

Prevention of falls among seniors with a visual impairment

Information Monitoring Summary

Documentary research

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January 18, 2013

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Prevention of falls among seniors with a visual impairment

Summary

Falls result from an interaction of multiple intrinsic (individual condition and behaviour) and extrinsic (environment) risk factors. Many, however, could be corrected or at least mitigated. Recommendations in fall prevention matter support personalized multifactorial interventions aimed minimally at **1.** improving motor activity capabilities (strength, balance and gait), **2.** improving safety in the home environment, **3.** reducing medication consumption and limiting use of psychotropic drugs, **4.** and acting on at least one of the four additional risk factors, among which are visual disorders.

Seniors who have a visual trouble or deficit are 1.5-2.0 times more likely to fall than those who do not. Visual impairment (VI) adversely affects perception of environmental elements that can cause a fall. By also interfering with perception and use of static and dynamic visual information, it compromises balance and posture and increases risk of falls.

Seniors with VI are generally less active, which may cause a reduction in functional abilities and, in return, a sensory loss. This closed loop may cause degradation in efficiency of the anticipatory process and postural regulation, a reduction of dynamic balance and increased risk of falls.

In addition, fear of falling, common in older persons with VI, is a significant predictor of a future fall. It can lead to a reduction in self-confidence and activities and, consequently, deterioration in physical capabilities and quality of life.

Frontline vision impairment screening is recommended, followed by guiding the senior with a suspected visual impairment toward specialized services of an eye care or vision rehabilitation professional. Rehabilitation can help improve several modifiable risk factors, such as motor activity capabilities (balance, muscular strength and gait); visual capabilities; functional capabilities; life habits accomplishment (travel, etc.); cognitive capabilities; behaviour capabilities (e.g. affect, safety behaviour, etc.); physical environment safety, such as at home (actions regarding architectural barriers).

Prevention of falls among seniors with a visual impairment

The prevalence of falls among seniors is high and represents a public health problem. Among risk of falls factors are vision disorders. This brought us to ascertain the extent of knowledge and current evidence on the effectiveness of prevention measures from a visual point of view and on the impact of rehabilitation on reducing falls among older adults with visual impairments.

To establish a better global perspective, risk factors for falls for seniors are addressed first, followed by visual impairment (VI) as a specific factor, and recommended actions.

1. Risk factors and fall consequences for seniors

According to various literature reviews, approximately 30% of individuals aged 65 and older fall every year [21]. Among those aged 80 and over, the risk increases to 45% [56]. Most falls result from the combination of intrinsic (person-specific) and extrinsic (environmental) risk factors.

a. Intrinsic factors

A number of recent literature reviews, including that of Dionyssiotis (2012) and Gagnon and Lafrance (2011), draw up an exhaustive list of intrinsic risk factors for falls, among which are the following [15, 21]:

Sociodemographic

- Age – The prevalence of falls increases with age.
- Sex – Among seniors, women fall more frequently than men and are more susceptible to fracture.
- History of previous fall.

Health Condition

- Medical Condition – Vascular disease, chronic obstructive pulmonary disease, depression and arthritis increase risk of falls by 32% each.
- Medication – Due to drug interactions and side effects, risk increases significantly if more than four drugs are consumed, regardless of their type.
- Foot problems – Calluses or deformity of the big toe, ulcers, pain with walking, etc.
- Dizziness.

Sense and perception capabilities

- Visual deficits (acuity, color and depth perception, sensitivity to glare, etc.) – Multiple visual functions are needed to travel safely (binocular vision, dark adaptation, depth perception, glare tolerance, contrast sensitivity and peripheral vision) [16]. Vision is important for maintaining posture and for orientation in space [16]. It is one of the four sensory mechanisms that detect balance disruptions, in addition to the vestibular function, tactile sensation in the feet and proprioception (perception of the position of a joint) in the lower limbs and neck [27]. But the ability to use static and dynamic visual information changes systematically in older adults, which impairs their balance and posture and increases risk of falls [39].
- Sensory deficits in the feet.

