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The Effects of Yoga on Physical Functioning and Health Related Quality of Life in Older Adults: A Systematic Review and Meta-Analysis

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Abstract

Objective: The goal was to review systematically the comparative effectiveness of yoga, compared with other exercise interventions, for older adults as shown on measures of health and physical functioning.
Design: This was a systematic review with both narrative synthesis and meta-analysis.
Data sources: Searches were conducted in MEDLINE®/PUBMED, PSYCINFO, CINAHL, Web of Science, and SCOPUS; bibliographies of selected articles; and one systematic review on the effects of yoga on cardiovascular disease.
Methods: Original studies from 1950 to November 2010 were sought, evaluating the effects of yoga on older adults. The search was restricted to randomized controlled trials of yoga in subjects ≥ age 60, and published in English. Data were extracted and evaluated regarding setting, population size and characteristics, intervention type and duration, comparison group, outcome assessment, data analysis, follow-up, key results, and the quality of each study according to specific predetermined criteria.
Results: The search yielded 18 eligible studies ($N = 649$). The studies reported on older adults across a range of settings, intervention intensity, and outcome measures. The majority of the studies had < 35 participants (range 9–77). Quantitative and qualitative synthesis of the studies suggested that the benefits of yoga may exceed those of conventional exercise interventions for self-rated health status, aerobic fitness, and strength. However, the effect sizes were modest, and the evidence was mixed for yoga's effect on depression, sleep, and bone-mineral density. Studies did not find an effect on cognition.
Conclusions: Small studies with mixed methodological quality suggested that yoga may be superior to conventional physical-activity interventions in elderly people. The precision of the estimates remains low. Larger studies are necessary to define better the intersection of populations, settings, and interventions in which yoga is most beneficial.

Introduction

Older adults who are physically inactive are at increased risk of functional limitations, disability, and frailty.[1–3] Research on aging has sought to identify effective ways to prevent or reverse frailty.[4] Current recommendations are 30 minutes of physical activity on most days of the week to prevent loss of abilities.[5,6] Physical activities that have been shown to improve functioning in frail older adults include weight training,[6] power training,[7] walking to promote endurance, balance, strengthening, and flexibility.[8]

Yoga is a potentially promising physical activity for older adults.[9–14] Surveys show that many older adults in the United States are practicing yoga.[9,11,15] Many forms of yoga exist—such as Hatha, Iyengar, and other yoga forms—that aim to promote overall movement, health, and wellness.[10] Iyengar yoga is a form of yoga that uses props such as bolsters, belts and chairs to adapt to an older individual's abilities.[13,16,17]

Yoga not only improves health-related quality of life (HRQoL)[18,19] but also enhances walking and balance,[8,16,17,20] muscle strength,[20–22] cardiovascular health,[23–25] blood pressure (BP),[23,25–27] sleep,[12,28] and functioning of other

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systems.[29–38] Yoga may also have psychosocial benefits through prevention and control of common health and emotional problems linked with aging.[19,39,40] An emerging evidence base describes the effectiveness of yoga for psychosocial and physical functioning in older adults.[18] The current authors performed a systematic review to compare effectiveness of yoga with other exercises for promoting physical performance and quality of life (QoL). Previous systematic reviews have looked at the effects of yoga in young adults; is effects on patients with insulin resistance syndrome and cardiovascular disease,[24] anxiety,[40] and chronic pain[41]; and yoga's therapeutic effects on children.[42] None of these reviews have addressed the effects of yoga in older adults.

This systematic review was framed around the following question: Among older adults in community and institutional settings, is yoga superior to other physical activity with respect to its effect on physical functioning measures and health related quality of life (HRQoL)?

Methods

Data Sources and searches

Astandardized protocol was developed and followed for all steps of this review (Appendix 1). Two (2) investigators searched databases to include MEDLINE®/PubMed, PsycInfo, CINAHL, Scopus, and Web of Science; these searches were augmented by hand-searching bibliographies of selected articles and a previous systematic review of yoga and cardiovascular disease on older adults. The search terms included yoga and older adults or elderly. The searches were limited to English language, age ≥65, and randomized controlled trials or clinical trials. A text word (.tw) search was also performed for yoga. Medical subject headings, keywords, and text words were used in search strategies. All electronic databases were accessed on November 3, 2010.

Study selection

Two (2) investigators independently reviewed the titles, abstracts and/or full-text of manuscripts of retrieved articles to determine if they met eligibility criteria. The inclusion criteria were: (1) randomized controlled trials; (2) participants 60 and older, (3) yoga, compared to another intervention; and (4) English. To evaluate potential subgroup effects, all eligible studies were included regardless of dwelling. There were no restrictions on year of study. Consensus among the investigators occurred through additional review of the original reports (Fig. 1). In one case, the study was excluded because the study design was unclear.[43]

Data abstraction

Two (2) investigators independently abstracted data, using a standardized form that was developed after a series of pilot abstractions and then was verified by a third reviewer. The abstracted data included author/year, database, age range, mean age, % male, sampling strategy, inclusion criteria, exclusion criteria, comorbid conditions, source of participant accrual, overall sample size and numbers in intervention and control groups, type of yoga (description, dose, duration of intervention), if outcome assessment was blinded, outcomes assessed, participant attrition, adverse effects, statistical analysis, conclusions, funding sources, and indicators of study quality.

Quality assessment

A methodological quality assessment (Table 1) was performed to evaluate sources of systematic bias.[44] Ten items used for quality assessment included: (1) source of patients; (2) number of controls; (3) selection description; (4) withdrawals; (5) therapeutic regimens described; (6) prior estimate of sample size; (7) statistical inference; (8) appropriate statistical analysis; (9) handling of withdrawals; and (10) side-effects. Rather than use a summary score of study quality, the effect of key quality measures on study outcomes was evaluated.

Data synthesis and analysis

Data were synthesized descriptively, emphasizing methodological characteristics of the studies, such as populations enrolled, definitions of selection and outcome criteria, sample sizes, adequacy of the randomization process, interventions and comparisons, outcome assessment or intervention administration, subjective versus objective measures, and study quality. In addition, a meta-analysis was performed for selected outcomes when they were similarly measured across studies.

Comparisons of yoga and other exercise interventions were based on absolute differences in continuous measures of physical functioning, QoL, or depressive symptoms. The summary measure in this meta-analyses was the standardized mean difference (SMD). The SMD is an effect-size measure computed by dividing the mean difference in outcomes between groups by the pooled standard deviation (SD) of the outcome. Standard cutoffs were used to interpret the effect sizes: 0.6 for modest effect size and 0.8 for large effect size. To evaluate heterogeneity among studies in the meta-analyses, the I^2 statistic, which measures the proportion of variability among studies that cannot be explained by chance, was used. The I^2 statistic ranges from 0% to 100% with values closer to 0 representing less heterogeneity. Typically 25%, 50%, and 75% are used to respectively define low, moderate, and high heterogeneity.

Because the included studies were small, there were imbalances in baseline scores after randomization, so it was not possible to compare outcomes at the endpoint. Change scores for each study arm were therefore computed and compared. Change scores were calculated from baseline and endpoint measures in the studies' data tables. Because none of the studies reported the SDs of the change scores, a procedure in the Cochrane Handbook (Section 16.1.3.2)[45] was used to impute these SDs. A sensitivity analysis was used to how the imputations affected the statistical significance of meta-analytical summary estimates. The results presented here represent the most conservative imputations. Meta-analyses were performed using Stata Version 11.0 (StataCorp, College Station, TX).

