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Yoga-based exercise improves balance and mobility in people aged 60 and over: a systematic review and meta-analysis

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Abstract

Objective: one-third of community-dwelling older adults fall annually. Exercise that challenges balance is proven to prevent falls. We conducted a systematic review with meta-analysis to determine the impact of yoga-based exercise on balance and physical mobility in people aged 60+ years.
Methods: searches for relevant trials were conducted on the following electronic databases: MEDLINE, EMBASE, Cochrane Central Register of Controlled Trials, CINAHL, Allied and Complementary Medicine Database and the Physiotherapy Evidence Database (PEDro) from inception to February 2015. Trials were included if they evaluated the effect of physical yoga (excluding meditation and breathing exercises alone) on balance in people aged 60+ years. We extracted data on balance and the secondary outcome of physical mobility. Standardised mean differences and 95% confidence intervals (CI) were calculated using random-effects models. Methodological quality of trials was assessed using the 10-point Physiotherapy Evidence Database (PEDro) Scale.
Results: six trials of relatively high methodological quality, totalling 307 participants, were identified and had data that could be included in a meta-analysis. Overall, yoga interventions had a small effect on balance performance (Hedges' $g = 0.40$, 95% CI 0.15–0.65, 6 trials) and a medium effect on physical mobility (Hedges' $g = 0.50$, 95% CI 0.06–0.95, 3 trials).
Conclusion: yoga interventions resulted in small improvements in balance and medium improvements in physical mobility in people aged 60+ years. Further research is required to determine whether yoga-related improvements in balance and mobility translate to prevention of falls in older people.
PROSPERO Registration number CRD42015015872.

Keywords: *yoga, aged, systematic review, randomised controlled trial, balance, mobility, older people*

Introduction

One-third of community-dwelling adults aged 65 and over fall at least once annually [1, 2]. These falls can result in serious injury, reduced quality of life and independence and ongoing disability [1]. Falls are also a leading cause of injury-related hospitalisation in people aged 65 and over [3] and can precipitate admission to a residential care facility [4]. In Australia, and internationally, the prevention of falls and mobility-related disability among older people is a major public health challenge that requires urgent attention [5].

A recent Cochrane review of interventions to prevent falls demonstrated that exercise can reduce the risk and rate of falls in older community-dwellers by between 15 and 32% [6]. Furthermore, there is clear evidence that exercise that challenges balance, is of a high dose and is ongoing, is most effective in preventing falls in older people [7].

Yoga-based activity takes many forms, ranging from the practise of standing postures that aim to improve strength, flexibility and balance through to relaxation and meditation-based forms [8]. Yoga is growing in popularity among all age groups [9], and previous trials demonstrate the physical benefits of yoga to include reduced hypertension [10], reduced chronic back pain and disability [11], and improved sleep quality [12] for general populations and specific patient groups. Little is known, however, about yoga's effect on independence in older age, measured by balance and mobility, and no randomised controlled trials have evaluated the impact of yoga on falls in older age.

A 2012 systematic review with meta-analysis [8] provides preliminary evidence of improvements in strength, aerobic fitness and self-rated health among older people after regular yoga practice. The review compared the benefits of yoga with other exercise interventions in older people and concluded that small studies indicated that yoga may be superior to conventional physical activity interventions in older people. This systematic review however did not evaluate the effect of yoga on balance outcomes.

A systematic review conducted by Jeter and colleagues [13] did examine the effect of yoga on balance outcomes. The review included 15 studies with a variety of study designs and concluded that yoga may have a beneficial effect on balance. However, this review included study participants of all ages (range from 10 to 93 years) and only included healthy study cohorts making it difficult to determine the effect of yoga on balance in older people with a range of co-morbidities.

The current systematic review aimed to address gaps in the current literature and answer the following questions:

(1) What is the effect of yoga-based exercise on balance in people aged 60 and older?
(2) What is the effect of yoga-based exercise on physical mobility in people aged 60 and older?