Motor activity capabilities

- Loss of strength in the lower limbs – It negatively affects the ability to climb stairs, recover from imbalance, cross a street quickly.
- Impairment of gait and balance – It is caused by a decrease in proprioception; postural reflexes; muscle tone, strength (10% loss per decade after age 30), power (30% loss per decade after age 30) and endurance, etc. Harwood (2001) reports that postural control depends more on vision in older adults than in younger people.
- Decrease in grip strength.

Intellectual and behaviour capabilities

- Cognitive problems – Impaired memory is a risk factors for falls for people over 75. Among those living in institutions, the presence of dementia doubles the risk of falls. The ability to control movement while performing a cognitive task asking to process information from several sources requires the sharing of cognitive resources and may result in reduced performance [43]. For example, as illustrated by Teasdale and Simoneau (2001), cited by Melton et al. (2011), talking on the phone while ascending or descending a staircase necessitates the allocation of resources to the task of conversation; this may lead to a reduction of the resources required to perform the walking movements. Moreover, the reduction of cognitive abilities causes a reduction of the useful visual field, which is correlated with an increase in accidents when driving or walking [43].
- Depression – Increases risk of falls of by 32%.
- Fear of falling – Fear of falling can result from a fall; according to the studies, up to 70% of people who have fallen may have felt this fear. Anticipatory anxiety may also occur in those who have never fallen. In

three prospective studies reported by Dionyssiotis (2012), fear of falling is a significant predictor of future falls. It can lead to a reduction in self-confidence and activities and, consequently, a deterioration of physical abilities and quality of life. Up to 50% of people who are afraid of falling restrict some or all of their social or physical activities due to this fear [58].

- Risk Behaviours – No use of walking aid when required, etc.
- Lifestyle – Alcohol consumption, physical inactivity, malnutrition, etc.

Daily activities

- Decreased functional abilities.

b. Extrinsic factors

Extrinsic (environmental) factors are those that can be prevented or controlled. Many can cause the individual to slip, trip or misstep [15, 21]:

- The condition of walking surfaces – Floor, stairs or sidewalk that are slippery, crowded, uneven, with doorsill, etc;
- Lighting – Insufficient or inappropriately oriented; glare, etc.;
- Presence of obstacles;
- Support structures – No bathroom grab bar, staircase railing, etc.;
- Equipment and accessories – Unsafe or in poor condition;
- Shoes – High or thin heels, insufficient foot support, slippery sole, etc.

It is not only important to identify intrinsic and extrinsic risk factors, but also to assess their possible interactions. According to the Dionyssiotis (2012) literature review, the fall rate among seniors who have 1 or 2 risk factors is 27%, and rises to 78% when 4 or more factors are present.

c. Consequences of a fall

For many seniors, falling triggers or aggravates a loss of independence and mobility. Fracture is one of the most serious consequences. According to a literature review published in 2009 by the National Public Health Institute of Quebec, among older adults who survive a hip fracture, half undergo residual loss of functional abilities; institutionalization becomes necessary in 13-20% of cases and about one-fifth die in less than 6 months [2].

Ivers et al. (2000) conducted a study with 911 cases and 910 controls, all aged 60 and over. Subjects with visual acuity less than 20/60 (6/18) were 1.5 times more likely to suffer a hip fracture than those who had good vision. This relative risk increased to 2.4 when the visual acuity was less than 20/100 (6/30). Poor visual acuity or depth perception was particularly associated with hip fractures,

accounting for 40% of the population fraction attributable of hip fracture risk (proportion of cases that would not occur if these factors were eliminated) [33].

Furthermore, in a study of Grue et al. (2009), among 544 older adults with hip fractures, 15.4% had a visual impairment and 30% had visual *and* hearing impairments [26].

A fall can also lead to fear of falling, loss of autonomy and depression [56], which are all risk factors for falls.

2. Visual impairment, a risk factor for falls for seniors

a. The visual problem-falls association

From 2-10% of individuals aged 65 to 74 have visual problems; after age 75, the prevalence increases dramatically to 12-20% [21]. Multiple conditions associated with aging and visual impairment make this segment of the population especially vulnerable to falls and their consequences.