Results

Search results and study characteristics

A total of 146 articles, titles and abstracts were retrieved via the search (Fig. 1). Of these, 48 articles were excluded as

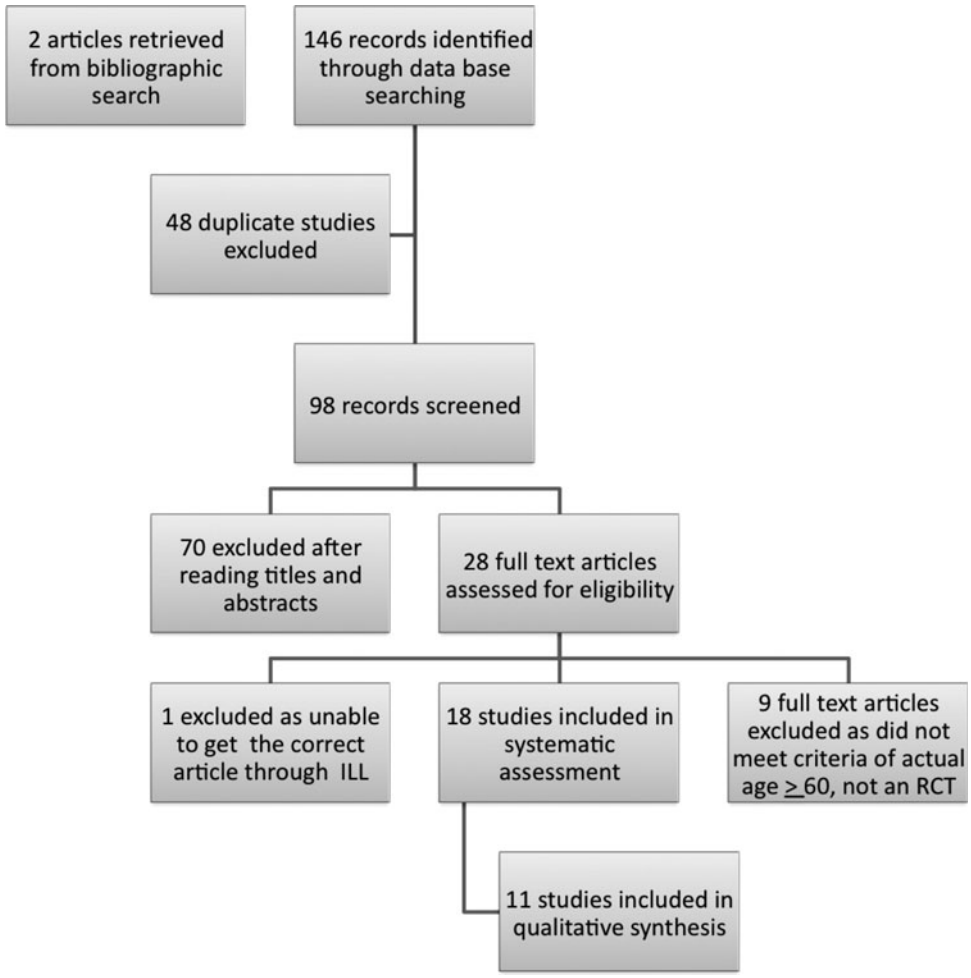

FIG. 1. Flow diagram showing the identification, screening, eligibility and those included for the systematic review.

duplicates; 70 were excluded after determining that their titles and abstracts were not relevant or did not meet inclusion criteria; 9 were excluded after full-article review as not meeting inclusion criteria; and 19 articles met eligibility criteria. It was not possible to retrieve 1 eligible article as a full text.[34] Thus, 18 articles were included in the systematic review. The 18 studies included 11 unique cohorts of participants, as 7 of the articles reported on different outcomes variables for cohorts previously described in other articles. The 11 cohorts thus represented the sample for the qualitative analysis of the various outcomes (Fig. 1).

The mean age of participants across the studies ranged from 63.5 to 77.5, and the majority (71%) were women (Table 2). The included studies represented four different countries—the United States,[19,23,26,32,36,46–49] Cuba,[31] Taiwan,[12,20] and India.[28,33] Thirteen (13) studies were conducted in community settings,[19,23,26,29–32,36,45–49] 4 studies were in institutional/residential or senior communities,[12,20,28,33] and 4 studies reported on stable patients from the community with either chronic obstructive pulmonary disease (COPD) or coronary heart disease (CHD) or diabetes.[30,31,46,47] Ten (10) studies were designed to evaluate yoga as the primary intervention,[12,19,20,28,30–33,36,49] whereas 8 studies were designed with aerobic exercise as the primary intervention and yoga as the active control.[23,26,29,36,46–48,50] The yoga intervention varied in frequency from once to twice a week, for 12 weeks to 14 months. The studies assessed various primary outcomes, maximum aerobic capacity ($VO_{2\ max}$),[23,26,36,50] depression,[12,19,23,33] sleep,[12,19,28] measures of cognition,[19,50] HRQoL,[12,19,31,32] upper- and lower-extremity strength BP, total cholesterol, body mass index (BMI),[19,20,23,26,30,31,46,48] bone density,[32,46–48] dyspnea intensity,[30] and kyphosis.[32]

Methodological quality of studies ranged from 6 to 9 of the quality elements present (Table 1). Half of the studies had well-defined inclusion and exclusion criteria. Only one study determined sample size *a priori*,[19] and another study[32] reported that outcome assessors were blinded. The intervention and control groups were well-described. There was poor reporting on allocation concealment. Baseline imbalances were evident between study arms for different HRQoL outcomes.[19,30,46,47] Presence or absence of adverse events was not reported by most of the cohorts (7 of 11).

Narrative Summary

Physical functioning, exercise, and yoga

Substantial improvements were reported on household activities, such as floor sweeping, vacuuming, laundry loading/unloading, and bed making in both the resistance training and yoga groups with no significant difference between groups.[47] Oken et al.[19] demonstrated that the yoga group had improvements in physical measures such as

Table 1. The Effects of Yoga on Physical Functioning and Health Related Quality of Life in Older Adults: A Systematic Review and Meta-Analysis

Author/ Year	Outcomes assessed	Mean age (in years)	Male %	Age range (in years)	Population	Sampling strategy	Participants in intervention group	Participants in control group	Intervention description	Control description	Type of yoga
Ades, P. A., Savage, P. D., Brochu, M., Tischler, M. D., Lee, N. M., & Poehlman, E. T. (2005).	Strength, energy expenditure, BMI, depression, bone mineral content	72	0%	68–77	females, community dwelling with established CHD for at least 6 months	Not described; stated based on self-reported functional level so they were similar at baseline	females with CHD; n=21	females with CHD; n=21	Resistance training aerobic exercise	Light yoga	Light yoga no specific type mentioned or described
Ades, P. A., Savage, P. D., Cress, M. E., Brochu, M., Lee, N. M., & Poehlman, E. T. (2003).	Strength, body composition, self-reported physical performance, BMI	72.3	0%	65–88	females, community dwelling with established CHD for at least 6 months	Not described; state according to self-reports of functional level so they were similar at baseline	(n=14) after dropouts	(n=19) after dropouts	3 sessions per week for 16 consecutive weeks	Yoga or Ayurveda (post trial)	Light yoga no specific type mentioned or described
Blumenthal, J. A., Emery, C. F., Madden, D. J., Coleman, R. E., Riddle, M. W., Schniebolk, S., et al. (1991).	BP, Body weight, BMI, total cholesterol, LDL, HDL, cardiorespiratory fitness	67	50%	60–83	community dwelling older adults	101 after exclusion randomized to 3 groups	n=33 in aerobic exercise (AE)	n=34 (yoga) and n=34 (waitlist control)	Subjects in the AE group attended three supervised exercise sessions per week	Yoga group non aerobic yoga for 60 minutes 2 times a week, and a waitlist group (not given any intervention)	Not mentioned
Blumenthal, J. A., Emery, C. F., Madden, D. J., Schniebolk, S., Riddle, M. W., Cobb, F. R., et al. (1991).	Bone density using single photon absorptiometry	67	50%	60–83	community dwelling older adults	Not described	n=33 in aerobic exercise (AE)	n=34 (yoga) and n=34 (waitlist control)	Subjects in the AE group attended 3 supervised exercise sessions per week	Yoga group 60 minutes of non-aerobic yoga 2 times a week for 16 weeks	Non aerobic yoga
Blumenthal, J. A., Emery, C. F., Madden, D. J., Schniebolk, S., Walsh-Riddle, M., George, L. K., et al. (1991).	Measures of mood, psychiatric symptoms, and neuropsychological functioning. Anxiety, depression and overall mood, memory functioning	67	50%	60–83	community dwelling older adults	Not described	n=33 in aerobic exercise (AE)	n=34 (yoga) and n=34 (waitlist control)	Subjects in the AE group attended 3 supervised exercise session per week	Yoga group 60 minutes of non-aerobic yoga 2 times a week for 16 weeks	Non aerobic yoga
Blumenthal, J. A., Emery, C. F., Madden, D. J., George, L. K., Coleman, R. E., Riddle, M. W., et al. (1989).	BP, lipids, bone density, peak oxygen consumption (VO2) and anaerobic threshold; measures of mood, psychiatric symptoms, and neuropsychological functioning. Anxiety, depression and overall mood, memory functioning	67	50%	60–83	community dwelling older adults	Randomly assigned	n=33 in aerobic exercise	n=34 (yoga) and n=34 (waitlist control)	Subjects in the AE group attended 3 supervised exercise sessions per week	Yoga group 60 minutes of non-aerobic yoga 2 times a week for 16 weeks	Not mentioned

