Article

CLINICAL REHABILITATION

Clinical Rehabilitation
2015, Vol. 29(3) 244–260

DOI: 10.1177/0269215514542636
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Can the Alexander Technique improve balance and mobility in older adults with visual impairments? A randomized controlled trial

Michael Gleeson[1], Catherine Sherrington[2], Serigne Lo[3] and Lisa Keay[1]

Abstract

Objective: To investigate the impact of Alexander Technique lessons on balance and mobility in older adults with visual impairments.

Design: Randomized assessor blinded controlled trial with intervention and usual care control groups.

Setting: Participants' homes.

Subjects: A total of 120 community-dwellers aged 50+ with visual impairments.

Intervention: Twelve weeks of Alexander lessons and usual care.

Main outcome measures: Short Physical Performance Battery items were primary outcomes at 3 months and secondary outcomes at 12 months. Additional secondary outcomes were postural sway, maximal balance range and falls over 12 months.

Results: Between-group differences in primary outcomes were not significant. The intervention group reduced postural sway on a firm surface with eyes open at 3 months after adjusting for baseline values (–29.59 mm, 95%CI –49.52 to –9.67, $P < 0.01$). Planned sub-group analyses indicated a greater intervention effect among past multiple-fallers (2+) than non-multiple fallers for gait speed ($P = 0.02$) and step length ($P < 0.01$) at 3 months and chair stand at 12 months ($P < 0.01$). There was a non-significant reduction in falls rate (IRR = 0.64, 95%CI 0.34 to 1.15, $P = 0.13$) and injurious falls (IRR = 0.61, 95% CI 0.28 to 1.30, $P = 0.20$) in the intervention group compared to the control group.

Conclusion: The intervention did not have a significant impact on the primary outcomes but benefits for the intervention group in postural sway, trends towards fewer falls and injurious falls and improved mobility among past multiple-fallers suggest further investigation of the Alexander Technique is warranted.

Keywords

Visual impairment, Alexander Technique, balance, mobility

Received: 13 November 2013; accepted: 13 June 2014

[1]Injury Division, The George Institute for Global Health, Sydney Medical School, The University of Sydney, Australia

[2]Musculoskeletal Division, The George Institute for Global Health, The University of Sydney, Australia

[3]Statistical Division, The George Institute for Global health, The University of Sydney, Australia

Corresponding author:
Lisa Keay, The George Institute for Global Health, PO Box M201, Missenden Rd, NSW 2050, Australia.
Email: lkeay@georgeinstitute.org.au

Background

Visual impairment is an independent risk factor for falls.[1-3] Well-designed exercise programs reduce falls in the general population[4,5] but have not been successful in community-dwelling older adults with visual impairments.[6] Three small studies in residential settings have shown multimodal exercise and Tai Chi improve physical functioning[7-9] in controlled environments where physical and verbal guidance is provided, but these results cannot be generalized to community-dwelling adults who are more mobile and encounter more environmental hazards.

The Alexander Technique uses verbal feedback and manual guidance to teach awareness of previously unnoticed tension. The Alexander Technique was developed in the 1890s and evolved within the performing arts but is also taught to people with movement difficulties with the aim of enhancing coordination and balance. It has only recently been investigated for therapeutic benefits.[10-12] The Alexander Technique may be a suitable intervention for people with visual impairment as it does not require vision or the performance of regular exercises to learn successfully. Although the physiological rationale has not been fully evaluated, Alexander Technique lessons have been shown to reduce axial stiffness through the spine and enhance dynamic modulation of muscle tone.[13]

The VISIBILITY study was designed to establish the impact of the Alexander Technique on physical functioning in community-dwelling older adults with visual impairments when compared to usual care. The outcomes were chosen due to their importance in their own right as well as their likely role in the prediction of falls. The protocol for this trial has been published elsewhere.[14]

Methods

Ethical approval was granted by the Human Research Ethics Committees at the University of Sydney (Protocol no. 12985) and the University of New South Wales (HREC10277). The trial was registered with the Australian New Zealand Clinical Trials Registry at http://www.ANZCTR.org.au/ACTRN12610000634077.aspx (ACTRN12610000634077). The study described in this paper adhered to the tenets of the Declaration of Helsinki.

Participants were recruited from the client database of a community organisation providing support for people with visual impairments in Sydney, Australia (Guide Dogs). Participants were required to be 50-90 years of age, live within the Sydney metropolitan area, not need an interpreter, and have had Orientation & Mobility training within the previous five years. We included people from age 50 years as reliance on vision for postural stability in bilateral stance on compliant surfaces is evident in women in their 50s.[15] Further, the most recent data shows that 82% of blind individuals and 65% of those with visual impairments are over 50 years of age.[16] We did not exclude people with neurological or cardio-thoracic disease in this study because incidence of breathing problems, diabetes, heart problems, hypertension and stroke is higher in people with visual impairments[17] and we wanted our sample to be representative of this population.

Clients meeting these criteria were sent an invitation and follow-up phone calls were made to those who did not respond. Recruitment ran from August 2010 to August 2011, and 488 potential participants were contacted. Telephone screening by one researcher excluded clients who were not independently mobile, did not have conversational English, or were planning cataract surgery within 12 months. Participants were assessed at baseline, 3 and 12 months in their own homes. Participant flow through the trial is presented in Figure 1. The CONSORT statement[18] was used to guide the content of this paper.

