Effectiveness of Chiropractic Care to Improve Sensorimotor Function Associated With Falls Risk in Older People: A Randomized Controlled Trial

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Abstract

Objective: This study assessed whether 12 weeks of chiropractic care was effective in improving sensorimotor function associated with fall risk, compared with no intervention, in community-dwelling older adults living in Auckland, New Zealand.
Methods: Sixty community-dwelling adults older than 65 years were enrolled in the study. Outcome measures were assessed at baseline, 4 weeks, and 12 weeks and included proprioception (ankle joint position sense), postural stability (static posturography), sensorimotor function (choice stepping reaction time), multisensory integration (sound-induced flash illusion), and health-related quality of life (SF-36).
Results: Over 12 weeks, the chiropractic group improved compared with the control group in choice stepping reaction time (119 milliseconds; 95% confidence interval [CI], 26-212 milliseconds; $P = .01$) and sound-induced flash illusion (13.5%; 95% CI, 2.9%-24.0%; $P = .01$). Ankle joint position sense improved across the 4- and 12-week assessments (0.20°; 95% CI, 0.01°-0.39°; $P = .049$). Improvements were also seen between weeks 4 and 12 in the SF-36 physical component of quality of life (2.4; 95% CI, 0.04-4.8; $P = .04$) compared with control.
Conclusion: Sensorimotor function and multisensory integration associated with fall risk and the physical component of quality of life improved in older adults receiving chiropractic care compared with control. Future research is needed to investigate the mechanisms of action that contributed to the observed changes in this study and whether chiropractic care has an impact on actual falls risk in older adults. (J Manipulative Physiol Ther 2016;39:267-278)
Key Indexing Terms: *Chiropractic; Feedback, Sensory; Aged; Postural Balance; Proprioception; Quality of Life; Accidental Falls*

Falls are a significant cause of death, injury, and loss of quality of life in older adults.[1] Falls account for more than 80% of injury-related hospital admissions in people older than 65 years, and they are the leading cause of injury-related death in older adults.[2,3] Approximately 30%-40% of community-dwelling older adults suffer from at least 1 fall per year.[4,5] This incidence rate rises dramatically with increasing age or when a variety of risk factors are present.[5] Compared with healthy community-dwelling older adults, the risk of falling increases in those experiencing lower limb muscle weakness (odds ratio [OR] = 4.4), gait deficits (OR = 2.9), or balance deficits (OR = 2.9); in those with a recent history of falling (OR = 3.0); and in individuals older than 80 years compared with those younger than 80 years (OR = 1.7).[6] Many of these risk factors are influenced by the general deterioration in the function of sensorimotor systems that regularly occur with normal aging.[7] Falls are often multifactorial in their origin, with no specific single cause being identified.[6] The most common causes of falls reported in the literature are accident and environment-related causes (31%), followed by gait and balance disorders (17%), and dizziness and vertigo (13%).[6]

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The role that chiropractors and other manual therapists may play in preventing falls in their patients is currently unclear. To date, few controlled trials have investigated how chiropractors and other manual therapists may influence falls risk.[8] There is however a growing body of basic science evidence that suggests that chiropractic care may influence sensory and motor systems that potentially have an impact on some of the neuromuscular risk factors associated with falling.[9] The extent of this potential impact, if any, is currently unknown. This study aimed to investigate this potential relationship by assessing whether usual chiropractic care had an impact on measures of sensorimotor function associated with falls risk in older adults over a 12-week period.

Methods

This single-blind, parallel-group, randomized controlled trial was conducted in Auckland, New Zealand, from May 2012 to June 2013.

Inclusion/Exclusion Criteria

Chiropractic practices were enrolled based on convenience and geographical location. Chiropractors were eligible to participate if they were registered with the New Zealand Chiropractic Board, had a permanent practice, and were available to see new patients.

Eligible study participants were community-dwelling adults 65 years or older, living in Auckland, who could understand the study information and consent process and wanted to receive chiropractic care. Volunteers were ineligible if they were wheel-chair bound, if they were unable to remain standing unassisted for a minimum of 1 minute, if they had received spinal manipulation within the previous 6 months, or if they were considered to be at risk of suffering an adverse event due to chiropractic care based on their clinical history. A convenience sampling frame was used to recruit participants through local advertisements at participating chiropractic practices, social media, and word of mouth.

Interventions

Participants were randomized to 12 weeks of chiropractic care or a usual care "control." Chiropractic care was provided by 12 chiropractic practices from across Auckland in their usual practice setting. Chiropractors were asked to care for study participants like any other patient presenting to their practice, apart from providing care at no charge. The type of care provided varied based on the chiropractors preferred technique approach and the participant's case history and examination findings. Techniques used included high-velocity, low-amplitude; table-assisted; and instrument-assisted adjustment approaches. Chiropractors were asked to summarize the nature of the care they provided by indicating which of these technique approaches were used with each participant. Control participants continued with any usual health care they required, or wished to engage in, during the course of the study.

Trial Outcomes

Outcomes included measures of sensorimotor function and quality of life. The primary outcome was joint position sense.[10] Secondary outcomes were choice stepping reaction time (CSRT),[11] postural stability, multisensory processing,[12] and health-related quality of life using the SF-36 version 2.0 short-form health survey.[13]

Joint Position Sense. Joint position sense error was measured at the ankle using an active/active method based on previously published protocols.[10] Participants stood with 1 foot on a swiveling platform and 1 foot on a stable base. They were then able to actively rotate the platform in order to place their ankle into plantar/dorsiflexion or inversion/eversion. Participants started in a neutral ankle position and were then asked to select a specific target ankle joint angle that was within their comfortable functional range. They were then instructed to return their ankle to the neutral position, before being asked to reproduce or match the target position. Continuous goniometric measurements of ankle angle were collected based on the angle of the platform using potentiometers that had a recording capability of 0.01°. Computation of ankle joint position sense error was obtained using the average absolute constant error between the target and actual angle across 20 trials (5 trials each for inversion, eversion, plantar flexion, and dorsiflexion angle presented in a random order).

