Occidental Therapy Interventions to Promote Driving and Community Mobility for Older Adults With Low Vision: A Systematic Review

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MeSH TERMS
- automobile driving
- evidence-based practice
- locomotion
- occupational therapy
- treatment outcome
- vision, low

A systematic literature review was conducted to evaluate the effectiveness of interventions within the scope of occupational therapy practice to improve or maintain the driving performance and community mobility of older adults with low vision. The results of this review identified a limited number of articles—eight—that met the inclusion criteria. Identified intervention strategies included the use of bioptics or prisms, multidisciplinary vision rehabilitation for community mobility, driving simulator training, driver education programs, and orientation and mobility training. Evidence is insufficient for the effectiveness of these interventions in improving or maintaining the driving performance or community mobility of older adults with low vision. Key study limitations included heterogeneity of sample characteristics (age, type of vision impairment), lack of standardization of interventions (device type, time, intensity duration), and lack of standardized assessments to measure driving and community mobility. This evidence-based review is informative for discussion of practice, education, and research implications.


Driving a personal vehicle is the primary mode of transportation that supports community mobility in U.S. society and is often identified synonymously with independence (Justiss, Mann, Stav, & Velozo, 2006; Stav, 2008; Stav, Justiss, McCarthy, Mann, & Lanford, 2008). This article provides the results of a systematic review synthesizing the evidence that guides and supports occupational therapy practice, education, and research regarding this important and dynamic occupation. The objective of this review was to identify and critically appraise the evidence for interventions that affect the performance, safety, and participation of older adults with low vision, whether as a driver or pedestrian, in navigating their community. The review addressed the following focused question: What is the evidence for the effectiveness of interventions within the scope of occupational therapy practice to improve the driving performance and community mobility of older adults with low vision?

Statement of the Problem and Background Literature

The number of older adults is rapidly increasing, and this demographic is projected to total 88.5 million by 2050 (Kinsella & Wan, 2009). According to the U.S. Department of Transportation (USDOT), approximately 31 million licensed drivers are older than age 65, a 19% increase from the previous decade (National Highway Traffic Safety Administration [NHTSA], 2008). Age-related changes in vision and an increasing prevalence of visual disorders (e.g., macular degeneration, diabetic retinopathy) among the older adult population may lower...
their ability to safely operate a motor vehicle or navigate independently within the community.

Community mobility is identified as an instrumental activity of daily living (IADL) in the Occupational Therapy Practice Framework: Domain and Process (2nd ed.), and driving is a subcategory within the functional spectrum of mobility (American Occupational Therapy Association [AOTA], 2008). Community mobility is defined as “moving around in the community and using public or private transportation, such as driving, walking, bicycling, or accessing and riding in buses, taxi cabs, or other transportation systems” (AOTA, 2008, p. 631). Because driving and community mobility are identified separately in the focused research question, for the purposes of this review community mobility is operationalized as activities that involve mobility outside the home that exclude driving. Both driving and community mobility provide the opportunity for people to participate in education, work, leisure, social participation, and other IADLs (Stav & Lieberman, 2008). Addressing the driving performance and community mobility of older adults with low vision is an important area of practice.

The performance skills required for independent driving and community mobility include sensory–perceptual skills, motor and praxis skills, emotional regulation skills, cognitive skills, communication skills, and social skills. One must be able to perceive and react appropriately to sensory input to plan and coordinate the tasks of operating a vehicle or traveling outside the home (AOTA, 2010). Most information processed for driving and community mobility is perceived through visual sensation (Charman, 1997; Dobbs, 2005). Decreased visual function can impede the accurate interpretation of stimuli vital to safe and independent mobility (Rudman & Durdle, 2009).

**Low Vision**

Low vision can be “defined as a degree of visual impairment that cannot be corrected by eyeglasses or surgery and that interferes with daily functioning” (Rudman & Durdle, 2009, p. 106). It is a highly prevalent condition, affecting approximately 3 million older adults in the United States (Congdon et al., 2004). Older adults who continue to drive with low vision have a much greater risk than adults in all other age groups of being involved in a crash (Stalvey & Owlsley, 2003).