This study used a randomized assessor-blinded controlled parallel group design with equal numbers in the intervention and control groups. Four Orientation & Mobility instructors from Guide Dogs attended a two-day training session on assessment procedures to ensure conformity to protocol. Written informed consent was obtained, demographic data collected and the Short Portable Mental Status Questionnaire[19] administered prior to enrolment. Clients with two or less corrected errors on the Short Portable Mental Status Questionnaire

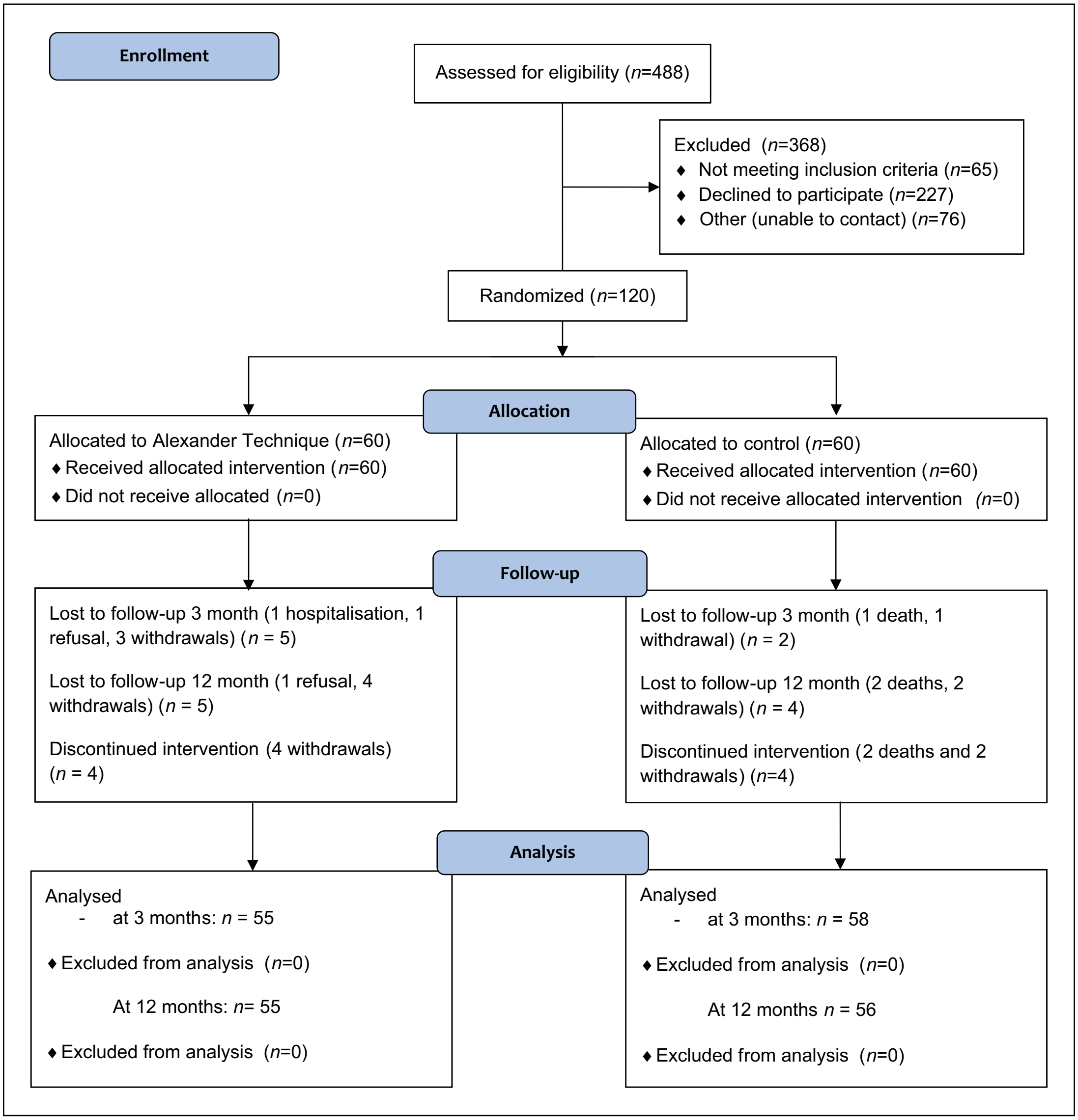

Figure 1. Flow of participants through the study.

were enrolled and the baseline assessment administered. Assessors informed one researcher who allocated a unique ID. They were then block-randomized (block permutation size 1, 2 and 4) using a computer generated list from http://www.randomization.com kept by a separate centre-based investigator who had no contact with the participants.

We were not able to include comprehensive vision assessments in baseline data collection as the assessments were performed in the participants' homes. Instead we obtained written consent from participants to contact their eye care practitioner if a recent report was not available. The nature of the study meant participants and the intervention provider could not be masked to group allocation. All outcome assessors remained masked to group allocation for all assessments, and participants were asked not to reveal their allocation status. The study was run in four blocks of 30 participants between September 2010 and December 2011, with the baseline assessment and randomization occurring prior to commencement of each block.

The control group received usual care from Guide Dogs and the intervention group received a weekly Alexander Technique lesson for 12 weeks in addition to usual care. Constraints on resources necessitated a reduction from a recommended 20-25 Alexander Technique lessons to 12 for this trial. This was chosen for feasibility of implementation and delivery within and beyond the study context. A factorial randomized trial for back pain found that six Alexander lessons followed by exercise prescription were nearly as effective as 25 lessons which provided some precedence for this reduction[10] although the study populations are different and this was a novel intervention in the population with visual impairment.

Lessons were typically 30 minutes in length. They provided a cognitive construct for examining habitual responses to the familiar stimuli that precede voluntary movements and did not prescribe the strength and balance exercises common in traditional therapy programs. A lesson protocol was developed using everyday activities such as movements between sitting and standing (approximately one third of each lesson), getting to and from the floor (approximately one third of each lesson) and walking, climbing stairs and carrying everyday articles (the remainder). As subsequent lessons were based on prior progress, the lesson plan was modified as necessary. The Alexander Technique lessons were delivered by one person who is an accredited teacher of the Alexander Technique. The lesson protocol is provided as online supplementary material.

The primary outcomes were the three items from the Short Physical Performance Battery[20] at three months. These were five times sit-to-stand test, the four metre walk, and the standing balance test which includes side-by-side, semi-tandem, tandem and single limb balance tests. All the tests are timed, and better performance in the sit-to-stand and walking items is indicated by quicker performance and better performance in the standing balance test is indicated by holding each position longer. The study was powered using the three items from the battery individually (primary outcome), but as they are usually presented as a total score[20] and more recently as a summary performance score[21] we analysed the results individually and in the total and summary performance formats as well.