Choice Stepping Reaction Time. Choice stepping reaction time involves an individual standing on a platform with 2 panels in front of them, 1 in front of each foot and 1 panel beside each foot. These panels can be individually illuminated, and the study participant is asked to place their corresponding foot on the illuminated panel as quickly as possible. The time taken from the panel illuminating until the foot is planted on the panel is called the *choice stepping reaction time*. This device was based on similar instruments used in a number of previous studies.[11,14,15] Choice stepping reaction time provides a broad composite measure for the neuropsychological and sensorimotor factors that are important when formulating and initiating appropriate compensatory steps.[11] Each assessment involved 20 trials, with 5 trials per panel. Panels were illuminated in a random order to eliminate anticipatory movements. The average time taken during the 20 trials was used in the analysis.

Postural Stability. A computerized balance platform (CAPs Lite Computerized Posturography System by Vestibular Technologies, Cheyenne, WY) was used to measure postural stability. The participants were assessed using an "eyes closed on an unstable foam surface" testing condition as the primary assessment of postural stability. We intended to use the "stability score" as the outcome for this assessment, which compares the amount of the participant's sway throughout the duration of the test to the theoretical limit of stability. However, a large number of participants (n = 32, 53.3%) were unable to complete the assessment at baseline, which meant that normality assumptions were violated. Therefore, a binary pass/fail assessment procedure was used instead of the originally intended stability scores.

Multisensory Processing. Multisensory processing and integration were evaluated using a custom-built Macroderma Sound-Induced Flash Illusion System following a protocol described by Setti et al.[12] In this illusion, a visual stimulus was flashed for 12 milliseconds either as a single stimulus or with a 190-millisecond stimulus onset asymmetry. An auditory beep was delivered in conjunction with the visual stimulus, with either a single beep presented simultaneously with the first visual stimulus or two beeps, with the second beep presented simultaneously with the second visual stimulus. Participants were informed that they would be presented with brief flashes and beeps and that they would be asked to report whether they saw 1 or 2 flashes when they were presented. They were instructed not to report the number of beeps but to respond solely based on the number of flashes. The illusory state consisted of 1 flash being presented with 2 beeps and was perceived as involving 2 flashes if the illusion was successful. Susceptibility to the sound-induced flash illusion appears to be related to an individual's ability to combine multisensory input into a single percept.[16] The illusion is robust and resilient to change,[7,17] with older adults who have had a previous fall being more susceptible to the illusion than younger adults and older adults who had not fallen.[12] In this trial, a 190-millisecond stimulus onset asymmetry was used with 40 illusory presentations randomly interspersed among 160 control presentations. The outcome that was recorded and used for statistical analysis was the percentage of illusory presentations that were correctly reported.

Health-Related Quality of Life. Health-related quality of life was measured using the New Zealand version of the SF-36 version 2.0 short-form health survey (QualityMetric Inc, Lincoln, RI). The survey was self-completed by participants with assistance provided by a blinded assessor if required. The survey outcomes that were included for statistical analysis in this study were the Physical Component Summary (PCS) and Mental Component Summary (MCS) scores. The summary scores were calculated using New Zealand population norms and US factor coefficients.[18]

All outcomes were assessed at baseline, 4 weeks, and 12 weeks. Potential harms or adverse effects were recorded by asking participants about injuries, hospitalizations, or perceived adverse effects from chiropractic care during the trial. Chiropractors were also asked to contact the researchers immediately if any perceived adverse effects from chiropractic care occurred during the trial. A data monitoring committee reviewed any reported events.

Sample Size

Predicted change in joint position sense error from previous research was used to estimate the sample size.[19] To detect a difference of 0.25° (SD 0.27) as statistically significant, 20 participants in each group were required (80% power, $\alpha = .05$). To allow for attrition, the trial aimed to recruit 60 participants.

Randomization and Blinding

Randomization was carried out by an independent assistant, at a distant site, using a computer-generated list of random numbers. Allocation occurred following informed consent and baseline assessment to maintain allocation concealment. The research assistants conducting all assessments remained blind to group allocation throughout the trial.

Statistical Analysis

Descriptive statistics including means, standard deviations, and counts were used to describe the baseline characteristics of the 2 groups. Mixed models for repeated-measures method were used to analyze the effect of chiropractic care on the change scores of the continuous primary and secondary outcomes recorded at week 4 and week 12 assessments. Generalized linear mixed models (GLIMMIX) were fit using likelihood-based techniques to the postural stability outcomes to assess the binary outcome. Baseline covariates were predefined based on previous studies that indicated that they may influence the dependent variable that was being analyzed and were included in each model as appropriate. All available data were used in the analysis, and no imputation was performed for missing data.

Trial Registration and Ethics Approval

The trial was registered with the Australian New Zealand Clinical Trials Registry (reference ACTRN12608000333314). Ethics approval was obtained from the New Zealand Northern Y Regional Ethics Committee (reference NTY/11/06063).