(*continued*)

Table 1. (Continued)

Author/ Year	Outcomes assessed	Mean age (in years)	Male %	Age range (in years)	Population	Sampling strategy	Participants in intervention group	Participants in control group	Intervention description	Control description	Type of yoga
Bowman, A. J., Clayton, R. H., Murray, A., Reed, J. W., Subhan, M. M., & Ford, G. A. (1997).	VO2max, BP, alpha index and heart rate variability	68	60%	62–81	Healthy sedentary from local community	Randomly assigned	n=14 , 4 women and 10 men	n=12, 6 women and 6 men	Aerobic exercise	Yoga- 2 times a week for 1.5 hours	Hatha yoga
Chen, K. M., Chen, M. H., Chao, H. C., Hung, H. M., Lin, H. S., & Li, C. H. (2009).	Sleep quality, depression and self-perception of health	68	< 10%	60–85	Recruited from senior activity centers	Cluster sampling, 8 senior centers; randomized into experimental and control groups	n=62 (combined for demographics, gender and other characteristics)	n=66	Yoga for 70 minutes	Wait list control, participated in other activities of the senior centers	Silver Yoga; Hatha Yoga
Chen, K. M., Chen, M. H., Hong, S. M., Chao, H. C., Lin, H. S., & Li, C. H. (2008).	Physical fitness indicators, height, weight, BMI, body fat composition, cardiovascular and respiratory health - blood pressure, breath holding time, hand grip strength, flexibility of joints shoulder, hip, walking speed	68.97	0.3	60–75	Recruited from senior activity centers	Convenience sample; randomized to three groups	n=62 and n=59	n=66	two experimental groups - 1) one with 70 minutes of yoga & 2) the other with 55 minutes of yoga	Wait list control	Silver Yoga; Hatha Yoga
Donesky-Cuenco, D., Nguyen, H. Q., Paul, S., & Carrieri-Kohlman, V. (2009).	Dyspnea Intensity and Dyspnea related distress; HRQOL and physical function	69.9	13%	60–78	Clinically stable patients with COPD	Stable COPD patients from American Lung Association better breathers - newsletters, email and physician referrals	n=20 (drop outs n=6)	n=21 (drop outs n=6)	Iyengar yoga techniques, use of props, 1 hour sessions for 2 times a week for 12 weeks.	Pamphlet for COPD management	Iyengar Yoga; Asanas explained in detail
Flegal, K. E., Kishiyama, S., Zajdel, D., Haas, M., & Oken, B. S. (2007).	Cognitive function, mood, fatigue, anxiety, HRQOL and physical measures, POMS, CES-D, STAI, SF36, MFI 20	73.7 (exercise group), 71.5 (yoga group); 71.2 (waitlist control)	30%	65–85	Generally healthy older adults	Randomly assigned	n=44	n=47(exercise), n=44 waitlist	Beginning Iyengar hatha yoga classes for 90 minutes 1 time a week with daily home practice, for 6 months, assessments at baseline, 3 and 6 months	Exercise outdoor track or walking for 60 minutes 1 time a week with daily home exercise encouragement; waitlist group no active intervention	Iyengar Yoga
Gordon, L. A., Morrison, E. Y., McGrowder, D. A., Young, R., Fraser, Y. T., Zamora, E. M., et al. (2008).	FBG, TC, HDL, LDL, VLDL and oxidative process - superoxide dismutase	63.5	19.50%	states 40–70 were invited but not clearly noted	National Institute of Endocrinology and a hospital in Cuba	Sample size & strategy determination not well explained	n=77 (yoga)	n=77 (conventional Physical Training); n=77 (control)	Hatha yoga for 2 hours including warm up, yoga poses and relaxation once a week for 6 months measurements at baseline, 3 months and 6 months	Conventional PT exercise for 2 hours 1 time a week, control no intervention asked to f/u with their physician on a regular basis	Hatha yoga no specific style

(*continued*)

Table 1. (Continued)

Author/ Year	Outcomes assessed	Mean age (in years)	Male %	Age range (in years)	Population	Sampling strategy	Participants in intervention group	Participants in control group	Intervention description	Control description	Type of yoga
Greendale, G. A., Huang, M. H., Karlamangla, A. S., Seeger, L., & Crawford, S. (2009).	Debrunner-Kyphosis angle primary, secondary kyphosis index and HRQL	77.5	19%	59.8–90	Community, highly functional older adults	Quasi-random assignment – couples assigned together	Two waves n=23 and n=35	Two waves n=25 and n=35	Hatha yoga for 1 hour	Monthly luncheons	Hatha yoga no specific style
Krishnamurthy, M., & Telles, S. (2007).	Depression	70.1, 72.1 and 72.3	40%	60 to 95	Residential home	Randomly assigned	n=18	n=18 and n=20	The yoga sessions were 75 minutes daily, 6 days a week, for 24 weeks.	The Wait-list Control Group was not given any intervention but was told that they could receive either yoga or Ayurveda after the trial.	Integrated approach to yoga
Manjunath, N.K & Telles, S. (2007).	Self-rated sleep	70.1 (yoga), 72.1 (Ayurveda) and 72.3 (wait-list control)	40%	60 to 95	Residential home	Randomly assigned	n=18	n=18 and n=20	The yoga sessions were 75 minutes daily, 6 days a week, for 24 weeks.	The Wait-list Control Group was not given any intervention but was told that they could receive either yoga or Ayurveda after the trial.	Integrated approach to yoga
Madden, D. J., Blumenthal, J. A., Allen, P. A., & Emery, C. F. (1989).	Physiological and cognitive assessments	67	50%	60–83	Community dwelling older adults	Randomly assigned	n=25	n=28 (yoga) and n=26 (waitlist control)	Subjects in the AE group attended 3 supervised exercise sessions per week	Yoga group 60 minutes of non-aerobic yoga 2 times a week for 16 weeks	Light yoga no specific type mentioned or described
Oken, B. S., Zajdel, D., Kishiyama, S., Flegal, K., Dehen, C., Haas, M., et al. (2006).	Cognitive assessments, Stroop test, EEC, SF36, HRQOL, POMS, MDFI, flexibility and timed one leg stance	73.7	30%	65–85	Generally healthy older adults	Randomly assigned; power analysis performed a priori	n=42, analyzed n=38	n=46 (exercise) and n=42 (waitlist control)	Iyengar yoga poses-beginner classes in a gentle way, 1 class per week for 6 months with home practice. Iyengar certified instructor	Exercise, nurse certified as personal trainer, aerobic exercise 1 class per week with home practice. and waitlist groups, no intervention, monthly phone calls	Iyengar Yoga
Stachenfeld, et al. (1998).	VO2 Max	73	0%	67–76	Retirement community older adults	Randomly assigned	n=9	n=8	The aerobic training group took part in a supervised program of treadmill (24 wks, n=4) or trampoline walking (16 wks, n=3).	Group stretching and yoga exercises (3–4 times per week for 1 h session)	Yoga exercises

(*continued*)

Table 1. (Continued)

