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Exploratory Study of Incident Vehicle Crashes Among Older Drivers

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Background. As the number of older adult drivers increases, distinguishing safe from unsafe older adult drivers will become an increasing public health concern. We report on the medical and functional factors associated with vehicle crashes in a cohort of Alabama drivers, 55 years old and older.

Methods. This prospective study involved 174 older adults, on whom demographic, medical, functional, and physical performance data were collected in 1991. Subjects were then followed through 1996 for incident vehicle crashes.

Results. Sixty-one subjects experienced between one and four police-reported vehicle crashes during the study period. Following adjustment for age, race, days driven per week, and gender, Cox proportional-hazards models showed the following variables to be associated with crash involvement: reported difficulty with yardwork or light housework (relative risk [RR] = 2.1; 95% confidence interval [CI] 1.1, 4.0; $p = .02$), or opening a jar (RR = 3.1; 95% CI 1.4, 6.7; $p = .004$); at least one crash before 1991 (RR = 2.1; 95% CI 1.2, 3.7; $p = .008$); using hypnotic medication (RR = 2.9; 95% CI 1.3, 6.6; $p = .01$); self-reported stroke or transient ischemic attack (RR = 2.7; 95% CI 1.1, 6.6; $p = .03$); scoring within the depressed range on the Geriatric Depression Scale (RR = 2.5; 95% CI 1.1, 6.0; $p = .03$), and failing the useful field-of-view test (RR = 1.9; 95% CI 1.0, 3.5; $p = .05$).

Conclusions. Variables related to function, medication use, affect, neurological disease, and visuocognitive skills were associated with vehicle crash involvement in this cohort. Our findings suggest that multifactorial assessments are warranted to identify at-risk older drivers.

WHEN corrected for miles driven, the elderly experience high motor vehicle crash and crash-related fatality rates, which are exceeded only by drivers in their late teens and early twenties (1). Although the majority of older drivers operate their vehicles safely, individuals with impairments that are due to age-related physiologic changes, functional limitations, chronic diseases, and medications appear to be crash prone (1–3). How to identify such individuals accurately before they actually crash is controversial, however (3). For example, although vision is the primary source of information in driving, simple tests of visual function (e.g., visual acuity screening) demonstrate unacceptable sensitivity in detecting unsafe drivers (4,5). In contrast, the Useful Field-of-View (UFOV) test, a combined measure of visual processing speed, attention, and sensory function, has proved to be more strongly associated with, and predictive of, vehicle crashes among older drivers than other visual or cognitive measures (5–7).

Findings from prior longitudinal studies of vehicle crashes in the elderly suggest that evaluations of the combined effects of several function, medication, disease, and cognition-related factors are necessary to define risks accurately for adverse driving events (8,9). In this report we summarize findings from a 5-year prospective study of police-investigated vehicle crashes in a cohort of Jefferson County, Alabama, drivers 55 years old and older, who were extensively evaluated by questionnaire and physical, cognitive, and visual performance test data. We hypothesized that variables related to self-reported function, medications, diagnoses, and impairments in visuocognitive domains would have an impact on crash involvement in these subjects.

Methods

Patient population.—The original source population for this prospective cohort study was assembled in 1990 to develop a structural equation model that predicts crash frequency based on visual and cognitive data. The recruitment strategy, which was previously reported, can be summarized as follows (6): The Alabama Department of Public Safety (ADPS) supplied a list of all 118,553 licensed drivers, aged 55 years or older and living in Jefferson County, Alabama, in 1989. For subjects identified as crash involved in the prior 5 years, written accident reports, completed by investigating officers at the scene and compiled by the ADPS, were also obtained. Seventy-five persons were randomly selected from each of 21 age categories (i.e., 55 to 59, 60 to 64, 65 to 69, 70 to 74, 75 to 79, 80 to 84, and 85+ years old) by crash frequency (i.e., 0, 1 to 3 and 4 or more) stratified cells. Contact letters were sent to 1342 potential enrollees, who were also listed in local telephone directories. Among subjects who responded positively to the telephone interviews, appointments were made such that representation among the 21 cells was as balanced as possible in the final test sample. Of 306 consenting older drivers, complete data were collected on 294 persons over a single 6-week period in 1990. Because the intent of the original study was to evaluate the visual and cognitive correlates of crash involvement in older adults, persons with Driving-Under-the-Influence convictions were excluded (6).

