Examining the Feasibility of a Mindfulness Intervention for the Prevention of Falls: A Pilot Study*

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RÉSUMÉ

Cette étude pilote avait pour but d'évaluer la faisabilité de la mise en œuvre d'une intervention de pleine conscience pour la prévention des chutes. Le devis quasi expérimental utilisé a impliqué 22 personnes âgées vivant en résidence qui ont suivi un programme régional de prévention des chutes en Ontario. L'intervention de huit semaines comprenait des exercices de pleine conscience intégrés dans une formation standard sur la prévention des chutes, ou la formation standard sur la prévention des chutes. Les participants ont été évalués à l'aide du test de Tinetti sur l'équilibre et la marche et du *Timed Up and Go* (TUG). Bien que l'intervention de pleine conscience n'ait pas eu d'effet notable sur les scores du TUG ou liés à l'équilibre, l'effet sur les scores associés à la marche a été significatif. Étant donné la facilité de mise en œuvre des interventions fondées sur la pleine conscience, des recherches plus approfondies sont souhaitables pour étudier le potentiel de cette modalité pour la prévention des chutes.

ABSTRACT

This pilot study was designed to assess the feasibility of implementing a mindfulness intervention in the prevention of falls. We employed a quasi-experimental design consisting of 22 participants from two retirement homes in Ontario partaking in the regional falls prevention class. Participants were assigned to either an eight-week intervention, comprising mindfulness exercises incorporated into the standard falls prevention class, or to the standard falls prevention class. Participants were assessed using the Tinetti Balance and Gait Scale and the Timed Up and Go (TUG) test. The mindfulness intervention showed no significant effect on TUG or balance scores; however, there was a significant effect on assessments of gait. Given the ease of implementation of mindfulness-based interventions, further research may be warranted in mindfulness as a potential modality for falls prevention.

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* The authors of this study thank and acknowledge Tim Siemens and the staff at Tabor Manor for their gracious support in the planning and completion of this study. Peter Hoang and Kim Moore have contributed equally to this article.

Manuscript received: / manuscrit reçu : 17/10/2018

Manuscript accepted: / manuscrit accepté : 15/01/2020

Mots-clés : vieillissement, chutes, prévention des chutes, personnes âgées, gériatrie, pleine conscience

Keywords: ageing, falls, falls prevention, older adults, geriatrics, mindfulness

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Introduction

Falls represent a significant public health issue among Canadian seniors, with nearly one third of adults over the age of 65 experiencing a fall each year (Public Health Agency of Canada, 2014). Falls – including fractures, concussions, and brain injuries – are the leading cause of injuries sustained by older adults, and are associated with a high level of morbidity and mortality (Public

Health Agency of Canada, 2014). An estimated two thirds of older adults requiring medical treatment for their fall require a visit to the emergency department, contributing to the estimated $2 billion annual cost associated with falls among seniors in Canada (Public Health Agency of Canada, 2014). Beyond its acute effects, quality of life has been shown to be reduced for up to nine months following a fall, with subsequent limitations in mobility, self-care, and activities of daily living. This often leads to a loss of functional independence that may precipitate episodes of anxiety and depression (Hartholt et al., 2011).

Fall prevention strategies are instrumental in minimising the risk of falls among older adults, and such strategies have traditionally been exercise-based (Michael et al., 2007). Gradual decreases in muscle mass is part of the natural course of ageing, with estimates suggesting that an older adult loses between 0.6 and 1.0 per cent in muscle mass and 2.5 to 4.0 per cent in strength each year. These age-related changes in muscle mass are known risk factors for falls (Clynes et al., 2015). Thus, programmes that aim at improving physical strength and functioning have played a central role in falls prevention interventions (El-Khoury, Cassou, Charles, & Dargent-Molina, 2013; Michael et al., 2010; Mitchell et al., 2012). Exercise programmes have also been shown to improve indirect measures of balance, gait, and proprioception, but given the significant heterogeneity of falls intervention studies, it is difficult to draw robust conclusions (Howe, Rochester, Neil, Skelton, & Ballinger, 2011).