Author/ Year	Type of yoga	Inclusion criteria	Exclusion criteria	Participants blinded	Outcomes assessor blinded	Comorbid conditions	Participant attrition	Participant accrual	Adverse effects in intervention	Statistical analysis
Ades, P. A., Savage, P. D., Brochu, M., Tischler, M. D., Lee, N. M., & Poehlman, E. T. (2005).	Light yoga no specific type mentioned or described	Age ≥ 65; Coronary Heart Disease (CHD) x 6 months; Physical Function score < 85 on the MOS-SF-36	Hospitalization for acute coronary syndrome; very low threshold angina; uncontrolled HTN; exercise-test limiting non-cardiac comorbidity	Not mentioned	Not mentioned	OA, diabetes, CVA, claudication	n = 9 of 51 approximately 20% (n = 42)	Community dwelling	Not mentioned	Paired t-test, ANOVA, non-paired t-test, univariate regression analysis
Ades, P. A., Savage, P. D., Cress, M. E., Brochu, M., Lee, N. M., & Poehlman, E. T. (2003).	Light yoga no specific type mentioned or described	Age ≥ 65; Coronary Heart Disease (CHD) x 6 months; Physical Function score < 85 on the MOS-SF-36	Hospitalization for acute coronary syndrome; very low threshold angina; uncontrolled HTN; exercise-test limiting non-cardiac comorbidity	Not mentioned	Not mentioned	Not mentioned	n = 9 of 42; 7 in exercise group and 2 in yoga group were dropouts (not because of adverse effects)	Not mentioned	Not mentioned	ANOVA, Univariate regression
Blumenthal, J. A., Emery, C. F., Madden, D. J., Coleman, R. E., Riddle, M. W., Schniebolk, S., et al. (1991).	Non aerobic yoga	Age ≥ 60; Free of CHD; sedentary	If did not meet inclusion criteria	Not mentioned	Not mentioned	Stated healthy subjects	n = 4 of 101; 2 in control and 2 in intervention	TV, radio, newspaper	Not mentioned	Repeated measures ANOVA
Blumenthal, J. A., Emery, C. F., Madden, D. J., Schniebolk, S., Riddle, M. W., Cobb, F. R., et al. (1991).	Non aerobic yoga	Age ≥ 60; Free of CHD; sedentary	If did not meet inclusion criteria	Not mentioned, there was also semi cross over after time 1	Not mentioned	Not mentioned	T1 (n = 101), for T2 (4 months; n = 97), T3 to T4 (6 months; n = 47)	Community, TV, radio	Not mentioned	ANOVA
Blumenthal, J. A., Emery, C. F., Madden, D. J., Schniebolk, S., Walsh-Riddle, M., George, L. K., et al. (1991).	Non aerobic yoga	Age ≥ 60; Free of CHD; sedentary	If did not meet inclusion criteria	Not mentioned	Not mentioned	Not mentioned		Community, TV, radio	Not mentioned	MANOVA
Blumenthal, J. A., Emery, C. F., Madden, D. J., George, L. K., Coleman, R. E., Riddle, M. W., et al. (1989).	Non aerobic yoga	Age ≥ 60; Free of CHD; sedentary	If did not meet inclusion criteria	Not mentioned	Not mentioned	Reported as potentially healthy older adults	n = 4 of 101; 2 in control and 2 in intervention	Newspapers, TV, radio from the community	Not mentioned	MANOVA
Bowman, A. J., Clayton, R. H., Murray, A., Reed, J. W., Subhan, M. M., & Ford, G. A. (1997).	Hatha yoga	Healthy, sedentary older adults	No significant PMHx; not a current smoker; no regular medications;	Not mentioned	Not mentioned	Not mentioned	n = 4 (30%) in aerobic and n = 5 (40%) in yoga group	From the community advertisements in newspapers	Not mentioned	Descriptive, mean, SD and standard paired t test

(*continued*)

Table 1. (Continued)

Author/ Year	Type of yoga	Inclusion criteria	Exclusion criteria	Participants blinded	Outcomes assessor blinded	Comorbid conditions	Participant attrition	Participant accrual	Adverse effects in intervention	Statistical analysis
Chen, K. M., Chen, M. H., Chao, H. C., Hung, H. M., Lin, H. S., & Li, C. H. (2009).	Silver Yoga; Hatha Yoga	Community-dwelling OA ≥ 60y; able to walk without assistance; cognitively alert Barthel Index ≥ 91	No previous training in yoga;	Not mentioned	Not mentioned	Not mentioned	6.47% participant withdrawal from both experiment and control group; reported similar characteristics	Clusters recruited from senior activity centers	Not mentioned	Descriptive, mean SD and Chi square
Chen, K. M., Chen, M. H., Hong, S. M., Chao, H. C., Lin, H. S., & Li, C. H. (2008).	Silver Yoga; Hatha Yoga	Community-dwelling OA ≥ 60y; able to walk without assistance; cognitively alert Barthel Index ≥ 91	No previous training in yoga;	Not mentioned	Not mentioned	Not mentioned	Not mentioned	Senior activity centers	Not mentioned	Descriptive statistics, Pearson chi square, ANOVA and ANCOVA
Donesky-Cuenco, D., Nguyen, H. Q., Paul, S., & Carrieri-Kohlman, V. (2009).	Iyengar Yoga; Asanas explained in detail	Age > 40y; ADLs limited by COPD; O2 saturation > 80%	Active symptomatic illness; yoga, pulmonary rehabilitation or exercise training in last 6 months	Not mentioned	Not mentioned	COPD	n = 6 (30%) in both groups	American Lung Association, physician offices	No adverse events noted	Descriptive, t-test
Flegal, K. E., Kishiyama, S., Zajdel, D., Haas, M., & Oken, B. S. (2007).	Iyengar Yoga	Age 65–85; Healthy men & women	Not mentioned	Not mentioned	Not mentioned	Not mentioned	14% in yoga group, 19% in exercise and 5% In waitlist control	Not mentioned	Not mentioned	Descriptive. t-test
Gordon, L. A., Morrison, E. Y., McGrowder, D. A., Young, R., Fraser, Y. T., Zamora, E. M., et al. (2008).	Hatha yoga no specific style	Age 40–70; Patients with Type II Diabetes Mellitus (T2DM) without disease complications; trained in diabetes education and nutrition; duration of T2DM 1–10 y; good psychological condition	No previous yoga exposure	Not mentioned	Not mentioned	Not mentioned	Not mentioned	Hospital in Cuba	Not mentioned	Two way ANOVA

(*continued*)

Table 1. (Continued)

Author/ Year	Type of yoga	Inclusion criteria	Exclusion criteria	Participants blinded	Outcomes assessor blinded	Comorbid conditions	Participant attrition	Participant accrual	Adverse effects in intervention	Statistical analysis
Greendale, G. A., Huang, M. H., Karlamangla, A. S., Seeger, L., & Crawford, S. (2009).	Hatha yoga no specific style	Age ≥ 60; adult-onset hyperkyphosis; Debrunner kyphometer angle ≥ 40 degrees; ability to move from floor to standing; stand feet together 30s; stand feet should width apart 60s	Active angina pectoris; uncontrolled HTN; high resting HR/RR; unstable asthma; COPD; cervical spine or knee/ankle instability; hemiparesis; paraparesis; inability to comprehend instructions; no physical examination in last year	No	Assessors blinded	Not mentioned	Not clear, but surmise that all participated in intervention and outcome assessments (0%)	Community	Not clear about this they measure side effects, I am not sure if they consider this to be adverse events	Descriptive, Wilcoxon two rank test and Fischer exact test
Krishnamurthy, M., & Telles, S. (2007).	Integrated approach to yoga	Age ≥ 60; Residential home for aged; general health screening	Uncontrolled T2DM; uncontrolled HTN; neurological disorders; dementia; hearing problem	The assigner was blinded	Not mentioned	Not mentioned	In the Ayurveda group	From a residential home	Not mentioned	ANOVA and Repeated Measures ANOVA, Paired t- tests.
Manjunath, N.K & Telles, S. (2007).	Integrated approach to yoga	Normal healthy older adults; no history of smoking or respiratory problems	Uncontrolled T2DM; uncontrolled HTN; neurological disorders; dementia; hearing problem	The assigner was blinded	Not mentioned	Not mentioned	In the Ayurveda group	From a residential home	Not mentioned	paired t test, ANOVA, repeated measures ANOVA; McNemar test
Madden, D. J., Blumenthal, J. A., Allen, P. A., & Emery, C. F. (1989).	Light yoga no specific type mentioned or described	Age ≥ 60; Medical History, physical examination, ECG monitoring during a cycle ergometry test	Uncontrolled T2DM; uncontrolled HTN or CAD; taking beta blockers or psychotrophic medications	Assigner blinded	Not mentioned	Not mentioned	n = 79 of 85 (93%)	Community, TV, radio, newspaper	Not mentioned	ANOVA, Univariate regression
Oken, B. S., Zajdel, D., Kishiyama, S., Flegal, K., Dehen, C., Haas, M., et al. (2006).	Iyengar Yoga	Screened for medical problems; physical examination; ECG monitoring	Insulin-dependent T2DM; uncontrolled HTN or CAD; liver or kidney failure; lung disease; CHF; alcoholism; drug abuse; ischemic heart disease; valvular disease; significant visual impairment; actively practicing yoga	Treatment groups assigned by statistician	Statistician was blinded	Not mentioned	12.40%	Community local new papers, OSHU newsletter website, community sites	No side effects noted	ANCOVA
Stachenfeld, et al. (1998).	Age ≥ 65; Free from CV and renal disease	Not taking medications	Not mentioned	Not mentioned	Not mentioned	Not mentioned	n = 2 (22%) in intervention group	Volunteers	Not mentioned	Repeated measures ANOVA

