

Does Yoga Engender Fitness in Older Adults? A Critical Review

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Interest in yoga is growing, especially among older adults. This review critically summarizes the current literature to investigate whether physical fitness and function benefits are engendered through the practice of yoga in older adults. A comprehensive search yielded 507 studies; 10 studies with 544 participants (69.6 ± 6.3 yr, 71% female) were included. Large variability in yoga styles and measurement outcomes make it challenging to interpret results across studies. Studies reported moderate improvements for gait ($ES = 0.54, 0.80$), balance ($ES = 0.25-1.61$), upper/lower body flexibility ($ES = 0.25, 0.70$), lower body strength ($ES = 0.51$), and weight loss ($ES = 0.73, 0.99$). Yoga may engender improvements in some components of fitness in older adults. However, more evidence is needed to determine its effectiveness as an alternative exercise to promote fitness in older adults. Further investigation into yoga as an exercise activity for older adults is warranted.

Keywords: physical function, fitness indicators, exercise alternative, complementary therapy

An emerging trend is the recommendation of yoga as an alternative medical therapy. Fourteen million people in the United States (6.1% of the population) have had a doctor or therapist suggest yoga as a therapeutic tool, and 45% of adults surveyed believe yoga is a beneficial adjunct therapy for traditional medical treatment (Macy, 2008). Participation in yoga has tripled in the last 4 years. According to a recent survey, 15.8 million U.S. adults (6.9%) are practicing it, and an additional 18.3 million express interest in the discipline (Macy, 2008). Of those who practice yoga, 18.4% are 55+ years of age (Macy, 2008).

Yoga is a physical and mental discipline that originated in Indian culture over 2,000 years ago (Morone & Greco, 2007). The term *yoga* comes from the Sanskrit word *yuj*, meaning “to join,” and symbolizes the integration of body and mind in perfect union (Choudhury, 2007). The physical practice of postures (*asanas*) was originally intended to prepare the body for meditation, and this has become synonymous with “yoga” in the Western world. However, this is only one of eight different branches of the yoga framework: *bhakti* (devotion), *karma* (service), *raja* (meditation), *mantra* (chanting), *laya* (abstract thought), *tantra* (ritual), *vedanta* (philosophy), and *hatha* (physical; Choudhury, 2007; Figure 1).

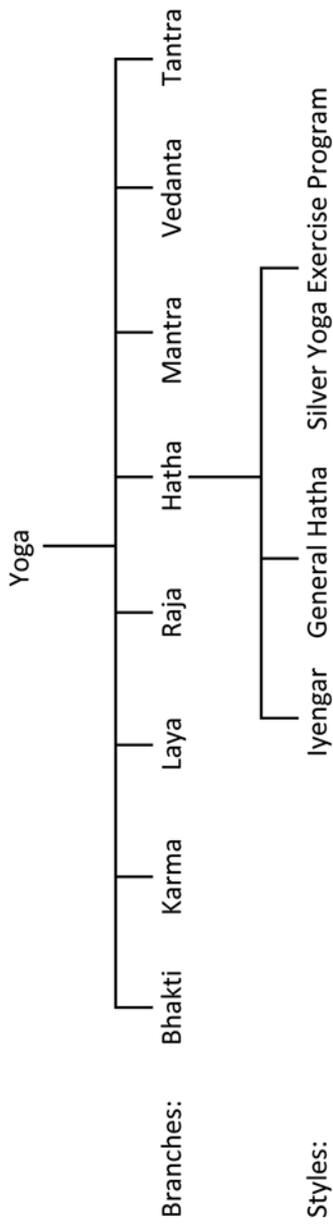


Figure 1 — The discipline of yoga has different branches. Hatha yoga (the focus of this review) is further divided by styles reported in this review.