The presence of low visual acuity, although its definition varies according to studies, is one of the main risk factors for falls for seniors [39, 51, 56], making them 1.5 to 2.0 times more likely to fall [21, 27]. The Harwood literature review (2001) shows an association between visual function measures (acuity and contrast sensitivity) and body sway, which is strongly associated with fall risk. Moreover, visual acuity less than 6/9 and a decrease in contrast sensitivity are risk factors for multiple falls [32]. Impaired depth perception [27] or visual field [4] also increases fall risk. Decreased contrast sensitivity is associated with postural instability and a change in gait, while visual field loss influences gait strategy during tasks presenting a high risk of falling, such as obstacle crossing [14, 55].

The association between poor vision and falls was shown to be valid as much for people living in the community as in an institution, and for those who had fallen in the past [27]. According to Harwood (2001), the causal link has been proven; it is clear that risk of falls increases with worse vision.

Other studies support the predisposing role of VI in risk of falls for seniors, but rather in a multifactorial dimension. For example, research conducted with older women found that when the reduction of visual acuity is considered alone, it does not contribute significantly to a fall rate increase [35]. However, older women who have both visual *and* hearing impairments are four times more likely to fall than their counterparts without sensory impairment (relative risk). This is probably due to their inability to compensate through auditory information for the lack of visual information on body posture and the environment. The relative risk of falling increases to 29.4 when a balance problem is added to the dual sensory impairment [35].

A study by Lamoureux et al. (2010) compared, in a visually impaired older population, a group of people who had fallen during the previous year to a group of non-fallers [37]. None of the visual factors (visual function, duration and main cause of visual impairment) was independently associated with a higher incidence of falls. However, fallers were less likely to engage in vigorous physical activity and experienced greater difficulties in carrying out their daily activities. The authors conclude that in the presence of VI, other factors, such as participation in physical activity, may be more significant in assessing risk of falls. These results are consistent with evidence showing that a decrease in muscle strength increases risk of falls among older adults with VI [14, 51].

In addition, seniors with VI more often have secondary conditions or comorbidities that may increase risk of falls than for those without sensory impairments. For example, in a study by the National Center for Health Statistics (1994) cited by Crews and Campbell (2004), seniors with VI were significantly more likely to report their health as fair or poor, or to have diabetes, a coronary heart disease, arthritis, high blood pressure or a history of stroke. They were also more likely to feel depressed and often experienced functional disabilities [9]. For example, they were about three times more likely to report difficulties in transferring from bed or chair, walking, going outside or preparing a meal. But this decrease in functional ability and in performing activities of daily living can bring about sensory impoverishment, which in turn contributes to a reduction in functional ability. From this closed loop may ensue efficiency degradation in anticipation and postural control processes, decreased dynamic balance and increased fall risk [45].

The presence of low vision is associated with increased frailty [51] and a higher proportion of relocation to institutions [14]. Frailty is associated with deconditioning, which increases postural and motor difficulties as well as risk of falls. In addition, other studies indicate that, compared to their peers who do not have visual problems, adults with visual impairments are more susceptible to a reduction in lower limb strength and muscle power, probably due to greater physical inactivity [43].

b. Fear of falling

Recent visual loss can lead to significant functional consequences, as shown in a prospective study in retired people's institutions in several countries. Among subjects who experienced a deterioration of their vision compared to three months earlier, 51% reported a consequent change in their social activities during this period (more frequent withdrawal from activities, restriction of social interactions), which resulted in psychological distress in 44% of them [25]. In addition, 60% limited their outdoor activities for fear of falling. This handicap

situation is more common among older adults with VI than in those with normal vision. For example, in a study by Wang et al. (2012), 40-50% of seniors with VI reported activity limitations associated with fear of falling, compared to 16% of control subjects with normal vision. According to these authors, although activity restriction may constitute a compensatory strategy to reduce risk of falls, it may be so to the detriment of functional abilities, health, psychological well-being and social participation. As noted, fear of falling is a risk factor for falls.

c. The cause of visual impairment and risk of falls

The main causes of vision loss among seniors are cataracts, age-related macular degeneration (ARMD), glaucoma and diabetic retinopathy [18, 25]. According to the World Health Organization, on a worldwide basis in 2002, among the major causes of visual impairment were cataracts (47.9%), glaucoma (12.3%), ARMD (8.7%) and diabetic retinopathy (4.8%).