(*continued*)

Table 1. (Continued)

Author/Year	Conclusions	Comments	Timeline	Funding source
Ades, P. A., Savage, P. D., Brochu, M., Tischler, M. D., Lee, N. M., & Poehlman, E. T. (2005).	Flexibility improved in all; Strength training should be considered an important component in the rehabilitation of older women with CHD	Not well defined criteria for exclusion and for measures, subject selection and randomization not stated well	6 months	NIA grant
Ades, P. A., Savage, P. D., Cress, M. E., Brochu, M., Lee, N. M., & Poehlman, E. T. (2003).	Disabled older women with CHD who participate in an intense resistance-training program improved physical capacity over a wide range of household activities	In discussion and conclusion mention no major adverse effects but not clearly stated in assessment	6 months	NIA grant
Blumenthal, J. A., Emery, C. F., Madden, D. J., Coleman, R. E., Riddle, M. W., Schniebolk, S., et al. (1991).	Improved peak oxygen consumption and lipid profile	Subjects in both the groups were given the option of participating in aerobic exercise and measurements were done at time 4	6 months	NIA and NHLBI
Blumenthal, J. A., Emery, C. F., Madden, D. J., Schniebolk, S., Riddle, M. W., Cobb, F. R., et al. (1991).	Increased bone density in men not women	The focus was on the aerobic treatment; with cross over design - both the yoga and wait list groups improved AE between T2-T3 and Aerobics Group maintained AE fitness levels	14 months 4 times: T1 , T2, T3 and T4	NIA and NHLBI
Blumenthal, J. A., Emery, C. F., Madden, D. J., Schniebolk, S., Walsh-Riddle, M., George, L. K., et al. (1991).	No objective effect on psychological functioning, but subjective improvement in all the groups after T2	More dropouts when all did exercise, not sure of the reason as none was given	14 months 4 times: T1, T2, T3 and T4	NHLBI
Blumenthal, J. A., Emery, C. F., Madden, D. J., George, L. K., Coleman, R. E., Riddle, M. W., et al. (1989).	Absence of objective changes but subjective benefits in yoga group	Control group subjective improvement	4 months	NIA and NHLBI
Bowman, A. J., Clayton, R. H., Murray, A., Reed, J. W., Subhan, M. M., & Ford, G. A. (1997).	Yoga increased the alpha HF component of the baroreceptor reflex sensitivity in normotensive elderly subjects; unrelated to exercise status	Yoga was intervention for control group	6 weeks	No mention
Chen, K. M., Chen, M. H., Chao, H. C., Hung, H. M., Lin, H. S., & Li, C. H. (2009).	Positive outcomes in community dwelling younger older adults	Mental health improved after silver yoga intervention after 3- and 6- months compared with the control group	6 months	National Science council of Taiwan
Chen, K. M., Chen, M. H., Hong, S. M., Chao, H. C., Lin, H. S., & Li, C. H. (2008).	Yoga improved physical fitness in both 70 minutes or 55 minute bouts	This is an RCT described as quasi-experiment pre-post design	12 and 24 weeks	National Science council of Taiwan
Donesky-Cuenco, D., Nguyen, H. Q., Paul, S., & Carrieri-Kohlman, V. (2009).	Improved COPD and in HRQOL	Included age > 40 but mean age of participants was 69.9 ranging from 60 - 78 years; dyspnea distress, exercise and self-related functional performance improved overall	12 weeks	Grant from NCCM
Flegal, K. E., Kishiyama, S., Zajdel, D., Haas, M., & Oken, B. S. (2007).	Healthy seniors adherence correlated to depression, fatigue and HRQOL	Adherence was greatest at yoga class (77%), then exercise class (69%), and home (54%).	6 months	NIH Grant
Gordon, L. A., Morrison, E. Y., McGrowder, D. A., Young, R., Fraser, Y. T., Zamora, E. M., et al. (2008).	Yoga was beneficial for management of diabetes	The age range was 40–70 with a mean age of 63; therefore included this study.	6 months	The National Institute of Endocrinology; Lascelles Chin and LASCO Group; Roche Pharmaceuticals
Greendale, G. A., Huang, M. H., Karlamangla, A. S., Seeger, L., & Crawford, S. (2009).	The decreased flexicurve kyphosis angle in the yoga treatment group showed that hyperkyphosis was remediable	Side effects were reported as adverse events	6 months	NIH grant and Claude De Pepper Center
Krishnamurthy, M., & Telles, S. (2007).	GDS score decreased in yoga group	Integration of physical and mental physical activity improved depression scores; perhaps an alternative for medication	6 months	not mentioned
Manjunath, N.K and Telles, S. (2007).	Improved subjective sleep	The authors mention about treatment fidelity in both the groups	6 months	Not mentioned
Madden, D. J., Blumenthal, J. A., Allen, P. A., & Emery, C. F. (1989).	Not conclusive; suggested that exercise-related changes in older adults' cognitive performance	Compared to a younger group but reported the data for older adults separately	16 weeks	NIA and NHLBI
Oken, B. S., Zajdel, D., Kishiyama, S., Flegal, K., Dehen, C., Haas, M., et al. (2006).	No improvements in cognitive function but yoga group showed significant improvement in QOL.	Not sure who conducted the assessments and if participants were blinded	26 weeks	NIH grant
Stachenfeld, et al. (1998).	Modest increase in VO2 maximum	Small sample of convenience; how randomized not mentioned, findings from control not mentioned	12 weeks	NIH grant

AE, aerobic exercise; BMI, body mass index; BP, blood pressure; CES-D, Clinical Epidemiological Scale – Depression; CHD or CAD, coronary heart disease or coronary artery disease; CHF, congestive heart failure; COPD, chronic obstructive pulmonary disease; CVA, cerebral vascular accident; FBS, fasting blood glucose; HDL, high density lipoprotein; HR, heart rate; HRQOL, health related quality of life; HTN, hypertension; LDL, low density lipoprotein; MFI – Multidimensional Fatigue Inventory; OA, Osteoarthritis; POMS, Profile of Mood States; MOS SF-36, Medical Outcomes Study SF-36; STAI, State Trait Anxiety Index; T2DM, type 2 diabetes mellitus; VLDL, very low density lipoprotein; VO2, maximal oxygen consumption.

Table 2. Quality Assessment of the Cohorts of the Studies

Author/ Indicators	*Source of patients*	*Number of controls*	*Selection description*	*Withdrawals*	*Therapeutic regimes described*	*Prior estimate of sample size*	*Statistical inference*	*Appropriate stat analysis*	*Handling of withdrawals*	*Side effects*	*Overall impression*
Ades 2003 & 2005	Y	Y	Y	Y	Y	N	Y	Y	N	N	7 out of 10
Blumenthal, J.A. 1989, 1991a, 1991b, 1991c and Madden DJ, 1989	Y	Y	Y	N	Y	N	Y	Y	N	N	6 out of 10
Bowman, A.J. 1995	Y	Y	Y	N	Y	N	Y	Y	N	N	6 out of 10
Chen, K. 2008	Y	Y	Y	N	Y	N	Y	Y	N	N	6 out of 10
Chen, K. 2009	Y	Y	Y	N	Y	N	Y	Y	N	N	6 out of 10
Donesky-Cuenco 2009	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	9 out of 10
Flegal, K.E., 2007 and Oken B.S. 2006	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	9 out of 10
Gordon LA, 2008	Y	Y	Y	Y	Y	N	Y	Y	Y	N	8 out of 10
Greendale, G.A., 2009	Y	Y	Y	N	Y	N	Y	Y	Y	N	7 out of 10
Manjunath, N.K. 2005 & Krishnamurthy, MN 2007	Y	Y	Y	N	Y	N	Y	Y	N	N	6 out of 10
Stachenfled N.S., 1998	Y	Y	Y	Y	Y	N	Y	Y	N	N	7 out of 10

timed one leg standing and forward flexibility as well as QoL measures related to sense of well-being, energy, and fatigue, compared to an aerobic exercise control group. The effects on kyphosis were evaluated by Greendale et al.,[32] who found that the yoga group experienced a 4.4% improvement in flexicurve kyphosis angle and 5% improvement in kyphosis index, compared with the monthly luncheon groups that served as controls.

