Person–Vehicle–Environment Interactions Predicting Crash-Related Injury Among Older Drivers

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KEY WORDS
- log-linear analysis
- older driver safety
- risk factors
- two-way interactions

OBJECTIVE. The object of this research was to identify interactions among person, vehicle, and environment factors associated with crashes and injuries among older drivers.

METHOD. We quantified risk factors and interactions for 5,744 drivers.

RESULTS. Women had a high crash risk during mornings (8:00 a.m.–1:00 p.m.; odds ratio [OR] = 1.73, confidence interval [CI] = 1.40–2.14) or afternoons (2:00 p.m.–8:00 p.m.; OR = 1.74, CI = 1.41–2.15); alcohol-related crashes were the least likely to occur during mornings (OR = 0.19, CI = 0.12–0.31). The greatest crash risk with another vehicle occurred during afternoons (OR = 3.89, CI = 2.41–5.05). Injury had interactions with fixed-object crashes (OR = 427, CI = 182.9–998.24), no seatbelt (OR = 5.69, CI = 3.90–8.29), female gender (OR = 1.54, CI = 1.67–1.92), and mornings (OR = 1.40, CI = 1.01–1.94).

CONCLUSION. An opportunity for crash and injury prevention research and shaping longer-range evaluation policies emerged.


With the increasing number of older adults and their greater susceptibility to injury and death from vehicular crashes, occupational therapists and rehabilitation professionals must seek innovative approaches to improve the safety of older drivers. The number of older adults will increase in the coming years; we will therefore see a rise in the frequency of crash-related injuries and, because of the frailty of especially the oldest group (85 years or older), a potential increase in injury severity. The complexity of factors that determine the occurrence and types of injuries calls for multifactor preventive or rehabilitative interventions. To date, however, most research of older drivers has focused on targeting single-cause risk factors associated with motor vehicle crashes, such as cognition, divided attention, or vision (Ball, Owsley, & Sloane, 1991; Ball, Owsley, Sloane, Roenker, & Bruni, 1993; Owsley et al., 1998).

We must go beyond single risk factor studies of crashes to identify the factors most highly related and predictive of safe driving. Factors to consider include person factors (gender, behaviors, driving history), vehicle factors (seating and positioning, managing controls, type of crash), physical environment factors (highway design, time of day), social–environment factors (influence of passengers), and policy factors (age-based licensing statutes). We used a socioecological model, the Precede-Proceed Model of Health Promotion (PPMHP; Green & Kreuter, 2005), to guide our work in identifying multiple factors underlying crash-related injuries and to build a foundation to suggest intervention strategies for safer driving outcomes (Green & Kreuter, 2005).

Impact of Unsafe Driving Performance on Older Adults

By 2030, approximately 25% of all drivers in North America will be older than age 65 (Dellinger, 2003). Motor vehicle crashes are the leading cause of injuries and
fatalities among older adults ages 65 to 74, and they are the second leading cause among those age 75 and older (Centers for Disease Control and Prevention [CDC], 2007). Compared with younger people exposed to a crash of similar impact, those 65 years and older have a two- to fourfold higher rate of injury, hospitalization, or death. In 2004, for example, of the more than 28 million licensed drivers age 65 and older in the United States, 191,000 experienced nonfatal injuries and 6,512 died following crashes, which is, on the basis of miles driven, substantially higher than most other age groups (National Highway Traffic Safety Administration [NHTSA], 2006). Research suggests that the underlying frailty, medical conditions, and medication use greatly contribute to the crash disparities and increased risks for injuries and fatalities (Langford & Koppel, 2006; McGwin, Sims, Pulley, & Roseman, 2000). Beyond loss of function and life, injuries also contribute to health care and economic costs. For example, the total cost of crash-related injuries and fatalities among older adults is not known, but the average cost of one nonfatal motor vehicle injury in the United States is more than $60,000, whereas one fatal injury costs approximately $1,150,000 (National Safety Council, 2006).