Results

Recruitment

Twelve chiropractic practices were invited, and all agreed to participate to provide care to study participants and to assist with participant recruitment. Sixty-five participants were screened for eligibility, and 60 were eligible and enrolled in the study (Fig 1). Fifty-six participants (93%) completed the study (n = 28 in each group). The 2 participants that withdrew from the control group lost motivation to continue with the study, 1 following group allocation and 1 after the 4-week

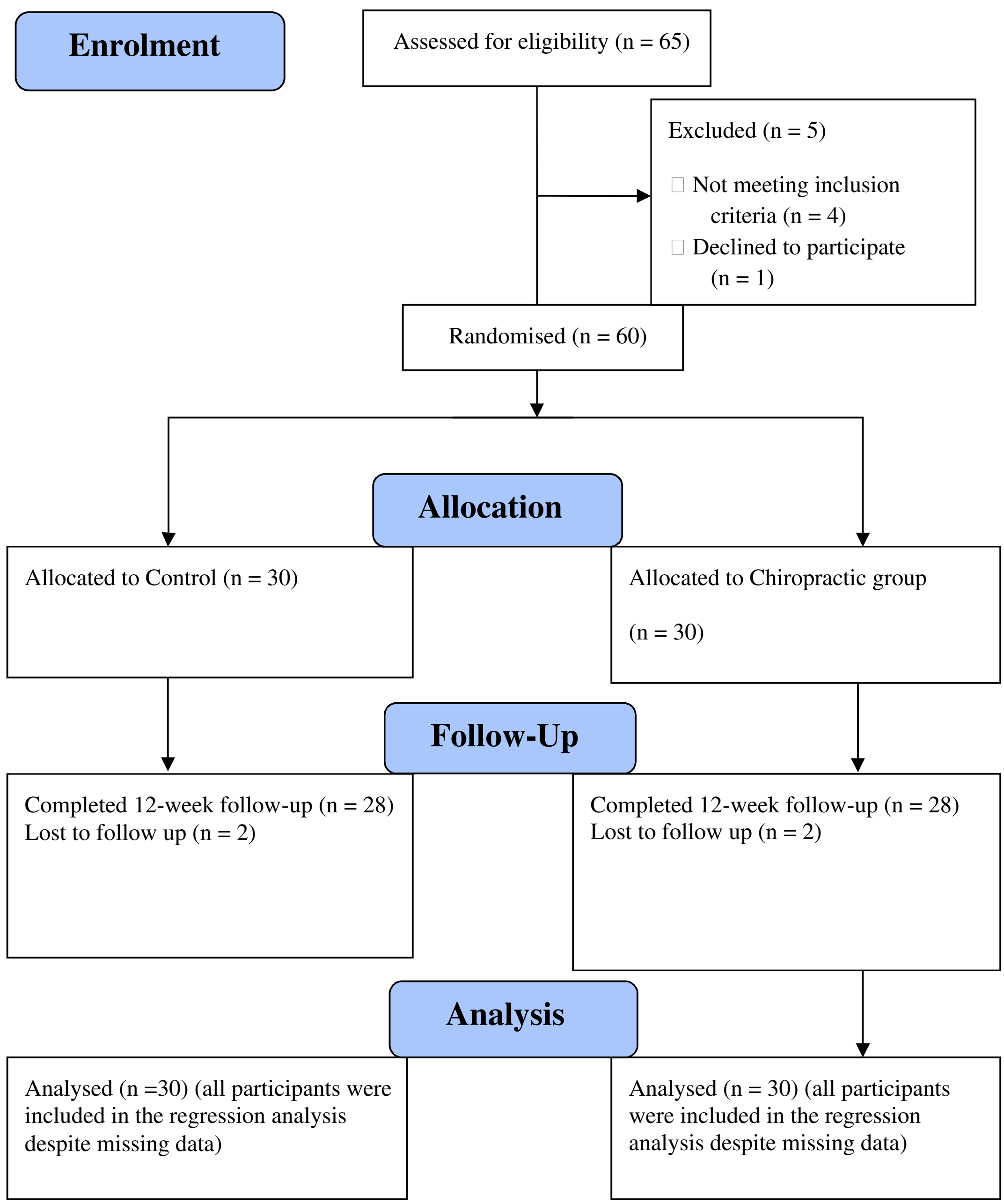

Fig 1. *Participant flow through the trial.*

assessment. One of the participants that withdrew from the chiropractic group was hospitalized because of health reasons unrelated to the intervention (viral illness), and the other withdrew because of transient soreness that was experienced following chiropractic care.

Baseline Characteristics

Demographic, falls, and medical characteristics at baseline were similar between the groups (Table 1). The average age of participants was 72 years (SD = 6.5), and 36% (60%) were women. Eighteen percent (n = 11) had experienced a fall in the previous year. Baseline values for primary and secondary outcome measures were also similar (Table 2).

Chiropractic Intervention Content

The chiropractic practices saw between 1 and 7 study participants each, and more than 1 chiropractor in each practice may have provided care to participants. The average number of visits to the chiropractor during the

Table 1. *Demographic, Fall History, and Medical History Baseline Characteristics of Study Participants*

	Control (n=30)	Chiropractic (n=30)	Combined (n=60)
Demographic factors			
Age [b]	72.7 (6.8)	71.7 (6.2)	72.2 (6.5)
Age, range	65-89	65-89	65-89
Female [a]	20 (66.7)	16 (53.3)	36 (60.0)
Living alone [a]	7 (23.3)	7 (23.3)	14 (23.3)
Fall history			
Fall in previous year [a]	6 (20.0)	5 (16.7)	11 (18.3)
Recent recurrent falls [a]	0 (0)	1 (3.3)	1 (1.7)
Medication use			
No. of medications [b]	3.2 (3.2)	2.4 (2.8)	2.8 (3.1)
Psychoactive medications [b]	4 (13.3)	3 (10.0)	7 (11.7)
Medical conditions			
Previous stroke [a]	2 (6.7)	1 (3.3)	3 (5.0)
Muscle weakness [a]	7 (23.3)	6 (20.0)	13 (21.7)
Poor balance [a]	9 (30.0)	10 (33.3)	19 (31.7)
Gait deficit [a]	5 (16.7)	10 (33.3)	15 (25.0)
Poor vision [a]	17 (56.7)	24 (80.0)	41 (68.3)

[a] Number (percentage).
[b] Mean (SD).

study period was 21.9 (SD 8.6) over the 12 weeks, with a range of 2 to 33. A summary of the types of care provided is included in Table 3.