A number of clinical conditions can result in low vision. Diabetic retinopathy affects 1 in 29 adults older than age 40 in the United States (Kempen et al., 2004). Glaucoma has become a leading cause of blindness worldwide, and the incidence is expected to increase significantly over the next 10 yr (Quigley & Broman, 2006). Although many disease processes lead to low vision and vision loss (e.g., age-related macular degeneration [AMD], stroke, cataracts), many of these diseases present with similar functional deficits, including visual field loss, decreased static and dynamic visual acuity, and decreased contrast sensitivity (Boyd et al., 2005; Dobbs, 2005). Licensing authorities primarily use static acuity and visual field for determining driver eligibility (Johnson & Keltner, 1983). According to NHTSA (2001), the American Optometric Association Environmental and Occupational Vision Committee (Shipp et al., 2000), and the American Medical Association (Carr, Schwartzberg, Manning, & Sempke, 2010), however, standards for driving licensure vary greatly among states, with acceptable acuity ranging from 20/20 to 20/200 and peripheral field ranging between 70° and 140°. States also vary as to what compensatory options they allow to maintain driving (e.g., adaptive mirrors, use of bioptics, prisms). Specialized low vision devices can compensate for visual field deficits and greatly diminished acuity.

Unfortunately, some visual deficits are too advanced (not correctable), and these are a leading factor in driving cessation (Ragland, Satariano, & MacLeod, 2004) or restricted community mobility. Visual disability leads to reliance on others for transportation needs, referred to as being transportation disadvantaged. Whether clients are transportation disadvantaged because of regulatory influences or of their own accord, being transportation disadvantaged has broader implications for society and affects both client and caregiver roles (West et al., 2003).

A variety of intervention strategies have been used to improve the function and independence of people with low or restricted vision. These strategies include both remediation (e.g., skill training) and compensatory techniques (e.g., use of adaptive equipment or devices). Some examples identified in the literature include vision restoration therapy, a remediation strategy grounded in neuroplastic principles (Horton, 2005; Mueller, Mast, & Sabel, 2007). Educational modules that provide insight into the driver’s visual deficits, driver training (on-road and simulation), and orientation and mobility (O&M) training have also been explored. However, the evidence related to the effectiveness of these strategies in specifically addressing driving and community mobility outcomes is limited. Therefore, the purpose of this study was to critically appraise the evidence for interventions that affect the performance, safety, and participation of older adults with low vision, whether as a driver or pedestrian, in navigating their community. These results can inform practice, education, and research regarding this important IADL.
Method for Conducting the Evidence-Based Review

This evidence-based review addresses the impact of low vision interventions on driving and community mobility among older adults. Detailed information about the methodology for the entire literature review can be found in the article “Methodology for the Systematic Reviews on Occupational Therapy Interventions for Older Adults With Low Vision” in this issue (Arbesman, Lieberman, & Berlanstein, 2013). An initial search of all terms and combinations of terms yielded a total of 973 possible articles (abstracts and titles) that met the inclusion criteria for this systematic review. Two raters screened abstracts or titles for suitability for full text retrieval. An additional 237 articles were retrieved using a reverse lookup strategy of reviewing the reference lists of selected full-text articles to identify potential articles that may have been missed because of key-word variations. The final number of articles that met all inclusion criteria was 8.

A liberal approach to the inclusion criteria was taken regarding the population of interest, older adults with vision loss; older was defined as age 65 yr or older. However, studies with adults younger than age 65 were included if there was an identifiable subsample or mean older than age 65 and participants had a visual deficit. Interventions had to be within the scope of occupational therapy practice. Driving outcomes included simulated and on-road performance or reported crashes. As described earlier, studies on community mobility outcomes had to identify means of outdoor mobility that excluded driving. Two pairs of raters reviewed articles for inclusion or exclusion and evidence rating. If the first two raters could not achieve consensus, the second set of reviewers was consulted. The quality of research included was Level III or higher using a modified Sackett rating scale (Sackett, Straus, Richardson, Rosenberg, & Haynes, 2000).