Efforts to Reduce Unsafe Driving, Crashes, Injuries, and Fatalities Among Older Drivers

Three Healthy People 2010 (U.S. Department of Health and Human Services, 2000) objectives (reduce crash-related fatalities, reduce crash-related injuries, and increase safety belt use) relate to driver safety. The CDC identified the prevention of transportation injuries among older adults as one of eight priorities, specifically to measure factors that affect safe motor vehicle use, to identify older adults at greatest risk, and to design public health programs to reduce the risks of crashes and injuries among that group (CDC, 2007). Crash- and injury-reduction programs traditionally apply strategies deriving from the “three E’s-concept” (Gielen, Sleet, & DiClemente, 2006), which can be further categorized as active or passive:

- Enforcement or policy (e.g., age-based licensure laws [passive protection]; Florida Department of Highway Safety and Motor Vehicles, 2004)
- Environment or vehicle design (e.g., making the environment safer, such as highway design [passive protection]) or improving the crashworthiness of vehicles (e.g., antirollover device technologies [passive protection]; Staplin, Lococo, Byington, & Harkey, 2001)
- Education (e.g., informing the person [active protection]; Gielen et al., 2006).

Current older driver interventions vary from general community-based classes to specialized driving evaluation and rehabilitation programs (Eberhard et al., 2006). Some programs (e.g., occupational therapy interventions and the AARP 55 ALIVE Course) target multiple factors; however, little empirical evidence demonstrates how those factors and their interactions explain the greatest risk for motor vehicle crash–related injuries.

Model for Multifactor Interactions

For guiding research, many successful health promotion and injury prevention projects have used the PPMHP (Green & Kreuter, 2005). This model is multidimensional and includes domains to recognize social, health, behavioral, environmental, educational, organizational, and administrative factors. The PPMHP may be used to guide investigators in identifying multiple factors in designing studies of complex constructs, such as older driver safety. The PPMHP, as a research tool, is useful for classifying the multitude of factors influencing older driver safety in domains and categories that can be operationalized and measured. Using this strategy, one can quantify all the potential determinants contributing to safe driving on the level of the person (e.g., safety belt use or safe medication use), vehicle (e.g., appropriate positioning to the steering wheel and clear view of the road and traffic), or environment (e.g., driving in optimal weather conditions during daylight hours). Figure 1 illustrates the conceptual framework for understanding driver safety. The Precede phase identifies potential explanatory factors for planning a targeted intervention conducted during the Proceed phase to address those factors (Green & Kreuter, 2005). Interventions must include multiple factors from person, vehicle, and environment domains, and some factors must originate from the following domains:

- **Predisposing** (i.e., knowledge, such as knowing the rules of the road; or attitudes, beliefs, and values, such as beliefs about driving skills)
- **Reinforcing** (i.e., feedback from others in informal and formal social networks)
- **Enabling** (i.e., societal forces or systems to help or hinder change, such as age-based licensure policies).

Rationale for Using a Multifactor Model

Unsafe driving and resultant crashes, injuries, and fatalities are largely preventable (Gielen et al., 2006). In using the PPMHP, we understand unsafe driving as an outcome that is preceded by a range of person, vehicle, and environment events and choices. For older drivers, person factors (e.g., self-restriction—only driving in optimal conditions), comorbidities (e.g., not understanding the limiting effect of arthritis on range of motion for scanning the road before exiting a driveway),
and medications (e.g., not realizing the potential adverse reactions associated with combinations of medication use) may affect driving safety. Person factors are affected by the underlying predisposing (e.g., not knowing rules of the road) and reinforcing (i.e., feedback from others in the social network) factors. Likewise vehicle factors (e.g., not being well positioned in relation to the steering wheel or not being able to manipulate the vehicle controls) and physical and social environment factors (e.g., highway design and influence of passengers), influenced by underlying enabling factors (e.g., absence of consistency in age-based driving laws; Grabowski, Campbell, & Morrissey, 2004), may affect driving safety.