Physiologic measures and yoga

There were no significant changes in body weight, BMI, % body fat, fat-free mass, appendicular muscle mass, or bone mineral density (BMD) for either the resistance training or the yoga group.[46] The resistance-training group increased in leg and arm strength as measured by a single repetition maximal (1RM).[46] Blumenthal et al.[26] confirmed that older adults had little objective improvement in physical strength. An increase in bone density occurred in men after 14 months of participation in both the exercise and yoga programs, but no change was found for women.[48] Body flexibility had significantly improved in both the upper and lower body in the yoga group, with improved lower-limb muscle endurance and walking speed, but there were no significant changes in body weight or BMI.[20]

Ades et al.[26] and Blumenthal et al.[46] found that dyspnea-related distress and heart rate were decreased at the end of a 6-minute walk test in the yoga group, but there were no significant changes in pulmonary function as measured by forced expiratory volume at 1 minute (FEV_1) and forced vital capacity (FVC).

The concentrations of fasting blood glucose and cholesterol decreased for older adults with diabetes in the yoga and exercise groups.[31] Lipid peroxidation, as indicated by malondialdehyde, decreased significantly in the Hatha yoga and the physical training groups. There was no significant difference from baseline to 6 months in protein oxidation.[31]

Psychosocial measures and yoga

Yoga was compared with control or wait-list control groups for cognition ($N=142$),[19,50] however, no differences were found after yoga training ($n=74$), compared with a control group ($n=68$). No changes in cognition, as measured using the Wechsler Adult Intelligence Scale—Digit symbol and vocabulary test, were reported to be related to aerobic exercise or yoga.[50] Nor were there effects of yoga on cognition, as demonstrated by subjects using the Wide Range Achievement Test.[19] Similarly, no changes were found for alertness and attention, as measured by the Stroop color and word testing.

A significant decrease in sleep latency and increase in number of hours slept were found after 6 months of yoga intervention.[28] Sleep outcomes, using the Pittsburgh Sleep Quality Index (PQSI), and depression, using the Taiwanese Depression Scale, were reported after 6 months of yoga decreased sleep latency, daytime dysfunction and depression decreased, while subjective sleep quality, physical health perception, and mental health perception improved.[12] Subjective scales—the Stanford sleepiness scale and Profile of Mood States—used to measure sleep and mood, showed no change among groups.[19]

Sleep and depression ($N=286$) were evaluated by three researchers, using a subjective assessment or a questionnaire to determine sleep quality.[12,19,28] None of the differences were statistically significant; however, the change scores may have been clinically meaningful as reported by Manjunath[28] ($N=23$), Chen,[12] ($N=128$), and Oken[19] ($N=135$). In contrast, depression, measured with the Geriatric Depression Scale (GDS),[15] was reduced in a yoga group at 3 and 6 months.[33] In older adults with COPD, however, there were no significant changes in depressive symptoms, anxiety, or general disease-specific HRQoL.[30]

Adherence to yoga

Flegal et al.[49] correlated adherence to yoga with baseline measures of depression, fatigue, and physical components of HRQoL. These researchers reported that adherence was not related to age, gender, or educational level.

Meta-Analysis

We performed a meta-analysis for selected outcomes for reports with similar outcome measures: (1) VO_{2max}; (2) depression (Center for Epidemiological Studies—Depression Scale (CES_D) and GDS); and (3) HRQOL (both physical and mental scales; (Fig. 2A–D).

Maximal aerobic consumption capacity (VO_{2max}; Fig. 2A; $N=282$) was measured in several studies using aerobic exercise (AE), compared with a control group who performed yoga.[26,29,46,50] The summary standardized mean difference for VO_{2max} was 0.54 (0.08–1.00), which was a moderate effect size favoring yoga over comparison activities. Heterogeneity among studies was modest.

Depression (Figure 2B; $N=543$), as measured by the CES-D (3 of 4 researchers)[12,19,30] or the GDS (1 of 4 researchers)[33] did not change in any of the 4 studies abstracted (exercise [$n=99$] versus yoga [$n=173$] versus control [$n=162$])].

The SMD for depression was -0.57 (-1.17 to 0.04), which was a moderate effect size in the direction of yoga reducing depression scores to a greater extent than comparison activities did, although this reduction was not statistically significant. Study heterogeneity was large (I^2 80%).

HRQoL was evaluated separately for the Short Form–36 (SF-36) physical and mental component scales (Fig. 2C and D; $N=422$).[12,19,30, 33] On the physical component scale of the SF-36, the estimated SMD (0.65 [0.02–1.28]) favored the yoga intervention. Study heterogeneity was large (I^2 82%). On the mental component scale of the SF-36, the estimated SMD again favored yoga (0.66 [0.10–1.22]). Study heterogeneity was large (I^2 77%). These effect sizes for the SF-36 mental and physical scales are classified as moderate.

Discussion

The current systematic review suggests that yoga may be superior to aerobic exercise interventions to improve self-rated physical and mental health status (measured by SF-36), flexibility, and aerobic fitness (measured by VO_{2max}). Mixed evidence was found for strength, BMD, sleep and depression. Cognitive function did not seem to improve after yoga intervention.

Consistent with a field in its early stages of development, the findings are based on a relatively small number of trials with little statistical precision and significant methodological weaknesses. Innes et al.[24] reported limitations in the