The 12 month measures from the Short Physical Performance Battery were secondary outcomes along with the postural sway tests from the Physiological Profile Assessment[22] and the maximal balance range test[23] at three and 12 months. The sway tests required participants to stand quietly for 30 seconds on firm and foam surfaces with eyes open and closed. Postural sway was traced on graph paper using a standardised instrument developed for the Physiological Profile Assessment.

Although the trial was not powered to detect an effect on fall rates, falls were collected prospectively with calendars over 12 months as these data would provide an indication of the size of any potential effect on falls. Participants recorded falls daily on calendars which were mailed to researchers on a monthly basis as recommended by the Profane Consensus.[24] Electronic calendars were provided for those with accessible technology via email if they were unable to use paper calendars. Where participants were unable to view the calendar, carers or family members agreed to manage the calendars on their behalf, and participants were contacted by telephone to record the details of any reported falls. The Short Falls Efficacy Scale – International[25] was also administered at baseline, 3 and 12 months as an additional secondary outcome related to participants concerns about falling. Supplementary data on social and emotional wellbeing was also collected and will be reported in a further paper.

Originally the primary outcomes were the three measures from the Short Physical Performance Battery at 3 and 12 months, however as there was uncertainty about effects beyond three months and for efficiency of project timelines, the 12 month outcomes were converted to secondary outcomes prior to the 12 month data collection or any data analysis (change to trial protocol made on 16 January 2012).

Sample size calculations indicated that 60 individuals in each of the two groups (n = 120) would give the study 80% power to detect a 15% relative difference between the groups at a 5% level of significance allowing for 15% drop-outs during the 12 months. The sample size calculations used data from a previous study in a similar population.[26] The estimates of between-group differences used in power calculations for the three primary outcomes measures were: five times sit to stand (effect 3.6 seconds, standard deviation 9.0, correlation between baseline and final measure 0.7), timed four metre walk (effect 0.1 meter/second, standard deviation 0.25, correlation between baseline and final measure 0.7) and standing balance test (effect 3.6 seconds, standard deviation 9.0, correlation between baseline and final measure 0.7).

A statistical analysis plan was developed prior to analysis and is available from the corresponding author on request. Data were analysed on an intention to treat basis. Physical assessment data at the 3 and 12 month visits for intervention and control groups were compared with adjustment for baseline values using linear regression models, and fall rates were compared using negative binomial regression models. A per-protocol analysis based on participants who received at least 50% of the intervention and four subgroup analyses were specified in the statistical analysis plan. Sub-group analyses were undertaken using interaction terms (group x subgroup variable) in the models and sub-groups were based on a) level of cognitive impairment (above and below the median), b) duration of visual impairment (above and below the median), c) visual field status (presence or absence of peripheral field in one or both eyes), and d) number of falls in the previous year (≤ 1 falls and ≥ 2 falls). A REDCap[27] online database system was used to manage all data after keyed data entry and 10% double-data entry confirmed < 7% errors, none of these in key variables. Data were analysed with SAS Version 9.2 and Stata Version 12.

Results

Figure 1 shows participant flow through the study. Of the 488 clients identified by the database, 227 declined to participate, 65 did not meet the inclusion criteria and 76 could not be contacted. We assessed 124 potential participants in their homes and excluded four prior to randomization for poor performance on the Short Portable Mental Status Questionnaire. We randomized 30 participants prior to the commencement of each intervention block (September 2010, January 2011, April 2011 and August 2011). Of the 120 participants who entered the study (Figure 1) 10 did not complete all assessments.

The study population had a mean (SD) age of 75 (11) years, were predominantly female and the majority suffered visual impairment from age-related macular degeneration (Table 1). Physical measures at baseline revealed that the control group had a slightly lower level of physical functioning, (Table 2) however more people fell two or more times in the intervention group in the year prior to the study (Table 1).

Between-group differences in the three primary outcome tests from the Short Physical Performance Battery did not reach statistical significance at 3 months (Table 2). Between-group differences in the same measures as secondary outcomes were also not statistically significant at 12 months (Table 2). The total score[20] and continuously-scored summary performance score version[21] of the Short Physical Performance Battery, and the number of steps in the four metre walk at 3 and 12 months are also presented in Table 2. The number of steps in the four metre walk improved in the intervention group compared to the control group at three months after adjusting for baseline values (–0.90 steps, 95%CI, –1.56 to –0.23, P <0.01) suggesting increased confidence when walking.

The 3 and 12 month data for the balance tests are presented in Table 3. When adjusted for baseline, there was significantly less postural sway in the intervention group compared to the control group in the 'Firm Surface Eyes Open' condition at 3 months (–29.59mm, 95%CI –49.52 to –9.67, P <0.01). At 12 months there were no between-group differences in the physical measures although there was a trend to better performance in the maximal balance range measure (P = 0.07) in the intervention group.

Table 1. Baseline demographic characteristics of study participants by group allocation.

