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# Older Drivers and Cataract: Driving Habits and Crash Risk

Cynthia Owsley,[1] Beth Stalvey,[1,2] Jennifer Wells,[1] and Michael E. Sloane[3]

[1]Department of Ophthalmology, School of Medicine/Eye Foundation Hospital; [2]Department of Health Behavior, School of Public Health; and [3]Department of Psychology, University of Alabama at Birmingham.

***Background.*** Cataract is a leading cause of vision impairment in older adults, affecting almost half of those over age 75 years. Driving is a highly visual task and, as with other age groups, older adults rely on the personal automobile for travel. The purpose of this study was to examine the role of cataract in driving.

***Methods.*** Older adults (aged 55–85 years) with cataract ($n$ = 279) and those without cataract ($n$ = 105) who were legally licensed to drive were recruited from eye clinics to participate in a driving habits interview to assess driving status, exposure, difficulty, and "space" (the distance of driving excursions from home base). Crash data over the prior 5 years were procured from state records. Visual functional tests documented the severity of vision impairment.

***Results.*** Compared to those without cataract, older drivers with cataract were approximately two times more likely to report reductions in days driven and number of destinations per week, driving slower than the general traffic flow, and preferring someone else to drive. Those with cataract were five times more likely to have received advice about limiting their driving. Those with cataract were four times more likely to report difficulty with challenging driving situations, and those reporting driving difficulty were two times more likely to reduce their driving exposure. Drivers with cataract were 2.5 times more likely to have a history of at-fault crash involvement in the prior 5 years (adjusted for miles driven/week and days driven/week). These asssociations remained even after adjustments for the confounding effects of advanced age, impaired general health, mental status deficit, or depression.

***Conclusions.*** Older drivers with cataract experience a restriction in their driving mobility and a decrease in their safety on the road. These findings serve as a baseline for our ongoing study evaluating whether improvements in vision following cataract surgery expand driving mobility and improve driver safety.

CATARACT, an increased opacification of the crystalline lens, is a leading cause of vision impairment in adults over 60 years old, affecting almost half of those aged 75 to 85 years (1). This condition compromises many aspects of vision including acuity (2), contrast sensitivity (2), and visual field sensitivity (3). Cataract hampers health-related quality of life and is associated with increased difficulty with visual activities of daily living (4,5), impaired physical performance (6), and reduced mental status (6). Vision impairment from cataract is now largely reversible because of technological advances in surgical techniques and intraocular lens design, with more than 85% of cases reaching 20/40 acuity or better postsurgery (7). Cataract surgery is the most common surgical procedure performed on Medicare beneficiaries and represents 12% of the overall Medicare budget (8).

Many older adults must cope for an extended period with vision impairment induced by cataract until the point in time when surgical removal of the cataract occurs, usually when best-corrected acuity reaches 20/40 or worse or when functional limitations become serious (9). The purpose of this study was to examine the role of cataract in driving. Driving is a highly visual task and, as with other age groups, older adults prefer to rely on the personal automobile for transportation (10). Earlier work has linked vision impairment and eye disease in elderly people to driving habits (11,12) and driving cessation (13,14). This study will address the following questions: What are the driving habits of older adults with cataract as compared to drivers without cataract? Do older drivers with cataract experience driving difficulties? Are driving habits related to self-perceived driving difficulties, suggesting self-regulation? Finally, do older drivers with cataract have an elevated crash risk? The results reported here will serve as a baseline for an intervention study, the Impact of Cataract on Mobility (ICOM) project, which is evaluating whether improvement in vision following cataract surgery expands driving habits and improves safety.

## Methods

### *Subjects*

Two groups of subjects were assembled, older drivers with cataract and those without cataract. Persons in both groups were required to be between the ages of 55 and 85, living independently in the community, and legally licensed to drive. The group with cataract had to meet the following additional inclusion criteria: a diagnosis of cataract in one or both eyes, acuity in one eye of 20/40 or worse (best-corrected distance), and no previous cataract surgery in either eye. This information, along with the type of cataract, was obtained from the medical record's most recent eye exam. The primary cause of vision impairment in both eyes had to be cataract according to the medical record; other eye conditions could be present, but cataract was required to be the primary cause of vision loss according to the eye care specialist. The inclusion criteria for controls were as follows: participants had to be free of a diagnosis of clinically significant cataract in either eye, acuity in each eye of 20/25 or better (best-corrected distance), no previous cataract surgery, and free of identifiable eye disease according to the medical record. Exclusionary criteria for both groups were amblyopia, use of a wheelchair for mobility, and the presence of dementia, Parkinson's disease, psychosis, or any illness that precluded annual clinic visits for 3 years (length of follow-up period for ICOM). The recruitment goal for the ICOM study was 276 older adults with cataract and 100 without cataract.