Although passive protection (e.g., intelligent cars with automated positioning systems or enhanced intersections that support driver performance in new ways) provides safety benefits, more can be done to influence the knowledge, choices, and decisions of older drivers; that is, older drivers
- Becoming more informed about age-related changes and their effects on driving,
- Making safer choices,
- Using self-restriction strategies,
- Adapting the vehicle, and
- Regulating trips to avoid environment complexities.

One way to facilitate this increased involvement is to identify the person, vehicle, and environment risk and protective factors and then to identify, on the basis of those factors, future research opportunities for testing prevention strategies for safer driving outcomes and reduction of crash-related injuries and fatalities.

Context for This Research

In a recently completed cross-sectional analysis, we quantified significant predictors of motor vehicle injuries for younger and older drivers (Awadzi, 2006). We analyzed a national crash dataset, the 2003 Fatality Analysis Reporting System (U.S. Department of Transportation, 2003), which contains census data of crashes on public roads within the 50 states, the District of Columbia, and Puerto Rico that resulted in at least one fatality up to 30 days after a crash. Using the driver as the unit of analysis, we examined risk factors predictive of injury. Those risk factors were person (demographics, i.e., female gender, and behavior, i.e., drinking and driving, non-seatbelt use), vehicle (i.e., risk for injuries from rollover crashes, crashes with a moving vehicle, or crashes with a fixed object), and environment factors (i.e.,...
driving in morning [8:00 a.m.–1:00 p.m.], afternoon [2:00 p.m.–8:00 p.m.], or before or after midnight hours [9:00 p.m.–7:00 a.m.]). Although the single-factor findings have implications for injury reduction interventions, we wanted to determine and quantify the multifactor interactions; that is, the simultaneous associations evident in multifactors and their higher-order effects.

Research Question

This older driver study is a continuation of the multifactor approach (Awadzi, Classen, Garvan, & Komaragiri, 2006; Classen et al., 2006; Classen & Lopez, 2006; Classen, Lopez, et al., 2007; Classen, Shechtman, et al., 2007). It is innovative in that it (1) builds on a previous analysis of a crash study; (2) uses a multifactor approach to identify the person, vehicle, and environment factors associated with crash outcomes; and (3) quantifies the two-way interactions among the factors. In this study, we answered the following research question: What are the multiple person, vehicle, and environment risk and protective factors predicting older driver crashes or injuries? By answering this question, we are more strongly positioned to create evidence-based guidelines for injury prevention interventions or to more rigorously implement long-range policies for older driver safety, both of which are critical for advancement of occupational therapy practice.

Method

Design and Participants

This research builds on a recently completed crash dataset analysis in which we quantified the significant risk and protective factors predictive of injuries among older drivers (Awadzi, 2006; Classen, Lopez, et al., 2007). We found 11 statistically significant single factors arising from the person, vehicle, and environment domains. The risk factors for injuries from crashes were increased age, female gender, evening hours, and adverse road conditions. Factors that had a protective effect on injuries after the crash were traveling on roads with intersections (compared with railroad crossings or other junctions), nonfunctioning traffic control devices, presence of two or more passengers, competence with vehicle maneuvers, prior citations, family involvement, and age-based licensing (on-site renewals).

Using some of those factors (explained in the procedure section), we quantified their two-way multifactor interactions. We included drivers ≥65 years old (age range = 65–96, with six drivers listed as >96; median age = 75; mean age = 75.96, SD = 7.11) who were involved in a crash from January to December 2003. All the drivers were involved in at least one crash during this period. The final sample yielded 5,744 older drivers. The Institutional Review Board of the University of Florida approved this study.

Data Analysis

We used log–linear modeling, a nonparametric method for analyzing multiway contingency tables (nominal or ordinal factors) to quantify in odds ratios (ORs) at the 95% confidence interval (CI) level the interactions among person, vehicle, and environment factors. An odds ratio is the ratio of the probability of occurrence of an event (such as being injured) to that of nonoccurrence (such as not being injured) when exposed to or not exposed to a condition (such as a motor vehicle crash). Thus, the statistically significant two-way interactions among domain-related crash and injury predictors were expressed in terms of their 95% probability level of occurrence.