Results

Supplemental Table 1 (available online at http://ajot.aotapress.net; navigate to this article, and click on “Supplemental Materials”) summarizes the evidence for the 8 articles that met the inclusion criteria. This systematic review included 4 Level I studies, 2 Level II studies, and 2 Level III studies. These 8 articles identified both outcomes. Three of the 8 studies had mixed outcomes.

Evidence validating simulator outcomes compared with the criterion standard of on-road performance is limited, however. Although this study demonstrates the effectiveness of simulator-based training for improving driving abilities poststroke, the mixed ages of participants and small number with vision impairment (<25%) limit its generalizability. Specifically, the authors did not specify whether any of the participants who demonstrated improvements were among those with visual impairment.

Driving Simulator Training

One Level I study (Akinwuntan et al., 2005) used the intervention of driving simulator training with participants, some of whom were older adults and some of whom had visual impairment identified poststroke. This randomized controlled trial (RCT) compared a simulator training group who received 15 hr of training over the course of 5 wk with a control group who received usual care. The study population included first-time stroke survivors (n = 73) who were younger than age 75 and were legally able to drive before stroke onset. Standardized on-road assessment was used to determine whether a participant was fit to drive, unfit to drive, or temporarily unfit to drive. At follow-up assessment, 73% of the experimental group passed and could legally resume driving, whereas only 42% of control participants passed. Simulator-based performance outcomes showed significant reduction in collisions, pedestrian hits, and total faults.

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Low Vision Rehabilitation for Community Mobility

A Level III study investigated the effectiveness of a multidisciplinary low vision rehabilitation program on participation in daily life and quality of life (Lamoureux et al., 2007). The sample population (n = 192) ranged in age from 18 to ≥90 yr (mean age = 80.3) with AMD (62%), diabetic retinopathy (12%), glaucoma (9%), or other type of retinopathy (17%). The outcome of interest in the study was scores on the Impact of Vision Impairment (IVI) measure, which includes a Mobility and Independence subscale that addresses outdoor mobility. The intervention used a client-centered service pathway model designed to provide the participants with what they needed in areas of skilled service (e.g., occupational therapy), support (e.g., devices), information (e.g., Braille library), mobility, (3) driver education programs, and (4) low vision devices (bioptics and prisms). Because the review targeted interventions, studies were categorized on the basis of intervention type regardless of outcome used (driving or community mobility); some studies (e.g., on bioptics use) identified both outcomes.
and external referral (e.g., community services). Professionals included occupational therapists and O&M specialists who had professional experience in providing community mobility training.

The Mobility and Independence subscale scores of the IVI did not significantly improve after the participants received the services described. Quality of life improved for this sample after receiving the intervention, but the article provided no way to determine whether this change could be attributed to community mobility.

**Driver Education Programs**

Driver education programs are often used to increase clients’ awareness or insight that a functional deficit may have a negative effect on driver safety (Bédard, Isherwood, Moore, Gibbons, & Lindstrom, 2004; Eby, Molnar, Shope, Vivoda, & Fordyce, 2003; Marottoli et al., 2007; Nilsson, 1990; Owsley et al., 2004; Stalvey & Owsley, 2003). Two Level I studies investigated the effectiveness of a standardized driver education program, Knowledge Enhances Your Safety (KEYS), in improving driver safety (Owsley et al., 2004; Stalvey & Owsley, 2003). The KEYS program provided a one-on-one, client-centered review over two sessions of visual risk factors that may affect driver performance and safety.

After the KEYS program, participants (\( n = 365 \)) demonstrated increased perceived vision impairment, improved understanding about its impact on driving, and a significantly higher number of perceived benefits of self-regulation (Stalvey & Owsley, 2003). However, no significant differences were found in perceived threat of crash involvement between the treatment and control (usual-care) groups. Owsley et al. (2004) conducted a Level I RCT with 403 drivers >60 yr of age with a visual acuity deficit. The primary outcomes were crashes (obtained from accident reports provided by the Alabama Department of Public Safety) and self-regulatory driving behavior measured with the Driving Habits Questionnaire (DHQ; Ball et al., 1998; Owsley, Stalvey, Wells, & Sloane, 1999). At 2-yr follow-up, the intervention group did not have a significant reduction in crashes compared with the control group. Regarding self-regulatory behavior, the intervention group significantly decreased driving frequency (miles/week) and number of locations visited compared with the control group. For both driving avoidance and self-regulation scores on the DHQ, after baseline equivalence, the intervention group had significantly higher scores than the control group at each follow-up visit. These driver education studies thus provide limited evidence that the KEYS program is effective in improving perceived threat of crashes or actual crash risk among older drivers with low vision.