Among the most commonly implemented programmes, tai chi is particularly efficacious at improving physical functioning and decreasing falls risk among older adults (Gillespie et al., 2012; Tsang & Hui-Chan, 2003). Researchers hypothesise that this is due to tai chi's unique blend of both physical and cognitive training (Chang, Nien, Tsai, & Etnier, 2010; Hsieh et al., 2018; Sun et al., 2015). A core concept in tai chi is mindfulness, a cognitive practice defined as the intentional focusing of attention on the experience occurring in the present moment in a non-judgemental or accepting way (Kabat-Zinn, 1982). Mindfulness, popularised by Kabat-Zinn's Mindfulness-Based Stress Reduction (MBSR) programme for the treatment of chronic pain (Kabat-Zinn, 1982), has been shown to reduce stress, decrease systemic inflammation, and improve overall health (Baer, 2006; Creswell et al., 2012; Tang, Hölzel, & Posner, 2015). Additionally, mindfulness-based programmes have been shown to enhance intentional awareness and decrease mind-wandering (Fujino, Ueda, Mizuhara, Saiki, & Nomura, 2018). This concept is pertinent to falls prevention, as distractions and inattention are known to increase the risk of falls (Hausdorff et al., 2006; Holtzer et al., 2007; Michael et al., 2007).

There are limited studies addressing the practicality of mindfulness interventions for older adults; however, there is evidence to suggest that mindfulness-based interventions can be feasibly implemented in this population (Spildooren, Speetjens, Abrahams, Feys, & Timmermans, 2018; Yang & Conroy, 2019). In addition, interventions that include both cognitive and physical components have been shown to be especially efficacious for improving cognition and overall function in older adults (Anderson-Hanley et al., 2012; Fabre, Chamari, Mucci, Massé-Biron, & Préfaut, 2002; Halvarsson et al., 2013). Therefore, the purpose of this pilot study was to evaluate the feasibility of adding a mindfulness component to a pre-existing exercise-based falls prevention programme for ambulatory older adults.

Methods

Participants and Recruitment

The current study was a clustered, quasi-experimental study with 22 independent-living older adults at two retirement homes in Southern Ontario. We recruited participants from residents enrolled in the falls prevention programme run by the Niagara Local Health Integration Network (LHIN). This programme consisted of physiotherapist-designed exercise classes delivered at a number of sites across the Niagara region, including the two retirement homes as the focus in our study. Classes were run by trained physiotherapist assistants (PAs) and held two to three times per week, each for a duration of 30 minutes. Each retirement home was arbitrarily designated as either the intervention or control condition. Classes administered at the intervention site consisted of the standard falls prevention class with the addition of verbal cues designed to enhance intentional focus (further described below under *Interventions*). The control site continued to administer the standard, exercise-only falls prevention class.

Participants were eligible for the study if they were referred by a physician for a mobility issue, consistent with the criteria for participation in the Southern Ontario Falls Prevention programme. Exclusion criteria included the presence of a neurological condition affecting cognition and mobility (e.g., dementia, Parkinson's disease, severely debilitating stroke), marked visual impairment, inability to ambulate, severe arthritis, or the necessity of a wheelchair. Participants enrolled into the programme were individually contacted prior to the falls prevention classes, and informed consent was obtained. Participants were not explicitly informed which experimental condition they were participating in; however, as all of our participants had previously attended the falls prevention programme, we assumed that deviations from the standard classes were obvious to participants. Thus, given the nature of the

https://doi.org/10.1017/S0714980820000033 Published online by Cambridge University Press

Table 1: Falls prevention (control) and mindfulness (intervention) class outline

Class Breakdown	Falls Prevention Class (Control)	Mindfulness Class (Intervention)
Warm-up	• Move head up/down • Move head left/right • Tap toes • Heel-to-toe • Kick legs out • Circle ankles • Circle wrists • Open and close hands • Play the piano (air) • Circle shoulders • Deep breaths • Seated reaches	• *2.5-minute body scan (CD player)* • Falls prevention class with cues *(i.e., Move head up/down exercise: move your head up and down. Feel the weight of your head as it moves through space. Feel the tension in the different areas of your neck.)*
Sit-to-stand exercises	• Sit to stand • Shift side-to-side • Heel raises • Step to the right/left • Alternating knee march • Leg lifts • Squats	• Falls prevention class with cues *(i.e., Sit to stand: plant your feet, and feel the solid ground below you. Place your hands on the arms of the chair. As you rise, focus on the feeling in your leg muscles.)*
Resistance band exercises	• Bicep curl • Shoulder raises • Seated rows • Toe taps • Knee abduction • Seated march • Leg extension • Lateral shoulder extension • Punching	• Falls prevention class with cues *(i.e., Bicep curl: feel the muscles of your arms as you perform the curl. Focus on where there is tension in your arms, and where your arms relax.)*
Cool down	• See warm-up exercises	• See warm-up exercises with cues • *Walking meditation*

Note. **Differences in the mindfulness class are italicised.**

intervention, groups were unblinded to the intervention and control arms. Participants were not compensated for this study. This study was approved by the Hamilton Integrated Research Ethics Board (HiREB).