Procedure

The log–linear modeling process consisted of three major steps. First, from the statistically significant factors from the former study, we ran a saturated model that contained all factors of interest (Awadzi, 2006; Classen, Lopez, et al., 2007). The aim was to determine the highest order (second order) of injury factor interactions in the model that plausibly predicted crashes or injuries. Second, to help select the model that would best answer our research question and using backward selection, we conducted a log–linear model to determine the second-order unsaturated models; that is, deriving models that excluded factors that did not have statistically significant relationships. This analysis yielded seven possible second-order interaction models. From those, we selected the model best fitting our research question; that is, containing factors with frequencies appearing five or more times across the seven models. Third, from the final general log–linear model, we quantified interactions, expressed as ORs at the 95% CI levels, among person, vehicle, and environment (Table 1). The referent categories in Table 1 indicate the baseline group and data used for the probability comparisons. For example, under gender, men were the baseline group to which women were compared. The OR will therefore indicate the probability of women being more or less likely to have an injury compared with their male counterparts.

Results

The sample was composed of 67% male drivers and 33% female drivers. Approximately 5% of drivers tested positive for alcohol, and 27% were not wearing a restraint (seatbelt).
Approximately 70% of drivers had crashes with other moving vehicles, 14% had crashes with fixed objects, and the rest (16%) had crashes with objects not fixed or rollover crashes.

Seventy-five percent of drivers had crashes on one- or two-lane roads, and 42% of drivers had crashes during the morning hours (8:00 a.m.–1:00 p.m.). Approximately 85% of older adults were injured in a crash.

**Person–Environment Interactions**

Statistically significant person–environment interactions occurred between gender and hour of the day, as well as drinking and driving and hour of the day (Table 2). Compared with male drivers and before and after midnight hours, female drivers had higher odds of crashes in the morning to early afternoon (OR = 1.73, CI = 1.40–2.14) or afternoon to early evening hours (OR = 1.74, CI = 1.41–2.15). Not surprisingly, crashes involving drinking and driving were 81% less likely to occur during the morning to early afternoon hours (OR = 0.19, CI = 0.12–0.31) and 32% less likely to occur in the afternoon to early evening hours (OR = 0.68, CI = 0.50–0.94).

**Vehicle–Environment Interactions**

We found a statistically significant vehicle–environment two-way interaction for type of crash and hour of the day. The odds of a motor vehicle crash with a fixed object (e.g., a tree) were 1.57 (CI = 1.03–2.42) during the afternoon hours or 2.25 (CI = 1.45–3.49) during the morning hours. A higher risk for rollover crashes existed in the afternoon (OR = 2.07, CI = 1.30–3.29), yet the highest risk for a crash with another motor vehicle was in the morning (OR = 2.59, CI = 1.82–3.68) and early afternoon hours (OR = 3.89, CI = 2.41–5.05).

**Table 1. Description of Injury Risk Factors by Person, Vehicle, and Environment Domains, Numbers, Percentages, and Odds Ratios (ORs) at 95% Confidence Interval (CI) Levels**