For the purposes of this review, balance was defined as 'the ability to maintain the projection of the body's centre of mass within manageable limits of the base of support, as in standing or sitting, or in transit to a new base of support' [14]. Physical mobility was defined as 'the ability to walk, move around and change or maintain body position' [15].

To make recommendations based on the highest level of evidence, this review included only randomised controlled trials.

Method

Design

We conducted a systematic review according to the PRIMSA statement [16], and the review protocol was registered on PROSPERO prior to commencement (#CRD42015015872). See Supplementary data, Appendix 1, available in *Age and Ageing* online for PRISMA checklist.

Search strategy and study selection criteria

Searches for relevant trials were conducted on the following electronic databases from inception to 18th February 2015: MEDLINE, EMBASE, Cochrane Central Register of Controlled Trials, CINAHL, Allied and Complementary Medicine Database and the Physiotherapy Evidence Database (PEDro) without language restrictions. Search terms included words relating to yoga, balance, randomised controlled trial and age and were selected with reference to Cochrane reviews on similar topics. The search strategies were developed by the authors and reviewed by a librarian to ensure appropriate terms were used for the different databases. The search strategies are included in Supplementary data, Appendix 2, available in *Age and Ageing* online. The reference lists of relevant systematic reviews were also hand searched.

Titles and abstracts were screened by one reviewer (S.Y.) to identify relevant studies. Only peer-reviewed papers were included. Two independent reviewers (S.Y. and M.W.) examined full paper copies for inclusion against predetermined criteria (Box 1). Conflict was resolved after discussion with a third reviewer (A.T.).

Characteristics of included studies

Quality

The quality of included studies was determined using PEDro scale scores extracted from the Physiotherapy Evidence Database (www.pedro.org.au). The PEDro scale scores the methodological quality of randomised controlled trials with a rating

Box 1. Inclusion criteria

Design: Randomised controlled trials
Participants: Adults aged 60 and over
Interventions: Physical yoga programs (excluding meditation and breathing exercises alone). No limitation was placed on the type, duration and frequency of yoga intervention.
Control: No intervention, usual care or wait list control
Outcomes measured: Balance and mobility measures.

between 0 and 10 [17]. The maximum attainable PEDro score was considered 8/10, because it is not feasible to blind treating therapists and participants during yoga-based interventions.

Participants

Eligible studies were those that included participants 60 years of age or older with no restriction on the characteristics of that population.

Intervention

The intervention included physical yoga, excluding yoga involving meditation and breathing exercises alone. No limitation was placed on the type, duration and frequency of yoga intervention. Session duration, frequency and program style were recorded to assess the similarity of the studies. The control intervention was defined as no intervention, wait list control or usual care.

Outcome measures

Trials were included if a balance measure was taken pre- and post-intervention. Any validated, standardised clinical or laboratory-based measure of balance such as (but not limited to) the Berg Balance Scale [18], one leg stand [19] and Short Physical Performance Battery were included [20]. Secondary outcome measures of physical mobility were also obtained including any validated methods measuring gait speed, sit to stand, functional tests or other mobility scales [21].

Data extraction and analysis

Data were extracted regarding trial characteristics and estimates of effect using a pilot-tested data extraction form by two reviewers (S.Y., M.W.) and cross-checked by a third reviewer (A.T.). Authors were contacted via email to obtain further information if there were insufficient data included in the publication. Duplicate publications were identified and excluded by comparing authors, interventions, outcomes and sample sizes of eligible trials. The pre- and post-intervention means and standard deviations for each study group were extracted to obtain the pooled estimate of the effect of intervention.

Details of the setting, yoga program components, program dose, outcomes measured and timing of measurement were summarised descriptively. The meta-analysis was conducted using Comprehensive Meta-analysis software (Version 2, Biostat, Englewood, NJ, USA). Intervention effect sizes for the balance and mobility outcome measures, standardised mean differences (SMDs) using Hedges' g statistic and 95% confidence intervals (CIs) were calculated.