**Low Vision Devices: Bioptics and Prisms**

The remaining 4 articles reported use of a compensatory intervention strategy involving low vision devices, specifically bioptic and prism lenses. The studies included participants with a variety of visual impairments (e.g., retinitis pigmentosa, choroidemia, Usher’s syndrome, hemianopsia, AMD); ages, with the proportion of older adults as low as 25%, limiting generalizability; and outcomes (simulator or on-road performance vs. outdoor mobility).

A Level I study (Szlyk et al., 2000) evaluated a regimented 8-wk driver training protocol with the use of bioptic telescopes. Significant improvements in driving-related skills (e.g., lane position, identification of speed limit and signs) were measured in a simulator and on the road. Three groups were compared for effects: the immediate training group, a delayed training group, and a no-training group. The trained groups showed significantly greater improvement than the untrained group in recognition, peripheral identification, and scanning but not in mobility, tracking, or visual memory.

Two Level II studies evaluating the same training protocol using prisms (Szlyk et al., 2005) and bioptic amorphous lenses (Szlyk et al., 1998) to address peripheral vision loss did not demonstrate significant improvements in driver safety. Although these authors reported an improvement of 37% in visual skill categories that included outdoor mobility, the results were not significant.

A Level III study (Bowers, Apfelbaum, & Peli, 2005) investigated the driving status of clients with low vision who reported having had bioptic training. Even though 83% reported they were driving, no inferential statistics were provided to attribute this result to a training protocol.

**Discussion and Implications for Practice, Education, and Research**

With the continuing trends of older adults living longer, driving longer, and experiencing an increased prevalence of vision impairment, the evidence presented in this systematic review has important implications for public health and occupational therapy practice, education, and research. Vision is a key sensory system used to perceive and safely navigate one’s environment and maintain independent community mobility. Although the review identified a limited number of quality studies with mixed results supporting the effectiveness of low vision interventions for older adults, the information provides guidance to
the profession by identifying needs and barriers in addressing driving and community mobility.

Implications for Practice

Occupational therapy practitioners and other health professionals (e.g., O&M specialists) are often involved in training clients in the use of assistive technology (e.g., bioptics) and providing education in driving and community mobility. Educational programs, as demonstrated by the rigorous research conducted by Owsley and Stalvey (Owsley et al., 2004; Owsley, Stalvey, & Phillips, 2003), improve clients’ awareness of visual deficits and have the potential to improve their safety. The review revealed evidence of modified behavior (e.g., decreased driving, avoidance) among older adults with low vision but no statistical improvement in driver safety or crash risk. Despite the widespread popularity of driver education programs, no empirical evidence was found to support their effectiveness in enhancing safety (i.e., decreased crash risk). A simulated driving environment provides a safe venue for training clients with functional skill deficits, and evidence supports the use of simulated driver training to improve the driving performance of older adults with low vision (Akinwuntan et al., 2005; Szlyk et al., 1998, 2000, 2005). As simulators become more affordable, they may provide a more efficient and safer option for improving the driving safety of high-risk clients.

Implications for Education

Low vision devices such as bioptic telescopes, bioptic amorphous lenses, and prisms have the potential to improve driving and community mobility for older adults with low vision. Training in the functional use of assistive devices is within the scope of occupational therapy practice. The educational content or protocols for training with these devices for the purposes of enhancing driving and community mobility are not standardized, and the evidence is mixed with regard to the effectiveness of the training (Bowers et al., 2005; Szlyk et al., 1998, 2000, 2005).