<table>
<thead>
<tr>
<th>Domain</th>
<th>Factor and Levels</th>
<th>N (%)</th>
<th>OR</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Person</td>
<td>Gender</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Male</td>
<td>3,827 (66.6)</td>
<td>(referent)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>1,917 (33.4)</td>
<td>1.51</td>
<td>1.29–1.73</td>
</tr>
<tr>
<td></td>
<td>Seatbelt use</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Yes</td>
<td>3,863 (72.5)</td>
<td>(referent)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>1,464 (27.5)</td>
<td>6.20</td>
<td>5.03–7.93</td>
</tr>
<tr>
<td></td>
<td>Driver drinking</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>5,451 (94.9)</td>
<td>(referent)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>293 (5.1)</td>
<td>2.00</td>
<td>1.57–2.54</td>
</tr>
<tr>
<td></td>
<td>Number of previous motor vehicle convictions</td>
<td>M ± SD = 0.09 ± 0.34</td>
<td>0.65</td>
<td>0.44–0.97</td>
</tr>
<tr>
<td>Vehicle</td>
<td>Type of crash</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Crash with object not fixed</td>
<td>471 (8.2)</td>
<td>(referent)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Crash with moving vehicle</td>
<td>3,979 (69.3)</td>
<td>30.99</td>
<td>23.82–40.31</td>
</tr>
<tr>
<td></td>
<td>Rollover crash</td>
<td>473 (8.3)</td>
<td>265.68</td>
<td>155.37–454.32</td>
</tr>
<tr>
<td></td>
<td>Crash with fixed object</td>
<td>815 (14.2)</td>
<td>249.55</td>
<td>152.61–408.03</td>
</tr>
<tr>
<td>Environment</td>
<td>Hour of day</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pre–post midnight (9:00 p.m.–7:00 a.m.)</td>
<td>742 (13.0)</td>
<td>(referent)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Morning–early afternoon (8:00 a.m.–1:00 p.m.)</td>
<td>2,419 (42.2)</td>
<td>0.72</td>
<td>0.57–0.90</td>
</tr>
<tr>
<td></td>
<td>Afternoon–early evening (2:00 p.m.–8:00 p.m.)</td>
<td>2,561 (44.8)</td>
<td>0.63</td>
<td>0.53–0.76</td>
</tr>
<tr>
<td></td>
<td>Highway design</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>1–2 lanes</td>
<td>4,321 (74.8)</td>
<td>(referent)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3 lanes</td>
<td>365 (6.4)</td>
<td>0.32</td>
<td>0.68–1.17</td>
</tr>
<tr>
<td></td>
<td>4–7 lanes</td>
<td>1,067 (18.8)</td>
<td>0.89</td>
<td>0.75–1.09</td>
</tr>
<tr>
<td>Injury</td>
<td>No injury</td>
<td>838 (14.6)</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Injury</td>
<td>Injury</td>
<td>4,906 (85.4)</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

*aNumber of previous motor vehicle convictions = ticketed offenses, including failure to yield, running a red light or stop sign, or making lane-related errors within 3 years from the date of the documented crash.*
Injury Interactions

Statistically significant two-way injury interactions occurred for type of crash, restraint use, gender, and hour of day (Table 2). Compared with crashes with objects not fixed, the odds of the driver sustaining injuries were 427 times higher (CI = 182.9–998.24) for a crash with a fixed object, 243 times higher (CI = 96.06–618.93) for a rollover crash, and 36 times higher (CI = 26.66–48.62) for a crash with another moving vehicle. Compared with drivers who used seatbelts, and as expected, drivers without seatbelts were more likely to sustain crash-related injuries (OR = 5.69, CI = 3.90–8.29). All older drivers were 40% (CI = 1.01–1.94) more likely to have injuries during the morning hours. We observed a gender bias: Female drivers were 54% more likely than male drivers to sustain crash-related injuries (OR = 1.54, CI = 1.67–1.92).

Discussion

Person–Environment Interactions

Interactions between female gender and hour of day are comparable with previous research on older drivers, which indicates that women drive mainly under favorable conditions—that is, daylight rather than nighttime hours (Bauer, Rottunda, & Adler, 2003). This literature explains that older female drivers are more likely than male drivers to use self-regulation strategies, such as driving during the day instead of at night, when visibility may be compromised. They thereby avoid potentially dangerous situations. Consistent with the findings of the Baker, Falb, Voas, and Lacey (2003) study, we found that compared with older men, older women have greater exposure during the day and therefore show a higher risk for crash-related injuries during this period. Therefore, older female drivers emerged as a high-risk group compared with their male counterparts, and self-regulation strategies fall short as the only crash prevention measure. As such, they must be supplemented with additional crash- and injury-prevention strategies (Dellinger, Sehgal, Sleet, & Barret-Connor, 2001; Foley, Heimovitz, Guralnik, & Brock, 2002), such as raising awareness, through education, of the effects of gender and the higher propensity of women for daytime crashes. Alternatively, strategies such as site-specific analyses for female drivers (e.g., evaluating their routes to their usual destinations) or testing women who resumed driving after the loss of a spouse (i.e., evaluating and improving their lacking driving skills) may be testable strategies for future research (Baker et al., 2003; Bauer et al., 2003; Dellinger et al., 2001; Foley et al., 2002).