Final Outcomes

Final results are included in Table 2 and Figures 2 to 7. Compared with control, the group receiving chiropractic care improved significantly in joint position sense across the combined 4- and 12-week assessments (*P* = .049; mean difference, 0.20°; 95% confidence interval [CI], 0.001°-0.39°). The interaction effect between intervention group and time was also statistically significant for CSRT (*P* = .01). A significant difference in improvement from baseline occurred at the 12-week assessment in CSRT for the group receiving chiropractic care compared with control group (*P* = 0.01, mean difference = 119 milliseconds; 95% CI, 26-212 milliseconds). The difference in the improvement from baseline in CSRT at 4 weeks was not statistically significant between the 2 groups (*P* = 0.8, mean difference = 10 milliseconds; 95%, CI −56 to 76 milliseconds).

At baseline, a large number of participants (n = 32, 53.3%) were unable to complete the "eyes closed" on a foam surface posturographic assessment of postural stability. Failures to complete were evenly spread between groups (n = 16, 53.3%, in each group). Normality assumptions were violated because of this large number of failed tests. Therefore, a binary pass/fail assessment procedure was used instead of the originally intended stability scores. No significant differences over time were observed between the groups.

There was a significant overall group effect (*P* = .02; mean difference, 11.2; 95% CI, 1.6-20.8) of chiropractic care on susceptibility to the sound-induced flash illusion, with the chiropractic group showing greater improvement than the control group across the 4- and 12-week assessments. The chiropractic group improved by 13.5% (*P* = .01; 95% CI, 2.9%-24.0%) compared with the control group at the 12-week assessment.

There were no significant differences for the SF-36 MCS score between the groups (*P* = .58); the interaction effect between the groups and time was also not significant (*P* = .93).

The interaction effect between the groups and time was significant for the SF-36 PCS scores (*P* = .04), indicating that the effect of intervention groups was not the same between the 2 follow-up time points (4 and 12 weeks). For the intervention group, the amount of change in PCS from baseline to 12 weeks was significantly different to baseline to 4 weeks (*P* = 0.04, change in 12 weeks − 4 weeks = 2.44; 95% CI, 0.03-4.85), indicating significant improvement between the 4- and 12-week assessment on PCS.

Harms and Falls

No serious adverse events were reported that were related to the study interventions or assessments. Seven participants reported experiencing a fall while participating in the trial. Five of these participants were in the control group, and 2 were in the chiropractic group. None of these falls resulted in injury that required hospitalization.

Discussion

Summary of Main Findings

The key findings in this study were that improvements were observed in the chiropractic group in joint position sense error, sound-induced flash illusion, and CSRT compared with the control group. Between-group differences were also observed in the physical component of

Table 2. *Sensorimotor and Quality of Life Outcome Results of Randomized Trial of Chiropractic Care vs Control Over 12 Weeks Among Older Adults*

	Observed Raw Scores, Mean (SD)						MMRM Analysis on Change From Baseline Scores [a]			
	Chiropractic			Control					LSM Difference (95% CI) [d]	
	Baseline	4 wk	12 wk	Baseline	4 wk	12 wk	Group Effect P value [b]	Group by Time Interaction P value [c]	Overall Group Difference (Chiro-Control) [b]	Group Difference at 12 wk (Chiro-Control) [c]
JPS, °	1.90 (0.58)	1.62 (0.56)	1.64 (0.45)	1.76 (0.56)	1.70 (0.42)	1.71 (0.54)	.0495	.99	0.20 (0.001-0.39)	NA
CSRT, ms	1163 (197)	1139 (152)	1055 (152)	1178 (206)	1152 (214)	1174 (282)	.07	.01	NA	119 (26-212)
SIFI, % correct	63.0 (40.2)	73.3 (38.4)	75.9 (35.4)	60.3 (40.0)	62.0 (38.0)	61.0 (39.5)	.02	.23	11.2 (1.6-20.8)	NA
CAPs, % pass [e]	46.7	60.0	64.3	46.7	55.2	60.7	.88	.91	0.58 (0.14-2.39)	NA
SF-36 PCS	44.6 (7.8)	45.0 (9.0)	48.5 (7.0)	46.1 (8.7)	47.9 (7.3)	45.9 (9.6)	.45	.04	NA	2.6 (0.4-5.6)
SF-36 MCS	52.8 (9.6)	53.5 (9.9)	53.0 (11.5)	46.3 (12.1)	47.3 (12.8)	46.9 (12.6)	.54	.93	1.0 (−2.2 to 4.1)	NA

CAPs, Comprehensive Assessment of Postural Systems postural stability assessment; *CSRT*, choice stepping reaction time; *JPS*, joint position sense; *LSM*, least square mean; *MCS*, Mental Component Summary; *PCS*, Physical Component Summary; *SIFI*, sound-induced flash illusion.

[a] Mixed models for repeated-measures analysis were conducted for variables of continuous type (JPS, CSRT, SIFI, SF-36 PCS, SF-36 MCS). A generalized linear mixed-effect model was conducted for CAPs.

[b] Model without group * time interaction.