Participants were recruited from 10 ophthalmology practices and 2 optometry clinics in Birmingham, Alabama, through medical record review of patients seen during the previous 12 months. All persons meeting the inclusion criteria were contacted by a letter describing the study, which was followed by a phone call. Those who agreed to participate were scheduled for a visit to the Clinical Research Unit in the Department of Ophthalmology, University of Alabama at Birmingham (UAB). Those who refused were asked to answer a few questions about their health and functioning, which would later allow us to examine selection bias on key variables. The study protocol was approved by the Institutional Review Board for Human Use at UAB.

*Protocol*

After the nature and purpose of the study were explained, each subject was asked to sign a document of informed consent before enrolling in the study. Demographic data were confirmed through interview, including birth date, race, gender, and contact information. The protocol was divided into two parts, interview and visual functional assessment, both of which were examiner-administered.

The Driving Habits Questionnaire (DHQ) was designed to obtain information about driving during the past year. Prototype versions of the DHQ were used in our earlier work (11,15,16). The DHQ as used in the present study is provided in the Appendix, along with test-retest reliability information. The DHQ is designed to be interviewer-administered, and it addresses six domains.

*Current driving status and miscellaneous issues.*—Items 1–10 establish current driving status, general driving practices (e.g., spectacle and seatbelt use, driving speed), and self-assessed quality of driving.

*Driving exposure.*—Items 11–14 ask about the average number of days driven per week and where the respondent drives in a typical week. The latter generates an estimate of the number of places traveled to, number of trips made, and number of miles driven in a typical week.

*Dependence on other drivers.*—Items 15 and 16 provide a detailed assessment of who the respondent travels with in a car on a regular basis and who usually drives with that person. From this interview, an estimate of "dependency" on other drivers is generated, which ranges from 1–3 with higher scores meaning greater levels of dependency on others to drive.

*Driving difficulty.*—Items 17–24 ask respondents to rate the degree of visual difficulty experienced in specific driving situations. Ratings are made on a 5-point scale (5 = no difficulty, 4 = a little difficulty, 3 = moderate difficulty, 2 = extreme difficulty, 1 = so difficult I no longer drive in that situation). A composite score of driving difficulty was computed based on the responses to all eight items and scaled on a 100-point scale [(mean score − 1) × 25]. Lower composite scores indicate a greater degree of difficulty.

*Driving space.*—Items 29–34 address the distance respondents typically drive into their environment away from their home base over the past year (e.g., within the neighborhood, outside the state). Subjects answered "yes" = 1 or "no" = 0 as to whether they had driven to the designated region in the past year. A summary score of driving space is computed by summing scores across all items (0–6) where lower scores indicate a smaller driving space.

*Self-reported crashes and citations.*—Items 25–28 ask respondents to report the number of crashes incurred and the number of citations received during the past year. It is important to emphasize that self-reported crash and citation variables were not used to evaluate risk factors for crash involvement in this study because these reports can have questionable validity and reliability (15–17). The state-recorded crash data were used to assess crash risk in this study.

General health, mental status, and depression were also assessed because they are known to affect older adults' performance of instrumental activities of daily living such as driving (18). This information would allow key findings to be adjusted for these variables.

*General health.*—This was assessed by asking subjects if they have problems in 17 areas (e.g., heart, cancer, diabetes, stroke) and, if so, to what extent they are bothered by the condition on a 3-point scale (1 = not bothered at all, 2 = bothered a little, 3 = bothered a great deal). This instrument was derived from one used in a prior study on cataract and quality of life (4). The questionnaire allows subjects to add conditions not specifically asked about if they so choose. To generate a comorbidity index, each medical condition present is weighted by the "bothersome score" (see above) and then all are summed. Scores can theoretically range from 0 (no health conditions present) to infinity (because subjects can add conditions to the query list).

*Mental status.*—This was evaluated by the Mattis Organic Mental Syndrome Screening Examination [MOMSSE (19)], specifically designed to assess cognitive function in elderly people. This 20-minute test provides a composite score of cognitive function that reflects performance in 14 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.

*Depression.*—The presence of depressive symptoms was assessed by the Center for Epidemiological Studies–Depression scale [CES-D (20)]. Patients were asked to rate 20 items based on how often they felt that way in the last week. Responses included "rarely or none of the time, some of the time, much of the time, or most or all of the time," which are scored from 0 to 3, respectively. Total scores ranged from 0 to 60 with a higher number indicating more depressive symptoms.