Hatha yoga is the most common form of yoga practiced in North America. It focuses on a combination of postures to address strength, flexibility, balance, and the mind-body-breath coordination (Smith, Hancock, Blake-Mortimer & Eckert, 2007). In addition, breathing (*pranayama*) and meditation exercises are practiced to calm and focus the mind and develop greater self-awareness (Morone & Greco, 2007). Hatha yoga requires participants to hold and move between a series of static postures. Major classifications of poses are standing, forward and backward bending, twists, hand balancing, inversions, and restoratives (Friend, 2006). Yoga requires focused effort in completing the pose, controlling the body, and breathing at a steady rate. A yoga pose involves isometric contraction of specific muscle groups to stabilize the body as one performs the posture. The pose is typically held from 30 s to several minutes, depending on the style. There are many different styles of hatha yoga characterized by the rate at which postures are performed, environmental temperature, physical intensity, level of difficulty, and emphasis on body alignment and relaxation (e.g., breathing, concentration; Table 1). These are designed to strengthen and stretch the body and are aimed at meeting the particular physical and/or spiritual needs of the wide variety of people who practice yoga. In addition, the use of aids (“props,” e.g., blocks and straps) enables those of most functional abilities to participate in yoga (Groessl, Weingart, Aschbacher, Pada, & Baxi, 2008). This review focuses on the physical practice of yoga as an alternative exercise to improve physical fitness and function in older adults. The term *yoga* will be used throughout this article to represent the hatha branch of yoga.

Table 1 Summary of Popular Styles of Hatha Yoga

| Style | Description |
|----------------------|---|
| Anusara | Combines life-affirming philosophies with alignment. Focuses on the key power center (i.e., most musculoskeletal force) during postures. |
| Ashtanga | Flowing series of postures synchronized with specific breathing (<i>ujjayi</i>). Often referred to as power yoga. |
| Bikram | A 90-min series, follows a strict sequence of 26 postures. 105 °F room to warm/stretch muscles, detoxify, and improve cardiovascular fitness. |
| Integral | Gentle. Aimed at stretching, strengthening, and calming the body and mind. Emphasizes comfortable postures, relaxation, breathing, and diet. |
| Iyengar | Developed by B.K.S. Iyengar and emphasizes proper alignment through use of props (blocks) for support. In addition, concentrates on breathing. |
| Kripalu | Focuses on comfortable pose, breath, and awareness. A blending of physical postures with meditation. Observation of energy flow. |
| Kundalini | Awareness. Refers to the energy channels that run between all the energy centers (<i>chakras</i>) of the body. Focuses on spine and endocrine system. |
| Restorative or (yin) | The practice of supported, conscious, mind–body relaxation. Derives from Iyengar. Gives the body the opportunity to renew and heal. |
| Sivanada | Naturally cultivates the body’s vitality. Emphasizes yogic breathing and frequent relaxation. Series of 12 postures that are sun salutations. |

A recent survey of health and fitness clubs across the United States found that 86% offered yoga programming (Cowen & Adams, 2007). The growing interest of older adults in yoga, as an alternative exercise, has led researchers to investigate its effects on older adults (Morone & Greco, 2007). Most of the current research using yoga as an alternative exercise intervention has concentrated on health-related quality-of-life issues, including reviews on musculoskeletal disorders (Luskin et al., 2000; Raub, 2002), chronic pain (Morone & Greco, 2007), cardiopulmonary function (Raub, 2002), chronic-disease risk factors (i.e., blood pressure, body-mass index, diabetes, and hypertension; Yang, 2007), cancer survivors (Smith & Pukall, 2009), and depression (Pilkington, Kirkwood, Rampes, & Richardson, 2005). There are three individual studies that have examined whether yoga promotes fitness (Clay, Lloyd, Walker, Sharp, & Pankey, 2005; DiCarlo, Sparling, Hinson, Snow, & Rosskopf, 1995; Hagins, Moore, & Rundle, 2007). However, those studies focused on adults younger than 40 years of age, and the results are not necessarily applicable to the needs of older populations.

Exercise is planned or structured repetitive bodily movement performed to maintain or improve one or more of the components physical fitness (cardiorespiratory, strength, flexibility, body morphology, and balance). Fitness reflects an increase of physiological reserve capacity that people have or achieve, allowing them to perform given activities at lower relative intensities. Physical fitness promotes physical function (e.g., mobility), which is required to maintain independence in older adulthood and will also be included in this review. A growing body of evidence supports exercise as a means to reduce the risk of premature mortality and to preserve functional independence in old age as per current physical activity and exercise guidelines for older adults (American College of Sports Medicine et al., 2009; Paterson, Jones, & Rice, 2007).