Baseline demographic characteristics	Intervention group (*N* = 60)	Control group (*N* = 60)
Age in years: mean (SD)	74.7 (10.9)	74.9 (11.0)
Female: *n* (%)	43 (72)	42 (70)
Education in years: mean (SD)	12.6 (3.9)	11.5 (3.8)
Corrected errors on SPMSQ: mean (SD)	0.52 (0.83)	0.73 (0.86)
Duration impaired in years: median (IQR)	10.0 (18)	15.5 (38)
Neurological symptoms: *n* (%)	14 (23)	10 (17)
Falls in previous year: mean (SD)	2.5 (1.7)	2.9 (5.2)
≥ 2 falls in year prior to study *n* (%)	21 (35)	17 (28)
Number of medications: mean (SD)	5.5 (3.6)	5.3 (3.02)
Take psychotropic medication: *n* (%)	10 (17)	10 (17)
Legally blind: *n* (%)	46 (77)	49 (82)
Living alone: *n* (%)	37 (62)	34 (57)
Body Mass Index: Kg/m^2	26.8 (5.0)	28.4 (4.9)
Comorbidities: mean (SD)	6.8 (3.3)	7.3 (3.2)
Visual acuity (vision report)		
Better than 6/18: *n* (%)	7 (12)	7 (12)
6/18 to 6/60: *n* (%)	6 (10)	1 (2)
6/60 or worse: *n* (%)	45 (75)	49 (82)
Field data (vision report)		
Peripheral loss – one eye: *n* (%)	4 (7)	4 (7)
Peripheral loss – both: *n* (%)	13 (22)	6 (10)
Central loss – one eye: n (%)	5 (8)	4 (7)
Central loss – both: n (%)	17 (28)	19 (32)
Total field involvement: n (%)	9 (15)	16 (27)
Diagnosis by vision report		
Macular disease: *n* (%)	22 (37)	25 (42)
Glaucoma: *n* (%)	9 (15)	5 (8)
Cerebral injury: *n* (%)	4 (7)	2 (3)
Diabetic retinopathy: *n* (%)	3 (5)	3 (5)
Retinitis Pigmentosa: *n* (%)	9 (15)	5 (8)
Other: *n* (%)	13 (22)	20 (33)
Assistance:		
Agency assistance: *n* (%)	26 (43)	31 (52)
Weekly or more: *n* (%)	16 (27)	18 (30)
Family assistance: *n* (%)	25 (42)	27 (45)
Weekly or more: *n* (%)	20 (33)	22 (37)

n = number, SD = standard deviation, IQR = Interquartile range, SPMSQ = Short Portable Mental Status Questionnaire.

There were no significant between group differences in intervention and control groups at three months (-0.69 points, 95%CI -1.77 to 0.38, P = 0.21) or 12 months (0.0008 points, 95%CI -1.26 to 1.26, P = 0.99) on the Short Falls Efficacy Scale – International. Only four participants received less than 50% of the intervention and they withdrew before the post-intervention assessment, so the per-protocol analysis was not required. There was no indication of a differential effect of the intervention on the physical measures based on cognitive impairment or visual field status.

Table 2. Short Physical Performance Battery. Single items, total and summary performance scores and number of steps in 4 metre walk at 3 months and 12 months Mean (SD) of groups, mean (SD) difference within groups, and mean (95% CI) difference between groups with P values.

Outcome	Groups						Difference within groups				Difference between groups	
	Baseline		3 months		12 months		3 months minus baseline		12 months minus baseline		3 months adjusted for baseline	12 months adjusted for baseline
	Int (n = 60)	Con (n = 60)	Int (n = 55)	Con (n = 58)	Int (n = 55)	Con (n = 56)	Int	Con	Int	Con	Int-Con	Int-Con
*Short Physical Performance Battery items												
Standing balance *(seconds)*	48.65 (9.37)	46.25 (8.70)	51.29 (7.45)	47.93 (8.83)	50.80 (8.08)	48.36 (9.89)	2.29 (7.18)	1.22 (7.98)	1.94 (8.16)	1.49 (8.78)	2.07 (−0.42 to 4.56) P = 0.10	1.31 (−1.60 to 4.23) P = 0.37
Chair stand test *(seconds)*	15.96 (5.27)	17.57 (6.12)	16.16 (5.19)	17.29 (6.13)	15.21 (4.50)	17.34 (6.72)	0.12 (5.05)	−0.90 (3.80)	−0.85 (5.53)	−0.59 (4.24)	0.39 (−1.10 to 1.89) P = 0.60	−0.92 (−2.59 to 0.75) P = 0.28
Gait speed *(metres per second)*	0.98 (0.41)	0.89 (0.33)	0.96 (0.31)	0.86 (0.31)	0.99 (0.38)	0.94 (0.33)	−0.03 (0.32)	−0.04 (0.19)	−0.02 (0.31)	0.02 (0.24)	0.05 (−0.03 to 0.13) P = 0.24	−0.01 (−0.11 to 0.09) P = 0.83
Secondary outcomes												
Total score (ordinal 0 –12)	8.58 (2.58)	7.85 (2.26)	9.06 (1.90)	8.23 (2.64)	9.11 (1.97)	8.69 (2.47)	0.25 (1.78)	0.28 (1.67)	0.31 (1.87)	0.56 (1.99)	0.21 (−0.40 to 0.82) P = 0.49	0.01 (−0.66 to 0.68) P = 0.97
Summary performance score (continuous 0 – 3)	2.25 (0.32)	2.13 (0.35)	2.30 (0.24)	2.18 (0.41)	2.31 (0.24)	2.21 (0.37)	0.04 (0.24)	0.06 (0.24)	0.07 (0.29)	0.05 (0.31)	0.02 (−0.07 to 0.10) P = 0.66	0.07 (−0.03 to 0.17) P = 0.19
Number of steps in 4 meter walk	8.92 (3.08)	8.86 (2.67)	8.36 (2.30)	9.23 (3.34)	8.67 (3.69)	8.67 (2.40)	−0.47 (1.86)	0.43 (1.84)	−0.09 (1.78)	−0.06 (1.69)	−0.90 (−1.56 to −0.23) P = 0.009	−0.04 (−0.69 to 0.62) P = 0.92

Int = intervention group, Con = control group.

*Standing balance, chair stand test and gait speed were primary outcomes at 3 months and secondary outcomes at 12 months.

Table 3. Maximal balance range and postural sway tests from the Physiological Profile Assessment at 3 and 12 months (secondary outcomes) Mean (SD) of groups, mean (SD) difference within groups, and mean (95% CI) difference between groups with *P* values.