Cataract is the cause of almost half the visual impairment cases in the world, even in people aged forty and over who live in the United States [18, 47]. It causes gradual reduction of central visual acuity. The clouding of the lens causes glare sensitivity and difficulty seeing in low-light conditions. The presence of cataracts is one of the risk factors for multiple falls [32]. But despite its high prevalence, it is the most reversible cause of vision loss, excluding refractive errors [18]. Numerous studies have shown that cataract surgery can significantly reduce the number of falls [46]. For example, in a study by Harwood et al. (2005) cited by Odom et al. (2011), cataract surgery for the first eye reduced falls by 34% among people aged 65 and over. However, no study has shown that this procedure helps to reduce the number of fallers [46]. Paradoxically, even if cataracts are now easily operable and surgery's effectiveness is proven, cataracts are still frequently unreported because the loss of vision is gradual or accepted by the individual as a consequence aging. In a study by Evans et al. (2004), cited by Turpin (2011), it was estimated that 26% of vision loss cases in people aged over 75 were due to cataracts and 90% of them were operable. A Canadian study by Hodge et al. (2007) concluded that individuals waiting over 6 months for cataract surgery may have a reduction in quality of life and increased risk of falls during the waiting period [30].

Age-related macular degeneration is the leading cause of serious vision loss in people aged 65 and over who live in industrialized countries [47]. It causes a loss of central vision, while the periphery remains relatively untouched. According to a literature review of Dhital et al. (2010), up to two-third of people with ARMD have visuomotor and balance trouble, resulting in some clumsiness and increased risk of falls [14]. A decrease in contrast sensitivity and visual acuity is associated with an increased fall rate in this population [59].

Glaucoma affects the visual field. In a retrospective study by Haymes et al. (2007), compared to those in the control group, individuals with glaucoma were three to four times more likely to have fallen during the previous year [29]. Those affected walk more slowly and with more difficulty; they are more likely to collide with obstacles and often have a balance deficit [50]. Inferior visual field being associated with safe navigation, its loss increases risk of falls [4]. Fear of falling, which increases with greater visual field loss severity, may partly explain the slower walking speeds and the restriction of physical activity and travel outside the home [50]. Medication for glaucoma is also a risk factor for multiple falls [32].

Diabetic retinopathy, associated with diabetes, causes a decrease of visual acuity. It can also cause decreased contrast sensitivity, glare and impaired visual field and color vision. Vision becomes blurred and dotted with black spots [19]. In a study of Azidah et al. (2012), seniors who were in the early stage of type 2 diabetes had a fall prevalence of 18.8% [1]. In fact, diabetes can lead to damage to peripheral nerves, which can cause sensory disorders (e.g. very intense leg pain, decreased sensitivity in the feet, decreased proprioception) and sometimes motor disorders. This frequently results in impaired mobility, gait and balance [1]. Moreover, in Azidah study, seniors who also had diabetic retinopathy were 2.2 times more likely to fall than those who did not.

3. Recommended actions

Falls among the elderly result from an interaction of multiple intrinsic and extrinsic risk factors. Many, however, could be corrected or at least mitigated. The most recent recommendations for fall prevention support personalized multifactorial interventions that aim minimally at **1.** improving motor abilities (strength, balance and gait), **2.** improving safety in the home environment, **3.** reducing consumption of medication and limiting the use of psychotropic drugs and **4.** acting on at least one of the four additional risk factors, among which are visual disorders [2, 16, 21, 23, 41].

a. Vision assessment and intervention

Visual impairment assessment is essential in attempting fall prevention among seniors [16]. It should include a yearly visual examination and an assessment of the individual's eyewear prescription for currency [2, 52]. The Begin et al. (2009) literature review shows that a considerable number of seniors have visual impairments that are potentially correctable but undetected. Often, seniors consider that their vision loss is a normal part of aging or that nothing can be done to improve it. Many are discouraged by the long delay before they can be examined by an ophthalmologist, while others are not aware of the extent of their visual problems or negative impacts in daily lifestyle [2]. They may also be

unaware of available services, not be referred to them or be unable to get to them due to mobility problems [2]. In fact, only a small proportion of people with impaired vision use public or private eye care services.