The following year, we invited study participants to return for in-depth medical, functional, visual, and cognitive evaluations. The 174 (59%) individuals who did so constituted the sample population for the current study. Compared with those of the original cohort, persons who returned in 1991 performed better on the UFOV test ($p < .001$), demonstrated less cognitive impairment on their Mattis Organic Mental Status Syndrome Examination (MOMSSE) scores ($p < .001$), were younger (71.1 versus 73.6 years old; $p = .02$) and were more often Caucasian (86.1% versus 80.8%; $p = .02$).

Measurements.—The instruments used in this study are described in detail elsewhere, but are recapitulated here (6,10): Self-reported information was collected on health status and medical diagnoses, including cardiovascular, neurological, pulmonary, renal, and gastrointestinal diseases; arthritis; diabetes mellitus; and cancer. All prescription and over-the-counter medications were recorded, with standardized procedures adapted from the Systolic Hypertension in the Elderly Program and the Cardiovascular Health Study [CHS (11,12)]. Mood, cognition, and alcoholism were assessed with the Center for Epidemiological Studies-Depression Scale, the MOMSSE, and the Short Michigan Alcoholism Screening Test, respectively. The nine-item Hearing Handicap Inventory in the Elderly evaluated self-reported hearing function. Subjects were asked about trouble performing specific tasks (i.e., the basic and instrumental activities of daily living, driving, walking half a mile, and climbing stairs) and activities they avoided. Then they rated the confidence with which these tasks were performed on a scale from 1 (= very confident) to 10 (= no confidence at all). These items were drawn from the CHS and the Supplement on Aging from the National Health Interview Survey (12,13). A questionnaire on driving habits, developed by two of the co-investigators, inquired about driving exposure (e.g., miles driven per year, number of trips per day), the avoidance of potentially critical driving situations (e.g., left turns across traffic), and the number of crashes incurred in the prior 3-year period for which the police came to the scene (5–7).

Supine, sitting, and standing blood pressures, a timed 15-foot walk, bilateral hand-grip strength, hearing, visual acuity, and contrast sensitivity were measured, and a Performance-Oriented Mobility Assessment score was generated for all enrollees (14). Urine was screened for amphetamines, barbiturates, benzodiazepines, cannabinoids, cocaine, opiates, and phencyclidine. All subjects were administered UFOV tests (Visual Resources, Incorporated, Bowling Green, KY), a composite measure of visual processing speed and divided and selective attention. A reduction in UFOV of 40% or more has been shown to be a sensitive and specific predictor of crash involvement in older drivers (5,6).

Outcomes.—Information on the primary outcome of interest, the occurrence of a motor vehicle crash between the 1991 clinic visits (June–August 1991) and December 31, 1996, was obtained from the ADPS. At the end of the follow-up period, details regarding vital and driving status were ascertained by means of a brief telephone interview. The Social Security Death Index (SSDI) was used to augment vital status ascertainment.

Follow-up.—Subjects for whom a crash report was obtained were considered to have experienced the outcome of interest. Persons who died or reported stopping driving before December 31, 1996, were deemed to be censored, as were crash-free subjects who were alive and still driving at the close date of the study. Of the 102 subjects interviewed by telephone in 1997, 6 individuals (or their proxies) reported driving cessation and were able to provide the approximate dates. The remaining subjects, who could not be interviewed and were not located in the SSDI, were assumed to have continued to drive up to the study close date. If information was not available on subjects' driving status before death, the date of death was taken to be the date of censoring. We found this assumption to be reasonable based on data from subjects for whom we had valid information on both dates of death and driving cessation. As few persons were involved in more than one crash during the follow-up period, we considered only first events in the calculation of person time. For each subject, person years were accrued from the date of enrollment until the date of the first crash, the date of a censoring event, or December 31, 1996, whichever came first. To calculate person miles of travel, the number of person years was multiplied by the average annual driving miles reported by subjects at their 1990 and 1991 visits. These results were then extrapolated to the study end date. Prior research suggests that the use of person miles rather than person years is a more accurate representation of an individual's time at risk for crash involvement (15).

Data analysis.—The relative risk (RR) was used as the measure of association to examine the relationship between crash occurrence and covariates of interest. Cox proportional-hazards models were utilized to calculate RRs and 95% confidence intervals (CIs). RRs were adjusted for age, race, gender, and days per week driven, as these variables were considered potential confounders a priori (1–3). We assessed the interaction between risk factors of interest and these covariates by entering multiplicative terms into the Cox model. The statistical significance of the interaction terms was determined with the likelihood ratio test at the $\alpha = .05$ level. We performed tests of linear trend by entering a continuous variable in the Cox models and assessing its significance with the Wald chi-square test (16).

