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Insight: Research and Practice in Visual Impairment and Blindness

A quarterly journal in the field of education and rehabilitation of persons of all ages with low vision or blindness



Insight: Research and Practice in Visual Impairment and Blindness

Call for Manuscripts Special Theme Issue: Low Vision and Rehabilitation Issues in Children and Adolescents of School through College Age, Including Those with Multiple Impairments



In the general literature on visual impairment, there has been less attention paid to children than to adults. This may be because of the lower prevalence among this age group. In North America, the prevalence of low vision and blindness in 0- to 19-year olds is a fraction of overall prevalence. However, the life expectancy of a 65-year old Canadian in 1997, for example, was 17.7 years compared to a newborn's, which was 76.5 years in the same year. So when considered in terms of visual impairment years, the need for rehabilitation and

accommodative services is much greater. Low vision statistics on children have often not included children with multiple impairments and yet approximately half to twothirds of children with low vision also have other impairments.

So **Insight** is planning a special issue devoted to issues of vision rehabilitation surrounding children and young people of school and university/college age with visual impairment and blindness. We are interested in papers describing new research on educational issues and challenges at home for this age group. These

could include, but are not limited to:

- access to print and school materials
- assistive technologies
- approaches to training
- new or improved interventions
- reading research
- O and M studies
- studies on encouraging independence and educational and home challenges

Guest Editor: Prof. Susan Leat

Manuscripts can be: Original Research; Practice Reports; Book, Film, or Literature Reviews; or Theory Pieces

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Cover Photo: A Braille Institute staff member assists a visually impaired older adult as she safely disembarks a mobile service vehicle. Photo courtesy of the Braille Institute of America, www.brailleinstitute.org.



Insight: Research and Practice in Visual Impairment and Blindness



We are pleased to announce Prof. Susan Leat, PhD, as Guest Editor for the upcoming **Special Theme Issue:** *Low Vision and Rehabilitation Issues in Children and Adolescents of School through College Age, Including Those with Multiple Impairments*, to be published in the Spring, 2012 issue.

Prof. Leat graduated in Optometry from the University of

Manchester (formerly UMIST), England. She obtained her PhD and undertook post-doctoral studies at Cardiff University (formerly UWCC), Great Britain. She founded the UWCC Low Vision Clinic and was instrumental in establishing the Special Assessment Clinic in UWCC. In 1991, she took up a faculty position at the University of Waterloo, Canada, where she is now a professor and a clinician in the Low Vision Clinic and the Paediatric and Special Needs Clinic. She teaches and conducts research in psychophysics, low vision, pediatrics, visual development, special needs, and gerontology. She also publishes in international optometric and ophthalmology journals and presents at international conferences.

Prof. Leat is a Fellow of the College of Optometrists (UK), a member of the College of Optometrists of Ontario, a Fellow of the American Academy of Optometry, and a member of the editorial board for the *Journal of Optometry*. She has co-authored a book on pediatric optometry entitled *Assessing Children's Vision—A Handbook*, published by Butterworth-Heinemann in 1999. She is Past Head of the Paediatric and Special Needs Clinic and is currently the Head of Residencies at the University of Waterloo.

Submission Deadline for the Special Issue on Low Vision and Rehabilitation Issues is October 1, 2011.

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Editorial

Falls and Falls Prevention

This issue is a testimonial to the value of meeting for disseminating ideas. At the 2009 Envision Meeting, I had the pleasure of chairing a session on Vision, Mobility, Balance and Falls. In the audience was Dr. Deborah Gold, who asked if I would be willing to edit a special issue on falls and falls prevention in low vision patients for *Insight*. You will see the result over the next several issues, but especially in this special issue.

It seems that Dr. Gold had chosen a very timely topic. We had roughly twice as many great submissions as would fit in this volume. Thus, I had the difficult responsibility of choosing which would be in this issue, leaving Dr. Gold to schedule the remaining accepted papers.

The six articles contained in this issue are a combination of research articles, a practice report, and reviews or thought pieces. I think as a group they provide a strong indication of where we are as a community serving the visually impaired and where we need to go. A careful reading of the six articles will tell us three things: (a) we know that falls are a major problem in low vision patients, (b) we do not fully understand how to reduce falls, and (c) whether in the laboratory or in our practices, we need to keep track of what we are doing to know if it is working.

Let me expand on these points briefly. Data from a number of studies in North America and elsewhere demonstrate something like a twofold increase in falls for those with visual impairments. Naturally, this has led to a number of large-scale studies to reduce falls. Although there are reports of a variety of programs which appear to reduce the frequency or risk of falls in low vision patients, these reports are not at all consistent. Studies which on the surface may appear to be very similar have differing results. Perhaps it is a bias, but I do not believe that this means that we have no ability to reduce falls and the injuries which result. It does mean that even now we do not fully understand what works and what does not. We do not fully understand how the various aspects of low vision rehabilitation, orientation and mobility training, home assessments and modifications, and visits to an ophthalmic professional interact to reduce the risk of falls. Although we do not fully understand what works, this does not mean that we should abandon efforts to reduce falls. It does mean that we should try to look at what we do and as best we can measure the effects, whether it is in our practice, in a community program, or in the laboratory. Only by realworld and laboratory observation will we discern the strategies that reduce falls consistently.

In the following pages you will find articles in which the investigators make a strong effort to track and evaluate what they have done in two laboratory studies and in a community program. In the three reviews, the authors examine critically what we know and do not know about falls and falls prevention. Hopefully these articles and the others which will appear in future issues will assist you in thinking about how to prevent falls. I know that reading all of these papers and editing this issue has enlightened me and will be affecting my research for years.

In closing, let me thank everyone who submitted a paper. I have learned from each and every one of them. Additionally, I thank Dr. Gold for the opportunity. It has been a pleasure. Last, I wish to thank Lindsey Buscher, the *Insight* managing editor at Allen Press, another excellent person to work with.

J. Vernon Odom, PhD Guest Editor

Mobility-Related Accidents Experienced by People with Visual Impairment

Roberto Manduchi, PhD* Sri Kurniawan, PhD

University of Santa Cruz Santa Cruz, CA

Abstract

Walking without sight raises questions about the risk of falls and collisions. This contribution reports on the results of a survey of more than 300 legally blind or blind individuals, focusing on the frequency, nature, and causes of head-level and fall accidents.

Keywords: orientation & mobility, assistive technology injuries

Introduction

Vision loss increases the risk of unintentional injury (Arfken, Lach, McGee, Birge, & Philip Miller, 1994; Felson et al., 1989; Glynn et al., 1992; Ivers, Cumming, Mitchell, & Attebo, 1998; Legood, Scuffham, & Cryer, 2002; Lord, 2006; Roberts & Roberts, 1995; Tobis, Block, Steinhaus-Donham, Reinsch, Tamaru, & Weil, 1990). Previous research highlighted the correlation between the type, severity, and frequency of injuries and the type and degree of vision loss. The categories of injuries considered included falls, occupational injuries, and traffic-related injuries. A thorough review of the literature (Legood et al., 2002) established that the risk of unintentional injury due to falls is higher for those with visual impairment than for the general population. Other than the literature about falls, very few studies are available relating visual impairment to other types of injuries, including occupational and traffic-related injuries. Only one other study (Arfken et al., 1994) briefly addressed the risk of collision against obstacles, which is one of the main themes of this contribution. In that study, each person in a cohort of elderly persons was asked to provide a visual self-assessment, with questions

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that included how often the person bumped into objects that he or she missed seeing. It was shown that bumping into objects was not correlated with visual acuity, and it was only weakly correlated with limited ambulation due to poor vision. Bumping into objects, however, was shown to be a good predictor of falls and recurrent falls.

This article is concerned with two specific categories of injuries: head-level accidents (bumping into things at chest height or higher) and falls while walking. It reports on the results of a survey with more than 300 respondents who are legally blind or blind. The questions in the survey focused on the frequency, nature, and causes of head-level and fall accidents, as well as on other factors such as the level of blindness, the type of mobility aid used, and the frequency of independent trips. The quantitative and qualitative data that emerged from this survey may be useful to orientation and mobility professionals and researchers or practitioners in assistive technology alike.

Motivation and Research Questions

Walking without sight raises questions about the risk of falls and collisions. Although mitigated by the use of mobility aids such as the long cane and the dog guide, this risk needs special consideration. The

Mobility-Related Accidents

first research question addressed by this article was whether accidents involving a blind ambulator in a "static" environment (i.e., accidents that are not due to traffic or to moving objects or persons near the person who is blind) represent a significant aspect of the experience of walking without sight, or if they should be considered sporadic and inconsequential incidents. This question should be relevant, among others, to anyone involved in the development of new mobility tools for people with visual impairments (such as electronic travel aids). Of course, other types of accidents (e.g., traffic-related accidents) are also important and should be addressed by appropriate research; they are, however, outside the scope of this work. A second research question was whether there is a difference in terms of frequency of accidents between cane users and doa guide users. These two mobility aids (cane and dog guide) are intrinsically different, and so it is interesting to ascertain whether they provide the same level of protection, or if one proves superior to the other in this particular context. A third question related to whether persons who venture out to unfamiliar routes are more likely to experience this type of accidents. This information may help identify which population segments may be more in need of technology to prevent injuries associated with independent ambulation.

Data Collection Methodology

The survey was composed of four main parts: (1) demographics; (2) travel habits, including the type of mobility aid used and the frequency of travel outside one's residence and outside familiar routes; (3) occurrence of head-level accidents, their frequency, circumstances, and consequences; and (4) occurrence of trips resulting in a fall, their frequency, circumstances, and consequences. Some of the questions called for a quantitative answer, while some were open-ended. Respondents were able to take the survey on the Internet (using SurveyMonkey[™], an accessible online service providing secure data transfer) or by phone. Online surveys are appealing because of their characteristics of flexibility, speed and timeliness, and convenience (Evans & Mathur, 2005). Those without access to the Internet or not willing to use the online survey tool were given the option of taking the survey by phone.

The only inclusion criteria were for the participants to be blind (with at most some light perception) or legally blind and to be at least 18 years of age. The survey, which ran from October 13 to December 15, 2009, was announced by e-mail to multiple organizations working with persons with visually impairment throughout the United States. То encourage participation, a random draw for two \$100 Amazon gift certificates was announced and later conducted on December 15, 2009. A total of 307 persons participated in the survey, of whom 268 took the survey online and 39 over the phone. Some who participated online were unable to complete the survey due to incompatibility with their screen reader. In these cases, all of the completed answers were considered in the subsequent analysis. All who took the survey over the phone completed the survey. Two hundred eighty-nine respondents were located in the United States (32 different states were represented). Ten respondents were located in Canada, 2 in New Zealand, 2 in Bulgaria, 1 in Mexico, 1 in Indonesia, 1 in the United Kingdom, and 1 in Germany.

Results

In this section we report and analyze the results of the survey. The section is organized in four subsections, corresponding to the four parts of the survey as mentioned previously. At the beginning of each subsection, we report the related survey questions. For multiple choice questions, we list the possible answers in square brackets.

Demographics

- **Q1**. Contact information:
- Q2. Gender:
- Q3. Age:
- Q4. Occupation:
- Q5. Level of vision loss: [Blind, Legally blind]
- Q5.1. Please describe your vision loss:

Q6: Do you use any mobility aids such as a cane, a guide dog, or an electronic aid? [Yes; No (please skip the next question)]

Q6.1. If you answer is "Yes," please describe what mobility aids you use, how often you use them, and in what situations.

Q7. When did you start using a mobility aid?Q8. Do you have any other impairments that affect your ability to walk? [Yes (please describe); No]



Mobility-Related Accidents

Fig. 1. Distribution of ages for survey respondents and for the U.S. population with significant vision loss.

Gender distribution was 65.5 percent women and 34.5 percent men. Ages ranged from 18 to 83 years (mean = 47 years, standard deviation = 15.2 years). Figure 1 compares the age distribution of the respondents with the age distribution of U.S. population with "vision trouble" as reported in the National Health Interview Survey (Pleis & Lucas, 2009). It can be noted that the age distribution of the survey respondents is skewed toward younger age groups. A possible justification for this is the fact that this survey focused on independent ambulation and therefore naturally attracted the younger and more mobile segment of the visually impaired community. It should also be noted that the survey restricted participation to respondents who were legally blind or blind, representing only a subset of the population with vision trouble considered in the National Health Interview Survey (Pleis & Lucas, 2009), where vision trouble was defined as "trouble seeing, even with glasses or contact lenses."

A total of 58.3 percent of the respondents affirmed to be blind (with at most some light perception), while 41.7 percent affirmed to be only legally blind (not blind). Compared with national statistics, which indicate that about 20 percent of persons who are legally blind have light perception or less (Leonard, 1999), it is seen that the community of blind individuals were overrepresented in this survey. In the remainder of this article, the term *blind* refers to "at most some light perception," while the term *legally blind* indicates "legally blind but not blind."

Respondents reported a wide variety of causes of vision loss, including birth defects such as retinopathy of prematurity, retinitis pigmentosa, retinoblastoma, Leber's congenital amaurosis, and age-related impairment such as cataract and glaucoma. Sixtyeight respondents (22 percent) had other impairments affecting their ability to walk, the most common being bad balance and arthritis. Fifty-two respondents (17 percent) were retired, either due to age or disabilities, and 15 (5 percent) were unemployed, while the remaining ones were either employed or students.

Fifty-five percent of the respondents stated that they use a long cane but not a dog guide, 12 percent stated that they use a dog guide but not a cane, and 26 percent stated that they have used both a dog guide and a cane, possibly at different times of their life. Some of the respondents confused what technically is considered a wayfinding aid for a mobility aid. Twenty-nine respondent (9 percent) stated that they use GPS, which is normally considered a wayfinding device. All of the GPS users also used a cane or a dog guide. Twenty-nine respondents (9 percent) stated that they also use aids such as monoculars, telescopes, TalkingSigns, tactile maps, or sighted companions. For subsequent statistical analysis, only two populations were



Fig. 2. Distribution of duration of use of mobility aids.

considered: those who used a long cane only, and those who used a dog guide, possibly complemented by a long cane. Legally blind respondents accounted for 45 percent of long cane users and for 35 percent of dog guide users.

It should be clear that this sample is not representative of the distribution of mobility aid usage within the general visually impaired community. For example, only about 42 percent of the persons who are blind in the United States used a cane in 1990 (Demographic Updates, 1994), and only 2 percent used a dog guide (Demographic Updates, 1995). The high ratio of persons using a mobility aid in this survey may be explained by the fact that the vast majority (96 percent) of the respondents were independent travelers, meaning that they were able to walk independently outside of their house, and thus were very likely to use a mobility aid. The reason for the disproportionally high ratio of dog guide users among the respondents is less clear. It could be conjectured that the survey received good advertisement by dog guide organizations.

Figure 2 shows the distribution of duration of use of mobility aids across respondents. Some respondents used different mobility aids during different periods of their life. In these cases, the cumulative duration of use of all mobility aids was recorded.

Travel Habits

Q9. In a typical week, how often do you travel alone outside your house/apartment/garden? (If your answer is "never," then please skip the next question.)

Q10. How often do you travel alone outside of your familiar routes?

Q10 generated a substantial number (35) of answers containing what could be termed "conjecture words" (about, maybe, probably, etc.). Q9 only generated five such conjecture words. It seems that the notion of "familiar route" is not well defined or that it was difficult for the respondents to clearly assess how often they travel outside familiar routes.

All 307 respondents to Q9 provided quantitative data. Answers to Q10, however, were often qualitative in nature (frequently, rarely, occasionally, as needed). Because it is impossible to clearly quantify such responses, these answers were discarded before subsequent quantitative analysis, resulting in only 177 answers to Q10 containing quantitative data. Based on these quantitative answers, it was decided to group replies to Q9 and Q10 into the following categories: never, once a month or more, once a week or more, five times a week or more, more often than once a day. The results are shown by the histogram of Figures 3 and



Mobility-Related Accidents

Fig. 3. Distribution of frequencies of travel outside one's own residence.

4. Note that about 6 percent of the respondents said that they never take trips outside their familiar routes (Q10). A smaller number of respondents (4 percent) said that they never leave their residence (Q9).