In 2004, the Quebec Ministry of Health and Social Services established the framework *La prévention des chutes dans un continuum de services pour les aînés vivant à domicile* (Preventing falls in a services continuum for seniors living at home), where personalized multifactorial intervention (PMI) is placed at the centre of offered services [2]. The frailest seniors are targeted to reduce the presence of risk factors that may cause falls and serious consequences. Screening for risk factors under the protocol is done in the person's home by a worker dedicated to fall prevention. Three main risk factors must be assessed for the senior eligible for PMI (gait and balance, medication, home environment), plus at least one of four additional factors, among which are vision deficits or disorders. The latter are assessed by means of visual acuity (Snellen scale) and confrontation visual field tests. In the event of failing either of these screening tests, the person is directed to optometry or ophthalmology resources. Depending on the case, the fall prevention worker monitors to facilitate implementation of the proposed solution.

In relation with senior vision correction, the Odom et al. (2011) literature review offers some warnings. Seniors' presbyopic glasses are usually multifocal (bifocal, trifocal or progressive). But multifocal lenses can impair contrast sensitivity and depth perception because the lower lenses blur the detection and discrimination of distant objects in the lower visual field [38]. This affects the senior's ability to visually detect obstacles in the environment and thereby increases risk of falls, especially in unfamiliar or hard-to-negotiate environments [38, 46]. This situation can cause missteps; errors in placement of feet on stairs and other change in elevation (e.g. sidewalk); difficulty in judging clearance from objects and bumps on them; alteration of the pattern of head position and gaze [46]. Incidentally, in the study by Lord et al. (2002), older people wearing multifocal lenses tended to be twice as likely to fall as those using non-multifocal glasses. Their falls were mainly due to tripping in or outside the home, or took place ascending or descending stairs. However, in the Wood et al. (2011) study where subjects had ARMD, falls were not associated with multifocal glasses, but 21% of those who had fallen were not wearing their usual eyeglasses. It therefore appears that among seniors, a change in prescription glasses may require a period of adaptation and warnings should be clearly addressed to them [5, 10, 46].

Also in line with fall prevention, a regional Visual Impairment Detection Program was established in 2008 with 12 Montreal Health and Social Services Centres (*Centres de la santé et des services sociaux*, CSSS), to identify seniors at risk of

falling due to visual loss [12, 40]. CSSS home health care program professionals receive training to screen for early vision loss among people aged 75 and over living at home. This screening, performed with the "Visual Impairment Screening Questionnaire" [24], aims to **1.** prevent visual impairment progression, **2.** better identify, orient and refer persons to the appropriate resources and **3.** ensure improved access to existing vision rehabilitation services [12, 40]. It is hoped that this will in turn prevent and/or reduce the incidence of falls. According Déry et al. (2011), the program has resulted in over 230 referrals to visual impairment rehabilitation centres mandated by the Montreal Health and Social Services Agency (*Agence de la santé et des services sociaux de Montréal*). The authors mention that visual impairments of many people would not have been identified without that screening questionnaire.

b. Visual intervention among seniors in care homes

According to Close (2001), cited by Turpin (2011), falls contribute to 40% of admissions in care homes. In addition, about 60% of people living in care homes have recurrent falls yearly [56]. Not only is the institutionalized population generally older and more fragile, but the prevalence of visual impairment is also higher. Paradoxically, there is a risk of vision care being neglected or considered unnecessary in these facilities, especially for users with cognitive deficit [48]. In addition, less accessibility to vision services has been reported for this clientele [3, 56].

The Manitoban Focus on Fall Prevention Project (FOF) was developed in 2006. It aims to compensate for the lack of visual care and services in long-term care facilities, to improve quality of life and safety of residents and to document the impact of improved vision on the prevalence of falls and fractures [3]. Featured services include vision screening, which requires only 10 minutes, and on-site optometry services; referrals to eye care specialists as needed; facilitation of residents to receive the recommended vision intervention(s); education of residents, families and staff about VI; vision interventions follow-up.

During the first year of the project, out of more than 200 residents who received screening, over 50% were referred for some form of vision intervention (medical intervention, optometry or the Canadian National Institute for the Blind services). Minor injuries associated with a fall decreased from 72 to 52; for major injuries, it decreased from 19 to 10. During the following years, sites that integrated the visual screening in their admission process showed a reduction in falls and associated fractures. Falls were even reduced by 76% in one institution during implementation of the program. Although that statistically, there was no direct association between program implementation and reduction of the number of falls and fractures, a downward trend was indeed observed in all participating

institutions. Clinical relevance of the results was sufficient for 19 other Manitoban institutions to join the FOF program. In addition, visual screening is now included in the nurse training program in at the University of Manitoba.