Effect sizes were catergorised as small (0.2), medium (0.5) and large (0.8 or greater) [22]. Statistical heterogeneity was quantified using the I^2 statistic: I^2 of >75% indicates considerable heterogeneity, I^2 of 50–75% indicates substantial heterogeneity and I^2 of <40% indicates limited heterogeneity [23].

Results

Flow of studies through the review

A total of 1,415 studies (excluding duplicates) were identified. After screening, six eligible randomised trials [24–29] were included in the review and the primary meta-analysis evaluating the effect of yoga on balance outcomes. For the secondary analysis, three trials [24, 26, 28] were pooled reporting mobility outcomes. Figure 1 outlines the flow of studies through the review.

Characteristics of included trials

The six trials included in the primary analysis involved a total of 307 participants. The three trials pooled for the secondary mobility analysis involved 225 participants. Table 1 summarises the characteristics of the trials, including age and gender of the sample, intervention and control group details and outcome measures included.

Quality

The mean PEDro score of the included studies was 6.7. Randomisation and concealed allocation was carried out in all six trials. Four studies scored 6 out of 10 [25–27, 29] on the PEDro scale and two scored 8 out of 10 [24, 28]. PEDro scores are included in Table 1.

Participants

The mean age of participants ranged from 63 to 84 years. Five of the six trials recruited participants from the community (n = 285) and one trial recruited participants from a residential aged care settings (n = 22). The characteristics of the samples included in the community-based studies varied. Two of the trials recruited healthy older people, whereas Colgrove and colleagues included participants with Parkinson's disease, Cheung and colleagues included women with knee osteoarthritis and Schmid and colleagues included people who had experienced a stroke. Both men and women were included in all but one of the studies [28], and 72% (220/307) of included participants were female.

Intervention

In all studies, the experimental group received a physical yoga intervention. Two trials included Iyengar yoga [24, 26], one included Hatha yoga [28], one trial included both Iyengar and Hatha styles [29] and two trials did not specify the style of yoga [25, 27]. Participants undertook 60–90 min of yoga, 1–2 times per week, for 8–24 weeks in total. The control groups of five studies received no intervention or wait list control/usual care and in one study control participants were provided with a fall prevention education booklet [24]. All six studies utilised a certified yoga instructor and used props such as blankets, chairs, blocks, pillows, straps and mats for support and comfort. Each study included progression of the intensity of the yoga intervention over time, from simple

