difficulty with upper extremity functions (e.g., turning a faucet). Arthritis, hypertension, organic heart disease, peptic ulcer disease, diabetes mellitus, and transient ischemic attacks were frequent diagnoses, and liver cirrhosis, seizures, stroke, and Parkinson's disease were not common. No diagnoses of dementia were reported. Reported medication use included 19% of subjects taking diuretics, 11.9% taking nonsteroidal anti-inflammatory drugs, 10.9% beta-blockers, 9.1% hypnotics, 8.0% antidepressants, 6.8% benzodiazepines, 5.7% sedating antihistamines, 3.4% skeletal muscle relaxants, 2.3% each for insulin, alpha-blockers, and anticonvulsant medications, 1.7% barbiturates, and 1.1% narcotics.

At the univariate level, crash-involvement was associated significantly with black race, difficulty reaching out, not using a beta-blocker, alpha-blocker, or diuretic, positive urinary opiates, falling in the previous 2 years, and failing the UFOV<sup>2</sup> test (Table 1). Statistically significant associations with crashing among continuous variables included older age, poorer visual acuity, contrast sensitivity, and performance on the MOMSSE (Table 1). Marginally statistically significant ( $P = .077$ ) lower mean scores on the Performance-Oriented Mobility Assessment suggested worse balance and gait among the cases. Driving exposure did not differ significantly between cases and controls ( $P = .248$ ). Initially, all noncollinear variables in Table 1 having associations at the univariate level with  $P < .1$  were included in logistic regression models. Likelihood ratio tests, however, indicated that four variables, race, failing the UFOV<sup>2</sup> test, falling, and not using a beta-blocker best fit the data (Table 2).

### DISCUSSION

This exploratory study examined which of a large array of medical and functional variables related to previous at-fault crashes in older drivers. Variables relevant to functioning and medication usage, rather than to medical diagnoses, emerged as being associated significantly with these events. Among the strongest independent predictors of crash-involved drivers was failure of the UFOV<sup>2</sup> test, a finding consistent with our earlier work.<sup>5,6</sup> The UFOV<sup>2</sup> test relies on several visual/cognitive processing domains, including visual sensory function (e.g., acuity and contrast and visual sensitivity),<sup>35</sup> visual processing speed, and divided and selective attention.<sup>36</sup> Impairment in one or more of these visual/cognitive domains impacts performance in the test negatively. Thus, unlike tests probing a relatively narrow aspect of vision/cognition (e.g., measurement of visual acuity), the UFOV<sup>2</sup> test can reveal problems in several different aspects of the visual processing stream, which explains its superior performance in predicting crash-involved drivers. In addition, it evaluates attentional capability, which has been linked in earlier work to both crashing<sup>6,36–39</sup> and vehicle control.<sup>40,41</sup>

This study identified falling, another adverse mobility event, as having a significant independent link with crash-involvement. Other evidence from this and an earlier case-control study suggests a potential fall/crash association: Lower mean Performance-Oriented Mobility Assessment scores, which predict falling in the elderly, were observed among the crash-involved drivers ( $P = .077$ ).<sup>28,42</sup> Koepsell and coworkers documented a 40% increased odds of injurious vehicle crashing by older HMO enrollees recounting a fall in the previous year, but this result was not statistically significant.<sup>12</sup> Falling and crashing are also associated with highly similar risk factors. Studies on falling in older adults document increased risks imposed by the use of sedative, psychotropic and antidepressant medications; cognitive impairment; gait and balance abnormalities; lower extremity disability, and neurological diseases.<sup>43–47</sup> Analogous risk factors have been identified for vehicle crashes in older drivers.<sup>1–14</sup> Whether there are risk factors (and preventive measures) common to both falling and crashing will have to await future prospective studies.<sup>48</sup>

Although the literature presents evidence for the adverse effects of several classes of drugs, including benzodiazepines and antidepressants, on older drivers,<sup>12–14,49,50</sup> our finding of reduced odds of at-fault crashing for patients using beta-adrenergic blocking drugs is new. None of the conditions for which beta-blockers were most likely prescribed (i.e., organic heart disease and hypertension) were statistically associated with crash involvement. Data from other studies, however, report beneficial effects in reducing performance anxiety and tremor, which may enhance vehicle control in some older drivers.<sup>51,52</sup> Tinetti and coworkers describe a parallel finding with respect to falls, reporting a reduced univariate odds of falling with beta-blocker use.<sup>48</sup> Our failure to find an association between crashing and the use of benzodiazepines, antidepressants, or narcotics may reflect the low utilization of these agents in our sample, leading to a lack of precision for the point estimates. However, the univariate analysis implicating positive urinary opiates in antecedent crashing is consistent with the literature.<sup>49</sup>

Table 2. Logistic Regression Model with At-Fault Crashing as the Dependent Variable

Variable	Odds Ratio	95% Confidence Interval	P
Failed UFOV <sup>3</sup> test	6.1	2.9, 12.7	<.001
Black race	6.6	1.7, 26.2	.007
Not taking a beta-blocker	4.3	1.2, 15.0	.023
Fell in last 2 years	2.6	1.1, 6.1	.025

UFOV = useful field of view.

The association of black race with at-fault vehicle crashing should be interpreted cautiously. Of the 26 black drivers who returned for the 1991 study, only four were non-crashers. That is, there were too few control subjects to provide sufficient statistical information about this association.

The finding that functional problems and medications may be more highly associated with crash-prone drivers than are medical conditions and chronological age is consistent with the results of several recent prospective studies that examined variables from these domains. Marottoli and colleagues found that impaired block design, fewer blocks walked, and more foot abnormalities were independently associated with self-reported crashes, moving violations, and being stopped by police.<sup>7</sup> Foley and associates reported that poor free recall memory, intermittent back pain, and the use of nonsteroidal anti-inflammatory drugs were associated independently with police-investigated motor vehicle crashes after 5 years.<sup>14</sup> Impaired performance on road tests has also been linked to deficits in memory, visual tracking, and cognitive status.<sup>53,54</sup>

Some limitations to this exploratory study, in addition to those already discussed, must be considered. We do not know if the exposures measured in 1991 applied to our older drivers during the previous 6 years when the crashes occurred or whether some of the earlier crashes may have contributed to subsequent medical conditions and disabilities. These preliminary findings will need to be confirmed in prospective studies. Although this study had a rather small sample size, contained limited numbers of persons with medical conditions previously reported to elevate crash risk, and relied upon self-report for diagnoses, we had sufficient power to detect significant and independent association between several variables and car crashes.

Results from previous studies finding that medical diagnoses have modest to weak associations with older adults' vehicle crashes, coupled with the findings of the present study and others that functional measures may be stronger predictors of crash-involved older drivers, provide a clear vision for future research in this area. Variables assessing functionality are likely to play key roles in the predictive models developed to identify high-risk older drivers.

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