Outcome	Groups						Difference within groups				Difference between groups	
	Baseline		3 months		12 Mmonths		3 months minus baseline		12 months minus baseline		3 months adjusted for Baseline	12 Months adjusted for Baseline
	Int (*n* = 60)	Con (*n* = 60)	Int (*n* = 55)	Con (*n* = 58)	Int (*n* = 55)	Con (*n* = 56)	Int	Con	Int	Con	Int-Con	Int-Con
Maximal balance range test												
Maximal balance range *(cm)*	12.58 (4.21)	11.99 (3.46)	13.13 (4.35)	12.17 (3.52)	13.16 (4.22)	11.57 (3.60)	0.05 (3.60)	0.17 (3.12)	0.17 (3.64)	−0.62 (3.48)	0.22 (−0.96 to 1.40) *P* = 0.71	1.14 (−0.09 to 2.38) *P* = 0.07
Postural sway tests from the Physiological Profile Assessment												
Firm surface eyes open *(total mm)*	122.92 (81.33)	145.53 (180.37)	99.20 (46.63)	130.11 (89.28)	123.70 (79.44)	137.93 (78.93)	−22.74 (62.65)	6.09 (57.02)	3.38 (60.23)	14.91 (86.36)	−29.59 (−49.52 to −9.67) *P* = 0.004	−12.71 (−38.09 to 12.66) *P* = 0.32
Firm surface eyes closed *(total mm)*	151.28 (104.11)	178.32 (117.70)	130.68 (83.61)	167.26 (117.91)	150.67 (104.85)	172.04 (113.68)	−14.40 (77.32)	−4.88 (105.06)	1.24 (77.32)	4.16 (99.27)	−20.60 (−52.16 to 10.95) *P* = 0.20	−8.79 (−39.69 to 22.11) *P* = 0.57
Foam surface eyes open *(total mm)*	353.81 (183.91)	342.39 (220.07)	351.21 (196.70)	322.07 (179.28)	299.15 (153.02)	321.17 (165.74)	5.54 (197.78)	−10.36 (186.98)	−36.13 (157.76)	−4.81 (193.68)	19.19 (−43.27 to 81.65) *P* = 0.54	−34.45 (−88.58 to 19.67) *P* = 0.21
Foam Surface Eyes Closed *(total mm)*	465.24 (260.05)	482.83 (283.71)	491.10 (298.11)	442.82 (253.60)	471.47 (259.57)	471.72 (268.62)	42.70 (283.43)	−37.00 (249.36)	24.96 (139.54)	3.64 (251.00)	60.88 (−30.82 to 152.58) *p* = 0.19	11.35 (−64.72 to 87.42) *p* = 0.77

Int = experimental group, Con = control group, cm = centimeters, mm = millimeters.

The subgroup analysis by duration of visual impairment produced variable results. There was an indication (interaction term $P = 0.05$) of a greater intervention impact on maximal balance range in those with a shorter duration of visual impairment but a greater impact on postural sway (interaction term $P = 0.04$) in those with a longer duration (> 14 years) of impairment at 12 months. Those with a longer duration of impairment also took longer to perform the chair stand at three months (interaction term $P = 0.03$). These results are presented in Table 4.

Analysis by subgroup based on number of falls in the previous year (multiple fallers ≥ 2 falls; non-multiple fallers ≤ 1 fall) showed larger between-group differences in multiple fallers on several tests at 3 months and 12 months. The intervention had a greater effect on multiple fallers compared to non-multiple fallers in three month measures of gait speed (interaction term $P = 0.01$; between group difference for multiple fallers after adjusting for baseline values 0.19 metres/second, 95%CI 0.03 to 0.36, $P = 0.02$; for non-multiple fallers -0.02 metres/second, 95%CI -0.12 to 0.08, $P = 0.68$) and steps taken in the 4 metre walk (interaction term $P < 0.01$; between group difference for multiple fallers after adjusting for baseline values -2.20 steps, 95%CI -3.79 to -0.62, $P < 0.01$; non-multiple fallers -0.32 steps, 95%CI -0.95 to 0.30, $P = 0.31$), and all the significant subgroup analyses by previous falls at 3 months are reported in Table 5.

The intervention also had a greater effect on multiple fallers compared to non-multiple fallers on the chair stand at 12 months (interaction term $P < 0.01$; between group difference for multiple fallers after adjusting for baseline values, -5.40 seconds, 95%CI -8.78 to -2.03, $P < 0.01$; for non-multiple fallers 0.90 seconds, 95%CI -0.92 to 2.72, $P = 0.33$) and all the significant subgroups analyses by previous falls at 12 months are reported in Table 6.

Subgroup analysis by cognitive impairment, duration of impairment, visual field status and previous falls did not reveal any significant sub-group differences between the intervention and control groups at 3 and 12 months on the Short Falls Efficacy Scale – International.

The mean number of calendars provided by the intervention group was 11.08 (range 0-12) and for the control group 11.03 (range 0-12). The mean number of falls was 0.93(range 0-7) in the intervention group and 1.37(range 0-17) in the control group. There were 82 falls in the control group compared to 56 falls in the intervention group. Injuries were reported in 54% of these falls, including three fractures and three head injuries, one of which lead to death (Table 7). Additional characteristics of the falls recorded by prospective calendars over 12 months are also provided in Table 7.

The unadjusted analysis (Table 8) showed a non-significant 33% lower rate of falls in the intervention group compared to the control group (IRR = 0.67, 95%CI 0.36 to 1.26, $P = 0.22$) and a 51% lower rate of injurious falls in the intervention group compared to the control group which approached statistical significance (IRR = 0.49, 95%CI 0.22 to 1.11, $P = 0.09$). A secondary analysis (Table 8) adjusted for past falls, visual field status and duration of impairment also revealed a non-significant 36% lower rate of falls in the intervention group compared to the control group (IRR = 0.64, 95%CI 0.34 to 1.15, $P = 0.13$) and a non-significant 39% lower rate of injurious falls in the intervention group compared to the control group (IRR = 0.61, 95%CI 0.28 to 1.30, $P = 0.20$).