Interventions

Participants in the exercise-only control group received the standardised Southern Ontario Falls Prevention class consisting of strength and balance exercises requiring either body weight resistance or resistance bands. The class began with warm-up exercises that targeted all body parts, including range-of-motion exercises such as shoulder rotations and leg extensions. Participants were then asked to stand, shift their weight from side to side, squat, and march on the spot. They then sat to perform resistance exercises such as bicep curls and rows with exercise bands. The class ended with a cool-down composed of exercises identical to those of the warm-up. The falls prevention classes in the control group had a designated class time of 30 minutes and were administered three times per week.

Participants in the intervention group received the above exercises in addition to the mindfulness intervention adapted from the MBSR protocol. The intervention started with a three-minute body scan, which was delivered via an audio recording from the UCLA Mindfulness Awareness Research Center (Greater Good Science Center, n.d.). Following the body scan, participants underwent the standard falls prevention exercises with supplemental verbal cues tailored to the specific class exercises. Cues were delivered by the PAs running the classes from an original script designed by the investigators. Participants were directed to focus their attention on current processes such as breathing and positioning in space (Table 1), with the goal of fostering the MBSR core concept of intentional awareness. Classes in the intervention group concluded with a walking meditation exercise, whereby participants were directed to walk while maintaining awareness of their movements and surroundings. The intervention classes also had a duration of 30 minutes, administered twice per week. Table 1 outlines the class structure for the control and intervention groups respectively.

The study duration was eight weeks. Outcomes measures were assessed by unblinded physiotherapists both prior to and eight weeks after the implementation of the intervention.

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Outcome Measures

Participants were evaluated for falls risk using the Tinetti Performance Mobility Scale, a 16-item assessment of balance and gait that generates a cumulative score corresponding to a falls risk category (low, medium, or high). This test consists of a series of tasks including sitting, ability to rise from a sitting position, standing balance, ability to turn 360 degrees, and gait (Tinetti, 1986). Each task is assessed on a discrete scale of zero to two. Additional measures included the Timed Up and Go (TUG) test, which is a timed measure of a participant's ability to stand from sitting, walk three metres, and return to the seated position. A score less than or equal to 20 seconds on the TUG test is associated with independent mobility (Lysack, 2010). The above assessments have been shown to correlate with future falls risk (Podsiadlo & Richardson, 1991; Tinetti & Kumar, 2010). We collected feasibility indicators to provide lessons learned for future studies, and these included (a) adherence rates, (b) attrition rates, and (c) a qualitative assessment of any technological or logistic difficulties during the course of the study. Adherence rates were defined as the percentage of total classes attended. Physiotherapist assistants monitored for falls during each class.

Data Analysis

We analysed the data using IBM SPSS software version 25. A one-way ANOVA let us assess for differences in baseline characteristics, and we used mixed repeated measures ANOVAs to examine within-subject and between-group differences in our outcomes as a result of the intervention. Statistical significance was set at $p < .05$.

Results

Participant Characteristics

Baseline characteristics for both groups are provided in Table 2. The two groups were comparable in terms of age but not gender, with the experimental site having a larger percentage of female participants (86% compared to 56%). At baseline, there were no significant differences between groups for balance, F (1, 18) = 3.240, p = .089. However, there were baseline differences in gait, F (1, 18) = 5.153, p = .036, and TUG, F (1, 18) = 19.264, p = .000, with the intervention group showing poorer performance.

Table 2: Mean and standard deviation for baseline participant characteristics

Demographics	Mindfulness Group ($n = 11$)	Exercise-Only Group ($n = 11$)
Age	85.13 (9.61)	86.11 (5.46)
Gender (% female)	86%	56%
Tinetti balance score	13.2 (1.2)	14.1 (1.0)
Tinetti gait score	9.9 (1.4)	11.4 (1.5)
TUG score	13.6 (3.1)	8.6 (1.8)

TUG = Timed Up and Go

Table 3: Mean and standard deviation scores for change in outcome measures

Outcome Measures	Mindfulness Group ($n = 7$)	Exercise-Only Group ($n = 9$)	Effect Size (Cohen's d)
Tinetti balance score	−0.4 (0.8)	−0.4 (2.7)	0.50
Tinetti gait score	0.0 (0.0)	−1.9 (1.5)	1.32
TUG score	1.6 (2.3)	0.6 (3.2)	0.33

Outcomes Measures

Values for outcomes measures are provided in Table 3. Analyses revealed no significant between-groups differences for either the Tinetti balance score, F (1, 14) = 0.0678, p = l.424, or the TUG test, F (1, 14) = 2.151, p = .165. There was a significant between-groups difference for the Tinetti gait score, F (1, 14) = 11.646, p = .004.