In Cox models, ties in follow-up time were handled with the Breslow method. We evaluated the appropriateness of this technique by comparing the results with models by using the exact method; no meaningful differences were observed. We checked the proportional-hazards assumption for each covariate by evaluating log-cumulative hazard curves plotted against person miles and by including multiplicative interaction terms between each covariate and a function of person miles in individual models. No variables were found to violate the proportional-hazards assumption.

Several techniques were used to assess model fit. Martingale and deviance residuals were calculated for models and plotted against the rank of person miles (16). Influence statistics were also computed and evaluated to determine if any single observation had an undue influence on model coefficients. The stability of estimates, inflated standard errors, and convergence difficulties were used to test qualitatively for the presence of collinearity. All statistical analyses were conducted with SAS Software (SAS Institute, Cary, NC).

Results

Using annual mileage data reported at the 1990 and 1991 clinic visits, we estimated that the 174 study subjects accumulated approximately 6,454,633 person miles (roughly 7,900 miles per person per year) during the follow-up period. Through December 31, 1996, 24 persons died, 6 stopped driving, and 61 sustained 76 vehicle crashes, for an overall incidence of 10 crashes per million person miles traveled. Most individuals (80.3%) experienced a single crash, with the remaining drivers having up to four events. No demographic characteristic appeared to influence crash risk (Table 1).

Following adjustment for age, race, gender, and days driven per week, older adults experiencing a vehicle crash in the 5 years preceding 1991 were twice as likely to be crash involved in the subsequent 5-year period. Reporting frequent falling and tripping was associated with a marginally statistically significant increased risk.

Subjects describing difficulty opening a jar and performing light housework or yardwork were predisposed to crash involvement compared with seniors without these functional limitations (Table 2). Although difficulty reaching out, driving, taking a bath or shower, and getting dressed or undressed also increased risk, the RRs for these factors did not reach statistical significance. The summary variables, difficulty with one or more but less than four activities and more than four activities, were associated with RRs of 1.6 and 3.0, respectively (p for trend = .06).

Among reported medical conditions, only a history of stroke or transient ischemic attack was significantly associated with crashing (Table 3), and subjects taking hypnotic medications demonstrated a nearly threefold risk of suffering at least one vehicle crash (Table 4). Although similarly high crash rates were noted in older drivers taking narcotics and skeletal muscle relaxants and in those with positive urinary opiates, these results were not statistically significant. Numbers of medicines, as described by the summary variables in Table 4, did not appear to influence incident crash involvement.

Compared with persons with normal Geriatric Depression Scale scores in 1991, subjects scoring in the depressed range were 2.5 times more likely to experience a vehicle crash in the next 5 years (Table 5), although the use of antidepressant medicines did not appear to increase crash occurrence (Table 4). UFOV reduction of 40% or more was associated with an almost twofold increased crash risk. Subjects with poor grip strength, walking speed, and hearing, and impairments on simple visual and cognitive function tests did not demonstrate similar relationships.

Discussion

The findings from this preliminary study suggest that several psychological, medication-related, visual attention and function-related factors, in addition to a stroke or transient ischemic attack history, have an impact on crash involvement in older drivers. That prior crash involvement predisposes affected subjects to future crashes is plausible and supported by results from another prospective study. Foley and associates documented a twofold risk of subsequent vehicle crashes among subjects who were crash involved in the first 2 years of a 5-year longitudinal

Table 1. Demographic and Historical Variables in Relation to Vehicle Crashes

Variable	Percentage with Characteristic	Crash Rate*	RR†	95% CI	p
Age (yr)					
55–63	22.3	9.6	REF		
64–69	24.6	9.5	1.12	0.58, 2.19	.74
70–77	26.3	8.2	0.97	0.45, 2.08	.94
78+	26.9	11.0	1.12	0.50, 2.52	.79
Gender					
Female	47.4	8.2	REF		
Male	52.6	6.7	0.82	0.48, 1.39	.45
Race					
White	85.1	12.3	REF		
Black	14.9	16.9	1.37	0.70, 2.66	.84
Prior vehicle crash†	34.9	12.6	2.12	1.21, 3.69	.008
Frequent falling or tripping†	15.4	19.5	1.85	0.93, 3.68	.08
≥ 8 Alcoholic drinks/week†	11.4	7.7	0.88	0.40, 1.98	.76

Notes: RR = relative risk, CI = confidence interval, REF = reference value for the odds ratio, which equals 1.0.