Chi-square analysis of these data reveals the following (please note that for all of the statistical analysis in this article, results with p < .05 are considered significant):

• The distribution of frequencies of travel outside one's residence (Q9) for respondents who are legally blind is consistent with the same distribution for respondents who are blind (Pearson's chi-square = 2.809, df = 3, p = .422). A similar result (Pearson's chi-square = 3.940, df = 3, p = .268) is obtained comparing the distribution of fre-



Fig. 4. Distribution of frequencies of travel outside of familiar routes.



Fig. 5. Distribution of frequencies of travel outside one's own residence for long cane users and for dog guide users.

quencies of travel outside familiar routes (Q10) for respondents who are legally blind and for respondents who are blind. This seems to indicate that the willingness and ability to travel outdoors is not affected by whether one is legally blind or blind

- The distribution of frequencies of travel outside one's residence (Q9) for long cane users and dog guide users are not consistent (Pearson's chi-square = 10.193, df = 3, p = .017). Thus, the data support the claim that the type of walking aid influences the frequency of travel outside one's residence. The histogram of travel frequencies for the two populations (long cane users and dog guide users), shown in Figure 5, strongly suggests that using a dog guide results in significant increase in the frequency of outside walks
- The distribution of frequencies of travel outside familiar routes (Q10) for long cane users and dog guide users are not consistent (Pearson's chi-square = 7.909, df = 3, p = .048). These data suggest that the type of walking aid may influence the frequency of travel outside familiar routes. However, no clear pattern emerges from visual observation of the histograms of travel frequencies for the two populations, shown in Figure 6

The respondents' ages are negatively correlated with the frequencies of travel outside one's residence (Spearman's rho = -0.173, p = .033). This result is perhaps not surprising, as it suggests that the younger respondents travel more often outside their residences than older respondents. It is interesting to notice that age does not appear to be correlated with the frequency of travel outside familiar routes (Spearman's rho = -0.042, p = .581).

Head-Level Accidents

Q11. How often have you experienced headlevel accidents? (that is, hitting your head against an unexpected obstacle): [Never; Once a year or less frequently; Once a month or more frequently; More often than once a month] **Q11.1** Please describe any head-level accidents you have experienced. For example, in which circumstances it occurred and what did you hit. **Q12**. Have any head-level accidents you experienced resulted in medical consequences? e.g., hospitalization, visit to the emergency room or to the doctor, home rest. [Yes (please elaborate); No]

Q13. Have any head-level accidents resulted in time lost (from work, school, appointments,...)? [Yes (please elaborate); No]

Q14. Have you ever changed your walking habits as a consequence of a head-level accident? e.g.,





Fig. 6. Distribution of frequencies of travel outside of familiar routes for long cane users and for dog guide users.

you became reluctant to walk in unfamiliar places or you changed your walking strategy. [Yes (please elaborate); No]

Q15. Was your confidence as an independent traveler ever affected by a head-level accident? [Yes (please elaborate); No]

Three hundred participants responded to Q11. Figure 7 shows the distribution of frequencies of head-level accidents as reported by the respondents. Chi-square analysis of these data reveals the following:

• The distribution of frequencies of head-level accidents for respondents who are legally blind and respondents who are blind are not consistent (Pearson's chi-square = 19.065, df = 3, p = .000). Visual analysis of the two histograms, shown in Figure 8, reveals a larger variance of frequencies of head-level



Fig. 7. Distribution of frequencies of head-level accidents.

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Fig. 8. Distribution of frequencies of head-level accidents for respondents who are blind and for respondents who are legally blind.

accidents for the legally blind population than for the blind population. Note that, among the respondents who are blind, only 2 percent never experienced head-level accidents versus 12 percent of the legally blind population. Note also that respondents who are legally blind were twice as likely to experience frequent head-level accidents (more than once a month) than respondents who are blind (with a proportion of 18 percent and 9 percent, respectively)

• The distribution of frequencies of head-level accidents for dog guide users and cane users are consistent (Pearson's chi-square = 2.792, df = 3, p = .425). This suggests that the type of mobility aid has little influence on this type of accidents

The frequency of head-level accidents is not significantly correlated to the frequency of travel outside one's residence (Spearman's rho = 0.045, p = .563) or outside of familiar routes (Spearman's rho = 0.048, p = .538).

Analysis of the qualitative data provided by the respondents sheds light on the different environ-

ments in which accidents are likely to occur. An overwhelming 86 percent of the head-level accidents happened outdoors, with 8 percent of the respondents reporting accidents both indoors and outdoors, and 6 percent only indoors. Outdoor accidents were due to tree branches (the majority), poles and signs, construction equipment, and trucks. Indoor accidents were typically due to doors and cabinets left ajar, shelf and tables, staircases (hit from the side), and walls.

Twenty-three percent of head-level accidents carried some medical consequences, of which 60 percent required assistance by medical professionals and 60 percent required home rest. The most common treatment for those needing medical attention was the application of stitches or staples (in one case, there was the need for plastic surgery) and dental treatment for broken teeth. Twelve percent of head-level accidents resulted in time lost, which includes missed appointments or the need to take time off work. (It should be noted that some of the respondents did not count visits to the emergency room or to the doctor's office as time lost, and therefore their answers only referred to time





Fig. 9. Distribution of frequencies of tripping resulting in a fall.

off work or missed appointments.) Forty-three percent of these accidents resulted in the respondents changing their walking habits after experiencing an accident, with most respondents stating that they walked more slowly and raised their arms whenever possible to protect their head against unexpected obstacles. In 26 percent of the times, a head-level accident affected the respondent's confidence as an independent traveler, with some avoiding certain areas and others opting for a sighted companion for their travels.

Trip/Fall Accidents

Q16. How often have you tripped resulting in a fall due to your vision loss? [Never; Once a year or less frequently; Once a month or more frequently; More often than once a month]

Q16.1 Please describe any accidents resulting in a fall you have experienced. For example, in which circumstances it occurred and what did you trip on.

Q17. Have the falls you experienced resulted in medical consequences? e.g., hospitalization, visit to the emergency room or to the doctor, home rest. [Yes (please elaborate); No]

Q18. Have the falls you experienced resulted in time lost (from work, school, appointments,...)? [Yes (please elaborate); No]

Q19. Have you ever changed your walking habits as a consequence of a fall? e.g., you became reluctant to walk in unfamiliar places or you changed your walking strategy. [Yes (please elaborate); No]

Q20. Was your confidence as an independent traveler ever affected by a fall? [Yes (please elaborate); No]

Two hundred eighty-nine participants responded to Q16. The results are summarized in Figure 9. Among the respondents who are blind, only 8 percent never experienced this type of accidents. This number grows only slightly (10 percent) for the legally blind population surveyed.

Similarly to the case of head-level accidents, respondents who are legally blind were twice as likely to experience frequent fall accidents (more than once a month) than respondents who are blind (with proportions of 10 percent and 5 percent, respective-ly). Chi-square analysis reveals that the distribution of frequencies of this type of accidents are consistent between respondents who are blind and respondents who are legally blind (Pearson's chi-square = 5.392, df = 3, p = .145) and between long cane and dog guide users (Pearson's chi-square = 1.494, df = 3, p = .684). The frequency of fall accidents is not significantly correlated to the frequency of travel outside one's residence (Spearman's rho = 0.053, p

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= .505) or outside of familiar routes (Spearman's rho = -0.062, p = .431).

Qualitative answers suggest that the main causes of falls were (a) lack of attention to the surroundings or to warnings from the dog guide, (b) unexpected obstacles where there were no obstacles before, and (c) misjudgment of distances or angles. The descriptions provided by the respondents were mostly in terms of activities (that led to a fall), whereas in the answers related to head-level accidents, descriptions were mostly in terms of objects (representing obstacles).

Thirty-six percent of the respondents stated that accidents resulting in falls had medical consequences. Sixty-three percent of these required assistance by medical professionals, and 14 percent required home rest. A wide variety of treatments were reported by those who needed medical attention, ranging from stitches to orthopedic surgery to rehabilitation. In 22 percent of the cases reported, an accident of this type resulted in time lost. Fifty-one percent of the respondents said that they changed their walking habits as a consequence of one such accident, and 30 percent reported loss in confidence as independent travelers.

Statistical analysis shows that the frequency of head-level accidents and of trips resulting in a fall are correlated (Spearman's rho = 0.221, p = .006). This suggests that persons who bump into things more often are also those who are more at risk of falls. This result is consistent with the findings of Arfken et al. (1994) who reported that bumping into objects predicts falls and recurrent falls.

Conclusions

This survey has highlighted some of the risks and issues related to independent mobility. Referring to the research questions stated previously, analysis of the respondents' data provides a number of interesting insights:

 Head-level and fall accidents represent a nonnegligible risk associated with walking without sight. Thirteen percent of the respondents experienced head-level accidents at least once a month; 7 percent experienced falls while walking at least once a month. These accidents often required medical attention. A substantial portion of respondents stated that this type of accidents changed their walking habits and reduced their confidence as independent travelers

- The type of mobility aid used does not have a significant effect on the frequency of accidents. Use of a dog guide does not seem to provide better protection against head-level or fall accidents than proper use of a long cane
- Individuals who travel more frequently outdoors do not seem to be at higher risk of head-level or fall accidents than those who leave their house less frequently

These results should be interpreted with consideration to the population interviewed, which was skewed toward younger age groups, expert travelers (with several years of experience using mobility aids), and dog guide users (representing 38 percent of the respondents).

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Falls Risk Assessment in People with Retinitis Pigmentosa

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Abstract

Visual impairment is a major risk factor for falls in older adults, but it is not known what specific falls risk factors are present in adults with impaired vision. The purpose of this study is to examine whether standard clinical outcome measures that have been validated to identify falls risk in older adults would adequately identify falls risk in individuals with visual impairment due to retinitis pigmentosa (RP). Ten adults with RP completed clinical gait and balance assessments, as well as visual function testing. The majority of participants had normal scores on gait and balance measures, yet 8 out of 10 had experienced at least one fall within the past year. The relationships between falls history, gait and balance measures, and visual fields were in the opposite direction to predictions. For example, faster gait speed, typically associated with better stability, was correlated with more falls. Further research is warranted in order to better elucidate the specific falls risk factors in individuals with impaired vision so that appropriate interventions can be developed.

Keywords: falls risk, outcome measures, retinitis pigmentosa

Introduction

It is well documented that older adults are at increased risk for falling and experience a greater rate of falls-related injuries. Falls are caused by multiple factors and typically result from the interaction of biological risk factors (e.g., individual factors, such as muscle weakness) and environmental risk factors (e.g., poor lighting). The most important intrinsic risk factors for falls include muscle weakness and gait and balance disorders, together with visual impairment (American Geriatrics Society, 2001). Visual impairment increases the odds of a fall by approximately 2.5 times (Rubenstein & Josephson, 2006). Various studies have identified specific visual deficits associated with the incidence of increased falls in older adults, including reductions in visual fields, depth perception, and contrast sensitivity (Freeman, Muñoz, Rubin, & West, 2007; Ivers, Cumming, Mitchell, & Attebo, 1998; Lord & Menz, 2000). These visual deficits can result in increased tripping as a result of not seeing hazards, falls on stairs due to poor depth perception, or failure to notice a change in surface due to poor contrast sensitivity.

A major goal in therapy is to identify individuals at risk for future falls in order to intervene before a fall

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occurs. Physical therapists typically use performance-based outcome measures of balance and gait in order to identify those individuals at risk for future falls. Researchers have tested older adults to develop criteria that optimize sensitivity and specificity of each outcome measure in order to predict future falls. One of the simplest measures used to identify older individuals at risk for falls is preferred gait speed. Gait speeds less than 0.7 meters per second have been associated with increased falls incidence (Monterro-Odasso et al., 2005). The Dynamic Gait Index (DGI) assesses an individual's ability to modify gait in the presence of external demands; total scores lower than 20 (out of a possible maximum score of 24) indicate falls risk (Shumway-Cook, Baldwin, Polissar, & Gruber, 1997; Whitney, Hudak, & Marchetti, 2000). The items of the DGI include walking with changing speed or head turns, walking over and around obstacles, and stair climbing. Computerized dynamic posturography assesses the ability to use sensory input to maintain balance. Sensory input is systematically reduced during the Sensory Organization Test (SOT) and total composite scores of less than 38 (out of a possible maximum 100) have been associated with recurrent falls (Whitney, Marchetti, & Schade, 2006).

Visual deficits are associated with postural instability and reduced mobility, and, as a result, increased incidence of falls. For example, a one-line reduction in visual acuity was associated with a 10 percent increase in the odds of mobility restriction, whereas visual field loss of 10 percent was associated with a 20 percent increase in the odds of mobility restriction (West, Gildengorin, Haegerstrom-Portnoy, Schneck, Lott, & Brabyn, 2002). Although it has been argued that peripheral visual field loss is more critical to postural stability and therefore falls incidence, studies have demonstrated that both central and peripheral visual field loss result in increased falls incidence. Older women with central visual field loss due to age-related macular degeneration (AMD) have significantly greater falls risk than their peers as a result of impaired balance, slow visual reaction times, and poor vision (Szabo, Janssen, Khan, Potter, & Lord, 2008). As a result, women with AMD fall at nearly twice the rate of women without AMD (Szabo, Janssen, Khan, Lord, & Potter, 2010). Patients with glaucoma, which results in loss of peripheral vision, have three times the risk of falls compared to those without glaucoma (Haymes, Leblanc, Nicolela, Chiasson, & Chauhan, 2007).

Retinitis pigmentosa (RP) is a term applied to a group of hereditary retinal degenerative diseases characterized by the loss of function of the rod and cone photoreceptors. It is estimated to affect approximately 1 in 3,700 people in the United States (Boughman, Conneally, & Nance, 1980). The primary symptoms of RP include night blindness (impaired vision at low light levels due to rod degeneration early in the progression) and constricted peripheral visual fields (Berson, Sandberg, Rosner, Birch, & Hanson, 1985; Felius et al., 2002; Grover, Fishman, Anderson, Alexander, & Derlacki, 1997; Massof & Finkelstein, 1981; Woods, Giorgi, Berson, & Peli, 2010). Other symptoms can include reduced visual acuity, reduced contrast sensitivity, and photopsias (Alexander, Derlacki, & Fishman, 1995; Berson, Rosner, Weigel-DiFranco, Dryja, & Sandberg, 2002; Bittner, Diener-West, & Dagnelie, 2009; Holopigian, Greenstein, Seiple, & Carr, 1996). RP can also lead to cataracts at a relatively young age (Jackson, Garway-Heath, Rosen, Bird, & Tuft, 2001), and is known to have an impact on many aspects of everyday function, including face recognition, color perception, and reading (Barnes, De l'Aune, & Schuchard, 2008; Fishman, Young, Vasquez, & Lourenco, 1981; Szlyk, Fishman, Alexander, Revelins, Derlacki, & Anderson, 1997).

The effects of RP on balance and mobility have been investigated in a number of studies using both self-report measures and performance-based measures (Black, Lovie-Kitchin, Woods, Arnold, Byrnes, & Murrish, 1997; Hartong, Jorritsma, Neve, Melis-Dankers, & Kooijman, 2004; Haymes, Guest, Heyes, & Johnston, 1996; Turano, Geruschat, & Stahl, 1998; Turano, Geruschat, Stahl, & Massof, 1999; Turano, Herdman, & Dagnelie, 1993), but the issue of falls risk has not been addressed as much. Studies have demonstrated that individuals with RP often cannot use available visual cues appropriately to stabilize balance and will exhibit increased postural sway (Turano et al., 1993). In addition, individuals with RP often have reduced gait speed and increased accidental contact with objects on obstacle courses in the environment, under both normal and reduced illumination (Black et al., 1997; Geruschat, Turano, & Stahl, 1998). Increased postural sway and reduced

gait speed typically indicate decreased stability, which in turn, increases falls risk.

Thus, the purpose of this study was to examine whether standard clinical outcome measures that have been validated in older adults to identify falls risk would adequately identify falls risk in individuals with visual impairment due to RP. This was accomplished by examining the relationships between falls history and clinical outcome measures.