Other studies inventoried, without specifically addressing the problem of falls, have examined the impact of improving the vision of seniors living in care homes, particularly their psychological well-being, functional independence, range of motion and ability to walk, all factors associated with risk of falls. Owsley et al. (2007) proved that prescription glasses correcting refractive errors, even minor ones, significantly contribute to increase activity and social interaction levels and reduce symptoms of depression in this population. Another study, by Teresi et al. (2005), was conducted among residents with moderate to severe cognitive impairment [54]. Offering a visual screening test and glasses with Croakies when needed helped to reduce overall functional decline as measured by range of motion, walking and performance of basic activities of daily living [54]. Functional status was further enhanced when, in addition to the above mentioned interventions, training (three 30 minutes workshops) on identification of visual deficits and techniques to encourage glasses wearing by residents was offered to nurses and nursing assistants. Improved vision increased exercise and activity performance and reduced overall functional decline. These studies thus demonstrate the importance of annual eye exams with adapted prescription lenses. The Teresi et al. study also emphasizes the importance of training nursing home staff to recognize vision problems and provide reinforcement techniques to monitor and encourage the proper use of eyeglasses.

c. Exercise or physical activity programs

People who fall tend to be less active. Consequently, physical deconditioning causes muscular atrophy and joint instability. Improving physical abilities, or at least maintaining them through physical exercise, is therefore important from the prevention perspective. According to the Gagnon and Lafrance literature review (2011), exercise programs reduce the number of people who fall by 13% and the number of people who are injured by 32%. They also reduce the number of recurrent fallers by 24%.

Exercise and physical activity programs seem more beneficial when they are developed to meet specific needs of a specific group, such as individuals with VI [52]. In addition, a program targeting specific functional deficits of an individual will be more beneficial than one that is more general. According to the Gagnon and Lafrance literature review (2011), individualized exercise programs result in a significant reduction of 29% in the number of people who suffer injurious falls and 20% in the number of recurrent fallers.

Three adapted physical activity programs were explored with a clientele with VI: the Tango, Tai Chi and the Stand Up! Program (a fall prevention program for seniors, including an integrated dynamic equilibrium exercise program).

Adapted Tango lessons were offered to 10 seniors with VI (1½ hours per lesson, 1 lesson per week, 8 weeks). Their dance partners were sighted, with or without experience in the tango. At the end of this feasibility project conducted among INLB users, multiple participants reported an improvement in their self-confidence, balance and mobility, which resulted for some of them in greater autonomy in travel [17]. Participation in tango classes also had a soothing effect on the fear of falling among some.

The results of a pilot project on Tai Chi (n=8, 2 classes per week, 8 weeks) show that it is a safe and effective practice to improve strength, balance and quality of life for seniors living with VI [44]. Another recent study with a control group was conducted with visually impaired seniors living in institutions (n=40; 1½ hours per class, 3 classes per week, 16 weeks) [8]. Participation in Tai Chi proved effective for improving knee proprioception and standing balance in contexts that require the use of visual or vestibular cues. According to the authors, the many eye and head movements executed in this form of Tai Chi provide vestibular stimulation and promote better use of residual vision, which contributes to improving balance control. There is also strong experimental evidence showing that Tai Chi exercises have beneficial effects on balance control and can improve postural stability for seniors better than any other type of exercise [15].

According to the Gagnon and Lafrance (2011) literature review, Tai Chi can reduce the number of seniors who fall by 24%, the number of recurrent fallers by 38% and the number of falls by 37%. The quality of evidence is high. However, a word of caution is in order: Dionyssiotis (2012) reported a personal communication with D Skelton, during which the latter mentions that Tai Chi exercise is probably the least recommended for people who have already suffered a hip fracture, given their fragility. Exercises would then need to be adapted so much that it would no longer constitute dynamic balance training.