Cataract is a condition that can vary in its impact on visual function. Visual functional status of all participants was measured with respect to acuity, contrast sensitivity, and visual field sensitivity. All measurements were made while subjects wore whatever correction they typically wore during the performance of everyday distance activities. Each eye was assessed separately. Distance acuity was measured using the ETDRS letter chart (21) and expressed as log minimum angle of resolution. Contrast sensitivity was assessed using the Pelli-Robson Contrast Sensitivity Chart (22) and expressed as log contrast sensitivity. Visual field was measured with the Humphrey Field Analyzer 81-point screening program for the central 60 degrees using the profile test option. As is standard in the visual field testing of older adults, subjects viewed targets through plus lenses to correct for the near test distance. Test performance was defined as the number of points correctly detected.

### *Crash Data*

Crash data on all participants from the 5 years prior to enrollment were obtained from the Alabama Department of Public Safety (ADPS), the state agency in charge of compiling such records. ADPS provided hard copy of accident reports that described the details surrounding each crash. As in our earlier work (15,16), we were primarily interested in at-fault crashes, those crashes where our participant was deemed at least partially responsible for the crash. Using our prior methodology (15,16), three independent raters studied each accident report and determined which driver(s) involved in the crash was at least partially responsible for the crash. The three raters agreed in 83% of the crashes about at-fault determination; in cases of disagreement they discussed the crash, which always lead to consensus. All raters were unaware of the functional and health characteristics of the drivers and identified drivers by vehicle unit number rather than by name.

### *Statistical Analysis*

Descriptive statistics characterized demographics and prevalence of driving habits in the cataract and no-cataract groups. *T* tests and chi-square tests were used to examine differences in driving habits between the two groups. Significance testing was evaluated in terms of $\alpha = .05$ in all statistical evaluations, except where noted below. Analysis of covariance evaluated age-adjusted differences in visual function between the cataract and no-cataract groups. Mann-Whitney U tests were used to evaluate age-stratified group differences for variables that were not normally distributed. Logistic regression was used to examine associations between the presence of cataract (independent variable) and selected measures from the DHQ and crash involvement (dependent variables). When a significant association between cataract and a dependent variable was identified, advanced age, poor health, impaired mental status, and depression were evaluated as potential confounders. If any of these potential confounders were significantly related to the dependent variable ($\alpha = .15$), relative risk estimates describing the association between cataract and each dependent variable were adjusted accordingly. If none of the potential confounders was related to the dependent variable, no adjustments in the relative risk estimate were made. Age was entered as a continuous variable when assessing its role as a confounder. Cutpoints for categorical variables used as covariates or outcomes were determined by distributional (50%) splits or conventions from prior studies. Impaired health was defined as a comorbidity score >4, impaired mental status as a MOMSSE score of >4, and depression as a total score on the CES–D of >9.

## Results

*Sample characteristics.*—Table 1 lists the demographic characteristics of the cataract ($n = 279$) and no-cataract groups ($n = 105$). Those with cataract were slightly older on average by about four years ($t(382) = -6.21, p < .001$). Both groups were split about evenly between males and females, and had similar racial composition, with the majority white and approximately 15% African American.

In the cataract group, 97% of subjects had cataract in both eyes, with only 3% having unilateral cataract. In terms of cataract type, for the right eye, 47% of subjects had nuclear sclerosis, 7% had cortical, 7% had posterior subcapsular, and 39% had a combination. The breakdown was similar for the left eye, with 51% nuclear sclerotic, 6% cortical, 5% posterior subcapsular, and 36% combination. Cataract was the only diagnosed eye condition (other than refractive error) in 75% of subjects in the cataract group. The following are the percentages of subjects in the cataract group having other secondary eye conditions: 9% age-related macular degeneration (AMD), 3% diabetic retinopathy, 8% glaucoma, 1% both AMD and glaucoma, and 4% other (e.g., corneal disease).

Visual function for both groups (adjusted for age differences in groups) is shown in Table 2. As would be expected by the case definition for cataract group membership, those in the

Table 1. Demographic Characteristics

| | Cataract $n = 279$ | No Cataract $n = 105$ | *p* value |
|---|---|---|---|
| Age (Mean, *SD*) | 71 (6) | 67 (6) | .001 |
| Gender | | | |
| Male | 53% | 48% | |
| Female | 47% | 53% | .31 |
| Race | | | |
| White | 86% | 84% | |
| African American | 14% | 16% | .70 |

Table 2. Age-Adjusted Visual Function in Cataract and No-Cataract Groups

| | Cataract Mean | No Cataract Mean | *p* value |
|---|---|---|---|
| Acuity* | | | |
| Best Eye | 0.23 | −0.01 | .001 |
| Worst Eye | 0.49 | 0.08 | .001 |
| Contrast Sensitivity† | | | |
| Best Eye | 1.39 | 1.61 | .001 |
| Worst Eye | 1.19 | 1.52 | .001 |
| | Median | Median | |
| Visual Field Sensitivity‡ | | | |
| Best Eye | 80 | 81 | .001 |
| Worst Eye | 77 | 80 | .001 |

*Age-adjusted log minimum angle resolvable. For Snellen conversion, see text.
†Age-adjusted log contrast sensitivity.
‡Total points correctly detected. Statistically evaluated by Mann-Whitney U because not normally distributed.

cataract group had impairments in visual function as compared to the no-cataract group. This was true for both the "worse" and "better" eyes. Those with cataract averaged 20/62 and 20/34 in the worse and better eye, respectively, whereas those without cataract averaged 20/25 and 20/20, respectively. Contrast sensitivity was also worse in both eyes for subjects with cataract, who also detected fewer points throughout the visual field than did their no-cataract counterparts (although the magnitude of this difference was very slight, probably due to a ceiling effect in the visual field measure).