Training in the use of these devices for driving and community mobility requires collaboration with other health professionals (optometrists and ophthalmologists, O&M specialists), and advanced training may be necessary for occupational therapy practitioners (e.g., low vision specialization). Fuhrer, Jutai, Scherer, and DeRuyter (2003) identified satisfaction with the use of assistive devices for functional activities as an important component of training evaluation to minimize the potential for device abandonment. Occupational therapy practitioners need to be aware of the laws in their jurisdictions concerning licensure for work with clients driving with low vision devices and should obtain any advanced training or certification required.

Implications for Research

Many driving-related intervention protocols exclude drivers with low vision as a matter of safety, which may be a reason for the paucity of literature on this population of older drivers. As the ecological validity of driving simulators improves, researchers may be able to test participants in this safer environment before transitioning to on-road procedures. Another limitation in many of the reviewed articles concerns the heterogeneity of the population of interest being investigated. Few studies had participants who both were older adults (≥65 yr) and had low vision (Owsley et al., 2004; Stalvey & Owsley, 2003). Study populations also had a high degree of variability in comorbid conditions pertaining to low vision. The researchers may have had difficulty recruiting participants with these characteristics, resulting in small sample sizes; for example, all three Szlyk et al. (1998, 2000, 2005) studies had sample sizes of <25.

A high degree of variability was also seen in the outcome measures used to capture the constructs of driving and community mobility. The three Szlyk studies incorporated an O&M training component (both indoor and outdoor), with subsequent assessment of the visual skills pertaining to the domains of recognition, peripheral detection, scanning, tracking, mobility, and visual memory. Although participants showed significant improvements in some of these skill domains, the domain scores appeared to be cumulative for both indoor and outdoor items, making it difficult to attribute change to items supporting community mobility.

Similarly, even when study authors provided quantifiable measures of these constructs, their description of the psychometrics (e.g., reliability, validity) was limited. Research with more homogeneous sampling for older adults with low vision is needed. Researchers need to identify or develop reliable and valid instruments that accurately measure constructs related to driving (e.g., crashes, performance) and community mobility (i.e., mobility outside the home). As Lamoureux et al. (2007) noted, participants’ scores on the Mobility and Independence subscale of the IVI did not significantly improve after the intervention. It is difficult to determine effectiveness using this outcome because the authors provided no description of how much weight in that score is attributable to out-of-home mobility. The intervention is highly variable because of individual needs; only 20% of the participants used occupational therapy or O&M services. Similarly,
Szylk et al. (2000) used a mobility subscore that reflected both indoor and outdoor items, so there is no way to determine the weighting that contributed to this domain value. Researchers need to provide adequate detail on time, intensity, and duration parameters for intervention protocols (e.g., education, driver or device training) to enable reproducibility and maximize effect size.

Another consideration for research pertains to the environmental factors that may influence the community mobility of older adults with low vision. According to Rudman and Durdle (2009), older adults with low vision associate fear with community mobility and often engage in risk-avoidance behavior that results in decreased participation and social isolation. Driving cessation and transportation disadvantage have been strongly associated with depression, decreased out-of-home activities (Marottoli et al., 2000), and increased mortality (Edwards, Perkins, Ross, & Reynolds, 2009). Identifying perceived environmental barriers to community mobility and developing strategies to effectively mitigate perceived risk and isolation behavior are necessary to maximize clients' independence and health (Rudman & Durdle, 2009).

**Conclusion**

This systematic literature review identified few studies pertaining to driving and community mobility interventions for older adults with low vision. As the older adult population continues to grow, the prevalence of low vision disorders will increase. Older adults who are transportation disadvantaged will place a social and economic strain on society. Driving and community mobility are important activities that support social participation and quality of life. More research is needed on effective interventions within the scope of occupational therapy practice that support independent community mobility for older adults with low vision. ▲

**Acknowledgments**

I thank Indiana University graduate occupational therapy students Jeff Butler, Chelsea Listenfelt, Nick Rush, and Julie Stover. I also thank Professor Elaine Ewing Fess for her guidance in the review process and acknowledge the contributions of Marian Arbesman and Deborah Lieberman, Program Director, AOTA’s Evidence-Based Practice Project.

**References**


*Indicates studies that were systematically reviewed for this article.*