The Stand Up! Program was developed in 1995 by the Montreal Public Health Department. After its scientific evaluation, a new version was introduced in the province of Quebec in 2002. Gemme and Lavoie (2012) adapted the program to seniors with visual impairments. The program has two parts. The first is a group physical exercise program to improve dynamic equilibrium, strength and proprioception of the lower limbs and ankle mobility, among other things. The second part consists of prevention capsules designed to develop participant ability to identify hazards in their environment and risk behaviours, and facilitate actions to reduce the risks. From their experience leading 7 groups (n=86),

Gemme and Lavoie noted that even if meetings are held only once weekly, participants on average doubled their tandem test performance (eyes open and eyes closed) and improved balance on one foot by 50% [22]. They also observed an improvement in localization of the body in space and faster and more spontaneous postural adjustment after a loss of balance.

Naturally, whether for Tai Chi, the Tango or the Stand Up! Program, the manner of teaching physical activity must be adapted. For example, the instructor should make greater use of body manipulation and verbal cues [17, 22, 44]. The latter should be more specific and detailed than usual, in relation with the kinematics of movement or a common mental image (e.g. reference to daily tasks).

Note that many factors can adversely affect participation of seniors with a VI in a group activity program, such as transportation difficulties, comorbid conditions, lack of motivation, fear of being in an unsafe environment or situation, etc. [34, 52]. It is important that these factors be considered and solutions implemented to mitigate their negative impact.

Doing exercises at home can be a worthwhile alternative, but adhering to the program can be a problem. For example, in a study by Campbell et al. (2005), 97 visually impaired individuals aged 75 and older received a visit from a physiotherapist who set up a personalized physical activity program of muscle strengthening and balance. A year later, however, the overall number of falls had not decreased. But many of the subjects only weakly adhered to the program. A more detailed analysis of the results showed that the more the program was adhered to, the lower was the rate of falls. For example, people who exercised at least 3 times per week had a 77% lower fall rate than those who did so less than once a week. However, very few of the subjects exercised at least 3 times a week (18%) or twice weekly (18%). These results are consistent with those of Day et al. (2002), where subjects performed exercises at home on average twice a week rather than daily.

Lastly, Radvay et al. (2007) assessed the effectiveness of balance training by sensorimotor stimulation, using a posture platform [49]. Sixteen subjects with ARMD and 13 control subjects with normal vision participated in 5 weekly 25-minute workouts. At initial assessment, the people with ARMD used more somatosensory (bodily sensations) information to maintain their balance than the controls. In both groups, the use of vestibular information (perception of movement and orientation relative to the vertical) was lower than that of somatosensory information, but the difference was much more pronounced in people with ARMD. But despite its very short duration, the training significantly improved vestibular response. The authors suggest that longer training could help improve postural balance.

d. Home adaptation

According Kochera (2002), cited by Steiman et al. (2011), 55% of falls among seniors in general occur in the home, 23% near the home and 22% in the community (e.g. parking, sidewalk, etc.). According to Fortin (2012), 70% of injurious falls among seniors living at home take place at home. [20] This illustrates the importance of conducting a thorough assessment of the risk of falls at home.

Campbell et al. (2005) studied the impact of a home safety program with 100 visually impaired seniors aged 75 and over [6]. An occupational therapist conducted an assessment of the home and functioning of the person to identify risk factors associated with environmental factors, lack of equipment and behaviour. Actions to take to reduce or minimize these risks were then discussed (e.g. remove slippery rugs, improve lighting, paint step edges, etc.). The therapist then sent a list of recommendations to the participant, facilitated acquisition and payment of equipment and conducted a second home visit to validate the equipment installation made by some providers. Telephone follow-up was performed 6 months later. The program's impact was quite positive; for a one-year period, the number of falls was 41% lower than for those who had not received the program. Falls were reduced outdoors as well as in the home, even though the intervention only addressed indoor safety. These results suggest that the professional's advice had a positive impact and promoted its generalization.