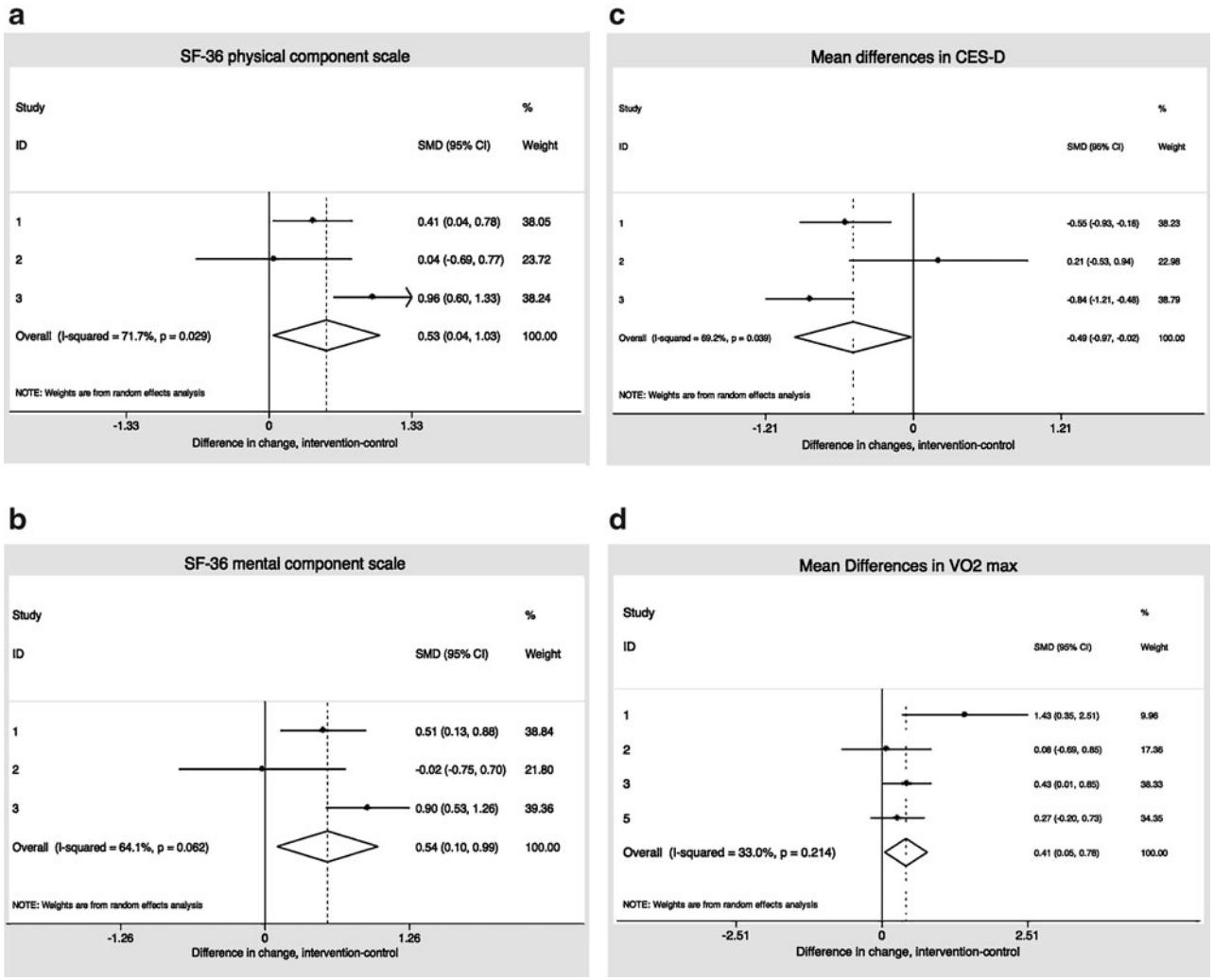

FIG. 2. Showing the forest plots of the primary outcomes of the included studies.

yoga studies and methodological quality of the studies such as limited numbers of participants, lack of reporting of adverse effects, and no sample size justification. Other systematic reviews showed promising results but had similar limitations with studies and the methodological quality.[40,42,51]

The current review indicated several limitations in the available evidence base. First, there was wide variability in the interventions. Many different types of yoga regimens were prescribed. The diversity in yoga intervention was not surprising, as there are many different types of yoga practiced based on each teacher's training and philosophy. The duration of intervention and frequency of intervention also varied widely among the various trials, as did the study outcomes and measurement methods. Second, poor adverse-event (AE) reporting in most of the studies limited any conclusions about the safety of yoga as an exercise. It was unclear if there was lack of reporting of adverse effects or no actual AEs occurred. Third, sample sizes were small, which limited the precision and generalizability of the estimates. Fourth, the interventions' durations varied considerably across studies.

The current authors recommend that researchers design clinical trials with well-specified yoga interventions that take into account the differences in approaches based on training and philosophy. The yoga intervention for any study should be described in more detail, in terms of frequency, intensity, and the duration of sessions to allow for determination of exercise dose–response. Investigators should specify clinically meaningful effect sizes. Future trials should formally monitor and report the incidence of AEs and reasons for dropouts, such as musculoskeletal injuries. Standardized, objective measurements of physical, psychosocial, and spiritual well-being are recommended, such as self-reports of pain (visual analogue scale), quality of life (SF-36) and sleep (questionnaire), and objective measures of functional ability (Short Physical Performance Battery), function (walking speed), balance (single-limb stance), flexibility (functional reach or sit and reach), and muscle strength (sit to stand and hand grip). These outcome measures are recommended based on the importance of early identification of people at risk for decline in function and frailty.[2,52,53] Given the low number of participants, it is important to assess barriers to participation. The current authors recommend that future research focus on

assessing barriers, perceived benefits, and cues to action for participation in, and adherence to, yoga exercise regimens in addition to exploring ways of recruiting and retaining participants. For example, one of the reasons for low participation may have been the religious beliefs of the participants.[54]

Conclusions

In summary 18 studies (11 cohorts) were systematically reviewed. The outcomes studied were diverse, thereby limiting a meta-analysis of all the studies. Limited evidence supports yoga's benefit for strength, flexibility, physical and mental health status, and aerobic fitness. Its effect on other important outcomes—household functioning, depression, sleep, and others—remains uncertain. Very little has been reported about potential adverse events. Overall, the current authors recommend yoga for older adults with careful observation and monitoring of side-effects.

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Disclosure Statement

No conflicts of interest exist.

References

1. Carlson SA, Fulton JE, Schoenborn CA, et al. Trend and prevalence estimates based on the 2008 Physical Activity Guidelines for Americans. Am J Prev Med 2010;39:305–313.
2. Espinoza S, Walston JD. Frailty in older adults: Insights and interventions. Cleve Clin J Med 2005;72:1105–1112.
3. Rockwood K, Mitnitski A. Frailty defined by deficit accumulation and geriatric medicine defined by frailty. Clin Geriatr Med 2011;27:17–26.
4. Hackstaff L. Factors associated with frailty in chronically ill older adults. Soc Work Health Care 2009;48:798–811.
5. American College of Sports Medicine; Chodzko-Zajko WJ, Proctor DN, et al. American College of Sports Medicine position stand: Exercise and physical activity for older adults. Med Sci Sports Exerc 2009;41:1510–1530.
6. Physical Activity Guidelines Advisory Committee report, 2008: To the Secretary of Health and Human Services. Part A: Executive summary. Nutr Rev 2009;67:114–120.
7. Miszko TA, Cress ME, Slade JM, et al. Effect of strength and power training on physical function in community-dwelling older adults. J Gerontol A Biol Sci Med Sci 2003;58:171–175.
8. National Institute on Aging. Exercise and Aging–Your Everyday Guide from the National Institute on Aging, Publication of the National. Institute on Aging, Gaithesburg, MD 20898, 2009.
9. Barnes PM, Bloom B, Nahin RL. Complementary and alternative medicine use among adults and children: United States, 2007. Natl Health Stat Report 2008;12:1–23.
10. Birdee GS, Legedza AT, Saper RB, et al. Characteristics of yoga users: Results of a national survey. J Gen Intern Med 2008;23:1653–1658.
11. Centers for Disease Control and Prevention. Prevalence of self-reported physically active adults—United States, 2007. MMWR Morb Mortal Wkly Rep 2008;57:1297–1300.
12. Chen KM, Chen MH, Chao HC, et al. Sleep quality, depression state, and health status of older adults after silver yoga exercises: Cluster randomized trial. Int J Nurs Stud 2009;46:154–163.
13. Iyengar B, ed. Yoga: The Path to Holistic Health. New York: DK Publishing, 2001.
14. Nguyen HT, Grzywacz JG, Lang W, et al. Effects of complementary therapy on health in a national U.S. sample of older adults. J Altern Complement Med 2010;16:701–706.
15. Nahin RL, Barnes PM, Stussman BJ, et al. Costs of complementary and alternative medicine (CAM) and frequency of visits to CAM practitioners: United States, 2007. Natl Health Stat Report 2009;18:1–14.
16. DiBenedetto M, Innes KE, Taylor AG, et al. Effect of a gentle Iyengar yoga program on gait in the elderly: An exploratory study. Arch Phys Med Rehabil 2005;86:1830–1837.
17. Iyengar BKS. Light on Yoga—The Classic Guide to Yoga by the World's Foremost Authority. New Delhi: Harper Collins, 2004.
18. Roland KP, Jakobi JM, Jones GR. Does yoga engender fitness in older adults? A critical review. J Aging Phys Act 2011;19:62–79.
19. Oken BS, Zajdel D, Kishiyama S, et al. Randomized, controlled, six-month trial of yoga in healthy seniors: Effects on cognition and quality of life. Altern Ther Health Med 2006;12:40–47.
20. Chen KM, Chen MH, Hong SM, et al. Physical fitness of older adults in senior activity centres after 24-week silver yoga exercises. J Clin Nurs 2008;17:2634–2646.
21. Bosch PR, Traustadottir T, Howard P, et al. Functional and physiological effects of yoga in women with rheumatoid arthritis: A pilot study. Altern Ther Health Med 2009;15:24–31.
22. Brown KD, Koziol JA, Lotz M. A yoga-based exercise program to reduce the risk of falls in seniors: A pilot and feasibility study. J Altern Complement Med 2008;14:454–457.
23. Blumenthal JA, Emery CF, Madden DJ, et al. Cardiovascular and behavioral effects of aerobic exercise training in healthy older men and women. J Gerontol 1989;44:M147–M157.
24. Innes KE, Bourguignon C, Taylor AG. Risk indices associated with the insulin resistance syndrome, cardiovascular disease, and possible protection with yoga: A systematic review. J Am Board Fam Pract 2005;18:491–519.
25. Yogendra J, Yogendra HJ, Ambardekar S, et al. Beneficial effects of yoga lifestyle on reversibility of ischaemic heart disease: Caring Heart Project of International Board of Yoga. J Assoc Physicians India 2004;52:283–289.
26. Blumenthal JA, Emery CF, Madden DJ, et al. Effects of exercise training on cardiorespiratory function in men and women older than 60 years of age. Am J Cardiol 1991;67:633–639.
27. Patel C, North WR. Randomised controlled trial of yoga and bio-feedback in management of hypertension. Lancet 1975;ii:93–95.
28. Manjunath NK, Telles S. Influence of yoga and Ayurveda on self-rated sleep in a geriatric population. Indian J Med Res 2005;121:683–690.
29. Bowman AJ, Clayton RH, Murray A, et al. Effects of aerobic exercise training and yoga on the baroreflex in healthy elderly persons. Eur J Clin Invest 1997;27:443–449.