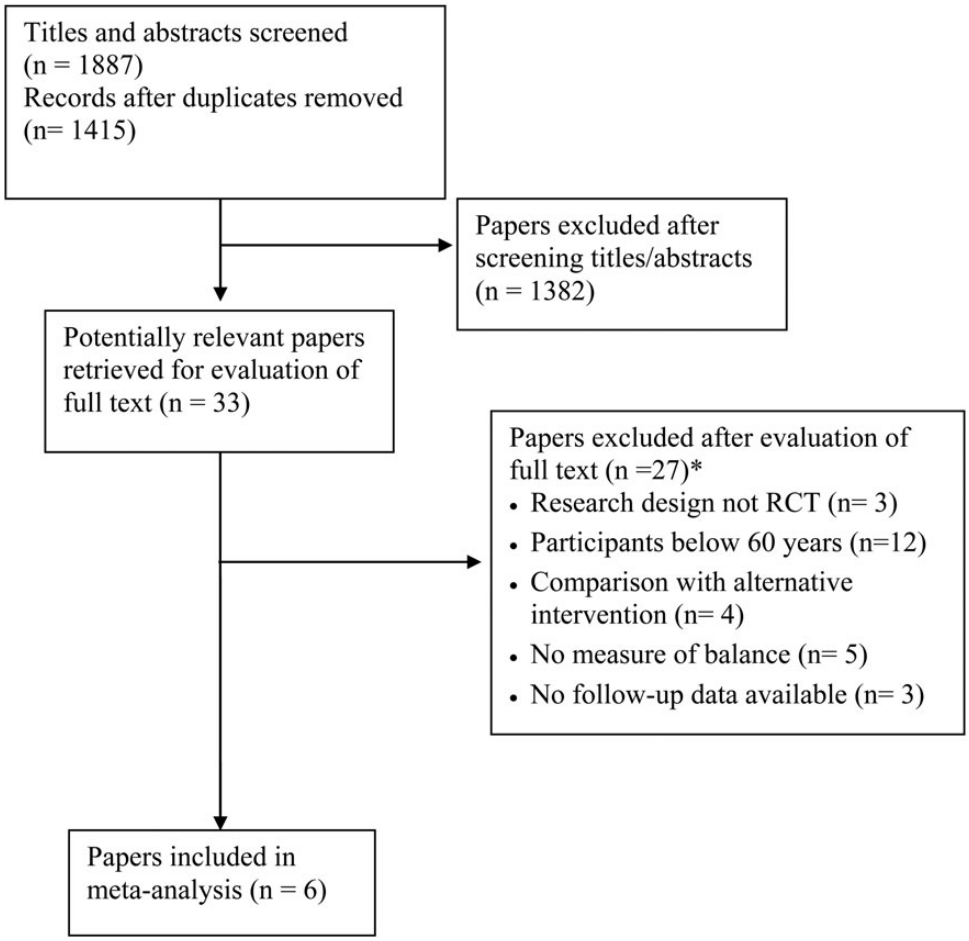

Figure 1. Flow of studies through the review. *Papers may have been excluded for failing to meet more than one inclusion criteria.

postures to more challenging. Yoga poses were conducted in standing, sitting and floor lying. Examples of the types of standing poses included were half knee squat with feet side by side ('chair pose'), one legged stand with arms extended ('tree pose'), one legged stand with trunk flexion and rotation ('half-moon pose'), hip abduction with trunk lateral flexion ('triangle pose'). The mean number of sessions attended by study participants was high, ranging from 75 to 99%.

Adverse events

All of the included trials measured adverse events related to the yoga intervention. Two of the trials reported that no adverse events occurred [25, 29]. One of the trials [27] reported that a fall occurred during the yoga intervention but that the participant did not sustain any injuries. It was subsequently discovered that the participant suffering from Meniere's disease. The remaining three trials reported minor adverse events as a result of the yoga intervention, ranging from knee pain, low back pain to minor muscle strain.

Outcome measures

Balance was measured in all studies, three studies used the Berg balance scale [18], two studies used the Short Physical Performance Battery [20] and one used a one leg stand [19]. Mobility measures were taken in three studies and included sit to stand and gait speed tests [21].

Effect of yoga on balance

The effect sizes from individual trials of the effect of yoga on balance involving 6 trials and 307 participants are shown in Figure 2. The pooled estimate of the effect of yoga on balance indicates a small but statistically significant effect on balance in yoga versus control participants (SMD 0.40, 95% CI 0.15–0.65). There was no indication of heterogeneity in the estimate of the effect of the intervention ($I^2 = 0\%$, $P = 0.615$).

Effect of yoga on mobility

The effect sizes from individual trials of the effect of yoga on mobility involving three trials [24, 26, 28] and 225 participants are shown in Figure 3. The pooled estimate of the effect of yoga on mobility indicates a medium, statistically significant effect on mobility in yoga versus control participants (SMD 0.50, 95% CI 0.06–0.95). There was an indication of some heterogeneity in the estimate of the effect of the intervention ($I^2 = 51.8\%$, $P = 0.126$).