Methods

Participants

Community-dwelling adults from metropolitan Atlanta and the surrounding area were identified via chart review at the Atlanta Veterans Affairs Medical Center (VAMC) Eve Clinic and Emory University Department of Ophthalmology and then sent letters of recruitment. Potential participants were also recruited via flyers and presentations at local organizations providing services to individuals who are blind or visually impaired, including the Center for the Visually Impaired in Atlanta, and the Georgia chapter of the Foundation Fighting Blindness. Inclusion criteria for the study were: an established diagnosis of RP or Usher's syndrome, adult age (between 18 and 90 years), legal blindness according to visual field standards (i.e., central visual fields less than 20 degrees in diameter, with nearly complete to complete peripheral visual field loss in the better eye), ability to walk household distance without an assistive device. and ability to stand for at least 20 minutes. Individuals were excluded if they had binocular visual acuity worse than 20/800, more than mild (1+) cataracts, other eye diseases (including glaucoma or diabetic retinopathy), history of eye injury, insulin-dependent diabetes or serious nonophthalmic diseases (e.g., Parkinson's disease) that might affect participation in the study. This study adhered to the tenets of the Declaration of Helsinki, and was approved by the institutional review board of Emory University and the Atlanta VAMC Research and Development Committee. Informed consent was obtained from all participants after the nature and possible consequences of the study had been explained.

Study Protocol

This study was part of a larger longitudinal study investigating everyday visual function in people with RP. The protocol involved two days of extensive assessment of visual impairment, functional vision, and gait and balance, in addition to self-report measures of balance-related confidence and visual abilities. The protocol included tests of visual impairment such as near visual acuity, low luminance acuity, and color vision as well as functional vision tests, such as face recognition, visual search, and reading. The results presented here concentrate on distance visual acuity, contrast sensitivity, and visual fields, along with balance and gait testing. Participants were compensated for their time and travel expenses.

Materials and Procedure

Vision Test Battery

The measurement of visual acuity and contrast sensitivity was performed with binocular viewing. Participants wore their habitual distance refraction. Visual acuity (logMAR) was measured with the Early Treatment in Diabetic Retinopathy Study (ETDRS) chart (Ferris, Kassof, Bresnick, & Bailey, 1982) at 3 meters or at 1 meter if the participant was unable to read all of the letters on the top two lines at 3 meters. Letter-by-letter scoring was used, as recommended for best test-retest reliability (Bailey, Bullimore, Raasch, & Taylor, 1991), and testing continued until the subject gave five consecutive wrong answers. Contrast sensitivity values were measured with the Pelli-Robson chart (Pelli, Robson, & Wilkins, 1988) at 1 meter, also with letter-by-letter scoring (Elliott, Bullimore, & Bailey, 1991). Visual fields were measured with the Humphrey Field Analyzer using the 81-point full-field 3-zone screening protocol. Eight of the 10 participants also had macular perimetry performed with the scanning laser ophthalmoscope (SLO) to determine the extent of the central visual field (Sunness, Schuchard, Shen, Rubin, Dagnelie, & Haselwood, 1995).

Balance and Gait Test Battery

Gait speed was assessed by having participants walk at their preferred and fast gait speed over a level indoor surface without an assistive device. The time to walk 6 meters was recorded using a stopwatch (Bohannon, 1997). The participant began the trial 1.5 meters behind the start point for the 6meter distance and continued walking for 1.5 meters past the end of the 6-meter distance. Timing began when the first foot crossed the start point and ended

when both feet crossed the end point. Participants were instructed first to walk at their "normal preferred pace" and then they repeated the task with the instructions "to walk as quickly as safely possible." Participants wore a safety belt and were accompanied by either a physical therapist or trained research assistant to ensure safety. Three trials of each instructed speed were performed and average speed was calculated.

The ability to adapt gait in the presence of external demands was assessed using the Dynamic Gait Index (DGI). The eight items of the DGI include walking while changing speed and turning the head, walking over and around obstacles, and stair climbing (Shumway-Cook & Woollacott, 2001). Scoring of the DGI items is based on a 4-point scale from 0 to 3, with 0 indicating severe impairment and 3 indicating normal ability. A maximum total score of 24 is possible and scores less than 20 indicate high risk for falling (Shumway-Cook et al., 1997; Whitney et al., 2000). The DGI has excellent inter-rater as well as test-retest reliability (0.96–0.98; Shumway-Cook et al., 1997).

The Sensory Organization Test (SOT) was used to assess the integration of sensory information for balance by measuring postural sway under conditions in which visual and somatosensory feedback is altered (Nashner, Black, & Wall, 1982). The SOT is organized into a series of six conditions of increasing difficulty. The first three conditions are performed on a firm surface with eyes open (condition 1), eyes closed (condition 2), and finally with vision swayreferenced (condition 3). The final three conditions are performed with the support surface swayreferenced with eyes open (condition 4), eyes closed (condition 5), and with vision sway-referenced (condition 6). Sway-referencing refers to either the visual surround or the support surface moving in the same direction and amplitude as the person's sway. Sway-referencing provides inaccurate visual or somatosensory input. The SOT composite score has been found to have good test-retest reliability, and to differentiate between fallers and nonfallers in community-dwelling older adults (Ford-Smith, Wyman, Elswick, Fernandez, & Newton, 1995).

Self-Report Measures

Falls history was based on self-report. Participants were asked to respond to the question "How many times have you fallen within the past year?"

Participants were asked the cause of each fall to determine the mechanism of the falls where possible.

The Veterans Affairs 28 questionnaire (VA-28; De l'Aune, Welsh, & Williams, 2000) focuses on visionrelated everyday function, or activities of daily living (ADLs). This self-reported assessment of ADLs was chosen because it was developed and validated specifically for individuals who are legally blind. The questions deal with activities that are important and can still be performed by those with severe vision loss or worse, such as outdoor chores, paying bills, or using public transportation. In addition to rating the difficulty of each activity, subjects were asked to rate the importance of the activity, their sense of independence for performing the task, and their satisfaction with their ability to perform the task. The self-report questionnaire was verbally administered by the research assistant. Of the 28 questions, the analysis for this study concentrated on the answers to the orientation and mobility (O&M) subscale items (11 questions, including how difficult is it for you to "generally avoid obstacles as you walk?"). The answer choices were: 1 through 4 (not difficult at all to impossible) or U (do not perform task due to nonvisual reasons). Answers of U were counted as missing data. An overall average difficulty score for all the items of the VA-28 scale was calculated as well as an average difficulty score for the O&M subscale.

The balance self-efficacy scale (BES) is a scale that measures an individual's current balance-related confidence while performing a variety of ADLs. These include getting in or out of a bed, chair, or shower; walking on uneven surfaces (with and without good lighting, with and without assistance); and going up and down stairs with or without a railing (Gunter, De Costa, White, Hooker, Hayes, & Snow, 2003). Subjects rated their confidence in their ability to perform different activities without losing balance. There are 18 items in the BES, and each is rated on a scale from 0 to 100 percent (0 indicates no confidence, 100 indicates absolute confidence). Average overall confidence across the 18 items was calculated. BES scores have been correlated with balance and mobility as well as faller status in older women (Gunter et al., 2003).

Data Analysis

Descriptive statistics were used to summarize the characteristics of the sample. Bivariate correlations (Pearson's) were performed to examine the relation-

	Median	Range
Age (years)	51.0	31–80
Gender	6 females; 4 males	
Number of falls in past year	1	0–3
Visual acuity (logMAR)	0.47	1.32-0.00
Contrast sensitivity (logContrast)	1.00	0.10–1.65
Visual field diameter (degrees)	8	2–18
VA-28 total score	1.80	1.45–2.93

Table 1. Participant Characteristics $(n = 10)^{a}$

^a VA-28 = Veterans Affairs 28 questionnaire.

ships between number of falls (by self-report history) and clinical measures of visual function and balance and gait. Due to the exploratory nature of the study, variables that accounted for at least 16 percent of the variance (r > 0.4, the strength of which is considered moderate) were considered significant. Data were analyzed using PASW Statistics (formerly SPSS), version 18.0.

Results

Participant Characteristics

Ten participants with established RP completed tests of vision and gait and balance (Table 1). One participant had been diagnosed with Usher syndrome type II, which causes congenital hearing loss, but spares vestibular function, unlike type I which results in vestibular deficits (Yan & Liu, 2010). That participant had rotary chair testing to confirm normal vestibular function. One participant was missing contrast sensitivity and visual field scores and one participant was missing BES score. The median age of the participants was 51.0 years. Given the small sample and broad age range, the actual ages of the participants are listed here for reference: 31, 36, 39, 49, 50, 52, 53, 59, 74, and 80 years. Six of the 10 subjects were female. The monocular visual fields were very similar between eyes for each participant. Since these subjects use the fovea, it is reasonable to overlap the monocular visual fields to determine the extent of the binocular visual field. The Humphrey visual fields confirmed that each of the participants had nearly complete to complete peripheral visual field loss and less than 20-degree central visual fields. The participants showed a range of visual acuity and contrast sensitivity values from agenormal to abnormally low.

Of the 10 participants, eight participants had experienced at least one fall (range: 1–3) for a total of 13 falls within the previous year. No reason was given for the majority of falls (n = 8 falls); otherwise, tripping was the only reason listed as causing the fall (n = 5 falls). Participants were asked to complete information on a health questionnaire regarding assistive device use. One participant did not use any assistive device, eight participants used a white cane (as a visual guide, not as a support cane), and data are missing for one participant. See Table 1 for complete demographic information.

Relationship Between Clinical Measures and Falls History

In spite of the majority of participants having experienced a fall in the previous year, the clinical assessments of balance and gait were normal for the majority of participants (Table 2). Six of the 10

Table 2.	Balance	and	Gait	Abilities	of	Participants ^a
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	Median	Range
Preferred gait speed		
(meters/second)	1.10	0.87–1.49
Fast gait speed	1 68	1 16_2 08
Dynamic gait index	1.00	1.10-2.00
(out of 24)	20	13–22
Sensory Organization	- 4	50.00
lest (out of 100)	/1	53-86
VA-28 O&M subscale	2.05	1.45–3.09
BES (percent)	78	65–97

^a VA-28 = Veterans Affairs 28 questionnaire; O&M = orientation and mobility; BES = balance self-efficacy scale.



Fig. 1. Relationship of falls history (i.e., the self-reported number of falls per person for the past year), with respect to the distribution of the variable for individual participants. A) fast gait speed (meters/second); B) Sensory Organization Test (SOT) composite scores; C) Dynamic Gait Index (DGI) scores; D) visual field diameters (degrees). The line for linear regression and the value of R^2 are displayed for each variable.

participants had normal preferred gait speed, and 8 of 10 had normal fast gait speed based on age and gender reference values (Bohannon, 1997). None of the participants met the criteria for falls risk based on gait speed (< 0.70 meters/second; Monterro-Odessa

et al., 2005). Seven participants had normal SOT scores for age (NeuroCom International, 2001). Six of the participants were classified as low risk for falls and four as high risk for falls based on their total DGI score.



Visual field diameter (deg)

Fig. 1. Continued.

The number of falls in the previous year was moderately correlated to fast gait speed (r = 0.57, p = 0.084; Figure 1A), SOT composite score (r = 0.52, p = 0.01; Figure 1B), DGI (r = 0.55, p = 0.010; Figure 1C), and visual fields (r = 0.60, p = 0.08; Figure 1D). The positive direction of these relationships (Figure 1A–D) indicates that a greater number of falls was related to faster gait speed (generally indicative of better mobility), higher SOT composite scores (higher scores indicate greater stability), higher DGI scores (higher scores indicate greater dynamic stability and lower falls risk), and larger visual fields. It was expected that the correlations between falls history and these variables

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Fig. 2. Relationship of falls history with contrast sensitivity. The line for linear regression and the value of R^2 are displayed.

would be negative; that is, a greater number of falls was expected to correlate to slower gait speed (indicative of worse mobility), lower SOT (indicative of greater instability), lower DGI (indicative of worse dynamic stability) scores, and smaller visual fields (indicative of greater limitations of peripheral vision). All other correlations with the number of falls (including age, BES, VA-28, and O&M subscale scores, preferred gait speed, visual acuity and contrast sensitivity) were small (r < 0.40; e.g., Figure 2) and thus considered not significant.

Discussion

In this group of adults with RP, the incidence of falls over the previous year was 80 percent. It is well recognized that falls are a problem in children and older adults, but not typically for adults between those two age groups, such as half of our participants who were in the middle-aged group. It is estimated that one-third of adults aged 65 and older will fall in a given year and that number increases with increasing age (Hausdorff, Rios, & Edelberg, 2001). Thus, the finding that 80 percent of our sample fell in the previous year was much higher than would be expected based on findings from normally sighted adults. Turano et al. (1999) also reported a high rate of falls among their survey respondents (46 percent), although not as high as in our study, and Black et al. (1997) cited tripping and falling as "commonly reported mobility problems" for individuals with RP. In combination with the present results, the findings from these studies suggest that much work remains to identify whether there are specific impairments that contribute to falls and how interventions might be tailored to individuals with RP in order to reduce falls incidence. Further studies should clarify the risk factors specifically for injurious falls in people with visual impairment in order to prevent injuries.

In the present study, the falls in which a mechanism could be determined were related to trips. Studies that have examined the types of falls that occur in older adults have identified the base-of-support disturbance (i.e., slips or trips) to be the most common cause of a fall, with trips being associated with approximately 40 percent of falls (Freeman et al., 2007; Maki, Holliday, & Topper, 1994; Nachreiner, Findorff, Wyman, & McCarthy, 2007). Based on the O&M literature, it was not unexpected that tripping would be a primary cause of falls in individuals with RP since reduced visual fields and/or reduced contrast sensitivity may decrease the observance of obstacles (e.g., Black et al., 1997). In addition, impaired night vision in RP could also increase falls incidence, again due to not seeing obstacles in dim lighting, both indoor and outdoor (Hartong et al., 2004).

Falls in older adults are known to be caused by multiple factors, typically resulting from the interaction of risk factors, which makes falls prediction a

complex task. In this study, each potential factor was explored independently (e.g., visual acuity or gait speed) when it is likely that more than one factor contributed to a fall. In addition, the specific factor(s) contributing to falls may be different for different people. Still, it was surprising that results from standard clinical tools used to identify falls risk in older adults and adults with impaired balance either did not correlate with falls history in this sample, or correlated in the opposite direction to expectations. For example, slower gait speed has been related to greater instability and increased falls incidence in older adults (Monterro-Odasso et al., 2005). However, in the present sample, the two individuals who had not fallen in the previous year had the slowest gait speed for the fast condition. Likewise, lower SOT and DGI scores were associated with fewer falls. It may be that some individuals with RP adopt a more conservative gait pattern and by slowing down, they allow more time to preview the environment and therefore avoid obstacles in the path. This is a common mobility strategy taught by O&M instructors (Geruschat & Turano, 2002). Risky behavior (fast walking speed) may predispose individuals to falls following a trip. Older adults with faster gait speed who are tripped are more likely to fall (Pavol, Owings, Foley, & Grabiner, 2001). It has been demonstrated in the literature that, as a group, people with RP walk more slowly than normally sighted peers (Black et al., 1997; Geruschat et al., 1998; Turano et al., 1998). However, in the present study, we found that 6 out of 10 participants walked within normal limits for age and gender at preferred speed, and 8 out of 10 at fast speed (Bohannon, 1997). Differences between the findings from the current study and these others may in part be attributed to a lack of matching on gender and differences in walking routes. For example, in the Black et al. study (1997), the control group had twice as many males as the group with RP, and females on average have a slower gait speed. Geruschat et al. (1998) timed walking on a route that involved avoiding overhead obstacles to compare walking speeds between groups, whereas the current study used a straight path without any obstacles to calculate gait speed and then compared those values to reference values in the literature. The findings in this study, while preliminary, serve as a reminder that criteria for falls risk based on outcome measures (such as gait speed, DGI, and SOT) need to be validated for specific groups, including those with visual impairment resulting in severely reduced visual fields. The majority of work in the area of falls prevention has been limited to older adults, rather than younger adults with specific disabilities.

Limitations

The sample of this study was small, so generalizations should be made with caution. In order to develop appropriate interventions to prevent falls in individuals with visual impairment, we have to understand the relationship between various types of visual impairment (e.g., central vs. peripheral visual loss), and balance and gait as it relates to falls risk. In this manner, appropriate interventions can be targeted to the specific balance and gait impairments. Alternatively, for some types of visual impairment (e.g., RP) it may be more critical to have appropriate O&M training in order to compensate for the loss of visual fields and to prevent falls, rather than targeting sensorimotor deficits, such as strength issues or sensory integration issues.