[c] Model with group * time interaction.

[d] When the interaction was significant, LSM difference is from the model with interaction. When the interaction was not significant, LSM difference is from the model with main effects only. For CAPs, the numbers displayed are OR and the associated 95% CI with intervention group as reference group.

[e] CAPs scores are unadjusted.

Table 3. *Type of Care That Was Provided to Study Participants*

Type of Care	No. of Participants
High velocity, low amplitude only	0
Table assisted only	8
Instrument assisted only	8
High velocity, low amplitude and table assisted	2
High velocity, low amplitude and instrument assisted	0
Table assisted and instrument assisted	9
All 3 approaches combined	3

health-related quality of life, with the chiropractic group improving compared with the control group between the 4- and 12-week assessments.

Compared With the Literature

It is difficult to make comparisons between the results of different intervention trials that investigate joint position sense because of the heterogeneity of outcome measures that are used in its assessment. Improvements in joint position sense error of up to 6° have been reported following a variety of interventions in clinical populations.[10,19,20] However, the baseline joint position sense error observed in this study was only 1.83° (SD = 0.57°), meaning that a 6° improvement would be impossible to achieve. The previous study that is most relevant to the present study reported a significant 0.28° (SD = 0.12°) overall improvement in the absolute constant elbow joint position sense error in a subclinical neck pain population immediately after cervical chiropractic adjustments.[19] Together, these results suggest that chiropractic care may have a beneficial effect on proprioception, but it is yet to be determined whether this effect is clinically meaningful.

The interesting finding in the CSRT assessment was that the 4-week assessment showed little change between groups, with the chiropractic group experiencing a very small, nonsignificant improvement compared with control (9 milliseconds; $P = .8$; 95%, CI −56 to 74). This lack of improvement at 4 weeks may be important, as it suggests that longer-term chiropractic care may be required to have a significant effect on some physiologically important aspects of sensorimotor function.

The baseline CSRT values observed in this study (combined mean = 1171 milliseconds, SD = 200 milliseconds) were consistent with those reported in similar populations elsewhere in the literature (993 milliseconds, SD = 197 milliseconds to 1264 milliseconds, SD = 268 milliseconds).[11,15,21,22] The between-group CSRT improvement that resulted following 12 weeks of chiropractic care (119 milliseconds) is consistent with, or exceeds, the reported results in other intervention trials involving CSRT.[23–25]

No significant differences were observed between groups in postural stability, suggesting that chiropractic care did not lead to a significant improvement in postural stability in older adults in this study. However, with such a large percentage of older adults failing the test, it is possible that the test is simply too challenging for this population. It may also be insensitive to small but significant improvements in postural stability that occur following an intervention, if they exist. A systematic review concluded that a limited amount of research has been published that supports a role for manual therapy in improving postural

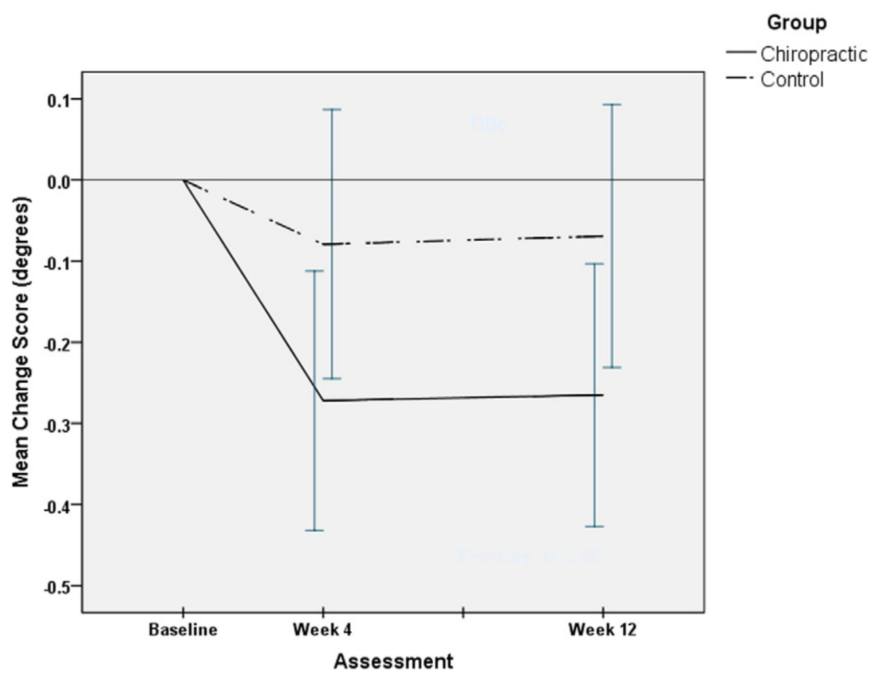

Fig 2. *Change from baseline in joint position sense error at 4- and 12-week assessments.Error bars represent 95% CIs. The overall group effect of chiropractic care on joint position sense was significant (P = .049). No significant between-group differences occurred at individual time point assessments.*

stability and balance.[8] The findings of this study do not add any further support to this potential role.

The chiropractic group became less susceptible to the sound-induced flash illusion compared with the control group in the present study. The sound-induced flash illusion is considered to be resistant to change, with only 1 study published that has reported an improvement in illusion performance following an intervention.[7] This study reported a similar magnitude of change in susceptibility to the illusion as the present study, following feedback training with the added motivation of a monetary reward based on the participants' performance accuracy. However, the authors concluded that the perception of the illusion did not change following feedback training. Instead, participants described subtle phenomenological differences between percepts induced by the illusory and nonillusory conditions that helped them to discriminate between the 2 conditions. The findings reported by Sturnieks et al[7] indicate that feedback training did not change the perception of the illusion, which suggests that the current study is the first to report an improvement in the perception of the sound-induced flash illusion following an intervention. This is also the first study to report improvements in multisensory integration in a group receiving chiropractic care.