*Per million miles driven.

†Adjusted for age, race, gender, and days driven per week.

Table 2. Self-Reported Functional Impairments Related to Vehicle Crashes

Activity Limitation*	Percentage with Characteristic	Crash Rate†	RR‡	95% CI	p
Negotiating stairs	20.6	11.9	1.36	0.67, 2.76	.39
Walking a block	18.9	14.9	1.68	0.85, 3.34	.14
Getting out of bed or chair	18.9	11.8	1.36	0.68, 2.71	.38
Yardwork/light housework	15.4	17.6	2.10	1.11, 3.98	.02
Opening a jar	12.6	23.5	3.09	1.42, 6.73	.004
Uses a hearing aid	12.6	6.1	0.66	0.22, 1.97	.46
Reaching out	10.9	25.5	2.32	0.95, 5.67	.07
Driving	8.6	11.3	2.35	0.89, 6.19	.08
Uses a walk aid (e.g., cane)	8.6	10.0	1.31	0.39, 4.39	.66
Taking a bath or shower	6.9	25.0	2.50	0.84, 7.47	.10
Getting dressed/undressed	5.7	24.2	2.32	0.65, 8.25	.20
Walking around house	4.0	15.9	1.54	0.35, 6.67	.57
No difficulty w/activities	69.2	7.8	REF		
Difficulty w/≥1, <4 activities	23.4	12.2	1.57	0.81, 3.01	.18
Difficulty w/≥4 activities	7.4	21.8	3.01	0.97, 9.41	.06
P for trend					.06

Notes: RR = relative risk, CI = confidence interval, REF = reference value for the odds ratio, which equals 1.0.

*No subject reported difficulty using a telephone, handling money, feeding, shopping, or preparing meals.

†Per million miles driven.

‡Adjusted for age, race, gender, and days driven per week.

Table 3. Relation of Medical Diagnoses to Vehicle Crashes

Medical Diagnoses	Percentage with Characteristic	Crash Rate*	RR†	95% CI	*p*
Arthritis	61.1	9.5	1.04	0.61, 1.78	.89
Prior fracture	53.7	10.5	1.27	0.75, 2.16	.37
Hypertension	47.5	11.5	1.36	0.81, 2.28	.25
Cataract	45.1	10.4	1.10	0.62, 1.97	.74
Pulmonary disease‡	25.7	11.0	1.29	0.73, 2.31	.38
Gastrointestinal diseases	36.6	9.3	1.02	0.60, 1.73	.94
Heart disease§	21.3	11.9	1.53	0.81, 2.89	.19
Peptic ulcer	17.7	11.4	1.10	0.54, 2.24	.80
Diabetes mellitus	15.4	6.3	0.67	0.28, 1.56	.35
Cancer history	14.9	7.7	0.83	0.37, 1.85	.65
Stroke/transient ischemic attack	9.8	21.1	2.71	1.11, 6.61	.03
Other eye disease	9.7	6.7	0.81	0.29, 2.28	.69
Macular degeneration	7.4	6.4	0.60	0.14, 2.55	.49
Glaucoma	6.9	6.4	0.84	0.30, 2.36	.74
Renal disease	6.3	6.9	0.82	0.29, 2.30	.71
Seizures	3.3	7.4	0.68	0.16, 2.90	.60
Liver disease	2.9	4.6	0.52	0.07, 3.77	.52
Diabetic retinopathy	2.3	8.6	1.37	0.19, 10.11	.76
No medical diagnoses	4.0	22.0	REF		
1–3 Medical diagnoses	60.0	10.1	0.46	0.16, 1.32	.15
≥4 Medical diagnoses	36.0	14.1	0.63	0.22, 1.86	.41
P for trend					.58

Notes: RR = relative risk, CI = confidence interval, REF = reference value for the odds ratio, which equals 1.0.

*Per million miles driven.

†Adjusted for age, gender, race, and days driving per week.

‡Includes diagnoses of asthma, emphysema, and chronic bronchitis.

§Includes diagnoses of prior myocardial infarction, congestive heart failure, and angina.