Future Directions

In order to identify the most appropriate approach to preventing falls in individuals with visual impairment, prospective studies should be done. These studies would aim to identify patterns of falls (i.e., trips, slips, or other), particularly with respect to injurious falls, by using falls diaries and assessing multiple measures of physical performance and more specific self-report measures of mobility (e.g., Turano et al., 1999). The outcomes of such research would inform the practice of physical therapists as well as O&M specialists by identifying specific areas of deficit and developing potential strategies (e.g., walking more slowly) to avoid future falls based on the deficits identified. Gathering additional information regarding past O&M training would also be useful, in order to determine its impact on falls incidence in people with RP. The question remains as to which assessments will be most helpful and whether new performance criteria need to be developed for people with visual impairment. While there was a significant relationship between visual fields and falls history in the present study, the relationship was in an unexpected direction. Furthermore, there was no significant relationship between falls history and contrast sensitivity for this (small)

group. Based on previous literature, these findings were unexpected and deserve further study to clarify the impact of age and other factors on the results.

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Original Research

Intrinsic and Functional Components of Falls Risk in Older Adults with Visual Impairments

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Abstract

Falls are the most common cause of hospital admissions for trauma annually, and the leading cause of accidental death in adults over the age of 65. Falls risk is increased by vision loss. The ability to perform functional tasks and activities of daily living is known to be affected by age-related declines in cognition, balance, muscle function, strength, and power. This diminished posture and activity level is compounded by a cyclical trend of declining health, physical ability, and decreased use of sensory information. Research supports the notion that vision loss affects the ability to live an active lifestyle, which adversely affects the physiology and functionality of individuals. The purpose of this paper is to present a review of the literature with regard to factors that are associated with risk of falls in visually impaired seniors. Here, we look specifically at factors that increase falls risk in visually impaired adults (vision, stability/sensory information, cognition), and factors that can be rehabilitated or maintained (overall health, gait, lower-limb power).

Keywords: aging, visually impaired, postural control, falls, older adults, balance

Introduction

The purpose of this paper is to present a qualitative review of the research literature with regard to factors that are associated with risk of falls in visually impaired seniors. In this review, we look specifically at factors that increase falls risk in visually impaired older adults (vision, stability/sensory information, cognition), and factors that can be rehabilitated or maintained (overall health, gait, lower-limb power). Falls are the leading cause of accidental death in adults over the age of 65, and are the most common cause of hospital admissions for trauma annually (CDC, 2010). Over a third of adults 65 and older, will fall once or more each year (CDC, 2010). Although falls are not always fatal they often lead to injury, loss of function, or fear-based

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changes in activity. The increased prevalence of falls and/or falls risk are a common result of the normal aging process, which is exacerbated in individuals with visual impairments (Felson, Anderson, Hannan, Milton, Wilson, & Kiel, 1989; Ivers, Cumming, Mitchell, & Attebo 1998; Ivers, Norton, Cumming, Butler, & Campbell, 2000). The ability to perform activities of daily living and functional tasks is affected by agerelated declines in cognition, balance, muscle function, strength, and power (Bassey, Fiatarone, O'Neill, Kelly, Evans, & Lipsitz, 1992; Lord, Clark, & Webster, 1991; Teasdale, & Simoneau, 2001, Tinetti, Doucette, Claus, & Marottoli, 1995). For example, decreased muscle strength and lower limb power result in gait deficiencies that affect one's ability to ascend and descend stairs, or to rise from a seated position (Bassey et al., 1992). Compromised posture and gait can negatively impact the older adult's activity level through self-imposed barriers to independence as well as loss of confidence (Vellas, Wayne, Romero, Baumgartner, & Garry, 1997). Decreased posture, inefficient gait, and increased falls are exacerbated by a cyclical trend of declining health, physical ability, and decreased use of sensory information (Tinetti et al., 1995; Vellas et al., 1997).

The ability to maintain postural control involves a number of sensory and physiological systems that can be affected by pathology or subclinical constraints (Horak, 2006). Aging is associated with deteriorating ability to maintain this function, which is further compromised by declining vision-an essential contributor to postural control and falls risk (Desapriya, Subzwari, Scime-Beltrano, & Samayawardhena, 2010; Horak, 2006; Ray, Horvat, Croce, Mason, & Wolf, 2008). Sensory information, especially vision, is crucial for maintaining postural control. In addition, somatosensory and vestibular sensory information decline with the aging process, further compromising movement ability, especially for the visually impaired. Previous research supports the notion that vision loss affects the ability to live an active lifestyle and adversely impacts the physiology and functionality of individuals (Ray & Wolf, 2008).

Falls risk can be categorized by numerous interconnecting factors. These characteristics can be categorized as either intrinsic or extrinsic variables (Ashley, Gryfe, & Amies, 1977; Nickens, 1985). Extrinsic variables include environmental factors that can be avoided and controlled, such as

poor lighting, slippery surfaces, inappropriately placed furniture, or unfit foot-ware. Intrinsic variables include spatial and temporal integration of vestibular, visual, and somatosensory information, as well as the ability to respond to that information in a timely manner. These intrinsic factors are directly impacted by the effects of aging with examples including: poor balance, sensory deterioration, neurological disorders, and muscle deterioration. (Nelson & Amin, 1990; Silsupadol, Siu, Shumway-Cook, & Woollacott, 2006). The intrinsic factors most responsive to physical rehabilitation can be grouped into deficiencies in gait, lower limb strength, overall health, and balance (Ray & Wolf, 2008). The intent of this paper is to show that decreases in function, which decrease one's ability to perform daily tasks, thereby predisposing the individual to falls, are affected by these primary age-related intrinsic deficiencies (Horvat, Ray, Nocera, & Croce, 2006). We will discuss the components of function and suggest several alternatives that have been successful in increasing functional skill in a variety of populations.

Cognition

The amount of cognitive processing required for stability depends on both the complexity of the task and the capability of the individual's postural control system (Horak, 2006). As task complexity increases, so does the level of cognitive processing required to maintain directed attention and focus on said task. A decrease in performance is linked to increasing task difficulty. Both the ability to control movements and to execute task demands compete for shared cognitive resources, resulting in declining task performance (Teasdale & Simoneau, 2001). Cognitive capacity declines with age and presents older adults with a quandary when confronted with the challenge of maintaining high cognitive processing to control function, while performing tasks that require processing information from two or more sources. For example, talking on a cell phone and ascending/ descending stairs may be compromised by the allocation of resources to the talking task, limiting processing to execute the walking movement (Teasdale & Simoneau, 2001). Likewise, the loss of vision linked with cognitive deficits produces added stress and contributes to lower functional capabilities. As the Visual Awareness Research Group points out, decreased cognitive capabilities are reflected in

decreased speed of processing or a reduced Useful Field of View (UFOV). A reduced UFOV has been consistently correlated with increased automobile accidents in addition to other types of mobility such as walking (Visual Awareness Research Group, n.d.; Rubin, Ng, Bandeen-Roche, Keyl, Freeman, & West, 2007).

Gait and balance deficiencies are not only related to increased falls risk, but are also related to low balance confidence (Tinetti et al., 1995; Vellas et al., 1997). In a 2 year prospective study, older adults who reported low balance confidence at the onset of the study experienced a higher prevalence of gait, balance, and cognitive disorders than those with high confidence at baseline (Vellas et al., 1997).

Vision

Poor vision reduces postural stability and doubles the risk of falls in older adults (Lord, 2006). Poor vision includes visual attributes such as visual acuity, visual field, contrast sensitivity, and depth perception. Specifically, some studies have shown that reduced contrast sensitivity and depth perception are some of the most important visual risk factors for falls (Lord, 2006; Wood, Lacherez, Black, Cole, Boon, & Kerr, 2009). With regard to sway and vision, it has been found that when individuals stand with their eyes closed, their postural sway increases by 20 to 70 percent (Lord et al., 1991; Lord, 2006). Furthermore, tests involving misleading visual cues significantly increased sway (Lee & Lishman, 1975). One important visual field is visual acuity. Visual acuity measures fine detail in vision and spatial resolution. Significant to this review, there has been an association between visual acuity and falls risk (Lord & Dayhew, 2001). A decrease in this visual field may adversely affect postural control. Contrast sensitivity is the visual property that allows one to distinguish between an object and the background; it takes in to account the difference in color and brightness of objects in the same field of view. Among visual fields, some researchers have found that contrast sensitivity may play one of the largest roles affecting postural control (Felson et al., 1989; Lord, 2006; Lord, Ward, Williams, & Anstey, 1994). Another important visual attribute to note is depth perception, which deals with the ability of an individual to judge distances and depths. Poor depth perception has been found to be a predictor of increased sway in older adults as well

(Lord & Menz, 2000). Depth perception may be a larger predictor of falls than contrast sensitivity and visual acuity, according to Lord & Dayhew (2001). Ultimately, a decrease in key visual fields can increase postural sway. A greater decrease in vision results in a greater risk of a fall incident.

Overall Health

It is apparent that visually impaired individuals are less physically active and mobile than their sighted peers (Crews & Campbell, 2001). Chronic diseases appear to be accelerated by the magnitude of vision loss and may also be related to the lack of physical activity (Newman et al., 2003). The Framingham Study found that the risk of hip fracture doubled for women with poor or moderately impaired vision (Felson et al., 1989). The Auckland Hip Fracture Study noted that the risk of hip fracture increased by 40 percent in individuals with poor visual acuity (lvers et al., 2000; Norton et al., 1995). Diabetes is strongly associated with obesity and hypertension, and would therefore be expected to be prevalent among individuals with significant visual impairments (Crews & Campbell, 2004). In this context, visual impairment is thought to be correlated with reductions in physical or leisure activities due to compromised mobility, social functions, and morbidity (Crews & Campbell, 2004). These reductions in mobility and decreased physical functioning contribute to obesity, which is often the source of chronic diseases such as hypertension, diabetes, and cardiovascular diseases. Thus, the implication of this observation is that lack of physical activity results in declines in physical function, and that older adults with visual impairment tend to experience obesity and chronic health conditions at a greater prevalence than their sighted counterparts. These conditions include lower femoral-neck bone mineral density and less maximal strength, in addition to higher rates of stroke, osteoporosis, depression, hypertension, heart disease, and diabetes (Crews & Campbell, 2001; Uusi-Rasi, Sievänen, Rinne, Oja, & Vuori, 2001; West, Gildengorin, Haegerstrom-Portnoy, Schneck, Lott, & Brabyn, 2002).

Gait

For visually impaired older adults, ambulation may present the most fundamental form of movement contributing to independence and function. Ambulation requires the incorporation and integration of a number of factors, including balance, strength, and gait for the purpose of walking without tripping, slipping or falling. The ability of an individual to access the environment and successfully shift their body weight between single- and double-limb support phases is critical as the individual initiates gait and moves forward. The inability to maintain balance, lift the leg, and support the body compromises the ability to move freely in the environment and complete most daily activities. Visually impaired older adults are more likely to be physically dependent and placed in a nursing home because of the deterioration of processes in neurological, vestibular, and musculoskeletal systems (lvers et al., 1998). These physiological changes can manifest themselves in reduced gait velocity, decreased stride length, and reduced single stance support time (Judge, Davis, & Ounpuu, 1996). Decreased gait velocity is significantly related to increased falls risks and independent functioning (Imms & Edholm, 1981). Physiological parameters such as reduced peak hip extension, increased anterior pelvic tilt, and reduced ankle plantar flexion, range of motion, and power are associated with aging, inactivity, and increased falls risk (Kerrigan, Todd, Della, Lipsitz, & Collins, 1998). Older adults and individuals with visual impairments who fall tend to walk slower, have a shorter stride length, have a wider base of support, and spend more time in double-support stance during gait (Ray & Wolf, 2008). Furthermore, mean gait speed for individuals in their 40s and 50s who are visually impaired is similar to that of sighted adults over the age of 80 (Lusardi, Pellecchia, & Schulman, 2003).

Lower-Limb Power

The ability of muscles to generate and sustain strength and power is significant for the purpose of maintaining a reasonable quality of life as one ages because lower-limb power plays a vital role in functional tasks (Bassey et al., 1992). Low levels of lower-limb power negatively affect one's ability to climb stairs or recover from a fall. Difficulty climbing stairs may negatively affect an individual's use of any form of transportation. This could also make crossing a busy street in an appropriate amount of time a challenge. Muscle power, or the product of muscle force (strength) and contraction velocity (Knuttgen & Kraemer, 1987), is negatively affected by numerous

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age-related physiological changes. Strength decreases 7.5 to 8.5 percent per decade during adulthood, while contraction velocity decreases 7 percent per decade (Skelton, Greig, Davies, & Young, 1994). These combined changes result in a loss of lower-limb power at a rate of 35 percent per decade (mean \pm standard deviation range = 213 \pm 51 W to 80 \pm 49 W over 24 years) (Skelton et al., 1994). There are clear and significant established correlations between lower-limb power, walking speed, stair-climbing speed, and stair-climbing power in sighted adults (Bassey et al., 1992). Research indicates that visually impaired adults are more susceptible to reductions in lower-limb strength and power than their sighted peers (Ray & Wolf, 2008).

Stability/Sensory Information

Visually impaired individuals place a greater demand on somatosensory and vestibular information in order to establish movement patterns (Horvat, Ray, Ramsey, Miszko, Keeney, & Blasch, 2003). According to Ray and Wolf (2008), vision loss results in reduced postural control. Visually impaired adults must rely on sensory information other than vision in order to initiate changes in their centers of gravity and bases of support. For example, in walking, information is received from pressure in the foot, leg muscles, ankle, and inner ear (vestibular). Balance with vision is more efficient and skillful than balance without vision, especially with changing conditions or matching stimuli in the environment, such as crossing the street (Williams, 1983). Individuals with visual impairments encounter problems such as difficulties using sensory information to establish and connect movement patterns and adjust to positions in space, as well as making corrections to movements (Spirduso, 1995). Postural sway also increases with visual impairment due to the lack of visual feedback to maintain postural control (Maeda, Nakamura, Otomo, Higuchi, & Motohashi, 1998; Judge, Davis, & Ounpuu, 1996). This reduction in standing balance is evident in the observation that individuals with visual impairment use proprioception as a substitute for vision when completing balance tasks (Spirduso, 1995).

If vision is compromised, other sensory inputs must compensate in order for the individual to initiate movement. Sighted individuals have the ability to

anticipate changing terrain and adjust their gait accordingly. Conversely, visually impaired individuals adjust to obstacles as they are encountered and have been observed to be more cautious and have more difficulty performing tasks when their center of gravity is outside of their base of support (Horvat et al., 2003). Thus, on clinical assessments (30 second sit-to-stand and timed up-and-go) visually impaired individuals in their 40s performed at a level similar to individuals in their 70s and 80s (Ray, Horvat, Williams, & Blasch, 2007a).

Interventions

Few exercise-oriented falls-prevention programs exist for the visually impaired that increase function and decrease falls risk. In this context, a program should be designed based on successful evidence based activities aimed at increasing specific functions. For example, Ray and colleagues implemented a tai chi-based intervention for individuals with visual impairment in order to develop sensory information, strength, and cognitive engagement (Ray, Horvat, Keen, & Blasch, 2005). Tai chi movements were implemented using physical information, along with somatosensory information paired with auditory cues, to focus on movements that developed strength, improved balance, and cognitively engaged the participant in movement learning sequences. Exercises were designed to develop areas of need; training programs were designed that are beneficial for both visually impaired individuals and other highrisk falls populations. This 10-week exercise intervention involved 90-minute sessions twice per week, and resulted in participants improving strength and postural control as measured by a Sensory Organization Test (SOT) equilibrium score from a NeuroCom[®] machine. The key to the intervention was to incorporate exercises that are purposeful and specific to the area addressed, such as strength, cognition, and balance. Conversely, an intervention by Campbell et al. (2005) looked at the effectiveness of a home safety program and a home exercise program in reducing falls in visually impaired adults, 75 years or older. An occupational therapist visited older adults at home and used a modified version of the Westmead home safety assessment checklist to identify hazards and to initiate discussion with the participant about any items, behavior, or lack of equipment that could lead to falls. The therapist and

participant agreed on which recommendations to implement. The occupational therapist listed these recommendations in a follow-up letter to the participant and acquired the appropriate equipment. Participants in the exercise group were expected to exercise three times a week for one year. This study found that the safety program group had fewer falls. However, only 18 percent of participants in the exercise group completed the program. This lack of adherence is most likely the reason the exercise group did not see a significant decrease in falls. The study did find that increased exercise adherence was correlated with fewer falls.