*Driving Habits Questionnaire.*—The results of the group comparisons for each DHQ domain are listed in Tables 3 to 7.

Table 3 presents information about current driving and miscellaneous issues related to driving. All drivers free from cataract and nearly all drivers with cataract (96%) were current drivers. Four percent of subjects with cataract ($n$ = 10) had stopped driving during the last 3 years because of vision problems, but all these individuals intended to start driving again after they had cataract surgery during the next year, and thus were eligible for enrollment in the ICOM sample. Nearly all subjects in both groups reported wearing glasses and a seatbelt when driving. Compared to drivers without cataract, proportionally more drivers with cataract preferred to have someone else drive when they traveled in a car, drove slower than the general traffic flow, and received advice that they limit or stop their driving. Logistic regression analysis evaluated these associations, examining the role of potential confounders (advanced age, impaired health, mental status deficit, depression). Cataract was associated with preferring to have someone else drive, RR = 2.37 (95% CI 1.04–5.41, adjusted for age), driving slower than the general traffic flow, RR = 1.79 (95% CI 1.01–3.16, adjusted for impaired health), and receiving advice that the person should limit/stop driving, RR = 5.00 (95% CI 1.15–21.33, no adjustments necessary). The self-rated quality of driving was about the same in both groups, although there was a tendency for those with cataract to rate the quality of their driving more poorly than those without cataract.

Table 4 presents information about driving exposure and dependency on other drivers. There were no group differences in the reported number of trips made and the number of people with whom the respondent traveled. However, drivers with cataract reportedly drove fewer days, miles, and places per week compared to those free of cataract. Logistic regression analysis was used to examine these significant associations adjusting for potential confounders (advanced age, poor health, impaired mental status, and depression). For the purposes of these analyses, the following dependent variables were defined categorically: reduced days of driving, ≤4 days/week; reduced driving destinations, <5 places/week; reduced miles, ≤150 miles/week. Results were that cataract was associated with reduced days of driving, RR = 1.89 (95% CI 1.06–3.34, no adjustments necessary), and reduced destinations, RR = 1.75 (95% CI 1.08–2.82, no adjustments necessary), but cataract was unrelated to reduced miles per week, RR = 1.51 (95% CI 0.95–2.42, adjusted for age).

With respect to driving difficulty, subjects were categorized on each difficulty item as having any difficulty (score 1–4: "little," "moderate," "extreme," "so difficult I've stopped") versus no difficulty. Table 5 shows results for each driving situation as-

Table 3. Current Driving

| DHQ Item | Cataract % of Group | No Cataract % of Group | $p$ value* |
|---|---|---|---|
| 1. Currently drive | | | .01 |
| Yes | 96 | 100 | |
| No | 4 | 0 | |
| 4. Wear glasses when driving | | | .19 |
| Yes | 75 | 81 | |
| No | 25 | 19 | |
| 5. Wear seatbelt when driving | | | .01 |
| Yes | 96 | 100 | |
| No | 4 | 0 | |
| 6. Way you prefer to get around | | | .05 |
| Drive self | 85 | 92 | |
| Someone else drive | 15 | 8 | |
| 7. How fast you drive | | | .01 |
| Same or faster | 70 | 82 | |
| Slower | 30 | 18 | |
| 8. Suggested you limit/stop driving | | | .01 |
| Yes | 9 | 2 | |
| No | 91 | 98 | |
| 9. Rate quality of driving | | | .13 |
| Above average | 79 | 86 | |
| Average | 21 | 14 | |
| 10. Not want to drive | | | .23 |
| Ask friend or relative | 79 | 71 | |
| Call taxi or take bus | 3 | 3 | |
| Drive regardless of feelings | 8 | 14 | |
| Postpone plans | 10 | 11 | |

*Chi-square test.