As there were a small number of multiple fallers who fell > 10 times, there was some concern that this may have skewed the results so an additional analysis which capped falls at 10 per participant was performed. This analysis yielded similar results (Table 8). The incidence rate ratios for total and injurious falls adjusted for past falls are presented in Table 8, along with the subgroup analyses. Although increased falls risk and fall rates have been reported in individuals with neurological impairments[28,29] the inclusion of these individuals was distributed across both groups in this study and did not differentially influence the outcomes (Table 1).

Discussion

Between-group differences in the primary outcomes were not significant, however the number of

Table 4. Subgroup analysis by duration of impairment (years ≤ 14 or > 14 years) significant interactions at 3 months and 12 months.

At 3 months	Groups				Difference within groups		Difference between groups
Subgroup analysis	Baseline		Month 3		Month 3 – baseline		Month 3 adjusted for baseline
	Intervention	Control	Intervention	Control	Intervention	Control	
Primary outcomes: Short Physical Performance Battery Item							
Chair stand test (seconds): Interaction terms for (duration impaired * group) $P = 0.03$							
≤ 14 years: mean (SD)	17.21 (5.78) $n = 34$	18.27 (6.67) $n = 26$	16.21 (5.13) $n = 32$	18.47(6.62) $n = 27$	−1.21 (5.57) $n = 31$	−0.34(3.40) $n = 25$	−1.10 (−3.25 to 1.05, $P = 0.31$)
> 14 years: mean (SD)	14.10 (3.80) $n = 23$	16.98 (5.67) $n = 31$	16.09 (5.38) $n = 23$	16.26 (5.58) $n = 31$	2.00 (3.54) $n = 22$	−1.38 (4.09) $n = 30$	2.44 (0.27 to 4.50, $P = 0.03$)
At 12 months	Baseline		Month 12		Month 12 – baseline		Month 12 adjusted for baseline
Secondary outcomes: Maximal balance range test, sway tests from the Physiological Profile Assessment							
Maximal balance range (cm): Interaction terms for (duration impaired * group) $P = 0.05$							
≤ 14 years: mean (SD)	12.82 (4.07) n=35	11.54 (3.32) n=28	13.77 (3.64) n=31	10.57 (3.41) n=25	0.4 (3.60) n=31	−1.37 (3.54) n=25	2.50 (0.81 to 4.19, P=0.0045)
> 14 years: mean (SD)	12.23 (4.47) n=24	12.39 (3.59) n=31	12.34 (4.86) n=23	12.37(3.61) n=31	−0.16 (3.75) n=22	−0.02(3.37) n=31	−0.07 (−1.93 to 1.79, P=0.94)
Firm surface eyes open (mm): Interaction terms for (duration impaired * group) $P = 0.04$							
≤ 14 years: mean (SD)	111.74 (75.48) n=35	167.86 (254.06) n=28	136.90 (95.76) n=31	127.12 (80.02) n=25	19.19 (51.71) n=31	3.96 (102.55) n=25	13.15 (−25.53 to 51.82, P=0.50)
> 14 years: mean (SD)	138.56 (88.06) n=25	126.00 (69.68) n=32	105.91 (46.08) n=23	146.65 (78.25) n=31	−17.91 (65.33) n=23	23.74 (71.27) n=31	−41.16 (−74.44 to −7.88, P=0.02)

cm = centimeters, mm = millimeters.

Table 5. Subgroup analysis by previous falls (multiple fallers ≥2 or non-multiple fallers ≤ 1) significant interactions for Short Physical Performance Battery at 3 months.

Subgroup analysis	Groups				Difference within groups		Difference between groups
	Baseline		Month 3		Month 3 – baseline		Month 3 adjusted for baseline
	Intervention	Control	Intervention	Control	Intervention	Control	
Primary outcomes: Short Physical Performance Battery items							
Gait speed (metres per second): Interaction term for (previous falls*group) *P* = 0.01							
Multiple fallers: mean (SD)	0.92 (0.39) *n* = 21	0.81 (0.35) *n* = 16	0.98 (0.38) *n* = 20	0.76 (0.32) *n* = 17	0.09 (0.30) *n* = 20	−0.08 (0.20) *n* = 16	0.19 (0.03 to 0.36, *P* = 0.02)
Non-multiple fallers: mean (SD)	1.02 (0.41) *n* = 38	0.92 (0.32) *n* = 43	0.95 (0.29) *n* = 35	0.91 (0.30) *n* = 40	−0.10 (0.32) *n* = 35	−0.02 (0.19) *n* = 40	−0.02 (−0.12 to 0.08, *P* = 0.68)
Secondary outcomes: Summary Performance Score, number of steps in 4 metre walk							
Summary Performance Score (continuous 0 -3): Interaction term for (previous falls*group) *P* = 0.048							
Multiple fallers: mean (SD)	2.25 (0.27) *n* = 20	1.97 (0.44) *n* = 15	2.30 (0.26) *n* = 20	2.02 (0.44) *n* = 17	0.07 (0.25) *n* = 19	0.03 (0.30), *n* = 15	0.14 (−0.05 to 0.32, *P* = 0.15)
Non-multiple fallers: mean (SD)	2.25 (0.35) *n* = 37	2.19 (0.29) *n* = 41	2.30 (0.24) *n* = 35	2.24 (0.38) *n* = 40	0.02 (0.24) *n* = 34	0.07 (0.21), *n* = 38	−0.03 (−0.12 to 0.06, *P* = 0.54)
Number of steps in 4 metre walk: Interaction term for (previous falls*group) *P* = 0.008							
Multiple fallers: mean (SD)	9.67 (3.40) *n* = 21	9.94 (3.28) *n* = 16	8.85 (2.78) *n* = 20	10.94 (4.34) *n* = 17	−1.00 (2.49) *n* = 20	1.19 (2.26) *n* = 16	−2.20 (−3.79 to −0.62, *P* = 0.008)
Non-multiple fallers: mean (SD)	8.50 (2.72) *n* = 38	8.47 (2.33) *n* = 43	8.09 (1.96) *n* = 35	8.50 (2.54) *n* = 40	−0.17 (1.34) *n* = 35	0.13 (1.57) *n* = 40	−0.32 (−0.95 to 0.30, *P* = 0.31)

Table 6. Subgroup analysis by previous falls (multiple fallers ≥2 or non-multiple fallers ≤ 1) significant interactions for Short Physical Performance Battery at 12 months.