Feasibility Indicators

Consent was collected from 22 participants in total, with 11 from each retirement home. Of the 13 potential participants in the intervention group, two declined participation in the study, citing that they wished only to attend the classes and did not want to participate in the assessments. One participant was excluded from the study due to a hearing impairment which precluded their ability to attend to the verbal cues. Two participants from the intervention group left the study when a gym opened in the retirement home and they opted to exercise there rather than continue participating in the falls prevention classes. One participant from the intervention group, and two participants from the control group, did not wish to have their final assessments performed due to personal reasons. Finally, one participant chose to defer her assessment because she joined the class late into its cycle. Overall attendance was similar between both arms (53% in the intervention and 57% in the control group respectively). Feasibility indicators are provided in Table 4.

Discussion

The goals of this study were twofold: first, to determine the feasibility of implementing a mindfulness intervention for the purpose of falls reduction, and second, to determine its effectiveness on assessments of gait and

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Table 4: Feasibility indicators of the mindfulness and exercise-only groups

Feasibility Indicator	Mindfulness Group	Exercise-Only Group
Adherence (% and *SD*)	53% (24%)	57% (18%)
Attrition (%)	30%	18%
Technological issues	None	N/A
Logistic issues	Opening of a new gym facility	N/A

balance. With respect to feasibility, we found that simple mindfulness prompts are easily incorporated into a pre-existing, exercise-based framework with minimal required training. Physiotherapy assistants were both comfortable and willing to run the intervention based on the script available. Furthermore, designated class run-times were unaffected by the inclusion of the intervention, ensuring that the falls prevention programme continued to be highly accessible. This is supported by our finding that adherence rates did not significantly differ between the two experimental conditions, and that attrition was secondary to participant factors, and not as a result of the intervention itself. For example, two participants in the intervention group preferred individual exercise sessions that were offered with the opening of new facilities at the retirement home halfway through the study period. In the end, we found that the mindfulness intervention was easily incorporated into the existing falls prevention programme without significantly increasing the duration of the classes, and that the intervention appeared to be well tolerated by participants. These findings support the notion that mindfulness can be feasibly implemented into different exercise-based programmes.

Although this intervention was restricted to the class setting in which it was delivered, previous studies that have employed mindfulness interventions have often engaged participants with mindfulness "homework". This typically entails daily exercises that are performed outside of the class setting to further develop the mindfulness skillset, thereby expanding the reach of the intervention beyond the borders of the classroom (Carmody & Baer, 2008). Although this methodology was not employed in our study, the foundational concept of our intervention – active, intentional focus on the present moment – is easily applied to participants' daily activities. It is precisely this flexibility and feasibility of implementation that makes mindfulness such an appealing modality for intervening in the processes that predispose a person to falls risk.

With respect to efficacy, we found that mindfulness positively influenced parameters of fall risk. Despite finding no significant differences in balance or TUG between groups, there did appear to be a significant protective effect on gait. That is, the control group demonstrated deteriorating gait scores over time, whereas those in the intervention group showed preserved function with no appreciable changes in gait assessments. These findings may be explained by the cognitive nature of mindfulness as an intervention. As the intentional focusing of attention, mindfulness is an inherently cognitive exercise, and has been shown to prevent cognitive decline (Chiesa, Calati, & Serretti, 2011; Smith-Ray, Makowski-Woidan, & Hughes, 2014; Smith-Ray et al., 2015; Verghese, Mahoney, Ambrose, Wang, & Holtzer, 2010). Additionally, the association between cognitive function and gait has been well described in the literature (Cohen, Verghese, & Zwerling, 2016), and a recent review article by Cohen et. al notes that individuals with cognitive dysfunction are at increased risk of gait disturbances (2016). So linked are gait and cognition that slowed gait has been proposed as an early marker of impending cognitive decline (Cohen et al., 2016). It is intuitive then that mindfulness would act preferentially on complex, dynamic processes such as gait, which necessitate greater cognitive input. Accordingly, while participants in both groups performed the physical act of walking to and from classes, the act of mindful walking as a purposeful exercise in the intervention group may have allowed participants to train the cognitive components of gait.