Table 4. Driving Exposure and Driving Dependency

| DHQ Item | Cataract % of Group | No Cataract % of Group | $p$ value* |
|---|---|---|---|
| 11. Number of days per week | | | .03 |
| ≥5 | 72 | 83 | |
| <5 | 28 | 17 | |
| 12. Number of places per week | | | .02 |
| ≥5 | 43 | 30 | |
| ≤5 | 57 | 70 | |
| 13. Number of trips per week | | | .16 |
| ≥11 | 49 | 57 | |
| <11 | 51 | 43 | |
| 14. Number of miles per week | | | .01 |
| >150 | 37 | 51 | |
| ≤150 | 63 | 49 | |
| 15. Number of people travel with | | | .21 |
| ≥4 | 43 | 51 | |
| <4 | 57 | 49 | |
| 16. Driving dependency | | | .14 |
| Usually the driver | 57 | 66 | |
| Have someone else drive | 43 | 34 | |

*Chi-square test.

sessed. Cataract was significantly associated with driving difficulty in the rain, driving alone, making left turns across oncoming traffic, on interstates, in high traffic, in rush-hour traffic, and at night. There were no differences in the two groups with regard to difficulty in parallel parking, with almost 30% of subjects in both groups reporting difficulty in this driving maneuver.

We were interested in the association between cataract and driving difficulty after adjustments for comorbid conditions and functional impairments believed to impact driving ability (advanced age, impaired health, mental status deficit, depression). For the purposes of this analysis, we used the composite difficulty score that ranged from 0 (extreme difficulty) to 100 (no difficulty). This composite measure of difficulty was then expressed as a categorical variable; driving difficulty was defined as scores <90; scores ≥90 signified those with no difficulty. Cataract was significantly related to driving difficulty, RR = 4.07 (95% CI 2.39–6.94, adjusted for depression).

Table 6 displays results for the driving space items. There were no differences in the groups with respect to driving in the immediate neighborhood, beyond the immediate neighborhood, and in neighboring towns. However, those with cataract were less likely to drive to more distant towns and beyond. The composite driving space score was used to generate a categorical variable of driving space. A restricted driving space was defined as ≤3 composite score, and a large driving space was defined as >3. Logistic regression analysis evaluated the association between a restricted driving space (dependent variable) and cataract, adjusting for the potential confounders of advanced age, impaired health, mental status deficit, and depression. Results were that cataract and restricted driving space were unrelated, RR 1.68 (95% CI 0.87–3.24, adjusted for age and mental status).

Twenty-five percent of the cataract group had secondary eye conditions (e.g., AMD, glaucoma, diabetic retinopathy). These conditions were not the primary causes of their vision loss as judged by the eye care specialist but were nevertheless present. Because none of our no-cataract control subjects had secondary eye conditions, the question arises as to whether the associations between cataract and driving habits reported here are confounded by secondary eye conditions in some (25%) cataract subjects. We reexamined our major findings by limiting the cataract group to those who only had cataract and no secondary eye conditions ($n$ = 207). Even after deleting those subjects with secondary eye conditions, cataract was a significant risk factor for driving mobility restrictions (reduction in days driven/week, RR = 1.88 [95% CI 1.04–3.40], number of destinations, RR = 1.79 [95% CI 1.09–2.95], and increased driving difficulty RR = 4.17 [95% CI 2.44–7.15]).

Responses to items about crashes and violations incurred in the prior year are presented in Table 7. There were no differences in the self-reports of the two groups on these items, although there was a nonsignificant trend toward proportionately more reports of crash involvement by the cataract group ($p$ = .20).

*Relationship between driving difficulty and driving habits.*—We were interested in the relationship between self-reported driving difficulty (composite driving difficulty score) and specific driving habits—restricted days of driving/week, slow driving, and restricted driving space (as defined above). Logistic re-

Table 5. Driving Difficulty

| DHQ Item | Cataract % of Group | No Cataract % of Group | $p$ value* |
|---|---|---|---|
| 17. Driving in the rain | | | .001 |
| Difficulty | 67 | 44 | |
| No difficulty | 33 | 56 | |
| 18. Driving alone | | | .001 |
| Difficulty | 24 | 5 | |
| No difficulty | 76 | 95 | |
| 19. Parallel parking | | | .50 |
| Difficulty | 30 | 26 | |
| No difficulty | 70 | 74 | |
| 20. Left turns in traffic | | | .001 |
| Difficulty | 21 | 3 | |
| No difficulty | 79 | 97 | |
| 21. Driving on interstates | | | .001 |
| Difficulty | 26 | 10 | |
| No difficulty | 74 | 90 | |
| 22. Driving in high traffic | | | .001 |
| Difficulty | 36 | 19 | |
| No difficulty | 64 | 81 | |
| 23. Driving in rush hour | | | .001 |
| Difficulty | 45 | 24 | |
| No difficulty | 55 | 76 | |
| 24. Driving at night | | | .001 |
| Difficulty | 77 | 41 | |
| No difficulty | 23 | 59 | |

*Chi-square test.