Conclusion

Improving and preserving physiological characteristics throughout life plays a vital role in maintaining independence and function and reducing falls (Wolf, Sattin, Kutner, O'Grady, Greenspan, and Gregor, 2003). Physical deficiencies acquired early in adulthood can persist, thereby increasing limitations, frailty, and sarcopenia as one ages (Sowers et al., 2005). Sarcopenia is defined as the loss of muscle mass and strength with age. This has been noted by many studies that have shown decreased physical performance in individuals with visual impairments, but few studies have explored rehabilitative interventions designed to meet physiological needs of individuals with visual impairments (Crews & Campbell, 2001; Horvat et al., 2006; Ray, Horvat, Williams, & Blasch, 2007b). A scarcity of information is available on the mechanisms or causality contributing to these declines. Little to no work has been done on adapting vestibular therapy or resistance-training programs in order to measure their effectiveness and adherence among visually impaired individuals. Increased knowledge about the specific functional and physiological deficiencies in visually impaired individuals is a precursor to evidence-based exercise interventions that can potentially alleviate these agerelated changes compounded by vision loss. Improvements in these areas of gait, balance, lower-limb power, cognition and overall health will likely lead to reduction in disability, and therefore a reduction in falls, which will increase independence and enhance the quality of life in visually impaired older adults. The inclusion of unique exercise interventions designed to target older adults with vision loss incorporated into rehabilitation bench-

marking will enhance the effectiveness of treatment by improving overall health and physical function and is the focus of this paper.

Based on our research, function can be improved with intervention (Ray & Wolf, 2008; Wolf et al., 2003); for example, the utilization of tai chi yielded positive results in balance and strength, both of which are essential for maintaining function (Ray et al., 2005). Likewise, the lack of physical activity precipitates a lowering of function and confidence that is compromised by a loss of vision. The loss of vision has no direct correlation to lowering of physical capabilities (i.e., lack of strength or balance) unless the individual is inactive and dependent. Increasing physical activity then becomes a necessity to overcome possible roadblocks in function that occur from the lack of interactions within the environment. The lack of activity compounds with the loss of vision and directly contributes to lowering functional ability, while increases in physical function increase the capabilities and enhance the ability to be selfsufficient and independent. Here we looked at factors contributing to increased falls risk (vision, stability/ sensory information, and cognition); and factors that can be rehabilitated or maintained (overall health, gait, and lower-limb power). Additionally, we touched on a limited number of exercise interventions addressing this rarely addressed issue. Ideally, more studies of visually impaired older adults will elucidate more effective methods of preventing falls in this population. These future studies should combine strength, balance, and endurance in order to increase effectiveness of exercise interventions.

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Practice Report

Falls Prevention through the Visual Impairment Detection Program

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Abstract

This article introduces the Visual Impairment Detection Program, developed in Montreal to reduce the risk of falls in persons with vision impairment. The goal of the program is to teach home health care professionals to screen for early vision loss among persons 75 years and older living on the Island of Montreal. Screening for early vision loss is intended to prevent more severe vision impairment, as well as better identify, orient, and refer persons to the appropriate resources and ensure improved access to existing vision rehabilitation services. This, in turn, serves to prevent and/or reduce the number of falls. Health care professionals are provided with Visual Impairment Detection Training Sessions and taught how to administer a Visual Impairment Screening Questionnaire. To date, more than 975 health care professionals have been specially trained to detect vision impairments, resulting in 227 referrals for vision rehabilitation services. The implementation of the program is discussed, along with the implications for practice and research.

Keywords: falls prevention, clinical program, service delivery, referral, training program

Introduction

In 2008, the MAB-Mackay Rehabilitation Centre (MMRC) and the Institut Nazareth et Louis-Braille (INLB), under the sponsorship of the Quebec government, l'Agence de santé et des services sociaux de Montréal, designed and implemented the Visual Impairment Detection Program. This program

was developed in response to the priorities identified by the government, subsequent to a National Fall Prevention Program within a Continuum of Services to Seniors Living at Home (Gouvernement du Québec, 2004). As of 2006, 1,854,442 persons resided on the Island of Montreal, of which 15 percent are over the age of 65 (Ville de Montréal, 2006). Of those, 46 percent are over 75 years old. By 2026, it is estimated that more than one of five residents of the Island of Montreal will be at or over retirement age. In Quebec, one of nine residents over the age of 65 and one of four over the age of

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75 years experiences vision loss, while 80 percent are not familiar with or referred to vision rehabilitation centers (Gresset & Baumgarten, 2002). Demographic trends also forecast a substantial increase in the number of Canadian seniors living with a visual impairment over the next 20 years (Statistics Canada, 2002). Moreover, the number of blind and visually impaired Canadians is expected to increase by 52 percent by the year 2026. Among seniors aged 75 and over, this represents a 72 percent increase (Gresset, 2005).

Over the 1999-2004 period, the incidents of falls resulting in hospital admissions for Montreal residents was 340 per 10,000 for persons aged 85 years and over, 138 per 10,000 for persons between the ages of 75 and 84, and 50 per 10,000 for those between the ages of 65 and 74. According to lvers, Norton, Cumming, Butler, and Campbell (2000), 40 percent of hip fractures are associated with a visual impairment. Support for this association between impaired visual function, measured or otherwise, and increased risk of hip fractures is reported in the findings of previous research studies (Cummings et al., 1995; Grue, Kirkevold, & Ranhoff, 2009; Jack, Smith, Neoh, Lye, & McGalliard, 1995). According to the study by Grue et al., nearly half of the patients with hip fractures had impaired vision. These findings are supported by Jack et al., who found 76 percent of older patients admitted to hospital after a fall had impaired vision. Thus, we most certainly can anticipate a rise in the incidents of falls, as well as hospitalizations, as the population ages. Given these demographic and statistical projections, the Visual Impairment Detection Program has been implemented specifically to identify individuals at risk for falls due to a visual impairment.

The Island of Montreal is divided into 12 regions where service delivery is provided by their respective health and social services establishments (Centre de la santé et des services sociaux, CSSS). The 12 CSSS regions have been strategically divided in proportion to the ratio of English- to French-speaking clientele with each rehabilitation center having the mandate to jointly establish, implement, and develop the Visual Impairment Detection Program. The goal of the program is to teach home health care professionals to screen for early vision loss among persons 75 years and over living on the Island of Montreal. Screening for early loss is intended to

Visual Impairment Detection Program

prevent more severe vision impairment, as well as better identify, orient, and refer persons to the appropriate resources and ensure improved access to existing vision rehabilitation services. This, in turn, serves to prevent and/or reduce the number of falls, among other serious occurrences that are detrimental to a person's health and well-being. Similarly, persons are better assisted to live safely at home or in any other living environment, while circumventing the need for premature institutionalization and possible morbidity.

As a primary objective of the program, health care professionals are provided with Visual Impairment Detection Training sessions and taught how to administer a Visual Impairment Screening Questionnaire. The target audience primarily consists of occupational and physical therapists, social workers, nurses, psychologists, and nutritionists and dieticians employed through the 12 CSSSs and working directly in home-care programs in neighboring local community service centers (CLSCs).

Visual Impairment Detection Training

The training session consists of a 2-hour Power-Point presentation and corresponding brochure of course material, provided in either English or French. The trainers are experienced vision rehabilitation specialists from the MMRC or INLB, with advancedlevel training in areas such as social work or low vision rehabilitation (i.e., activities of daily living). Training is provided on-site at the CLSC and includes a maximum of 12 participants. These sessions are experiential and interactive as participants engage in exercises using simulators that demonstrate visual impairments associated with the most common agerelated ocular pathologies. Participants voluntarily take part in a role-play exercise to demonstrate how the Visual Impairment Screening Questionnaire is administered and are given a scored copy of the questionnaire for reference purposes. These exercises serve to sensitize participants to the implications of living with impaired vision. Participants are also educated about the referral process using a graphic outline and given an overview of vision rehabilitation services offered by the two centers. The session concludes with comments and guestions generated from the participants' experiences

and course outline. They are asked to complete a Training Session Appraisal Form, which is later used for program planning purposes.

Questionnaire Background

To increase the utilization of vision rehabilitation services among older persons. Horowitz and Cassels (1985) validated the 15-item Functional Vision Screening Questionnaire (FVSQ) used to identify older persons with a visual impairment as potential candidates for rehabilitation services. The questionnaire, inspired by existing assessment instruments (Gurland et al., 1977; Gurland & Wilder, 1984), was developed to allow gerontology professionals to screen individuals that experience vision loss. The FVSQ was translated, modified, and validated in French and named Questionnaire de dépistage des problèmes de vision fonctionnelle, consisting of 20 items (Gresset & Baumgarten, 2003). The additional 5 items, questions 1, 2, 17, 18, and 20 (Figure 1), were included for descriptive purposes to facilitate the resulting referral. The final score is established only from answers derived from guestions 3-16 and 19. Both the English and French version of the 20item guestionnaire was renamed the Visual Impairment Screening Questionnaire/Questionnaire de repérage des incapacités visuelles for the purpose of the program. Both the English and French versions and accompanying test manual (Gresset & Baumgarten, 2009) are extremely useful standardized instruments that can be utilized by health care professionals and nonspecialized persons alike, to identify individuals requiring further clinical evaluation and/or specialized vision rehabilitation services.

Questionnaire Format and Administration

The measure consists of a total of 20 questions, 15 of which have a response code of either 0 or 1, with a higher total score indicating more severe visual impairment. The remaining 5 qualitative questions provide descriptive information for the purpose of directing clients to the appropriate resources or services, as needed. The final score is calculated using a mathematical formula located at the bottom of the questionnaire. Upon completion of the training, the health care professional is required to administer the questionnaire systematically to persons 75 years and over whose need for home-care services is being evaluated or reevaluated by the CLSC.

When the score is 6 and over, the person is directed to the admission services of the MMRC/ INLB. With the person's consent, the health care professional is expected to forward the Visual Impairment Screening Questionnaire, along with an interestablishment referral form, to the rehabilitation center. For those persons who have not consulted an optometrist or ophthalmologist, the health care professional collaborates with the rehabilitation center to facilitate and ensure that the person undergoes an optometric or ophthalmologic examination. In the case in which the health care professional makes the referral to a vision care specialist, he or she conveniently provides the person with an eye report form to be completed at the time of the examination. Further, all information pertinent to the person's overall functioning, such as being at risk for falls, depression, or social isolation, are documented on the interestablishment referral form. If needed, a home visit by a community optometrist may be arranged. When the score is less than 6, persons who have not been seen by an eve care specialist in the past 2 years are encouraged to undergo an eye examination as a preventive measure. In cases in which the person does not have an optometrist or ophthalmologist, a referral is recommended. An optometrist mailing list, subdivided by the 12 CSSS regions, and the eye report form are provided to the health care professionals.

All referrals are processed by admissions services at either MMRC or INLB who work collaboratively with the health care professionals to obtain the necessary eye report and nominative information. Once admitted to the MMRC/INLB, a rehabilitation specialist is assigned accordingly. The role of the rehabilitation specialist is to evaluate the person's needs for vision rehabilitation services in collaboration with the health care professionals as part of the person's individual service plan. Not only does the MMRC/INLB have the mandate to provide direct individualized vision rehabilitation services but they are available for consultations.

As per the government's directives, the 12 regional CSSSs and the MMRC/INLB are all required to keep records for statistical purposes. For their part, the 12 regional CSSSs are required to report on the number of Visual Impairment Screening Ques-

	CSSS	
inlb Institut Nazareth &Louis-Braille	Name at Birth	First Name
	Phone Number	File Number
Centre de réadspitation MAB-MACKAY Renabilitation Centre	Medicare Number	Expiry Date

VISUAL IMPAIRMENT SCREENING QUESTIONNAIRE

1. Do you use glasses for reading?					Yes		No 🗆	
2. Do you use glasses for distance?					Yes		No 🗆	
All q you t the a	All questions should be answered in terms of your best vision. This means with your glasses on if you usually wear glasses. A question is "not-applicable" (n.a.) if the respondent does not perform the activity for some reason other than because of his/her vision.							
	QUESTIONS RESPONSES			IF YES	IF NO	SCORE		
3.	Do you ever feel that problems with your vision make it difficult for you to do the things you would like to do?	yes	no	n.a.	1	0		
4.	Can you see the large print headlines in the newspapers?	yes	no	n.a.	0	1		
5.	Can you see the regular print in newspapers, magazines or books?	yes	no	n.a.	0	1		
6.	Can you see numbers and names in a telephone directory?	yes	no	n.a.	0	1		
7.	When you are walking on the street, can you see the walk sign and street name signs?	yes	no	n.a.	0	1		
8.	When crossing the street, do cars seem to appear near you very suddenly?	yes	no	n.a.	1	0		
9.	Because of your vision, is it difficult to watch TV, play cards and do sewing or any similar type of activity?	yes	no	n.a.	1	0		
10.	Can you see labels on medicine bottles?	yes	no	n.a.	0	1		
11.	Can you see prices when you shop?	yes	no	n.a.	0	1		
12.	Can you read your own mail?	yes	no	n.a.	0	1		
13.	Can you read your own handwriting?	yes	no	n.a.	0	1		
14.	Can you recognize the faces of family or friends when they are across an average size room?	yes	no	n.a.	0	1		

Fig. 1. Visual Impairment Screening Questionnaire. Printed with permission from l'Institut Nazareth et Louis-Braille and MAB-Mackay Rehabilitation Centre within the framework of the Visual Impairment Detection Training Program.

	QUESTIONS	RESPONSES			RESPONSES IF YES NO		SCORE
15.	Do you have any particular difficulty seeing in poor or dim light?	yes	no	n.a.	1	0	
16.	Do you tend to sit very close to the television?	yes	no	n.a.	1	0	
17.	When was the last time you had your eyes examined? (Please check one)						
	Professional's Name and Phone Number						
18.	Have you ever talked to your doctor about a vision problem?	yes	no				
19.	Has your doctor ever told you that nothing more could be done for your vision?	yes	no		1	0	
20.	Have you ever gone to a low vision clinic or other type of service to get a special optical aid to help your vision?	yes	no				
A)	TOTAL NUMBER OF «1» SCORES (MAXIMUN	/1 15)					
B)	TOTAL NUMBER OF QUESTIONS ANSWERED W « 0 » AND « 1 » (MAXIMUM 15, EXCLUDE N.A.	NITH /	A SCO	ORE O	F		
Calc	ulation Method to Obtain the Final Score						
	А)÷ В)		X 1	5 = _			
Name of the Professional (capital letters) Title / CSSS site mailing address						/ M DD	

Telephone and extension

Orientation: A questionnaire with a final score of 6/15 or more should be forwarded by fax to the Admissions services of the **MAB-Mackay 514 482-4536** or l'**Institut Nazareth et Louis-Braille 450 463-0243.**

Questionnaire de dépistage des incapacités visuelles : manuel de passation, published by Institut Nazareth et Louis-Braille, 2003. © Adaptation par J. Gresset et M. Baumgarten, Université de Montréal (1995) de Horowitz, A. & Cassels, L. *Functional Vision Screening Questionnaire*. New York: New York Association for the Blind (The Lighthouse), 1985. Version produced by l'Institut Nazareth et Louis-Braille and MAB-Mackay Rehabilitation Centre within the framework of the Visual Impairment Detection Training Program.

Fig. 1. Continued.

tionnaires that are systematically administered. The MMRC/INLB are required to submit a biannual assessment, citing the number of health care professionals trained on how to administer the Visual Impairment Screening Questionnaire, the number of person's referred and admitted to its respective rehabilitation center, and information on the offer of services to those individuals admitted. Thus, these government directives function as a built-in incentive that renders all parties responsible and accountable for the success of the program.