The present study is one of the few randomized controlled trials to report the effect of chiropractic care on health-related quality of life in an older adult population. A small number of controlled trials have reported similar findings to those reported here in different study populations.[26–28] The small sample size and relatively short duration of the study, combined with uncertainty surrounding the results, suggest that caution should be used when interpreting the SF-36 results. The results do however suggest that chiropractic care had a positive influence on the SF-36 PCS scores, which warrants further investigation.

Possible Mechanisms

A number of possible mechanisms of action may have contributed to the changes observed in this study. Firstly, chiropractic care may influence neuroplastic processes within the central nervous system through altered afferent input due to improved/altered spinal function. Secondly, chiropractic care may have an influence on pain that, in turn, affects cognition, particularly with respect to attentional focus, and physical function. Thirdly, chiropractic care may have resulted in changes in muscle strength or muscle activation patterns. Lastly, placebo effects may have been involved.

As a pragmatic effectiveness trial, with a "black-box" intervention, no firm conclusions can be made regarding which, if any, of these potential mechanisms made a significant contribution to the results that were observed. Future research is required to help gain a greater understanding of the mechanisms of action that may have been associated with the results of this study.

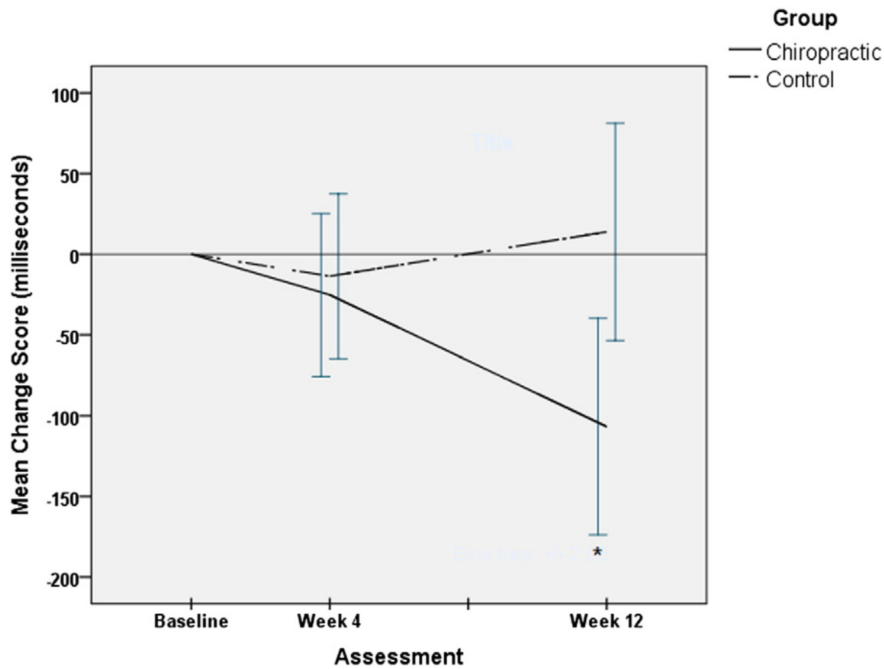

Fig 3. *Change from baseline in CSRT at 4 -and 12-week assessments.Error bars represent 95% CI. Change scores are measured in milliseconds. A negative change score represents an improvement in CSRT. A significant (P = .01) group by time interaction occurred, meaning that there was a difference in change scores between the 4- and 12-week assessments. *A significant (P = .01) between-group difference was also present at the 12-week assessment.*

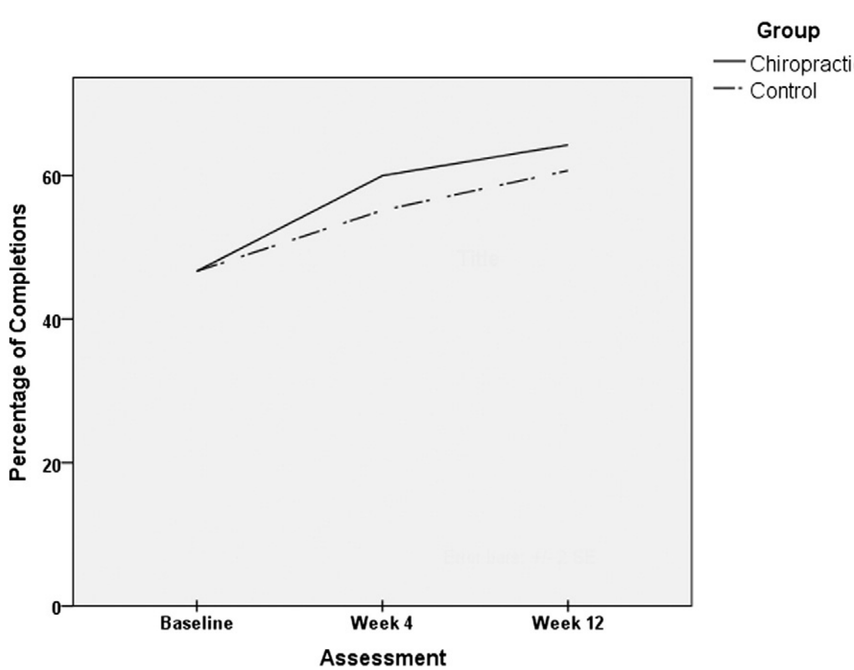

Fig 4. *Percentage of participants that passed the CAPs posturographic assessment at each assessment.To pass the test, participants were required to remain standing on a perturbing foam cushion with their eyes closed for 20 seconds. No significant differences were observed between groups for the CAPs assessments.*