Table 6. Driving Space

| DHQ Item | Cataract % of Group | No Cataract % of Group | $p$ value* |
|---|---|---|---|
| 29. Immediate neighborhood | | | .17 |
| No | 1 | 0 | |
| Yes | 99 | 100 | |
| 30. Beyond neighborhood | | | .70 |
| No | 1 | 1 | |
| Yes | 99 | 99 | |
| 31. Neighboring towns | | | .35 |
| No | 11 | 8 | |
| Yes | 89 | 92 | |
| 32. Distant towns | | | .003 |
| No | 27 | 13 | |
| Yes | 73 | 87 | |
| 33. Outside the state | | | .001 |
| No | 48 | 27 | |
| Yes | 52 | 73 | |
| 34. Outside the southeast U.S. | | | .001 |
| No | 81 | 66 | |
| Yes | 19 | 34 | |
| Overall Score | | | .001 |
| Restricted driving space† | 28 | 13 | |
| Unrestricted driving space | 72 | 87 | |

*Chi-square test.
†Does not drive beyond neighboring town.

Table 7. Self-Reported Crashes and Citations

| DHQ Item | Cataract % of Group | No Cataract % of Group | p value* |
|---|---|---|---|
| 25. Number of accidents in past year | | | .19 |
| 0 | 71 | 94 | |
| ≥1 | 11 | 6 | |
| 26. Number of accidents where police came to scene | | | .20 |
| 0 | 93 | 96 | |
| ≥1 | 7 | 4 | |
| 27. Number of times pulled over by police | | | .44 |
| 0 | 92 | 91 | |
| 21 | 8 | 9 | |
| 28. Number of times received a ticket (other than a parking ticket) | | | .75 |
| 0 | 99 | 98 | |
| ≥1 | 1 | 2 | |

*Chi-square test.

Table 8. 2 × 2 Contingency Table for Cataract and At-Fault State-Recorded Crash Involvement*

| | Crasher | Noncrasher |
|---|---|---|
| Cataract | 35 | 241 |
| No cataract | 6 | 97 |

*Notes:* Crude RR = 2.3 (95% CI 1.00–5.76); RR = 2.48 (95% CI 1.00–6.14) adjusted for driving exposure (days driven/week; miles/week).

*Five subjects are not included because they had out-of-state licenses; thus, crash data were unavailable through the Alabama Department of Public Safety.

gression analysis evaluated associations between each of these driving habits (dependent measure) and the composite driving difficulty score. Advanced age, impaired health, mental status deficit, and depression were evaluated as potential confounders. Results were that driving difficulty was associated with reduced days of driving, RR = 2.07 (95% CI 1.28–3.34, no adjustments necessary); driving slower than the general traffic flow, RR = 1.80 (95% CI 1.13–2.88, adjusted for health); and restricted driving space, RR = 2.65 (95% CI 1.58–4.41, adjusted for mental status, age).

*State crash data.*—According to state records, subjects in this study incurred a total of 76 crashes in the prior 5 years. As discussed earlier, we were primarily interested in those crashes where the older driver was deemed at least partially at fault. There were 46 at-fault crashes for the sample during the prior 5 years. Eighty-nine percent of the subjects incurred no at-fault crashes, 9% incurred one at-fault crash, and 2% incurred two or more at-fault crashes in the previous 5-year period. To examine the association between at-fault crashing and cataract, drivers were categorized as at-fault crash-involved or not. Table 8 displays the 2 × 2 contingency table showing a significant crude association between cataract and at-fault crash involvement, which remained significant after adjusted for driving exposure (days driven/week and miles driven/week), RR = 2.48 (95% CI 1.00–6.14). When adjusted for impaired health (the only other health and functioning variable related to crash involvement), the association between cataract and crash involvement remained significant, RR = 2.46 (95% CI 1.00–6.16).

We also evaluated the relationship between self-reported crashes for the prior one-year period (Appendix, item 26) and actual crashes as recorded by the state for the same period. All but two crashes were reported in the self-report interview.

*Characteristics of refusers.*—There were 714 persons eligible for participation in the study and, of these, 330 (46%) declined our invitation to participate. Of these 330 "refusers," 259 (79%) consented to a brief phone interview. Those persons with cataract who refused had the following characteristics. Compared to participants, refusers were on average 3 years older, had slightly worse visual acuity impairment (by only one letter), were more likely to reduce days of driving/week, and were less likely to be crash-involved during the prior 5 years (all $p < .05$). Participants and refusers in the cataract group were no different with respect to gender, race, and general health. With reference to the no-cataract control group, compared to participants, refusers were more likely to have poorer health ($p < .05$). Participants and refusers in the no-cataract control group were no different with respect to gender, race, age, days of driving/week, vision status, and crash involvement over the prior 5 years.