Table 4. Medications in Relation to Vehicle Crashes

Medication Class	Percentage with Characteristic	Crash Rate*	RR†	95% CI	*p*
Diuretic	19.1	12.5	1.08	0.53, 2.22	.83
Calcium channel blocker	15.0	11.6	1.23	0.65, 2.33	.52
Nonsteroidal anti-inflammatory drug	12.1	13.9	1.56	0.78, 3.14	.21
Beta blocker	11.0	6.2	0.66	0.28, 1.55	.34
Nonprescription	9.2	9.9	1.20	0.56, 2.55	.64
Estrogen	9.1	8.2	0.65	0.21, 2.03	.46
Hypnotic	8.7	28.1	2.92	1.29, 6.57	.01
Antidepressant	8.1	13.6	1.43	0.63, 3.24	.40
Benzodiazepine	6.9	19.4	2.04	0.85, 4.85	.11
Sedating antihistamine	5.8	16.9	1.88	0.64, 5.48	.25
Adrenocortical extract inhibitor	5.2	4.7	0.58	0.08, 4.32	.59
Oral hypoglycemic	4.6	7.0	0.87	0.21, 3.58	.84
Skeletal muscle relaxant	3.5	29.2	2.72	0.87, 8.47	.09
Centrally acting antihypertensive	2.9	8.2	0.73	0.17, 3.07	.67
Alpha blocker	2.3	19.1	1.30	0.18, 9.72	.80
Anticonvulsant	2.3	7.8	0.77	0.11, 5.61	.80
Insulin	2.3	11.9	1.73	0.42, 7.21	.45
Barbiturate	1.7	14.6	1.42	0.19, 10.34	.73
Narcotic	1.2	30.2	2.05	0.24, 17.56	.51
(+) Urinary benzodiazepines	7.1	11.1	1.27	0.50, 3.22	.62
(+) Urinary opiates‡	3.6	27.9	2.29	0.53, 9.87	.27
No medications	42.8	8.2	REF		
1–2 Medications	42.9	10.1	1.24	0.71, 2.18	.45
≥3 Medications	14.3	12.1	1.58	0.70, 3.59	.27

Notes: RR = relative risk, CI = confidence interval, REF = reference value for the odds ratio, which equals 1.0.

*Per million miles driven.

†Adjusted for age, gender, race, and days driving per week.

‡No other agents detected in urine.

study of elderly rural drivers (9). Some of the impairments implicated in previous motor vehicle crashes can be longstanding and chronic (e.g., stroke). Thus predisposing functional limitations that are due to the effects of neurological disease, visual–cognitive disorders, and the like may contribute to both prior and incident vehicle crashes. The finding that older adults with reported difficulty performing housework or yardwork and opening a jar had elevated crash risks supports this view. Also, older drivers reporting frequent tripping or falling experienced a marginally significant 85% increased risk of crashing. This result is consistent with our earlier case-control study of this cohort, which identified an independent association of falls and prior crash involvement, and with findings from another report, which noted an increased odds of injurious crashes among older Health Maintenance Organization enrollees, who had fallen in the preceding year (10,17). We did not detect associations of beta-blocker use and African American race (or factors associated with African American race) with vehicle crashing, although the RRs for these variables are in the same direction (albeit of lesser magnitude) as the odds ratios reported in our case-control study (10). Methodologic differences most likely underlie these findings. The prospective methods used in the current study were better able to account for losses that were due to death and driving cessation, which otherwise would have biased point estimates away from the null. By accounting for

Table 5. Vehicle Crashes in Relation to Impairments in Physical Examination and Performance-Related Variables

Variable	Percentage with Characteristic	Crash Rate*	RR†	95% CI	*p*
Grip strength <55 lb	49.1	12.2	1.39	0.52, 3.15	.24
Walk time >4 s	48.0	9.5	0.82	0.45, 1.49	.52
Mobility score ≤11	41.7	11.9	1.39	0.80, 2.40	.24
UFOV reduction ≥40%	33.1	13.8	1.87	0.99, 3.54	.05
Audioscope score ≥13	28.0	6.3	0.64	0.31, 1.32	.23
Orthostatic blood pressure change	16.9	11.1	1.10	0.53, 2.28	.79
MOMSSE score >9	12.1	5.6	0.69	0.23, 2.06	.51
Contrast sensitivity <1.8	9.1	9.6	1.49	0.34, 6.57	.60
Visual acuity <20/40	6.9	5.7	1.07	0.26, 4.47	.92
GDS score ≥16	6.9	19.2	2.53	1.08, 5.95	.03

Notes: RR = relative risk. CI = confidence interval. UFOV = Useful Field-Of-View test. MOMSSE = Mattis Organic Mental Status Syndrome Examination. Scores greater than 9 indicate cognitive dysfunction. GDS = Geriatric Depression Scale. Scores of 16 or greater are associated with major depression.