Strengths and Limitations

This pragmatic randomized controlled trial limited the number of exclusion criteria that were used and provided participating chiropractors with flexibility when it came to making case management decisions. A "usual care" control group was also used, and blinding of chiropractors or

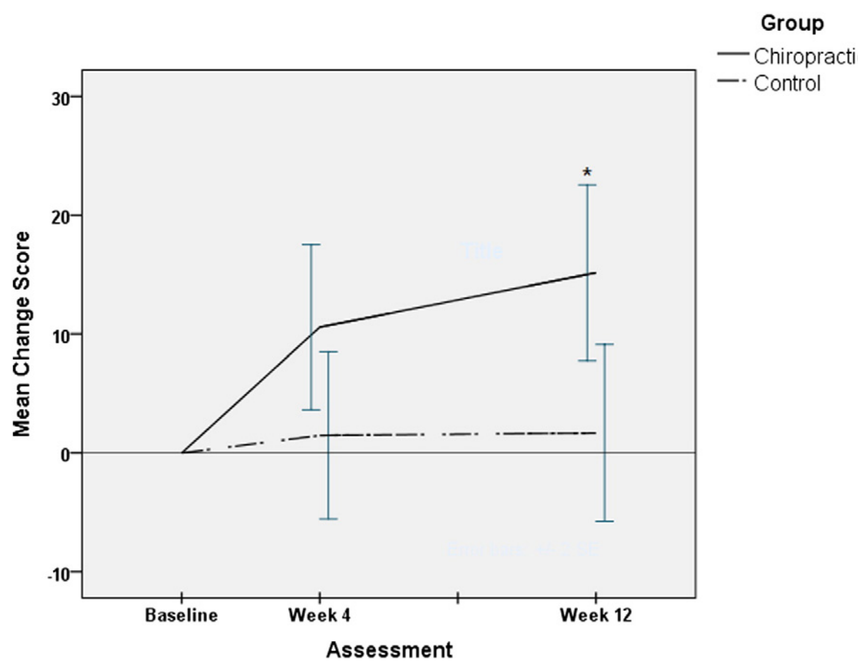

Fig 5. *Change from baseline in susceptibility to the sound-induced flash illusion at 4- and 12-week assessments.Error bars represent 95% CIs. Change scores represent the overall percentage improvement in illusory responses. The overall group effect of chiropractic care on the sound-induced flash illusion was significant (P = .02). *A significant between-group difference also occurred at the 12-week assessment (P = .01).*

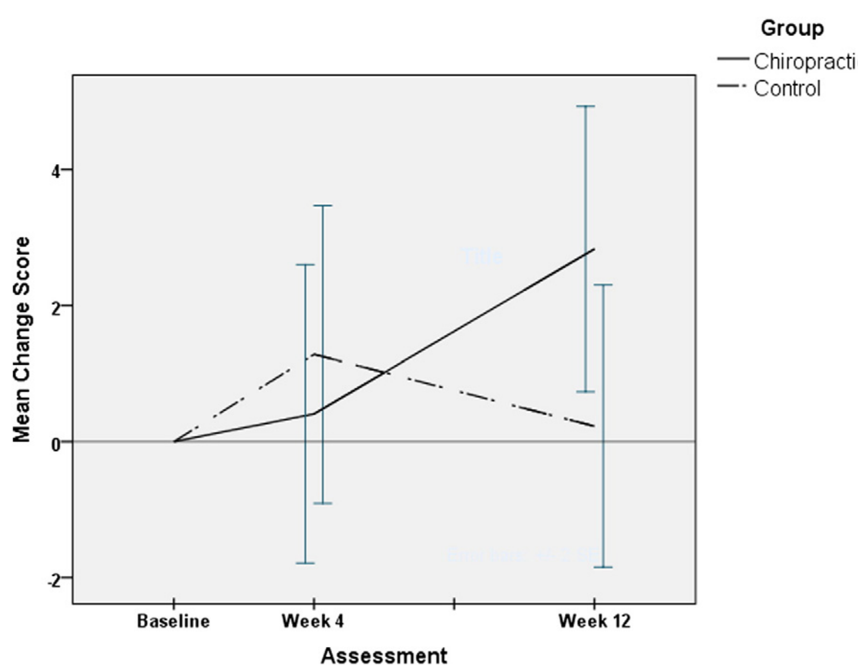

Fig 6. *Change from baseline in health-related quality of life (SF-36) PCS scores at 4- and 12-week assessments.Error bars represent 95% CIs. Change scores represent the change in norm-based summary score from baseline to each assessment. The group by time interaction for the PCS score was significant (P = .04), with the chiropractic group improving compared with the control group. No significant between-group effects were present at individual time points.*

participants was not attempted because of the challenges associated with blinding in a trial investigating a manual therapeutic intervention.[29] Convenience sampling was used to recruit chiropractic practices to assist with the study and volunteers to participate in the study, which may have resulted in selection bias. Together, these aspects of the