## Discussion

The results of this study clearly imply that older adults with cataract were more likely to experience reductions in driving exposure and restrictions in driving habits, as compared to older drivers without cataract. Those with cataract reported that they drove fewer days/week, miles/week, and to fewer destinations, limited their driving to areas closer to their home base, preferred that others be the driver, and drove slower than the general traffic flow. Comorbid medical conditions and functional impairments, although present in our cohort, did not account for most associations between cataract and restricted driving mobility. Reduced mobility is one of the most commonly reported problems of older adults (23), especially among those who are visually impaired (24,25). Our demonstration that restrictions in driving mobility are related to an eye condition that is reversible suggests that interventions to improve vision in older adults may also improve driving mobility.

Older drivers with cataract were dramatically more likely to express difficulty in challenging driving situations (a fourfold increase) than were those who were cataract-free, which agrees with another recent study (26). All situations addressed in the interview, except for parallel parking, were more difficult for drivers with cataract, including driving in the rain, alone, on interstates, on high-traffic roads, in rush hour, and at night, and in making left turns across oncoming traffic. It is important to point out that these are not rare driving scenarios, but situations commonly encountered on the road in nonrural areas. The failure to find a difference between cataract and cataract-free drivers with respect to difficulty in parallel parking probably stems from the fact that many drivers of all ages do not encounter situations where parallel parking is required, or where it is the only parking option available. The association between cataract and driving difficulty reported here is consistent with the findings of previous studies on functional impairments and reported difficulty and avoidance of certain driving maneuvers.

For example, we and others have reported previously that older adults with vision impairment (regardless of etiology) or visual processing deficits such as attention impairment are more likely to report that they avoid or have difficulty with challenging driving situations (10,11).

We have demonstrated that a questionnaire instrument designed to probe driving habits can have good test–retest reliability in older adults. To what extent DHQ responses reflect actual on-road driving performance, experiences, and difficulties remains to be determined.

Our earlier studies on drivers recruited through state records indicated that many crash-involved drivers underreport their crash involvement compared to state records. In the present study, self-reported crash involvement for the prior year was in remarkable agreement with state crash records. Because subjects in the present study were recruited through clinics, they fundamentally represent a different population than those randomly selected from driver licensing files as in our earlier work (14,15). We recommend that the most prudent approach in studies using crash involvement as an outcome measure is that investigators refrain from assumptions about the validity of self-report data in the population under study, until its validity is established against state records. Beyond the validity issue, an advantage to crash data from the state is that many states make available the actual accident report, which details the circumstances surrounding the crash; this can be used in at-fault determination (as done in this study) and in examining other aspects of the crash event.

Our analyses indicated that almost 50% of persons eligible to participate in the ICOM study declined our invitation to enroll. The ICOM protocol had a substantial time commitment, requiring three patient visits each lasting 2–3 hours, and several follow-up phone interviews. In addition, many persons with cataract in our sample were scheduled for cataract surgery for the following week, and preferred not to make an additional visit to the clinic to participate in our study so close to their surgery date. Fortunately, the vast majority of those who refused to participate consented to phone interviews, which gave us clues about their functional and health status. Those who refused to enroll were slightly older and reported more visual difficulty and reductions in driving exposure than those who agreed to participate, especially in the cataract group. One implication of this is that we may not be studying those at highest risk for restriction in driving mobility. Interestingly, refusers were less likely to be involved in a state-recorded crash in the prior 5 years than were participants, which may be due to their tendency to remain at home, thus reducing driving exposure. It is worth emphasizing that the ICOM study was not intended to be a prevalence study on current driving versus driving cessation in the cataract population. By design, we were specifically interested in older adults who maintained current, legal licenses to drive.

What is especially interesting is that self-acknowledged driving difficulty is associated with decreased driving exposure. Those older drivers in our sample reporting driving difficulty were two times more likely to report that they drove fewer days/week, and limited their travels to a smaller driving space, implying that some older drivers may self-regulate their driving based on self-acknowledged functional limitations. Although we do not know that this relationship is actually causal, these results are consistent with this idea. Given this association, self-regulation as a way to promote older driver safety is an idea that deserves further investigation (27,28).

This study has indicated that older drivers with cataract have an elevated crash risk compared to those without this condition. Cataract is a common medical condition in older adults, and thus its association with a reduction in driver safety is a critical point. Highly effective treatments for cataract are available, namely surgical removal of cataract followed by intraocular lens implantation. As with many medical and surgical procedures, cataract surgery is closely scrutinized in terms of its cost versus benefit to the patient's quality of life and well-being (29). As the ICOM study unfolds and subjects are followed postsurgically, we will be able to examine whether cataract surgery indeed lowers crash risk and enhances driving mobility in our older driver sample. This approach contributes toward evaluating surgical and medical procedures in the elderly population using outcomes defined in terms of the performance of activities of daily living and enhanced quality of life.