At 12 months	Groups				Difference within groups		Difference between groups
	Baseline		Month 12		Month 12 – baseline		Month 12 adjusted for baseline
Secondary outcomes: Short Physical Performance Battery items, total score, summary performance score, number of steps in 4 metre walk							
Chair stand test (seconds) Interaction term for (previous falls*group) $P = 0.0004$							
Multiple fallers mean (SD)	15.45 (4.82) n = 20	19.35 (6.19) n = 16	14.08 (3.44) n =19	21.84 (7.73) n = 16	−1.83 (4.840 n = 18	1.65 (5.36) n = 15	−5.40 (−8.78 to −2.02, P = 0.003)
Non-multiple fallers: mean (SD)	16.23 (5.54) n = 37	16.87 (6.03) n = 41	15.83 (4.93) n = 35	15.55 (5.40) n = 40	−0.33 (5.86) n = 39	−1.45 (3.43) n = 39	0.90 (−0.92 to 2.72, P = 0.33)
Gait speed (metres per second) interaction term for (previous falls*group) $P = 0.02$							
Multiple fallers: mean (SD)	0.92 (0.39) n = 21	0.81 (0.35) n = 16	1.05 (0.49) n = 19	0.81 (0.44) n = 16	0.11 (0.21) n = 19	0.003 (0.36) n = 15	0.12 (−0.09 to 0.32, P= 0.27)
Non-multiple fallers: mean (SD)	1.02 (0.41) n = 38	0.92 (0.32) n = 43	0.96 (0.31) n = 35	0.99 (0.26) n = 39	−0.09 (0.33) n = 35	0.03 (0.19) n = 39	−0.08)−0.18 to 0.02, P = 0.11)
Total score (ordinal 0 – 12) interaction term for (previous falls*group) $P = 0.02$							
Multiple fallers: mean (SD)	8.52 (2.54) n = 21	6.94 (2.30) n = 17	9.05 (2.37) n = 19	7.00 (2.65) n = 15	0.58 (1.71) n = 19	0 (2.45) n = 15	1.09 (−0.32 to 2.49, P = 0.12)
Non-multiple fallers: mean (SD)	8.62 (2.63) n = 39	8.21 (2.17) n = 43	9.14 (1.75) n = 35	9.33 (2.09) n = 39	0.17 (1.96) n = 35	0.77 (1.77) n = 39	−0.41 (−1.15 to 0.34, P = 0.28)
Summary performance score (continuous 0 -3) interaction term for (previous falls*group) $P = 0.01$							
Multiple fallers: mean (SD)	2.25 (0.27) n = 20	1.97 (0.44) n = 15	2.32 (0.29) n = 19	1.96 (0.49) n = 15	0.11 (0.21) n = 18	−0.01 (0.52) n = 13	0.26 (−0.01 to 0.52, P = 0.06)
Non-multiple fallers: mean (SD)	2.25 (0.35) n = 37	2.19 (0.29) n = 41	2.32 (0.22) n = 35	2.30 (0.26) n = 39	0.05 (0.32) n = 34	0.07 (0.21) n = 38	0.003 (−0.09 to 0.10, P = 0.95)

Table 7. VISIBILITY falls data by group allocation.

Variable	Prior year (self-report)		Study year (calendar)	
	Intervention	Control	Intervention	Control
Total months recorded: *n*			665	662
Months per person: mean (SD)			11.08 (3.10)	11.03 (2.91)
Participants who fell: *n* (group %)	34 (57)	32 (53)	25 (42)	27 (45)
≥ 2 falls year: *n* (group %)	21 (35)	17 (28)	13 (22)	16 (27)
Falls per month: *n*	7.17	7.83	4.667	7.279
Falls per person year: *n*	1.43	1.57	1.01	1.49
Number of falls: *n* (total %)	86 (48)	94 (52)	56 (41)	82 (59)
Number of falls: mean (SD)			0.93 (1.55)	1.37 (3.08)
Inside falls: *n* (group %)			15 (27)	34 (41)
Outside falls: *n* (group %)			41 (73)	47 (57)
Total injurious falls: *n* (group %)			25 (45)	50 (61)
Head injuries: *n* (group %)			0 (0)	3 (4)
Fractures: *n* (group %)			1 (2)	2 (2)
Sprains: *n* (group %)			2 (4)	10 (12)
Cuts: *n* (group %)			15 (27)	9 (11)
Other: *n* (group %)			16 (28)	33 (40)
Cause of fall:				
Tripped: *n* (group %)			29 (52)	48 (59)
Slipped: *n* (group %)			11 (20)	8 (10)
Lost balance: *n* (group %)			8 (14)	11 (13)
Other: *n* (%)			8 (14)	15 (18)
Time of fall:				
00:00 < fall ≤ 06:00			0 (0)	3 (4)
06:00 < fall ≤ 12:00			20 (36)	32 (39)
12:00 < fall ≤ 18:00			30 (54)	22 (27)
18:00 < fall ≤ 24:00			3 (5)	11(13)

steps in the 4-metre walk and postural sway in quiet standing both improved significantly in the intervention group at 3 months, suggesting an improvement in balance. There were also greater intervention effects in the subgroup of multiple fallers who are at an increased risk of injury compared to non- multiple fallers.

Around one third of people over 65 years of age in the general population fall each year,[28,30] but we found a 43% fall rate in our study. Injuries were reported in 54% of the falls in this study, which is also higher than the 31.3% rate reported in the general older population.[30] This highlights the vulnerability of this population to fall-related injury and the need to identify interventions with the potential to reduce this level of risk. Although the study was not powered for falls the trend towards a lower rate of falls and injurious falls in the intervention group is an encouraging result given that fall reduction from a physical intervention has not been reported in community-dwelling older adults with visual impairments to date.[6]

The Alexander Technique emphasises the need for more perceptual awareness in activity and does not use repetitive exercises or strength training. The focus is on quality of movement and economy of effort, and teaches the individual how to best use the resources they have to perform ordinary daily activities. For this reason there would not necessarily be an expectation that performance speeds would

Table 8. Fall rate analysis by group allocation.