Although only 5% of drivers had alcohol-related crashes, fewer of those crashes occurred at night; about half of such crashes occurred during the afternoon hours. This finding may be a function of older drivers’ preference for driving during the morning or afternoon and therefore not being exposed to traveling during the hours immediately before and after midnight—the time associated with the higher prevalence of drinking and driving crashes evident in their younger cohorts (NHTSA, 2003). These findings are important to alert occupational therapists of the person–environment factors predicting motor vehicle crashes among older adults. Occupational therapists may therefore choose to adopt a health education focus in their older driver practices to help prevent drinking and driving, regardless of the hour of day.

Vehicle–Environment Interactions

Clearly, increased risks exist for all types of crashes during the daytime and early evening hours. During this period, older drivers have the highest risk for crashes involving colliding with another moving vehicle, the second highest risk for rollover crashes, and the third highest risk for crashing with a fixed object. This finding suggests that despite the

<table>
<thead>
<tr>
<th>Interaction by Domain and Variables</th>
<th>OR (p ≤ .001)</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Person-environment interactions</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female × Afternoon–Early Evening</td>
<td>1.74</td>
<td>1.41–2.15</td>
</tr>
<tr>
<td>Female × Morning–Early Afternoon</td>
<td>1.73</td>
<td>1.40–2.14</td>
</tr>
<tr>
<td>Driver Drinking × Morning–Early Afternoon</td>
<td>0.19</td>
<td>0.12–0.31</td>
</tr>
<tr>
<td>Driver Drinking × Afternoon–Early Evening</td>
<td>0.68*</td>
<td>0.50–0.94</td>
</tr>
<tr>
<td><strong>Vehicle-environment interactions</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crash With Moving Vehicle × Morning–Early Afternoon</td>
<td>3.89</td>
<td>2.41–5.05</td>
</tr>
<tr>
<td>Crash With Moving Vehicle × Afternoon–Early Evening</td>
<td>2.59</td>
<td>1.82–3.68</td>
</tr>
<tr>
<td>Crash With Fixed Object × Morning–Early Afternoon</td>
<td>2.25</td>
<td>1.45–3.49</td>
</tr>
<tr>
<td>Rollover Crash × Afternoon–Early Evening</td>
<td>2.07**</td>
<td>1.30–3.29</td>
</tr>
<tr>
<td>Crash With Fixed Object × Afternoon–Early Evening</td>
<td>1.57*</td>
<td>1.03–2.42</td>
</tr>
<tr>
<td><strong>Unsafe driving Interactions</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crash With Fixed Object × Injury (yes)</td>
<td>427.10</td>
<td>182.91–998.2</td>
</tr>
<tr>
<td>Rollover Crash × Injury (yes)</td>
<td>243.40</td>
<td>96.06–618.93</td>
</tr>
<tr>
<td>Crash With Moving Vehicle × Injury (yes)</td>
<td>36.02</td>
<td>26.66–48.62</td>
</tr>
<tr>
<td>Seatbelt Use (no) × Injury (yes)</td>
<td>5.69</td>
<td>3.90–8.29</td>
</tr>
<tr>
<td>Female × Injury (yes)</td>
<td>1.54</td>
<td>1.67–1.92</td>
</tr>
<tr>
<td>Injury (yes) × Morning–Early Afternoon</td>
<td>1.40*</td>
<td>1.01–1.94</td>
</tr>
</tbody>
</table>

Note. Morning–early afternoon = 8:00 a.m.–1:00 p.m.; afternoon–early evening = 2:00 p.m.–8:00 p.m.; pre–postmidnight = 9:00 p.m.–7:00 a.m.