Table 1. Summary of included studies

Study	Participants	Intervention details	Dose (total hours offered)	Class attendance[a]	Follow-up (weeks)	Adverse events due to yoga	Control group	Outcome measures	PEDro Score
Cheung *et al.* [28]	*n* = 36 Mean age = 72 36 females, 0 male Women who had symptomatic knee osteoarthritis	Yoga type = Hatha Sessions included poses in seated, supine and standing positions; breathing exercise and meditation. Home practice 4× per week encouraged. 60 min × 1 per week × 8 weeks Specific yoga poses included: Mountain, Warrior 1 and 2, Tree, Chair, Easy seated, Bound angle, Open angle, Half locust variation, Bridge, Standing forward fold, Reclining hamstring stretch, Reclining twist, Relaxation pose	8	75%	8	1 dropout due to knee pain	Wait list control	Balance = Short Physical Performance Battery Mobility = 8' walk	8
Colgrove *et al.* [29]	*n* = 13 Mean age = 67 7 females, 6 males Parkinson's disease patients who could ambulate	Yoga type = Iyengar, Hatha 60 min × 2 per week × 12 weeks Sessions included poses in seated, supine and standing positions; breathing exercise and meditation. Home practice encouraged. Specific yoga poses included: Information not reported	24	99%	12	Nil	Usual care	Balance = Berg balance scale	6
Oken *et al.* [26]	*n* = 135 Mean age = 72 101 females, 34 males Healthy community-dwelling	Yoga type = Iyengar 90 min × 1 per week × 24 weeks Sessions included poses in seated and standing positions; breathing exercise, visualisation and meditation. Daily home practice encouraged. Specific yoga poses included: Information not reported	36	78%[b]	24	1 minor groin strain that did not preclude participation	Wait list control	Balance = One leg stand Mobility = Sit to stand	6
Saravanakumar *et al.* [26]	*n* = 22 Mean age = 84 16 females, 6 males Aged care facility residents	Yoga type = not specified 30 min × 2 per week × 14 weeks Sessions included poses in seated and standing positions; breathing exercise and meditation. Specific yoga poses included: Mountain, Warrior, Tree, Chair, Side stretch, King dancer, Eagle, Staff, Cat, Half spinal twist	14	76%	14	1 fall during class that did not preclude participation	Usual care	Balance = Berg balance scale	6
Schmid *et al.* [25]	*n* = 47 Mean age = 63 17 females, 30 males Participants with chronic stroke (>6 months duration)	Yoga type = Yoga 60 min × 2 per week × 8 weeks Sessions included poses in seated, supine and standing positions; breathing exercise and meditation. Specific yoga poses included: Mountain, Warrior, Chair, Cow, Cobra, Half moon, Fish king, Pigeon, Locust, Awkward, Big toe, Bridge, Energy-releasing, Corpse pose	16	78%[c]	8	Nil	Wait list control	Balance = Berg balance scale	6

Continued

Table 1. Continued

Study	Participants	Intervention details	Dose (total hours offered)	Class attendance[a]	Follow-up (weeks)	Adverse events due to yoga	Control group	Outcome measures	PEDro Score
Tiedemann *et al.* 2013 [23]	$n = 54$ Mean age = 68 43 female, 11 male Healthy community-dwelling	Yoga type = Iyengar 60 min × 2/week × 12 weeks Sessions included poses in supine and standing positions; breathing exercise and meditation. Home practice encouraged. Specific yoga poses included: Mountain, Warrior 1, 2 and 3, Tree, Chair, Triangle, Half moon, Downward facing dog, Forward facing dog, Revolved Lateral Angel, Legs on the wall, Lying down big toe, Bound angle, Open angle, Staff, Corpse pose	24	83%	12	1 dropout due to low back pain, 5 reports of minor joint pain that did not preclude participation	Fall prevention booklet	Balance = Short Physical Performance Battery Mobility = 4-m walk	8

[a]Average class attendance across all participants.
[b]Average class attendance for participants who completed the trial.
[c]Proportion of participants who attended all yoga sessions.

The review also set out to assess the differential impact of yoga-based exercise on balance and mobility in people aged 60 and older on the basis of program or population characteristics. However, we could not achieve this due to the small number of trials identified.

Discussion

This systematic review and meta-analysis included six trials of relatively high (all studies scored 6 or greater on the PEDro scale) methodological quality that found that physical yoga improved balance and mobility in people aged 60 and over. The magnitude of the effect of physical yoga on balance (SMD = 0.40) demonstrates a small potential of physical yoga for improving balance in older people. The meta-analysis also indicated that there is a significant, moderate effect of yoga on the mobility outcomes of gait speed and timed chair stands (SMD = 0.50). No yoga-related serious adverse events were reported in any of the trials.