Primary unadjusted analysis:
All falls (IRR = 0.67, 95%CI 0.36 to 1.26, P = 0.216)
Injurious falls (IRR = 0.49, 95%CI 0.22 to 1.11, P = 0.089)
Adjusted for past falls:
All falls (IRR = 0.79, 95%CI 0.44 to 1.42, P = 0.431)
Injurious falls (IRR = 0.60, 95%CI 0.28 to 1.29, P = 0.193)
Falls (capped at 10) adjusted for past falls (capped at 10):
All falls (IRR = 0.81, 95%CI 0.46 to1.42, P = 0.463)
Injurious falls (IRR = 0.57, 95%CI 0.26 to 1.26, P = 0.165)
Adjusted for past falls, duration of impairment, visual fields
All falls (IRR = 0.64, 95%CI 0.34 to 1.15, P = 0.13)
Injurious falls (IRR = 0.61, 95% CI 0.28 to 1.30, P = 0.20)
Subgroup Analyses: There were no significant subgroup differences
Previous falls: ≤ 1 fall (n= 82) or ≥ 2 falls (n= 38) in previous year; P = 0.7
Duration impaired: ≤ 14 years (n = 56) >14 years (n = 53); P = 0.8
Visual fields: Yes (n = 52) /no (n = 59) peripheral field involvement; P = 0.7

increase, although this is likely in those whose performance is poor, and improved performance could theoretically lead to increased mobility over time.

Older adults with visual impairments have a higher risk of falls due to limited environmental preview and the impact of reduced visual input on postural control.[31,32] This helps explains why home modification and safety programs reduce falls in this population.[33] The Alexander Technique does not require the regular performance of exercises and so may be a more acceptable intervention in this vulnerable population as it may not put the participants at perceived risk of harm.

Physical performance measures are routinely used in clinical trials and so it is increasingly important to determine if identified changes are clinically meaningful. Perera et al.[34] suggested that 0.10 m/s was a substantial meaningful change in gait speed for a four metre walk. Our study was powered to detect an effect size of 0.10 m/s, and the between-group difference in the sub-group of multiple fallers was 0.19 m/s i.e., almost twice the substantial meaningful change. This needs to be interpreted with caution as it is a sub-group analysis but indicates the potential impact of the tested intervention.

The improvement in gait speed in multiple fallers in our study was not maintained at 12 months, but their performance on the chair stand test at 12 months was better than multiple fallers in the control group after adjusting for baseline (Table 6), indicating a maintenance effect of the intervention beyond three months. It may be that a higher and more sustained dose than we were able to provide is needed in order to maintain the effect over a longer time period, but this would require further study.

One of the limitations of this trial was the lack of a placebo group to control for the effect of touch and personal attention received by the intervention group. This was due to limited resources that did not allow for an active control with social visits or sham exercise each week, and so caution is required when interpreting the findings of this study due to this limitation. Additionally there were a high number of physical functioning tests administered, which raises the issue of multiplicity of analysis. We acknowledged this in our statistical analysis plan and cautioned on the interpretation of any results above P =0.025 in the analysis. Given that most of the reported between group differences met this criteria this is unlikely to have been a major issue.

The other major limitation was limiting the Alexander Technique intervention to 12 lessons. The results of the ATEAM back pain trial[10] did show that a smaller number of lessons could be of benefit, and as research into the therapeutic benefits of the Alexander Technique in different populations has only recently begun the dosage level for a therapeutic effect has yet to be established with certainty.

A strength of the study was that we did not exclude people with neurological or cardiothoracic disease, making our findings more translatable to all of the population with visual impairment. It should be pointed out however that strategies to prevent falls in people with neurological impairments have yet to be clearly ascertained, and as 20% of participants self-reported neurological symptoms in the study, this may have impacted on our findings.

The Alexander Technique is a novel intervention that has not been previously trialled in community-dwelling older adults with visual impairments. This study did not find a significant impact of Alexander lessons on the primary outcomes, however the improvement in balance in quiet standing, the improved gait speed in the subgroup of multiple fallers, along with indications of a possible reduction in the rate of all falls and injurious falls suggests an effect of the Alexander Technique on physical functioning and physical falls risk in older adults with visual impairments.

That the intervention was successfully delivered in the participants homes makes it a candidate program for delivery to a population that has difficulty accessing generic fall prevention programs provided in the community, and is worthy of further investigation in a trial powered to measure its impact on fall rates. Based on the estimates from this study a sample size of 350 (175/arm) will have 80% power to detect a significant 33% lower rate of falls (i.e. IRR = 0.67) for participants receiving the Alexander Technique compared to control participants (assuming a dispersion parameter of 0.8 and a two-sided level alpha=5%).

Clinical messages

- The Alexander Technique improved quiet standing balance in older adults with visual impairments.
- The Alexander Technique improved gait speed and step length in past multiple fallers.
- A larger study is needed to confirm a possible effect on fall rates.

Acknowledgements

The authors would like to acknowledge Guide Dogs NSW/ACT for the support that allowed this study to succeed. Dr John Black supported the study, Ewa Borkowski helped co-ordinate the study, and Jessie Chen, Karen Doobov, Kelly Prentice and Kerrie Suffolk conducted all of the assessments.

Conflict of interest

The authors declare they have no conflict of interest.

Funding

Guide Dogs NSW/ACT provided substantial ‘in-kind’ support. The Australian Society of Teachers of the Alexander Technique and the FM Alexander Trust (UK) both provided small grants to support the study. MG received an Australian Postgraduate Award Scholarship from the Australian Federal Government. CS’s salary is funded by the Australian National Health and Research Council. LK’s salary is funded by the Australian Research Council.

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