Program Status

From April 1, 2008 to March 31, 2010, 975 health care professionals from 10 of the 12 CSSS regions have been specially trained to detect vision impairments. Participants completed the Training Session Appraisal Form, which contains specific items evaluating the content of the program and its relevance to the detection of visual impairments. Having acquired practical knowledge and skills, they now have the ability to recognize the critical link between early detection of vision impairment and falls prevention. Moreover, they recognize the benefits of referring persons for vision rehabilitation services. Further, 227 persons were referred for vision rehabilitation services. Eightv-seven were referred to the MMRC, while 140 were referred to INLB, depending on service language preferences and/or geographic location. Of the 87 persons referred to MMRC, 54 (62 percent) were admitted to the center. Similarly, 101 (72 percent) of those referred to INLB were admitted. Most persons admitted to either center met the following government's visual aids loan program criteria: visual acuity in each eye is less than 6/21 (20/70) or a visual field in each eye less than 60 degrees in the 180-degree and 90-degree meridians after correction by appropriate ophthalmic lenses (Regie de l'assurance maladie du Quebec/RAMQ, 2006). Coinciding with the implementation of the program has been the change of admission criteria to the MMRC/INLB. The new criteria include persons with a diagnosis of a degenerative eye disease who, after correction, experience significant difficulties in executing one or more activities of daily living, notwithstanding the person's visual acuities and fields. This change in admission criteria is based on the conceptual model, Processus de production du handicap (Fougevrollas, Cloutier, Bergeron, Cote, & St. Michel, 1998). Further, it is coherent with the

Visual Impairment Detection Program

principles of the government's Improvement, Access and Continuity Plan (Ministère de la Santé et des Services Sociaux, 2008) that serves to optimize, harmonize, and manage the organization and delivery of services. Hence, had the new criteria been applied from the onset, most persons, if not all, would have been admissible to receive vision rehabilitation services, increasing the number of persons admitted to both centers.

Although some persons admitted to the MMRC/ INLB may not meet the RAMQ criteria for dispensing visual aids and technical devices, most are expected to be eligible to receive vision rehabilitation services. As such, both rehabilitation centers need to further develop and tailor their offer of services to meet the needs of this emerging and increasing clientele. Such services might include information sessions, peer support groups, and rehabilitation workshops that address various psychosocial and rehabilitation issues. More specifically, the topic of falls prevention and low vision could be a specific theme for discussion with the support of an orientation and mobility specialist. Further, innovative, creative, and resourceful measures and partnerships will need to be explored. This includes networking with community partners who share a common goal.

Implications for Practice

The main beneficial effect of this program is the systematic screening and early detection of persons 75 years and over, whose visual needs would likely not have been detected had the questionnaire not been administered. In other words, 227 persons might not have been referred had they not been systematically screened. Rather, most of those referred were admitted to MMRC/INLB and are eligible to receive a global evaluation and vision rehabilitation services consistent with their individualized needs. In keeping with the goals of the program, regularly scheduled training sessions need to be firmly in place within the 12 CSSS regions to ensure the ongoing administration of the questionnaire. Furthermore, given staff turnover, it is imperative that new health care professionals be equipped with the necessary knowledge to contribute to the success of the program.

An important implication for practice involves the problems administering the questionnaire to persons with cognitive impairments. Health care professionals

report problems identifying the origins of their handicapping situation(s). As such, health care professionals are less likely to administer the questionnaire to persons experiencing cognitive impairments, in accordance with their clinical judgment. Therefore, it is particularly important that the MMRC/INLB and CLSCs adopt an interdisciplinary and collaborative approach to service delivery. Certainly, partnerships between primary health care professionals and secondary rehabilitation specialists are an essential component in the development and success of the program. Evidence of such is already seen in the increased number of referrals received by the rehabilitation centers and the concerted effort to jointly coordinate individualized service plans.

Also of particular importance to practice is the recent change to the admissibility criteria. As such, both rehabilitation centers are further exploring the needs of persons meeting the new criteria. The goal is to develop and harmonize the offer of services consistent with this clientele's need to access information, resources, support (individual and group), and rehabilitation services. It is intended that preventative vision rehabilitation and intervention will serve to reduce not only the prevalence of falls but also other handicapping situations. Conversely, the rehabilitation centers' efforts and measures to better respond to this emergent clientele is also expected to place a greater demand on the MMRC/INLB's material and human resources. Notably, it is expected to place a greater strain on vision rehabilitation specialists, many of whom are in short supply. This increase in the demand for services will likely have implications on existing waiting lists and the delivery of services. With systematic screening, improved access, and partnerships, along with harmonization of services, the MMRC/INLB will need to be responsive to these anticipated challenges.

Implication for Research

Unfortunately, due to gaps in data entry into the statistical coding system, it is presently not possible to extract complete summary statistics on the total number of questionnaires administered across the 12 CSSS regions. Had all the questionnaires been administered and entered into the system, more detailed summary statistics on the number and proportion of those classified with a score of 6 and over, and referred to the MMRC/INLB, would be

available. Using information obtained through the program's statistical database, we would have compiled more information on each individual's demographic profile, along with other valuable data such as the individual's visual diagnosis, activities of daily living, comorbid conditions such as hearing loss, and cognitive function.

It will be possible to ascertain a complete demographic profile, given the plans to improve the coding system and the process of statistical data entry. Likewise, the effectiveness of the questionnaire will also need to be established. These data will be of particular interest when examining the Visual Impairment Detection Program questionnaire's sensitivity (74 percent) and specificity (86 percent) for detecting the presence or absence of moderate-tototal clinical visual impairment at a cut-off score of 6 (Gresset & Baumgarten, 2003, 2009). Such data will also be useful when comparing our data to the information collected by the Lighthouse Vision Education and Outreach/Demonstration Project, whereby a similar questionnaire was used to identify and evaluate aging persons with vision problems in community settings (Horowitz, Teresi, & Cassels, 1991). The authors reported that the vision scale had an 80 percent overall accurate classification rate (sensitivity) at a cut-off point of 9. By using a score of 6, detection of mild impairment is more likely to increase; however, the most appropriate cut-off score will need to be investigated further in light of the new admission criteria in the context of this program.

Important to research is the administration of the questionnaire to persons with cognitive impairments. According to Chertkow et al. (2008), between 25 and 75 percent of older persons are reported to have memory problems, depending on its definition. The comorbidity between the visual and cognitive deficits is probably more prevalent than the suspected 3 to 9 percent among persons 75 years and over. Given the anticipated needs of this clientele, a study is being undertaken by INLB in collaboration with its partners, with the objective of adapting and developing effective visual impairment screening methods.

Another important implication for research is whether the Visual Impairment Screening Program is effectively reducing the number of falls associated with visual impairments. This will need to be reevaluated within the established parameters of Ivers et al. (2000) who associated 40 percent of hip fractures with a visual impairment. Ideally, this association would hopefully be significantly reduced once the program is fully operational. To establish whether this beneficial outcome is present, the National Fall Prevention Survey would need to be repeated within the context of the program. Grue et al. (2009) report that there is a potential for improvement for persons with visual impairments, given that half of their study population had not had an eye examination or adjustment in their glasses for the past 2 years. A recent systematic review on the topic of prevention of falls and fall-related injuries acknowledged that visual impairment, together with poor balance and dementia, is among the main risk factors for falls in the elderly, whereby cataract surgery in the first eye was associated with a reduction in falls rate (Gillespie & Handoll, 2009). The authors reported that most prevention programs studied in randomized clinical trials highlight the protective effects of exercise; however, the multifactorial nature of fall risk factors makes it difficult to isolate the contribution of a vision impairment detection program in such a context.

The present article, introducing the Visual Impairment Detection Program, is an innovative and collaborative interestablishment initiative, aimed at detecting visual impairment and reducing the risk of falls among persons 75 years and over. Its goal is to be accomplished by training home health care professionals to screen for signs of early vision loss and to properly orient and refer those persons to the appropriate resources and vision rehabilitation services. Given the consequences of falls and fall-related injuries, it is hoped that the training program presented will reach its full potential and inspire others.

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Theory Paper/Thought Piece

Falls-Prevention Interventions for Persons Who Are Blind or Visually Impaired

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Abstract

The purpose of this article is to describe four main areas of falls-prevention intervention for older adults who are blind or visually impaired. When integrated into multifactorial programs, interventions pertaining to education, medical assessment, exercise and physical activity, and environmental assessment and modification have been shown to be effective in falls reduction. These areas of intervention are discussed with respect to specific concerns of older adults who are blind or visually impaired. In describing these areas of intervention, the increasing need for cross-disciplinary falls-prevention programs designed specifically for older persons with vision loss, as well as research demonstrating the efficacy of multidisciplinary programs designed for this group, are emphasized.

Keywords: multifactorial falls prevention, older adults, blindness, vision impairment

Introduction

Varying degrees of vision loss, including blindness and visual impairment, often appear near the top of lists indexing the many factors that place older people at greater risk for falling. The association between vision loss and falls has often been discussed in terms of various clinical measures of poor vision status that could independently influence falls risk, including visual acuity, contrast sensitivity, depth perception, and loss in visual fields (De Boer et al., 2004; Ivers, Cumming, Mitchell, & Attebo, 1998; Lord & Dayhew, 2001). Nevertheless, blindness and visual impairments rarely operate completely independently of other systems to increase the likelihood of a fall. For instance, Lord, Smith, and Menant (2010) described the important relationships between the visual system and systems that control and coordinate balance and gait. Similarly, Steinman, Pynoos, and Nguyen (2009) described an integrated effects view by which self-reported poor vision could indirectly lead to losses in upper and lower limb strength, by way of reduced physical activity associated with vision loss. These views recognize

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the potential for vision loss to dynamically affect and be affected by other health dimensions that contribute to falls risk. Furthermore, the range of visual functioning that is possible—from total blindness to vision impairments—is wide, and different problems often require different interventions. Some diseases and conditions that result in vision impairments may be progressive leading even to blindness, so interventions associated with vision loss may need to be reevaluated over time. Thus, in thinking of visual functioning as a dynamic system that is integrated with other systems, effective interventions aimed at reducing falls would need to consider blindness and visual impairment in their context among other falls risk factors.

Among researchers and practitioners who are interested in developing effective falls-prevention programs for older adults, there is marked consensus that integrated risk-management programs emphasizing multiple interventions, including educational programs, medical risk assessment, exercise and physical activity, and home hazard assessment and implementation of modifications, are most effective for improving function and reducing falls among community-dwelling older people (Close et al., 1999; Day et al., 2002; Gillespie et al., 2003; Tinetti et al., 1994). Studies that have compared single interventions to those that address multiple falls risk factors have found the greater efficacy of multifactorial programs compared to most singular interventions on their own. For example, Day et al. tested the effectiveness of three interventions separately and together, including vision improvement, group-based exercise, and home hazard management. Whereas statistically significant effects were reported for exercise alone, and for the other interventions when combined with exercise, neither management of home hazards nor treatment of poor vision alone were statistically significant in reducing falls.

In its national action plan to reduce or prevent falls, the National Council on Aging (NCOA; 2005) set goals that would prioritize multiple areas of concern by encouraging collaboration among diverse stakeholders, including older adults themselves, health care providers, policy makers, aging service professionals, representatives of building and construction industries, and community health professionals. Indeed, the "no wrong door" approach to falls prevention, in which older adults who are found to be at risk of falls in medical or community settings are linked to a standard falls risk evaluation (Ganz, Alkema, & Wu, 2008), reiterates the importance of establishing strong network connections between organizations that provide services to persons who are blind and visually impaired and other agencies that serve older people (Steinman & Moore, 2007).

The purpose of this article is to describe four main areas of falls-prevention intervention that, when integrated into multifactorial programs, have been shown to be effective in reducing falls among the older population at large. Interventions pertaining to education, medical assessment, exercise and physical activity, and environmental modification are discussed with respect to specific concerns of older adults who are blind or visually impaired. In describing these areas of intervention, we hope to emphasize the increasing need for cross-disciplinary collaboration in the development of falls-prevention programs designed specifically for older persons with vision loss, as well as more research testing the efficacy of multifactorial programs for this group who are at high risk for falls.

Education

Improving knowledge of older adults about falls and falls risk was among the primary goals developed by NCOA in its national action plan (2005). An important aspect of falls prevention for older persons who are blind or visually impaired is educating individuals about specific risk factors that can increase their likelihood of experiencing a fall. For example, older adults with poor vision may acquire unique falls risks associated with functional losses (such as an inability to walk from one room to another; Crews & Campbell, 2004), in part, because they no longer feel safe due to their difficulties seeing. These types of functional losses may be reduced or avoided through the provision of training in daily living activities, which have the potential to make up a large portion of an older individual's daily physical activity. Vision rehabilitation services, such as those provided by state/federal independent living programs for older individuals who are blind, can serve a vital role in training older adults to maintain their ability to safely perform activities of daily living and instrumental activities of daily living that are crucial to health maintenance and for preserving independence. In particular, public and private

agencies that serve older people who are blind or visually impaired under the Older Blind Independent Living program (Title VII, Chapter 2, of the Rehabilitation Act of 1973, as amended-hereafter, VII-2) may have much to contribute in efforts to prevent falls. VII-2 independent living services that are available (but not necessarily provided) under the program include services to help correct blindness (including visual screening and surgical or therapeutic treatment); hospitalization related to such services; the provision of visual aids (such as magnifiers or eyeglasses); and other specific services that are designed to assist older individuals to adjust to blindness, maintain independence, and become more mobile and more self-sufficient (Orr. 1998). These services have been shown to be effective in helping older adults complete meaningful activities independently, including preparing meals for themselves and continuing to participate in the lives and activities of family, friends, and their communities (Moore, Steinman, Giesen, & Frank, 2006). Although VII-2 programs serve only a fraction of the number of older adults who could benefit from vision rehabilitation services, the program's access to older persons who are blind or visually impaired makes VII-2 a potentially effective agent for provision of training in falls-prevention techniques and for disseminating information about falls and falls prevention to the individuals they serve.

Older persons who are blind or visually impaired can also benefit from educational materials that are created and disseminated by nonprofit organizations and government agencies, whose collective mission is to prevent falls among older adults. For example, there are a range of materials available from the Fall Prevention Center of Excellence (FPCE), located at the University of Southern California. Materials are made available on the FPCE website (http://www. stopfalls.org) for service providers and researchers, as well as for individuals and their families. Information is available regarding falls risk factors (including vision loss), assessment tools for evaluating environments, and programs and services that are available, aimed at preventing falls.

Checklists are another educational tool available to older adults who are blind or visually impaired. Because of their relative ease of use, checklists can provide older adults with a practical and inexpensive basis for evaluating risk related to the presence of hazards that may be present in their homes. In addition to being easy to administer, checklists usually require little or no training to conduct and may be disseminated directly to older adults via facilities where older people may congregate to receive services (such as senior centers and health clinics), by way of programs that serve older adults who are blind or visually impaired (including the VII-2 program), or through Internet sites that target older adults in need of services. An example of a home assessment checklist is Check for Safety: A Home Fall Prevention Checklist for Older Adults, disseminated by the Centers for Disease Control and Prevention (CDC; 2005) and attainable in large print from the CDC's website (http://www.cdc.gov). It should be noted, however, that checklists may vary greatly with respect to their comprehensiveness, and suggested solutions may be generic or may not apply in all cases (Pynoos, Steinman, & Nguyen, 2010). For example, checklists that are designed for older people in general may overlook some problems that are especially important for individuals who are blind or visually impaired. By contrast, the American Foundation for the Blind (AFB) disseminates a House Survey Tour and Checklist on its website (www.afb.org/seniorsite/homesurveychecklist). This checklist focuses on specific safety issues within the homes and apartments of individuals who are blind or visually impaired, which may be addressed very briefly or omitted from other checklists. The AFB checklist also provides room-by-room suggestions about adaptations that could be implemented to address specific hazards (such as the application of color and/or texture contrast to mark edges on stairs and entrance thresholds. Finally, the adoption of recommendations presented by checklist assessments may also vary according to the willingness of older adults to change aspects of their homes and their beliefs as to whether making changes would influence their likelihood of falling (Cumming et al., 1999). Therefore, educational materials for older adults who are blind or visually impaired may be more effective when accompanied by researchvalidated materials emphasizing the efficacy of making specific changes to reduce falls risk.