These results are in accordance with other recent systematic reviews that identified some evidence of a beneficial effect of yoga on balance in healthy populations [13] and on measures of strength and fitness among older people [8].

Since exercise that challenges balance is known to decrease fall risk, these results demonstrate preliminary evidence that yoga shows potential as a fall prevention intervention. The included trials focused on standing and seated balance postures, trials adapted the yoga programs to suit the needs of the older population, and certified yoga therapists and instructors implemented the interventions included in these trials. The types of yoga included in the trials varied; some trials specifically incorporated Iyengar yoga while others incorporated a broad Hatha yoga program. Future studies should investigate the optimal type of yoga to best suit the older population with the possible use of supportive equipment such as blocks or chairs. The included postures only varied slightly in the trials, with commonly included standing poses being; the mountain pose, warriors 1 and 2, tree pose, chair pose and locust pose.

This review has both strengths and limitations. To our knowledge, this is the first meta-analysis of randomised controlled trials to evaluate the impact of physical yoga on balance in older people. This systematic review was prospectively registered and not restricted by publication language or date. A key strength is that the included trials involved older people with a broad range of health states, including post-stroke [25], Parkinson's disease [29], knee osteoarthritis [28], aged care facility residents [27] and healthy community-dwellers [24, 26]. Yoga appears to be a feasible intervention for older people with a range of abilities. Furthermore, the reported number of adverse events was low across all trials. These results provide support for health professionals to confidently recommend yoga interventions to improve balance and mobility in people aged 60 and over in a variety of settings.

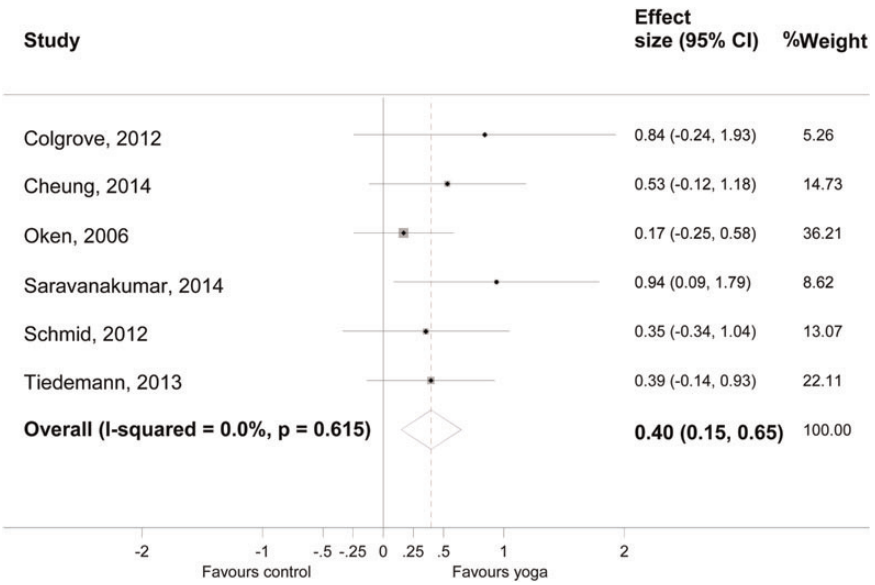

Figure 2. Effect size (95% CI) of yoga on balance by pooling data from six studies comparing yoga versus control using random-effects meta-analysis ($n = 307$).