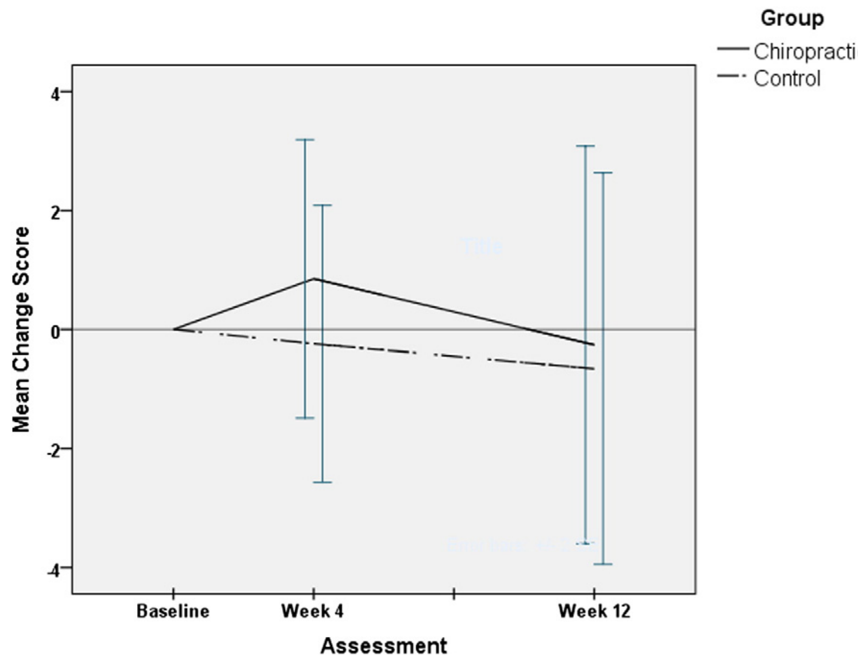

Fig 7. *Change from baseline in health-related quality of life (SF-36) MCS scores at 4- and 12-week assessments.Error bars represent 95% CIs. Change scores represent the change in norm-based summary score from baseline to each assessment. No significant changes occurred in the MCS scores.*

study design mean that few conclusions can be made about mechanisms of action that may have been involved. It is also possible that placebo effects or performance bias associated with the attention received by the chiropractic group had an impact on the study results. Multiple outcome measures were analyzed without making adjustments to *P* values. Adjustments were not made to avoid errors of interpretation. This approach has been recommended as appropriate, particularly when exploring new areas of research.[30] Even so, using multiple comparisons means that the amplitude of effect size should be regarded as tentative until the results are corroborated by further study.[30]

Another potential limitation of the study is that the outcome measures used in this trial may have lacked sensitivity to change or clinical significance. Issues with sensitivity to change, responsiveness, and floor and ceiling effects have been identified in relation to the postural stability measures used in the present study. A number of alternative methods of examining postural stability were reviewed, but there is currently little agreement between authors concerning the most appropriate method for documenting improvements in postural stability in relatively healthy community-dwelling older adults following an intervention.[23,31]

The 12-week follow-up period used in this study means that this is one of the few trials that has investigated the effect of chiropractic care on sensorimotor function that involved more than a single intervention session.[9] This is a strength of the study. However, a number of the outcomes assessed improved significantly between the 4- and 12-week assessments. It is unclear if improvements would have continued beyond 12 weeks of care.

Implications of the Findings

This study found that joint position sense error, CSRT, and the sound-induced flash illusion improved in the older adults receiving 12 weeks of chiropractic care. These outcome measures are associated with an individual's risk of falling,[12,11,32] which opens up the possibility that chiropractic care may play a role in preventing falls in older adults. However, the clinical significance of the changes observed is somewhat debatable and should be considered when interpreting these findings.[7,11,12,32] It should also be acknowledged that, until the results of the study are corroborated and further research is conducted that investigates the effect of chiropractic care on the rate of falls in older adults, the implications of the study from a policy or public health perspective remain limited.

Further research is required to investigate which mechanisms were involved in the improvements observed in this trial. Further research should also attempt to investigate whether the improvements in sensorimotor function and multisensory integration observed in the chiropractic group also reflect a reduction in overall fall risk.

Conclusion

The results of this trial indicated that aspects of sensorimotor integration and multisensory integration associated with fall risk improved in a group of community-dwelling older adults receiving chiropractic care. The chiropractic group also displayed small, statistically significant improvements in health-related quality of life related to physical health when compared with a "usual care" control. These results support previous research which suggests that chiropractic care may alter somatosensory processing and sensorimotor integration.[9] However, limitations of the trial design mean that no firm conclusions can be made about potential mechanisms of action associated with the improvements that were observed.

This study builds on previous research and makes a significant contribution to the literature, as the bulk of this previous research comes from single–intervention session basic science trials in relatively healthy younger people and, often, the changes reported do not indicate whether they reflect clinically relevant improvements or not.[9] This is the first trial to report improvements in multisensory integration in a group receiving chiropractic care. The chiropractic intervention was well tolerated by the older adults in this trial with no serious adverse events being reported that were due to the chiropractic intervention.

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Contributorship Information

Concept development (provided idea for the research): K.H., H.H., C.R.E., B.M.
Design (planned the methods to generate the results): K.H., H.H., C.R.E., B.M., A.C.L.L.
Supervision (provided oversight, responsible for organization and implementation, writing of the manuscript): C.R.E., H.H., B.M.
Data collection/processing (responsible for experiments, patient management, organization, or reporting data): K.H.
Analysis/interpretation (responsible for statistical analysis, evaluation, and presentation of the results): K.H., A.C.L.L.
Literature search (performed the literature search): K.H.
Writing (responsible for writing a substantive part of the manuscript): K.H.
Critical review (revised manuscript for intellectual content; this does not relate to spelling and grammar checking): H.H., C.R.E., B.M., A.C.L.L.

Practical Applications

- Sensorimotor function and multisensory integration associated with falls risk improved in older adults receiving chiropractic care compared with control participants over 12 weeks.
- The physical component of quality of life improved in older adults receiving chiropractic care compared with control participants over 12 weeks.

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