* p ≤ .05, ** p ≤ .01.
potential benefit of having the good visibility rendered by daytime driving, other demands may pose a risk to safe driving. Inherent risks of daytime driving may be related to the demands associated with driving in denser traffic patterns or attending to increased environmental stimuli. Occupational therapists, who are trained in activity demands and variable context factors, may assist older drivers in trip planning by helping them take into consideration the time of day and strategies for safely coping with traffic density or may raise awareness of neighborhood traffic patterns (e.g., increased pedestrian activity at school zones) that may potentially distract attention from the road (American Occupational Therapy Association [AOTA], 2002).

Injury Interactions
In this study, as is documented in nearly all motor vehicle safety studies, failure to use seat belts continues to be a strong positive predictor of injuries following a crash (Levitt & Porter, 2001). However, female drivers have a higher risk than male drivers of experiencing crash-related injuries (Awadzi et al., 2006; Baker et al., 2003; Bedard, Guyatt, Stones, & Hirdes, 2002) regardless of seatbelt use. This finding may be a function of older women not having the driving skills that their male counterparts have, either because men are the dominant drivers among older adult couples (Charlton et al., 2006) or because women, who are known to have a longer life expectancy than men, resume driving out of necessity after the illness or death of their spouses and have “rusty” skills (Foley et al., 2002). Yet, both men and women, potentially as an effect of self-restriction (i.e., not driving at night) are more vulnerable to crash injuries during daytime hours (Baker et al., 2003; Finison & Dubrow, 2002; NHTSA, 2006). Although these findings are not all that surprising, a new finding emerged: Multifactor interactions exist between injuries and person–environment, vehicle–environment, and person–vehicle–environment. As such, occupational therapy interventions should be planned from this multifactor perspective and tested accordingly. When such interventions are found to be effective, occupational therapists will have empirically demonstrated the critical and clinical importance of interventions pertaining to older driver safety, and, as such, have valuable input in ensuring safe mobility for older adults.

Conclusion
This study used a multifactor (person, vehicle, and environment) approach to quantifying the risk and protective factors and their second-order interactions related to crashes and injuries. Motor vehicle crashes and their resulting injuries are the outcome of a series of preventable events or factors.

The findings in this article suggest that further research is needed into the activity demands and physical context related to driving for clients who are at risk for occupational performance problems. Such research could uncover crash prevention strategies for occupational therapists working with older drivers (AOTA, 2002).

Limitations to analysis of cross-sectional data include temporality (not being able to discern cause-and-effect relationships) and selection bias (all cases were crash involved, and at least one person had to die in the crash). As such, the sample also excluded crashes resulting in minor dents or scratches (i.e., “fender benders”) and crashes that occurred on nonpublic roads. The statistical modeling method allowed selection of 10 factors for the analyses; although the factors were chosen with care, other potentially significant person–vehicle–environmental interactions may have been omitted. The major strengths of this study pertain to using public health data with sample sizes sufficient to reduce Type II error. We selected injury-related factors for log–linear modeling systematically and in so doing found interactions that predicted injury patterns in motor vehicle crashes. As such, we quantified, for the first time in the occupational therapy literature on older drivers, the results of multifactor interactions predictive of motor vehicle crashes and injuries among older adults.

We encourage occupational therapy researchers to further examine knowledge gained from this research for assessing performance patterns, contexts, and activity demands related to driving, the instrumental activity of daily living so important for social participation. In doing so, as researchers, we will be able to identify strategies to restore, maintain, modify, prevent, or promote driver safety among older adults. This article offers some strategies pertaining to educating women and evaluating their site-specific routes, planning routes to drive during less demanding times of the day, and adhering to safe habits (e.g., seatbelt use) or roles (not driving after social drinking). These findings also suggest that researchers interested in intervention should design and test interventions on the basis of multifactor approaches. When such interventions are shown to be effective, we will as a profession occupy a valuable societal role in injury prevention and promotion of safe driving among older adults and be better able to shape policies pertaining to driving evaluations and related services. ▲

References