Another study, published in 2002, did not give the expected results. The home safety program was conducted with 58 people aged 70 and over living in their own home. A worker identified environmental elements that constituted risk factors for falls in the home, to then be removed either by participants themselves or by professionals of a municipal home maintenance program [11]. After 1 year, the effect was not significant (3% fall reduction). It is possible that changes at home were not appropriate or sufficient, and that the interventions were not sufficiently intense.

d. Vision rehabilitation interventions

Kuyk et al. (2004) showed that comprehensive inpatient vision rehabilitation program, which include training in orientation and mobility, can reduce the number of falls. The program's impact was measured among 128 seniors, two months after stopping the rehabilitation program [36]. Their degree of perceived difficulty in everyday situations, such as locating ascending stairs, using public transit or avoiding tripping on uneven surfaces decreased significantly. Also recorded was an increase in confidence level in travel situations in familiar, unfamiliar and outdoor areas, and inside a store. In addition, although the number of fallers was not significantly decreased, the number of falls was halved.

The decrease of functional abilities is one of the risk factors for falls [2]. Moreover, not only is the ability to perform activities of daily living (ADL) limited in the presence of VI [28], but ADL are likely to represent the major portion of physical activity for seniors [52]. Thus, optimizing the ability of seniors with VI to perform daily activities could help limit deleterious effects of inactivity. For example, for those with ARMD, eccentric vision training can significantly improve the ability to perform dynamic tasks such as meal preparation, housework, shopping, mobility, etc. [57].

Furthermore, we know that about a third of seniors with VI have depressive symptoms [7, 13, 31]. There is also a strong negative correlation between depressive symptoms and participation in ADL [53]. However, it has been proven that clinical low vision services and counselling, as well as use of optical aids, all contribute significantly to reduce depression, which is a risk factors for falls [31].

e. Multifactorial interventions

A randomized clinical study by Day et al. (2002) was used to assess the long-term (18 months) effectiveness of three types of interventions, alone or in combination, to reduce the number of falls among 1090 seniors living in their own homes [11]. The interventions targeted **1.** strength and balance (group exercises 1 hour per week, 15 weeks + daily individual program at home), **2.** home hazards management (by the participant himself or via the City of Whitehorse's home maintenance programme) and **3.** vision (screening with referral to a vision specialist, general practitioner or optometrist if needed). For a one-year period, the success rate was better for the three methods in combination (fall reduction of approximately 14%) than for uni- or bi-modal interventions. Exercise had the greatest contribution. Furthermore, the latest fall prevention recommendations support personalized multifactorial interventions [2, 16, 21, 23, 41].

Multifactorial interventions should also include strategies to encourage participants to adopt safe behaviours. For example, one study showed that a gait-stabilizing device on winter boots reduced outdoor falls by 58% and injurious falls by 87% [42]. The quality of the evidence is high, even if it is only one study.

4. Conclusion

The problem of falls in the elderly is complex because it involves the interaction of a multitude of individual and environmental factors. Fall prevention recommendations endorse personalized multifactorial interventions aimed minimally at **1.** improving motor activity capabilities (strength, balance and gait), **2.** improving safety in the home environment, **3.** reducing consumption of medication and limiting the use of psychotropic drugs and **4.** acting on at least one of four additional risk factors, among which are visual disorders. Visual

impairment is also a recognized risk factor for falls. In the senior population, it is associated with increased fragility, admission to care homes and poorer general health. However, very few fall prevention programs are developed specifically for seniors with VI.

The current demographic trend and the higher prevalence of VI among people over 65 suggests that visual impairment identification and screening, as well as multifactorial intervention initiatives are needed to efficiently prevent falls and their consequences in this population. Early intervention can help to optimize functional ability and avoid the accumulation of risk factors for falls. The fall prevention approach is important not only to seniors living in their own homes but also those in care facilities.

With a view to preventing falls, it is important that seniors, whose visual impairment leads to significant and persistent disabilities impeding lifestyle, be referred to vision rehabilitation services. These can help reduce risk of falls by improving and optimizing visual and oculomotor ability, behaviour (emotions, volition, etc.), home safety and life habits accomplishment. Moreover, it is established that exercise programs and activities contribute significantly to reducing risk of falls and are more effective if they are tailored to the individual or VI. Low Vision Rehabilitation Professionals are therefore well situated to encourage seniors to increase their physical activity by offering an individual or group program. Should they not be able to offer such a service, their knowledge of the field puts them in a favoured position to fully inform users or refer them to an appropriate specialized resource. For all these reasons, rehabilitation services for the visually impaired appear a quite marked and essential part of a fall prevention program for seniors living with a visual impairment.

4. References

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