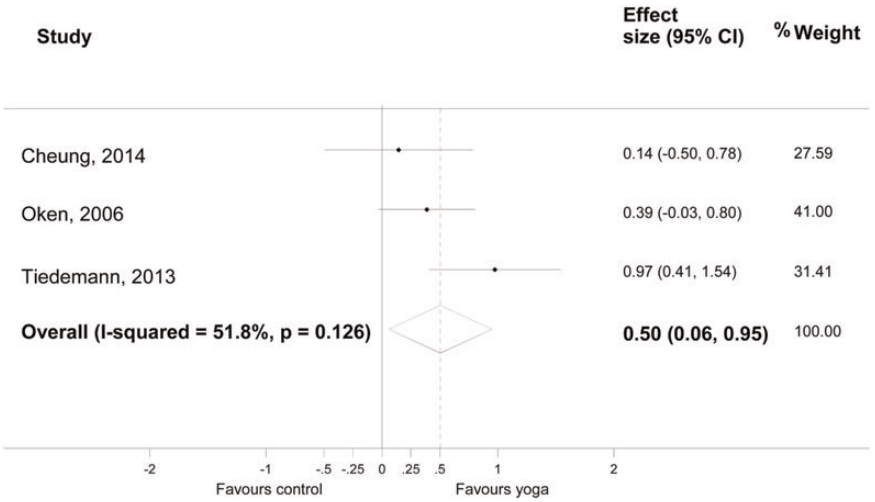

Figure 3. Effect size (95% CI) of yoga on mobility by pooling data from three studies comparing yoga versus control using random-effects meta-analysis ($n = 225$).

We acknowledge that the review had limitations. A source of bias in the studies included in this review was lack of blinding of therapists and patients. Attempts were made to minimise the risk of bias as a result of this lack of blinding through the use of blinded outcome assessors for most of the included trials. Additionally three of the six included trials did not use an intention-to-treat analysis which may have introduced study bias. We chose to use the PEDro scale to measure risk of bias; however, the Cochrane risk of bias tool could also have been used. The best way to assess risk of bias in trials of yoga interventions is not clear and warrants further investigation. The included trials all had quite small sample sizes, with just 307 participants in total for the six trials, which makes it difficult to draw conclusions about implications of the results for the broader population of older people. Additionally, the estimates of effects of yoga on mobility need to be interpreted cautiously as not all studies that have measured the effect of yoga on mobility were captured in this systematic review. It is also not clear whether the improvements in balance and mobility as a result of yoga participation were large enough to be of clinical relevance. Due to the pooling of data from different outcome measures for the meta-analyses, it was necessary for us to calculate the SMD to determine intervention effects, which adds difficulty to the interpretation of the results. However, we consider the advantages of pooling via SMD outweigh this limitation. Finally, the balance measures utilised as outcomes in the included trials were limited in the scope of postural control elements that they measured. This makes it difficult to assess the true

potential of yoga-based interventions for improving the aspects of postural control that are crucial for preventing falls in older age.

While this review provides preliminary evidence of the beneficial effect of physical yoga on balance and mobility in people aged 60 and over, the optimal volume, intensity and frequency of yoga for maximising balance and mobility outcomes to provide clinically relevant improvements remain to be determined. Of the six trials included in this review, only one trial conducted their yoga program for 24 weeks [26]. The remaining five trials ranged in durations from 8 to 14 weeks. In light of evidence of increased fall prevention benefit from exercise programs of a higher dose [7], future studies should include a longer duration intervention to fully explore the potential size of the impact on balance from a higher dose yoga-based intervention.

Conclusion

This review provides preliminary evidence that balance and mobility can be safely improved with participation in yoga by people aged 60 and over. Physical yoga warrants investigation as a potential intervention to prevent falls in older age.

Key points

- Health professionals can confidently recommend yoga for those aged 60+ to improve balance and physical mobility.
- Yoga-based exercise shows promise as a fall prevention intervention.
- Well-designed randomised controlled trials investigating the effects of yoga on falls are warranted.

Authors' contributions

A.T. and C.S. conceived the study and contributed to study design and interpretation of the data. S.Y. coordinated the literature search and data collection with assistance from M.W. S.Y., A.T. and C.D. contributed to data analysis, interpretation of the data and drafted the manuscript. All authors had access to the data and data analysis, contributed to revisions and approved the final manuscript. A.T. is the guarantor for the study.

Conflicts of interest

None declared.

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Supplementary data

Supplementary data mentioned in the text are available online to subscribers to *Age and Ageing*.

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