In conclusion, older drivers with cataract experience reductions in driving mobility and an elevation in crash risk, as compared to those without cataract. Those who report driving difficulty are more likely to report decreased driving exposure, implying that they may be self-regulating their driving behavior in response to self-perceived limitations. These findings serve as a baseline for the ICOM study, which is evaluating whether improvement in vision following cataract surgery expands driving habits and improves safety.

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Address correspondence to Dr. Cynthia Owsley, Department of Ophthalmology, School of Medicine/Eye Foundation Hospital, University of Alabama at Birmingham, Birmingham, AL 35294-0009. E-mail: owsley@eyes.uab.edu

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## Appendix

*Driving Habits Questionnaire*

**Current Driving**

1. Do you currently drive? 1 = yes (go to #4) 0 = no (go to #2–3 only)
2. Why did you stop driving? ______________________________
3. When is the last time you drove? ________________(month/year)
4. Do you wear glasses or contact lenses when you drive? 1 = yes 0 = no
5. Do you wear a seatbelt when you drive? 1 = always 2 = sometimes 3 = never
6. Which way do you prefer to get around?
   3 = drive yourself 2 = have someone drive you 1 = use public transportation or a taxi
7. How fast do you usually drive compared to the general flow of traffic?
   5 = much faster 4 = somewhat faster 3 = about the same 2 = somewhat slower 1 = much slower
8. Has anyone suggested over the past year that you limit your driving or stop driving? 1 = yes 0 = no
9. How would you rate the quality of your driving? 5 = excellent 4 = good 3 = average 2 = fair 1 = poor
10. If you had to go somewhere and didn't want to drive yourself, what would you do?
    1 = Ask a friend or relative to drive you. 2 = Call a taxi or take the bus. 3 = Drive yourself regardless of how you feel.
    4 = Cancel or postpone your plans and stay home. 5 = Other

**Exposure**

11. In an average week, how many days per week do you normally drive? _____number of days

12–14. Please tell me all the places you drive in a typical week.

12. ___ Total places 13. ___ Trips per week × ___ Miles one-way = ___ subtotal × 2 = 14. ___ Total miles

**Dependence**

15–16. Please list your friends and/or family members that you regularly travel with in a car over the past year. When traveling with this individual, who usually drives?

15. ___Total no. people 16. ___Average score (1 = I drive 2 = about half and half 3 = this person drives)

**Difficulty**

17. During the past 3 months, have you driven when it is raining?
18. During the past 3 months, have you driven alone?
19. During the past 3 months, have you parallel parked?

20. During the past 3 months, have you made left-hand turns across oncoming traffic?
21. During the past 3 months, have you driven on interstates or expressways?
22. During the past 3 months, have you driven on high-traffic roads?
23. During the past 3 months, have you driven in rush-hour traffic?
24. During the past 3 months, have you driven at night?
    If YES: Would you say you drive in that situation with:
        5 = no difficulty at all   4 = little difficulty   3 = moderate difficulty   2 = extreme difficulty.
    If NO: Is it because of visual problems that you do not drive in that situation?   1 = yes   0 = no

**Crashes and Citations**

25. How many accidents have you been involved in over the past year when you were the driver?
26. How many accidents have you been involved in over the past year when you were the driver where the police were called to the scene?
27. How many times in the past year have you been pulled over by the police, regardless of whether you received a ticket?
28. How many times in the past year have you received a traffic ticket (other than a parking ticket) where you were found to be guilty, regardless of whether or not you think you were at fault?

**Driving Space**

29. During the past year, have you driven in your immediate neighborhood?   1 = yes   0 = no
30. During the past year, have you driven to places beyond your neighborhood?   1 = yes   0 = no
31. During the past year, have you driven to neighboring towns?   1 = yes   0 = no
32. During the past year, have you driven to more distant towns?   1 = yes   0 = no
33. During the past year, have you driven to places outside the state ?   1 = yes   0 = no
34. During the past year, have you driven to places outside the southeast region of the USA?   1 = yes   0 = no

**Test-retest reliability** was evaluated on a separate sample of current drivers ($n$ = 41) ranging in age from 53 to 85 (Mean = 71; $SD$ = 8). Acuity in the best eye averaged 20/25 (range 20/15–20/60). Self-reported health status in this sample represented a wide range: 5% in excellent health, 32% in very good health, 27% in good health, 22% in fair health, and 15% in poor health. The DHQ was administered twice by phone, separated by two weeks. Reliability on each item was assessed by Pearson correlation coefficients for items whose responses were continuous variables, Spearman coefficients for items based on ordinal scales, and Kappa coefficients for categorical variables. The average reliability coefficient for each domain (including ranges) follows: (1) .73 (.54–.89), (2) .83 (.73–.92), (3) .71 (.70–.71), (4) .60 (.44–.74), (5) .65 (.42–1.0), and (6) .86 (.72–1.0). A copy of the DHQ can be obtained from the first author.