*Per million miles driven.

†Adjusted for age, gender, race, and days driving per week.

these factors, the current findings are probably the more valid.

Among the medical conditions reported in 1991, only a stroke or transient ischemic attack history was associated with a more than twofold risk of incident crashing. Prior observational studies, evaluating stroke and other diagnoses in relation to older driver vehicle crashes, found no such independent association (18–20). Publications on the driving performance of stroke survivors, however, note impaired abilities in many such subjects. In comparison with unaffected control subjects, stroke patients in one report demonstrated inferior driving skills, especially when confronted with the need to perform emergency maneuvers (21). A more recent prospective study of on-road tests in 12 persons with mild multi-infarct dementia documented significantly worse driving capabilities than those of healthy age-matched control subjects (22). Higher drive scores, denoting better driving performance, were positively correlated with short-term memory, visual tracking, and Mini-Mental State Examination scores, but negatively correlated with numbers of collisions and moving violations. Because 30% of stroke survivors eventually resume driving, further research on motor vehicle crashes involving larger numbers of such subjects is probably warranted (17).

Psychoactive drugs, including cyclic antidepressants and benzodiazepines, have been previously implicated in vehicle crashes in older adults (23). More recently, Hemmelgarn and associates published a case-control analysis of 5,579 older Quebec drivers involved in injurious crashes and 10 crash-free controls per case (24). Subjects consuming long-acting (but not short-acting) benzodiazepines suffered an increased odds (odds ratio = 1.5; 95% confidence interval 1.0, 2.0) of having a crash-related injury, particularly in the first week of use. Although we cannot address the types and prescribing patterns for specific hypnotic medications, the observed threefold and statistically nonsignificant twofold risks for subjects prescribed hypnotics and benzodiazepines, respectively, are consistent with these results.

Subjects with a reduced UFOV experienced elevated crash risks as well. In a study of the visual and cognitive factors related to crash risk in older drivers, Owsley and colleagues observed that the size of the UFOV was a highly sensitive (89%) and specific (81%) measure of prior crash involvement (6). Seniors with shrinkage in their UFOV tests of 40% or more, indicating impaired visual attentiveness, had a sixfold odds of having sustained a vehicle crash in the previous 5 years. In contrast, physician assessments of overall eye health, chronological age, and visual sensory (e.g., visual acuity) and mental status tests, although correlated with crashes, did not reliably discriminate among subjects who had crashed and those who had not.

The association of symptoms of depression with vehicle crashing also merits further investigation. In a prospective study of elderly rural drivers, Foley and associates reported an independent association of 80th percentile or higher depression scores with incident crashes (9). Whether or not this result relates to the symptoms themselves, to functional impairments known to co-occur with late life depression, or to the use of psychoactive medicines cannot be addressed by this study.

Because of several limitations, the findings of this report should be considered as preliminary: The small size of the study population and the limited number of incident vehicle crashes reduced our ability to adjust for the effects of all potential confounders. Because the study sample was enriched with crash-involved older drivers, the observed crash rates are artifactually high and not reflective of population-based rates. Nevertheless, estimates of the comparative effects of many variables on rates of crashing within the cohort are probably valid. In addition, we extrapolated reported mileage data collected on the 1990 and 1991 visits, so vehicle crash rates and observed RRs must be interpreted cautiously. We depended on patient reports for driving exposure and information on health status. However, Haapanen and colleagues documented the general agreement of self-report with medical record data for well known chronic diseases (e.g., diabetes), for which definitive and easily communicated diagnostic criteria exist (25). Likewise, the large number of statistical tests may have resulted in some associations occurring by chance. Of the original study subjects, 72 (41%) could not be reached by telephone in 1997. If persons were not in the SSDI and could not be contacted, we assumed that they continued to drive up to the study close date. This was the most conservative assumption that would have biased the observed relationships toward the null. Therefore our conclusions are unlikely to be changed by these limitations. This study was strengthened by the use of police-investigated crash records and the broad array of both self-report and performance-based data frequently lacking in prior research (3). We suggest that a larger longitudinal study, possibly involving annual assessments of multiple medical, functional, cognitive, visual, and psychological domains, is warranted in the assessment of older driver safety.

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