Medical Risk Assessment

Customarily, older people may begin to seek out redress for age-related vision loss or related health

conditions through consultations with physicians who are trained to address vision loss on the basis of a medical examination. Physicians and other health care professionals are an important source of information for older individuals who are blind or visually impaired and concerned about the possibility of falling. Increasingly, geriatricians have begun to integrate falls prevention into practices that have traditionally focused on treating chronic and acute conditions, including falls-related injuries, after they occur. Many of the most common chronic conditions often experienced by older people who are blind or visually impaired have been associated with falls, including stroke, diabetes, osteoarthritis, cardiovascular problems, and cognitive impairments (Cronin & Kenny, 2010; Lord, Sherrington, & Menz, 2001). Furthermore, among older adults in general, the risk of mobility loss and falls increases relative to the degree of frailty and to the number of chronic conditions that are experienced by individuals (Guralnik et al., 1993; Tinetti, Williams, & Mayewski, 1986).

Chronic disease and vision loss have a unique association that is directly relevant to an individual's falls risk. Identifying integrated relationships between vision and other health dimensions during a formal assessment of falls risk has the potential to inform effective interventions designed to reduce falls and to improve overall health of persons who are blind or visually impaired. A formal medical risk assessment should include a visual examination, as well as an assessment of the individual's eyewear prescription for currency. Uncorrected refractive errors have been shown to be a significant cause of vision impairments among people of all ages (Resnikoff, Pascolini, Mariotti, & Pokharel, 2008), as well as a falls risk for older people (Day et al., 2002). In addition to evaluating vision status, additional risk factors can be identified by conducting a detailed history of the patient's health, including his or her medical conditions and medications, and inquiries about mobility and functioning and about the environments in which the older person spends his or her time (Tideiksaar, 1998). According to Rubenstein, Robbins, Josephson, Schulman, and Osterweil (1990), much can also be learned by conducting post-fall medical assessments designed to identify underlying and possibly modifiable falls risk factors that could inform preventive and therapeutic interventions. Even

when falls do not result in injuries, reviewing the circumstances that lead up to falls episodes with physicians may be informative, as these discussions may elucidate symptoms of underlying disease or functional losses that, if addressed early on, could prevent more serious health problems, functional losses, and falls in the future.

Exercise and Physical Activity

It is well known and documented that persons with vision loss have greater risk of acquiring functional difficulties that, in part, may reflect age-related losses in the musculoskeletal system (Crews & Campbell, 2004). For this high-risk group of individuals and for older adults in general, exercise may serve to prevent, slow, or reverse the progress of many negative health outcomes commonly experienced by older people (Campbell et al., 2005; Rose & Hernandez, 2010). Even minimal doses of regular exercise by older adults have been shown to modify many of the most prevalent chronic medical conditions experienced in old age, including arthritis, heart disease, stroke, and pulmonary disease (Bean, Vora, & Frontera, 2004). Studies that have assessed the effects of exercise on the musculoskeletal system have reported positive effects on muscle strength, neuromuscular performance, and bone mineral density (Taaffe, Duret, Wheeler, & Marcus, 1999), in addition to improving balance and mobility (Shumway-Cook, Gruber, Baldwin, & Liao, 1997) and increasing flexibility and joint range of motion (Fatouros et al., 2002). Studies that have directly assessed the impact of exercise in reducing falls risk have generally confirmed the efficacy of various exercise regimens alone and in conjunction with other interventions for reducing falls (Day et al., 2002; Province et al., 1995; Rose & Hernandez, 2010). In the review conducted by Province and colleagues, which assessed effects of various exercise interventions administered as part of the Frailty and Injuries: Cooperative Studies of Intervention Techniques trials, general exercise programs were found to reduce falls by about 10 percent, whereas balance exercises reduced falls by 17 percent. Thus, all exercise programs are not equal in their beneficial effects with respect to falls prevention, and it appears that the greatest benefit is achieved

when exercises are chosen to address specific decrements experienced by older individuals-that is, when exercises are tailored to address the individual's specific functional limitations. For example, Lord et al. (2001) described resistance or strength training as a means to increase the ability of muscles to generate force, such as that needed to stand from a chair or to climb stairs. Various studies have demonstrated that resistance training, including weight training, can reduce falls risk by increasing muscle strength and improving functioning and performance in daily tasks (Hunter, McCarthy, & Bamman, 2004). Lord et al. noted, however, that strength training for isolated muscle groups that are not used in everyday tasks may do little to improve functional capacity because carryover to muscles that are not directly trained may be limited. Greater improvement may be possible by practicing particular functional activities in which individuals have deficits. For example, older persons who have trouble climbing a flight of stairs may benefit most by training that practices stair-climbing or exercises that simulate stair-climbing. In addition to formal exercise classes, older persons who are blind or visually impaired could potentially acquire valuable physical training in programs (such as VII-2, described previously) that teach orientation and mobility-a protocol that focuses on training specific skills needed for safe and effective travel through the environment (Ramsey, Blasch, & Kita, 2003).

Although evidence overwhelmingly supports the need for all older people to remain physically active to maintain optimal health, older persons who are blind or visually impaired are often at a decided disadvantage in their ability to easily participate in formal exercise programs, even when they are available to them in their communities. Older adults with vision loss may have many reasons for not participating in formal exercise programs. For example, practical considerations such as procuring transportation may be of greater concern for older adults who are blind or visually impaired. Some agencies, such as the Braille Institute in Los Angeles, provide limited door-to-door transportation from the homes of participants to their classes; however, expenses associated with overhead costs, including paying for fuel and drivers, as well as general maintenance of a fleet, make this option impractical and prohibitive to many agencies that serve older people. In addition to transportation concerns, vision impairments may also result in motivational difficulties that could arise due to health disparities related to blindness and vision impairments. Chronic conditions, which are often experienced disproportionately by people with vision impairments (Crews & Campbell, 2004), may limit the types of exercise that can be performed and the duration of time that they are able to participate. Older people who have mobility difficulties due to their vision loss may feel that their safety is threatened by venturing beyond their homes, or they may feel uncomfortable or unstable while participating in formal exercise programs. Finally, older people with visual impairments may have greater difficulty following instructors, who may rely heavily on visual cues while leading classes. Some exercise regimens that have been adapted specifically for falls prevention, such as tai chi for older adults, may involve a complex series of choreographed movements, which are not easily replicated without being able to see them demonstrated by an instructor. In this case, older adults who are blind or visually impaired would likely forgo attending exercise classes if special provisions were not available to address their concerns.

Those who instruct older adults in physical fitness classes should become knowledgeable about the unique circumstances that older people who are blind or visually impaired may face when attempting to participate in groups where others have normal vision. In addition, instructors as well as physicians should become aware of techniques and strategies available to older people who are blind or visually impaired for maintaining or increasing physical activity levels, to avoid unduly limiting activities due to vision loss (Lieberman, 2002). Morgenthal and Shephard (2005) provided some basic recommendations and modifications that would foster participation by persons with vision impairments, including making sure that exercise areas are well lighted and that instructions are provided in large print or are spoken clearly and slowly, with enough detail to ensure comprehension. Exercise areas should be kept clear of objects that can cause trips or stumbles. If possible, the provision of external support devices, such as chairs or wall bars, should be provided to individuals who have a history of falls. For individuals who are blind, who are visually impaired, or who have dual sensory impairments, an array of

techniques and adaptations have been developed to help improve access to fitness alternatives, including the use of sighted guides, guide wires, tethering, and cueing techniques, which allow persons of all ages to participate in walking, running, bicycling, swimming, exercise training in a health club, aerobics, and fitness at home (such as jumping rope, yoga, and basketball; see Lieberman, 2002). Despite the availability of techniques, there is a clear need for continued development of exercise regimens specifically designed for older people who are blind or visually impaired to target their unique balance, strength, and coordination problems, while providing structure, motivation, and social support to this group.

Home Hazards and Home Modifications

The settings in which older people who are blind or who have vision impairments live often contain many hazards and problem areas or lack supportive features that could reduce falls risks if they were present (La Grow, Robertson, Campbell, Clark, & Kerse, 2006; Pynoos et al., 2010; Stevens, 2002/ 2003). To compound these problems, the oldest old, those who are most likely to experience vision loss, may become less mobile due to their functional losses and spend more of their time in and around their homes (Pynoos, Sabata, & Choi, 2005), thus increasing the potential for environmental factors to influence falls risk. Among older adults in general, the majority of falls-related injuries (55 percent) occur inside the home, including falls on stairs and in rooms throughout the house. An additional 23 percent of injuries experienced by older adults due to falls occur outside but near the home, such as in the driveway, on the patio, or in the back yard. The remaining 22 percent occur out in the community, in public spaces such as parking lots and sidewalks (Kochera, 2002), as well as in the built environment (Pynoos et al., 2005). According to Li et al. (2006) risk profiles for indoor and outdoor falls are different. with increased leisure-time physical activity being associated with outdoor falls and a greater number of physical difficulties and indicators of poor health associated with indoor falls. In all, it is estimated that around 40 percent of falls result from factors that are related to the environment (Josephson, Fabacher, & Rubenstein, 1991).

According to Lawton and Nahemow's (1973) theory of environmental press, well-designed environments and effective home modifications should function to reestablish equilibrium between a person's abilities, which may have declined due to vision loss and the demands of the environment. The concept of universal design (UD) has been employed to create products, buildings, and exterior spaces that reduce sensory, cognitive, and environmental demands for people of all ages, sizes, and abilities to the greatest extent possible, without the need for adaptation. Effective UD minimizes barriers and increases supportive features to facilitate participation in daily living activities (Mace, Hardie, & Place, 1996). Among many other possibilities, UD features that may be especially helpful for reducing falls among older persons who are blind or visually impaired include a zero-step entrance with flush or low-profile threshold, high contrast trim and glarefree or textured floor surfaces, curbless or roll-in showers in bathrooms, and motion sensor lighting that automatically turns on and off when individuals enter or exit a room (Pynoos, 1992; Young, 2006).

In older homes or homes that have not been well designed for older persons who are blind, are visually impaired, or have other related disabilities, home modifications can be employed to address hazardous areas that could increase falls risk. Home modification refers to the converting or adapting of environments to make everyday tasks easier, reduce accidents, and support independent living (Pynoos et al., 2005). Just as visual functioning and health status of older individuals is dynamic, environments also can change over time, as homes become older and keeping up with repairs may become more difficult. The range of available home modifications is wide and expenses vary from low-cost adaptations to more expensive renovations (Pynoos et al., 2010). Home modifications that are particularly germane to older adults who are blind or visually impaired include improving lighting throughout the home, removing hazards (e.g., clutter and throw rugs), adding special features or assistive devices (e.g., grab bars that provide color contrast with the surrounding decor), moving objects and furnishings to create clear pathways, placing contrasting nonskid textured mats in showers and tubs, and painting door frames in bright solid colors (Duffy, 2002; Pynoos et al., 2005).

Researchers generally agree that home modifications are important for promoting safety and independent living; however, research findings are inconsistent and sometimes counterintuitive in their reports of the impact of hazard reduction and home modification on falls rates. For example, Steinman et al. (2009) analyzed data from the Health and Retirement Study and reported that persons whose homes had been modified to accommodate someone living with a disability were more likely to fall than persons who lived in homes that had not been modified. This finding was interpreted to reflect the greater likelihood of acquisition of home modifications by those who need them, whether due to chronic conditions, functional difficulties, or vision loss-that is, that those who were at greater risk of falls were more likely to invest in home modifications to prevent a fall.

When hazard reduction and home modifications have resulted in significant reductions in falls, it has usually been described as a combined effect in which environments interact with other falls risk factors. The general removal of home hazards without consideration for interactions of physical and behavioral traits with specific aspects of the environment may not only be ineffectual for reducing falls but also has the potential to increase falls risk by interfering with idiosyncratic relationships established over time between individuals and their home environments (Pynoos et al., 2010). For instance, a common recommendation is to clear all walkways and paths of obstacles that may be viewed generally as trip hazards. On the surface, this recommendation seems sensible; however, many older adults who are blind or visually impaired may have adopted personal strategies based on environmental features to improve mobility and compensate for decrements in their vision. Older people who are blind or visually impaired may use large pieces of furniture as cues to orient themselves as to their location in a room or relative to other known but less salient environmental hazards. Similarly, older people with balance impairments may use table tops or the backs of sofas to support themselves as they make their way across a room. By exploring unique forms of support that environments afford and observing how persons carry out tasks, recommendations by occupational therapists and/or vision rehabilitation therapists can be better tailored to address specific combinations of intrinsic (including vision-related) factors experienced as a function of age, behavioral attributes, and environmental falls risk factors.

Conclusion

This article highlights multiple interventions that address the specific needs of older individuals who are blind or visually impaired, which when integrated into multifactorial programs are effective for reducing falls. The most effective intervention strategies consist of multiple components that address relationships between vision loss and other falls risk factors that are intrinsic, extrinsic, and behavioral in origin (Clemson, Mackenzie, Ballinger, Close, & Cumming, 2008; Pynoos, Rose, Rubenstein, Choi, & Sabata, 2006). Programs that hold the greatest potential for reducing or preventing falls among this high-risk group require exploration of dynamic interactions between the health and functional abilities of older adults who are blind or visually impaired and their surrounding environments. In accordance with this view. AGS Clinical Practice Guideline: Prevention of Falls in Older Adults established by the American Geriatrics Society (AGS; 2010) recommends that older adults who are at high risk of falling (including those who are blind or visually impaired) undergo multifactorial falls risk assessments that could serve to identify factors that may be uniquely associated with blindness and visual impairment in late life. Implicit in the recommendation of AGS is the acknowledgment that any single intervention is likely to be less effective than when complex relationships between multiple falls risk factors are considered together. Thus, there is a concerted need for continued development of cross-disciplinary multifactorial falls-prevention programs specifically targeting older adults who are blind or visually impaired. To deal most effectively with the problem of falls among this population, an array of medical and rehabilitative services including providers from the aging network will need to be enlisted, and collaborative relationships strengthened between public agencies and private agencies that serve older adults who are blind or visually impaired. Given projections of a growing number of older individuals with vision loss, it is clear that practitioners across numerous fields who are interested in preventing falls among older adults will need to become increasingly aware of issues related to medical, functional, and rehabilitative aspects of

blindness and visual impairment, especially as they relate to falls prevention. In addition, new and continued research is needed to demonstrate the efficacy of programs and to establish a body of evidence on which to base programs aimed at improving health and functioning, enhancing independence, and reducing falls among older persons who are blind or visually impaired.

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Does Improving Vision Reduce the Risk of Falls? A Review

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Abstract

Falls in the elderly constitute a major health problem. Preventing falls is a major public health concern. Most strategies to prevent falls rely on environmental modifications or on increasing the strength or balance of the person. Overall, vision impairment, usually measured as reduced binocular visual acuity, doubles the risk of a fall. It seems logical, therefore, to presume that if one could improve vision, the frequency of falls would decrease. A literature review was conducted to determine if previous research supported the conclusion that improving vision decreases the risk of falls. The review of the literature failed to find strong, consistent evidence that improving vision reduced the risk of falls. Absence of consistent evidence that improving vision reduces the risk of falls implies that a better understanding of vision and its relation to falls is important in developing vision rehabilitation strategies that reduce the risk of falls.

Keywords: falls, cataract extraction, refractive correction, vision impairment, vision improvement

Introduction

Falls in the elderly constitute a major health problem. Approximately 40 percent of adults aged over 65 years fall each year (CDC, 2008). Older people with impaired vision are more likely to suffer injuries from falls (Felson, Anderson, Hannan, Milton, Wilson, & Kiel, 1989; Kulmala et al., 2008; Legood, Scuffham, & Cryer, 2002; Lord, 2006; Black & Wood, 2005; Dhital, Pey, & Stanford, 2010; Lord, Smith, & Menant, 2010); including hip fractures (Anastasopoulos, Yu, & Coleman, 2006). Falls are approximately equally distributed between those that occur indoors and those that occur outside. Importantly, the risk factors for the two types of falls are quite

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different. Outside falls are more likely to occur to healthier, active males, and those with higher education levels. Inside falls are more likely to occur to more frail, less active females, and those with lower education levels (Kelsey et al., 2010). Visionrelated injuries and especially hip fractures following falls are a major risk factor leading to entry into a nursing home (Wang, Mitchell, Smith, Cumming, & Leeder, 2001; Wang, Mitchell, Cumming, & Smith, 2003; Klein, Moss, Klein, Lee, & Cruickshanks, 2003). Additionally, visual impairment increases the likelihood of death (LaForge, Specor, & Sternberg, 1993; Thompson, Gibson, & Jagger, 1989; McCarty, Nanjan, & Taylor, 2001), presumably because of an increase in the number and severity of accidents including falls. Overall vision impairment, usually measured as reduced binocular visual acuity, doubles the risk of a fall (Black & Wood, 2005; Lord, 2006; Lord et al., 2010; Dhital et al., 2010; Klein, Klein, Lee, & Cruickshanks, 1998; Klein et al., 2003; Knudtson, Klein, & Klein, 2009).