30. Donesky-Cuenco D, Nguyen HQ, Paul S, et al. Yoga therapy decreases dyspnea-related distress and improves functional performance in people with chronic obstructive pulmonary disease: A pilot study. J Altern Complement Med 2009;15:225–234.
31. Gordon LA, Morrison EY, McGrowder DA, et al. Effect of exercise therapy on lipid profile and oxidative stress indicators in patients with type 2 diabetes. BMC Complement Altern Med 2008;8:21.
32. Greendale GA, Huang MH, Karlamangla AS, et al. Yoga decreases kyphosis in senior women and men with adult-onset hyperkyphosis: Results of a randomized controlled trial. J Am Geriatr Soc 2009;57:1569–1579.
33. Krishnamurthy MN, Telles S. Assessing depression following two ancient Indian interventions: Effects of yoga and ayurveda on older adults in a residential home. J Gerontol Nurs 2007;33:17–23.
34. Manjunath NK, Telles S. Pulmonary functions following yoga in a community dwelling geriatric population in India. J Indian Psychol 2006;24:44–51.
35. Skoro-Kondza L, Tai SS, Gadelrab R, et al. Community based yoga classes for type 2 diabetes: An exploratory randomised controlled trial. BMC Health Serv Res 2009; 9:33–33.
36. Stachenfeld NS, Mack GW, DiPietro L, et al. Regulation of blood volume during training in post-menopausal women. Med Sci Sports Exerc 1998;30:92–98.
37. Telles S, Naveen VK, Balkrishna A, et al. Short term health impact of a yoga and diet change program on obesity. Med Sci Monit 2010;16:CR35–CR40.
38. Williams KA, Petronis J, Smith D, et al. Effect of Iyengar yoga therapy for chronic low back pain. Pain 2005;115:107–117.
39. Rao MR, Raghuram N, Nagendra HR, et al. Anxiolytic effects of a yoga program in early breast cancer patients undergoing conventional treatment: A randomized controlled trial. Complement Ther Med 2009;17:1–8.
40. Kirkwood G, Rampes H, Tuffrey V, et al. Yoga for anxiety: A systematic review of the research evidence. Br J Sports Med 2005;39:884–891;discussion 891.
41. Morone NE, Greco CM. Mind–body interventions for chronic pain in older adults: A structured review. Pain Med 2007;8:359–375.
42. Galantino ML, Galbavy R, Quinn L. Therapeutic effects of yoga for children: A systematic review of the literature. Pediatr Phys Ther 2008;20:66–80.
43. Chen KM, Tseng WS. Pilot-testing the effects of a newly developed silver yoga exercise program for female seniors. J Nurs Res 2008;16:37–46.
44. Chalmers TC, Smith H,Jr, Blackburn B, et al. A method for assessing the quality of a randomized control trial. Control Clin Trials 1981;2:31–49.
45. Higgins JPT, Green S (editors) Cochrane handbook for Systematic Reviews of Interventions Version 5.1.0 [updated March 2011]. The Cochrane collaboration, 2011. Available from www.cochrane–handbook.org
46. Ades PA, Savage PD, Brochu M, et al. Resistance training increases total daily energy expenditure in disabled older women with coronary heart disease. J Appl Physiol 2005;98: 1280–1285.
47. Ades PA, Savage PD, Cress ME, et al. Resistance training on physical performance in disabled older female cardiac patients. Med Sci Sports Exerc 2003;35: 1265–1270.
48. Blumenthal JA, Emery CF, Madden DJ, et al. Effects of exercise training on bone density in older men and women. J Am Geriatr Soc 1991;39:1065–1070.
49. Flegal KE, Kishiyama S, Zajdel D, et al. Adherence to yoga and exercise interventions in a 6-month clinical trial. BMC Complement Altern Med 2007;7:37.
50. Madden DJ, Blumenthal JA, Allen PA, et al. Improving aerobic capacity in healthy older adults does not necessarily lead to improved cognitive performance. Psychol Aging 1989;4:307–320.
51. Cooper C, Balamurali TB, Selwood A, et al. A systematic review of intervention studies about anxiety in caregivers of people with dementia. Int J Geriatr Psychiatry 2007;22:181–188.
52. Studenski S, Perera S, Patel K, et al. Gait speed and survival in older adults. JAMA 2011;305:50–58.
53. Studenski S, Perera S, Wallace D, et al. Physical performance measures in the clinical setting. J Am Geriatr Soc 2003;51:314–322.
54. Patel N, Akkihebbalu S, Espinoza, SE, Chiodo, LK. Perceptions of community based yoga intervention for older adults. Activities, Adaptation Aging 2011;35:151–163.

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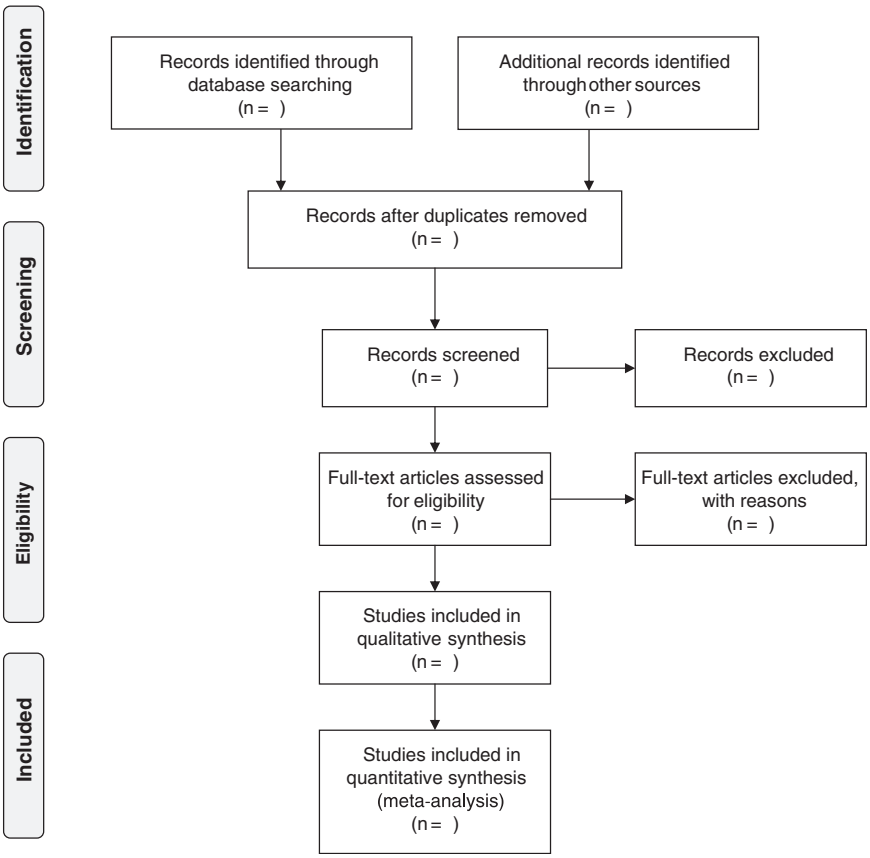
(*Appendix follows* →)

Appendix


Identification
Screening
Eligibility
Included
Records identified through database searching (n =)
Additional records identified through other sources (n =)
Records after duplicates removed (n =)
Records screened (n =)
Records excluded (n =)
Full-text articles assessed for eligibility (n =)
Full-text articles excluded, with reasons (n =)
Studies included in qualitative synthesis (n =)
Studies included in quantitative synthesis (meta-analysis) (n =)