Although we are not aware of any studies that have specifically studied the effect of mindfulness on parameters of gait, other cognitive training programmes have shown beneficial effects on balance, gait, and the TUG test. In comparison, other multi-component physical exercise programmes have generally shown small to moderate effect sizes in components of balance (0.72), gait (0.09 to 0.69), and TUG (0.42) (De Labra, Guimaraes-Pinheiro, Maseda, Lorenzo, & Millán-Calenti, 2015). One multi-component study that utilised assessments similar to our own demonstrated moderate to large effect sizes on the Tinetti mobility test (0.49) and dynamic gait (0.94) (Shumway-Cook, Gruber, Baldwin, & Liao, 1997). Other tai chi–based interventions have shown similar effect sizes on related balance scales (0.48) and dynamic gait (0.39) (Li et al., 2005). Although the limitations of this study preclude any definitive conclusions, the mindfulness intervention did show a large effect size on gait (1.32) and a moderate effect size on balance (0.50), which may warrant further studies.

Despite the general ease of implementation, there were modest barriers to universal uptake of the intervention. The body scan exercise encouraged participants to embody a cognitively relaxed state for subsequent exercises; however, there were participants who indicated that they found this unappealing, stating that it made them drowsy at the beginning of the class. This may

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have limited their engagement in the subsequent mindfulness exercises. Although drowsiness is a plausible risk factor for falls, the PAs administering the classes did not observe any falls during the course of the intervention classes. We also note that none of the participants who left the study cited the mindfulness intervention as a reason for drop-out. Additionally, previous studies utilising intervention programmes in older populations have generally been limited by high attrition rates, with some studies reporting rates of over one third in the first three months (Jancey et al., 2007; Schmidt, Gruman, King, & Wolfson, 2000). Our study showed a similar attrition rate of 30 per cent. Unfortunately, attendance was highly variable, with five out of seven participants attending over 50 per cent of the classes (11 of 21 classes), and only two participants attending over 70 per cent of classes (15 of 21 classes). Particularly among exercise programmes, studies have shown that adherence rates can vary between 58 to 77 per cent of sessions attended (Picorelli, Pereira, Pereira, Felício, & Sherrington, 2014). Our study had a slightly lower adherence rate given the large heterogeneity in class attendance. Finally, feedback from the PAs indicated that the length of the verbal cues distracted them from counting the number of repetitions done per exercise, although the implication of this is unclear.

These feasibility limitations may be minimised in the future through several potential avenues. With regards to adherence, providing a comprehensive explanation of the benefits for participants (for example, at town hall meetings) can increase resident interest in mindfulness. Similarly, increased positive reinforcement and goal planning may increase adherence over longer periods, particularly given the improvements in assessment measures seen in our study. Greater class availability (i.e., more classes during the day or week) may also increase adherence by allowing participants to better accommodate classes in their schedules. In terms of the class design, longer classes and a less structured mindfulness script may also increase the quality of exercises offered. Delaying exercises that may cause participants to feel drowsy until the end of the classes may improve participant satisfaction with mindfulness. For example, participants could benefit from starting with a mindful walking exercise and conclude with a body scan. Furthermore, participants who have hearing impairment could potentially partake in the study through classes that contain audio-video recordings with subtitles. With regards to PA's feelings of distraction, increased mindfulness training for instructors could allow PAs to provide instruction more naturally without the aid of a script.

Additional study limitations include significant between-comparison group heterogeneity at baseline, with the intervention group demonstrating poorer function on the gait-associated assessments measures. It is possible that this group derived more value from this intervention precisely because their baseline function was poorer at the outset. Furthermore, assessors were not blinded to the intervention and control arms, which may have influenced assessments. Future designs may better elucidate the role of mindfulness with respect to falls by enrolling a larger, randomised sample and by blinding assessors to the experimental groups.

Conclusion and future directions

Although the role of physical functioning with respect to falls has been robustly studied, there is increasing interest in the neurocognitive factors that predispose older adults to falls risk (Chen, Peronto, & Edwards, 2012; Public Health Agency of Canada, 2014). Impaired cognitive function is highly associated with falls incidence, with proposed mechanisms including gait disturbances and impaired attentional processes (Cohen et al., 2016). It is perhaps for this reason that programmes like tai chi, which combine physical exercises with mindfulness, have demonstrated such utility in minimising falls among seniors (Gillespie et al., 2012; Tsang & Hui-Chan, 2003). Our intervention demonstrated a protective effect of mindfulness on assessments of gait with relative ease of intervention implementation. Although the limitations of the present study proscribe any definitive conclusion regarding the efficacy of mindfulness on falls prevention, these initial results are promising and merit further investigation. As such, mindfulness may serve as a potential adjunct to future falls prevention strategies. Future studies may benefit from larger sample sizes, randomisation, and by blinding assessors to the experimental groups.

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