If impairing vision increases the risk of falls, it seems logical to presume that if one improved vision that the risk of falls would decrease. To the extent that improving vision reduces the risk of falls, it becomes important for health care workers who notice difficulties in vision to refer patients to ophthalmic professionals for treatments which might improve their vision.

There are a number of difficulties with this rather straightforward premise, however. First, falls can occur in many different circumstances, for example, in the home, while gardening, while walking, or while shopping (Bleijlevens, Diederiks, Hendriks, van Haastregtm Crebolder, & van Eijk, 2010; Kelsey et al., 2010). Secondly, as people age, their abilities decline in many ways; vision is only one. Changes in strength, balance, and vision are related (Knudtson et al., 2009). Even if one limits one's interest to vision, a variety of visual functions decline and may increase the risk of falls. These include central visual acuity, peripheral visual fields, and depth perception, among others. At the very least, central and peripheral visual functions are independently related to falls (Patino, McKean-Cowdin, Azen, Allison, Choudhury, & Varma, 2010; Freeman, Muñoz, Rubin, & West, 2007). Lastly, we may ask what it means to "improve vision," given the variety of visual functions indicated above. Most ophthalmic therapies do not change the underlying problem causing vision loss; at best, they halt further decline in a specific visual function. Moreover, the relationship between vision and falls may reflect a more general decline in functioning rather than being an independent cause of falls (Lamoureux et al., 2010). Thus, although there is strong evidence that impaired vision increases the risk of falls, the evidence which indicates that improving vision decreases the risk of falls is much less compelling.

Search of the Research Literature

We conducted a literature search to identify and review studies that examined whether improving vision reduced the risk of falls. We conducted several searches of the PubMed database using the search terms falls, gait or balance crossed with vision, low vision, age-related macular degeneration (AMD), glaucoma, diabetic retinopathy, cataract, spectacle, magnifier, optics, or refractive error. The primary aim in conducting the searches was to determine if treatments of the common blinding eye diseases (refractive error, cataracts, AMD, diabetic retinopathy, and glaucoma) that improve vision or functional vision might decrease falls or improve balance or gait parameters, both risk factors for falls. A secondary aim was to determine if other ophthalmic procedures decreased falls or improve balance or gait parameters.

In total, 2,787 references were identified. None of the references examined the role of improving vision in wet AMD, diabetic macular edema, or diabetic retinopathy on the rate of falls or on the risk factors for falls. Despite evidence that field loss increases the risk of falls (Patino et al., 2010; Freeman, et al., 2007), no studies were identified that indicated that conserving or reducing field loss through treatment of glaucoma reduced the risk of falls. We found no studies that indicated an effect of magnifiers, telescopes, or prisms affect the number, rate, or severity of falls. Of the references identified, only 10 references directly examined the question of whether improving vision decreased the risk of falls. Six references examined the role of improved vision following cataract extraction on falls (Brannan, Dewar, Sen, Clarke, Marshall, & Murray, 2003; Harwood, Foss, Osborn, Gregson, Zaman, & Masud, 2005; Schwartz, Segal, Barkana, Schwesig, Avni, & Morad, 2005; McGwin, Gewant, Modjarrad, Hall, & Owsley, 2006; Foss, Harwood, Osborn, Gregson, Zaman, & Masud, 2006; Desapriya, Subzwari, Scime-Beltrano, Samayawardhena, & Pike, 2010). Studies that indicated that cataract extraction improved quality of life, functional vision, or mobility were not included, as there was no direct measure of falls. Four studies examined the effects of improving corrective lenses on falls (Day, Fildes, Gordon, Fitzharris, Flamer, & Lord, 2002; Cumming et al., 2007; Haran et al., 2010; Fitzharris, Day, Lord, Gordon, & Fildes, 2010). Since refractive error and cataract extraction are the two leading causes of preventable blindness (WHO, 2007) and their correction is relatively easy, correction of refractive error and cataract extraction have been suggested as strategies to reduce falls (Buckley & Elliot, 2006). An additional three studies were identified that

involved a multifactor approach, which included ophthalmic care. This last group of studies often included home modifications made by an occupational therapist or nurse as one factor. We shall discuss these studies and their implications for efforts to reduce falls below.

Results of the Literature Search

Cataract Extraction and Reduction of the Risk of Falls

Cataract extraction typically results in monocular visual acuity (VA), which is close to 20/20 following the cataract extraction (Powe et al., 1994). Although cataracts are a ubiquitous feature of aging, and cataract extractions are a common and usually effective surgery in all industrialized countries, there are data that indicate that cataracts are frequently undetected or underreported (Evans & Rowlands, 2004).

Schwartz et al. (2005) found that postural stability was improved following cataract surgery in 23 consecutive patients, aged 51 to 85 years, who underwent cataract surgery and who had no ocular or neurological comorbidities, such as AMD, glaucoma, retinopathy, or balance disorders. Brannan et al. (2003) observed a statistically significant difference in the rate of falls in 91 patients, aged 65 years or older, during the 6 months before and the 6 months after they underwent cataract extraction. The exclusion criteria included only symptoms of postural hypotension (i.e., a drop in systolic blood pressure of \geq 20 mmHg upon standing).

Harwood et al. (2005) conducted a randomized controlled trial of the effects of first cataract extraction by phacoemulsification on falls using an expedited surgery group (n = 154) and a waiting list control group (n = 152). Subjects were women 70 years of age or older. Exclusion criteria were major refractive errors, ophthalmic diseases that might reduce acuity or restrict visual fields following cataract surgery, and those with cognitive impairments. Cataract surgery reduced the rate of falls (number of falls per number of days) by 33 percent, a statistically significant reduction. The reduction in the rate of falls was primarily a reduction in the number of second falls in the operated group. There was not a significant difference in the number of patients who fell between

the operated and control groups. However, significantly fewer members of the operated group had two or more falls. Foss et al. (2006) followed up on the earlier work of Harwood et al. (2005). They randomized 239 women over 70 who were eligible for cataract surgery into an expedited surgery group and a normal surgery group. They found no significant difference in the rate of falls, number of falls, or injury rate from falls for those who received a second cataract surgery as compared to those who did not have a second cataract removed. Desapriya et al. (2010) performed a meta-analysis of available randomized control studies of cataract surgery (i.e., Harwood et al., 2005; Foss et al., 2006) and their effects on falls and found no significant effect of cataract surgery. Perhaps this is not surprising since the two studies they analyzed were underpowered, restricted to only women, and they analyzed only the number of patients who fell, which was not statistically significant in either study.

McGwin et al. (2006) examined the effects of cataract surgery in two groups of patients, 55 years of age or older, who either elected to have cataract surgery (n = 122) or did not elect to have cataract surgery (n = 92). Patients were interviewed at baseline and two years after baseline and asked if, during the previous 12 months, they had fallen, had difficulties with mobility, or had difficulties with balance. Exclusion criteria included amblyopia, use of a wheelchair, reduced mental capacity, or any disease that might prohibit annual visits to the physician. Although the cataract surgery group differed from the control group in several ways, there was no statistically significant difference in the number of patients who reported falling in the 12 months prior to the follow up interview or in the numbers who reported difficulties with mobility or balance. One methodological weakness in the McGwin et al. (2006) study was that subjects were asked about their falls on a yearly basis rather than using a diary method, as employed by Harwood et al. (2005) and Foss et al. (2006). This highlights the difficulty of conducting these studies using questionnaires.

In summary, although there is evidence that cataract surgery improves balance and reduces the rate of falls, there is no evidence that cataract surgery decreases the number of patients who fall or decreases the severity of injuries that result from falls. The role of ocular or systemic comorbidities in modifying the effects of cataract surgery is also unclear.

Optical Correction and Reduction of the Risk of Falls

Worldwide, uncorrected refractive errors are the second leading cause of preventable blindness, accounting for 18 percent of cases (WHO, 2007). Roughly 50 percent of the U.S. population has a clinically significant refractive error in one or both eyes (Kempen et al., 2004). About 83 percent of those in the general population with visual impairment can be corrected with appropriate refraction (Vitale, Cotch, & Sperduto, 2006), and about one-third of older adults with reduced visual acuity can be corrected with refractive error may be a leading cause of falls in older adults. However, the nature of refractive correction makes this rather simple picture much more complicated.

Cumming et al. (2007) conducted a randomized control trial in which 616 people over 70 were divided into a one group that received comprehensive optometric services and a control group. The intervention group received recommended refractive correction. In addition, if deemed appropriate by the optometrist, they received home visits by an occupational therapist or were referred for other ophthalmic problems, such as glaucoma management or cataract surgery. Surprisingly, at the end of a one year follow-up period, the intervention group had a statistically higher percentage of participants who fell (30 percent), a greater falls rate ratio (57 percent), and a greater relative risk of the fall resulting in a fracture (74 percent). Cumming proposed three possible explanations. First, many of the older patients had major changes in their refractive correction, so they may have had difficulties adjusting to these corrections. Second, as a result of their improved vision they may have increased their physical activity or the type of their physical activity, leading to an increased number of falls. Lastly, there is some evidence that the types of lenses usually prescribed to older patients (i.e., bifocals, multifocals, and progressive lenses) may increase the likelihood of falls.

Cumming does not provide specific information about the refractive prescriptions given to the

intervention group. However, older patients have presbyopia and would commonly receive bifocal, multifocal, or progressive prescriptions. Bifocal and progressive lens wear has been associated with errors in foot placement on stairs and other changes in elevation (Davies, Kemp, Stevens, Fronstick, & Manning, 2001). Multifocal lenses blur edges at ground level, distort visual space, and reduce object contrast for older patients and lead to an increase in the risk of falls (Lord, Dayhew, & Howland, 2002). The importance of the distortions in lenses in altering distance perception may be especially important in the effects which they have on misstep errors (Davies et al., 2001), difficulties in judging toe clearance over objects (Johnson, Buckley, Harley, & Elliott, 2008; Johnson, Elliott, & Buckley, 2009), as well as bumping into objects and altering head position and gaze patterns (Menant, St. George, Sandery, Fitzpatrick, & Lord, 2009; Menant, St. George, Fitzpatrick, & Lord, 2010; Johnson, Buckley, Scally, & Elliott, 2007).

One proposed solution to the concerns about bifocal and multifocal lenses is to prescribe single lenses for outdoor wear where a distance correction is needed (Buckley & Elliott, 2006; Haran et al., 2009). Haran et al. (2010) conducted a randomized control trial of 606 regular wearers of multifocal lenses. Overall, prescribing a single lens resulted in an 8 percent reduction in falls, which was not statistically significant. This nonsignificant effect may be a consequence of the fact that the study was designed to affect only outside falls and roughly half of the falls were inside falls. Planned subgroup analyses were conducted. They indicated that, for those who were active at baseline, wearing single lens distance corrections decreased all falls, decreased outside falls, and decreased the severity of injury from falls. However, for those who were less active at baseline, wearing single lens distance corrections increased outside falls and increased the severity of injuries of those falls. It is possible that habitual multifocal lens wearers who are less active and engage in fewer outside activities have a greater difficulty adjusting to the use of new single lens prescriptions or perhaps they became more active because they could see more clearly, creating a greater number of opportunities for falls.

In summary, optical correction of impaired vision improves vision but appears to have possible risks

as well as benefits. One interpretation of these studies is that, as patients age, changes in spectacle prescriptions may require adjustment and instruction—as much or more than less common adaptive devices. Another important factor is that single lens corrections are appropriate for outside mobility, but outside falls (as noted above) account for only about half of the falls. Also, those who have outside falls are more likely to be younger and male.

Multifactor Studies and Reduction of the Risk of Falls

Several teams have conducted studies in which multiple treatments were assessed, including correcting vision problems. Although generally showing successful reduction in falls on the order of 15 to 30 percent, these multifactor programs do not permit an independent evaluation of the effects of improving vision (Close, Ellis, Hooper, Glucksman, Jackson, & Swift, 1999; Clemson, Cumming, Kendig, Swann, Heard, & Taylor, 2004; Casteel, Peek-Asa, Lacsamana, Vazquez, & Kraus, 2004). Day et al. (2002) conducted a multifactor, randomized control trial to reduce falls in a population of 1,060 patients. In the treatment arm, three variables were examined: exercise, home modifications, and ophthalmic treatment for those who had reduced visual acuity. Appropriate ophthalmic treatment included refractive correction. Neither home modifications nor the vision intervention alone resulted in significant reductions of falls. Only an exercise program independently decreased falls. However, there was no significant improvement in the visual acuity of the intervention group, making interpretation of the success of this intervention questionable. The strongest effect was observed when all three interventions were combined which produced an estimated 14 percent reduction in the annual fall rate. The number of people needed to be treated to prevent one fall a year ranged from 32 for home hazard management to 7 for all three interventions combined. In a second study, Fitzharris et al. (2010) performed a reanalysis of the Day et al. (2002) data. The authors evaluated the incidence of all falls, falls resulting in injury, and those requiring medical care. As in the prior analysis, the only single intervention that significantly reduced falls was exercise. For falls resulting in injury and the subset requiring medical care, the vision-plus-exercise intervention was associated with fewer falls. Thus,

the major effect of improving vision was in decreasing serious falls that required medical care.

Conclusions

In summary, there is very little data to show that improving vision decreases falls, the rate of falls, or their severity. While there are differences in the designs of the studies of visual improvement on falls reviewed above, the commonality is that it is difficult to demonstrate a change in the number of falls or rate of falls in a small population because falls are infrequent events which occur under variable circumstances. Falls are multiply determined as a result of environmental factors, muscle strength, balance, and the ability to see objects. Consequently, improving vision alone may have limited impact in altering the rate of falls or the severity of the fall should it occur. Moreover, most studies aim to impact a limited range of factors which determine falls. This may limit the size of the effect that can be demonstrated.

Low vision rehabilitation is a multifaceted process. It involves a combination of prescription of optical devices, occupational therapy, and orientation and mobility training. It is unclear which aspects of low vision rehabilitation are effective in reducing falls. Currently, there are no definitive trials.

The evidence that modifications of environmental hazards in the home alter falls is not strong. To the extent that home modifications are effective, the effect is primarily for the frail and/or those with low vision (Gillespie et al., 2009), and even these data are weak (Mahoney, 2010). Just as there may need to be adaptations to changes in refraction, there may need to be adjustments to the changes in the home. There do not seem to be studies that examine the possibility of adverse effects of home modifications.

Home modifications resulting from visits by occupational therapists or nurses cannot be the sole factor involved in those studies showing their effectiveness because the numbers of falls at homes related to an environmental hazard and those with no hazard involved are both reduced (La Grow, Robertson, Campbell, Clarke, & Kerse, 2006). It appears that the visits alter behavior in ways that are beneficial. Identifying those factors that are effective in home visits will require further research.

Most studies of falls interventions have involved community wide efforts or at least large scale multifactor approaches (Gillespie et al., 2009). There

is evidence, however, that the costs of these large programs and their lack of focus on individuals may not be as effective as targeted approaches in which an individual practitioner determines the needs of a patient at risk and designs a program of referrals appropriate for that individual (Gates, Fisher, Cooke, Carter, & Lamb, 2008). While many sophisticated tools exist to evaluate the individual's risk for falling, simple tools that can be used by all are often just as effective (Gerdhem, Ringsberg, Akesson, & Obrant, 2005). As those who work with the elderly who are visually impaired strive to assist them in their activities of daily living, they can fulfill this role.

The lack of clear evidence of the success of improving vision or factors involved in low vision rehabilitation to reduce falls suggests the need for clinical trials and the need to design these trials carefully. Other than the obvious need to have sufficient power to detect effects, at least four variables need to be considered in the design of these future trials: the content of the intervention, the process by which the intervention is delivered and evaluated, the targeted group (Mahoney, 2010) and the context of the falls, for example, indoors or outdoors (Bleijlevens et al., 2010; Kelsey et al., 2010).

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