This review aims to provide a summary of the current evidence regarding the practice of yoga to improve physical fitness and function in older adults. The quality of the evidence is examined and summarized, with the objective of informing exercise specialists on the current evidence that may support the practice of yoga with older adults.

Literature-Search Methods

The articles included in this review were retrieved using the following databases: PubMed, Scholars Portal, AgeLine, CINAHL, EBSCO, MEDLINE, SPORTDiscus, PsycINFO, and EMBASE. The reference lists from relevant articles were reviewed for additional studies that fit the inclusion criteria. The key search terms were *yoga*, *older adults*, *senior*, *elderly*, and *aged*. Publication dates of articles were considered from 1970 to 2009, spanning enough breadth to examine foundational studies, as well as the most recent evidence. Searches were completed up to March 2010.

The review was restricted to articles on human subjects and published in English. After the original search, the article titles were screened and duplicate articles were removed. The inclusion criteria were being either a healthy (i.e., no chronic diseases or clinical populations) older adult (65+ years) or 55- to 64-year-old first-wave baby boomers. A yoga intervention was administered, and physical fitness-related (e.g., strength, flexibility, balance, cardiorespiratory function, body composition) and function-related (e.g., mobility) outcome measures were used.

The search primarily targeted randomized controlled trial study designs; however, pre- and postassessment designs were included when all search criteria were met. Planned comparators included exercise groups (i.e., yoga compared with aerobic exercise), nonexercise control groups, and pre- compared with postyoga measures. The reviewer, who was not blinded to the purpose of the evaluation, appraised the abstracts according to the inclusion criteria. A full-text review was completed for the remaining articles to ensure that they fully met all inclusion criteria, and data extraction and quality analysis were completed on the remaining studies.

A standardized data-extraction table was used to document study objectives, study design, sample size, participant characteristics, details of the yoga intervention, style of yoga, outcome measures, and power and effect-size calculations. Studies were assessed using a modified Downs and Black (DB; 1998) quality-rating checklist because of its applicability to nonrandomized controlled trials. The modified DB checklist consisted of 16 items with a maximum score of 20 to account for the limited recruitment, methodology, and statistical analysis undertaken in the included studies. Studies of all levels of quality (*poor* 1–10, *moderate* 11–15, and *high* 16–20) are discussed in further detail.

Results

With the key search terms *older adults*, *elderly*, *senior*, *aged*, and *yoga*, a total of 507 citations were found. Titles were scanned for evidence of a yoga intervention with functional and fitness-related outcomes in older adults. Relevant articles were recorded using reference-managing software (RefWorks, Bethesda, MD). After duplicates were removed, 161 articles remained for assessment. The abstracts of the remaining articles were then reviewed, with attention to the inclusion criteria. This process resulted in the exclusion of an additional 120 publications, leaving a total of 41 studies. These articles were then subjected to a full-text review, with 10 of the 41 studies meeting all selection criteria. The final sample of 10 studies underwent data extraction and quality analysis (Figure 2). Full-text articles were excluded based on age of participants (<50 years) and lack of fitness-related outcome measures. Articles that met all inclusion criteria were published between 1989 and 2009.

Participants

Overall, 544 participants (mean age = 69.6 ± 6.3) were included in the analysis, 71% of which were women. This demographic reflects the general North American population that practices yoga (72% women; Macy, 2008). Study populations included those living in the community or in retirement homes. Two studies examined those 55–64 years of age (Sierpowska, Ciechanowicz, & Cywinska-Wasilewska, 2006; Van Puymbroeck, Payne, & Hsieh, 2007) and eight investigated older adults (65+ years; Blumenthal et al., 1989; Bowman et al., 1997; Brown, Koziol, & Lotz, 2008; Chen & Tseng, 2008; Chen et al., 2008; DiBenedetto et al., 2005; Morris, 2009; Oken et al., 2006). The number of participants in the studies included in this review ranged from 13 (Van Puymbroeck et al., 2007) to 176 (Chen et al., 2008; Tables 2A and 2B). Intervention and control groups were similarly matched for age, sex, and health. Demographic characteristics between study groups did not differ significantly unless otherwise noted.

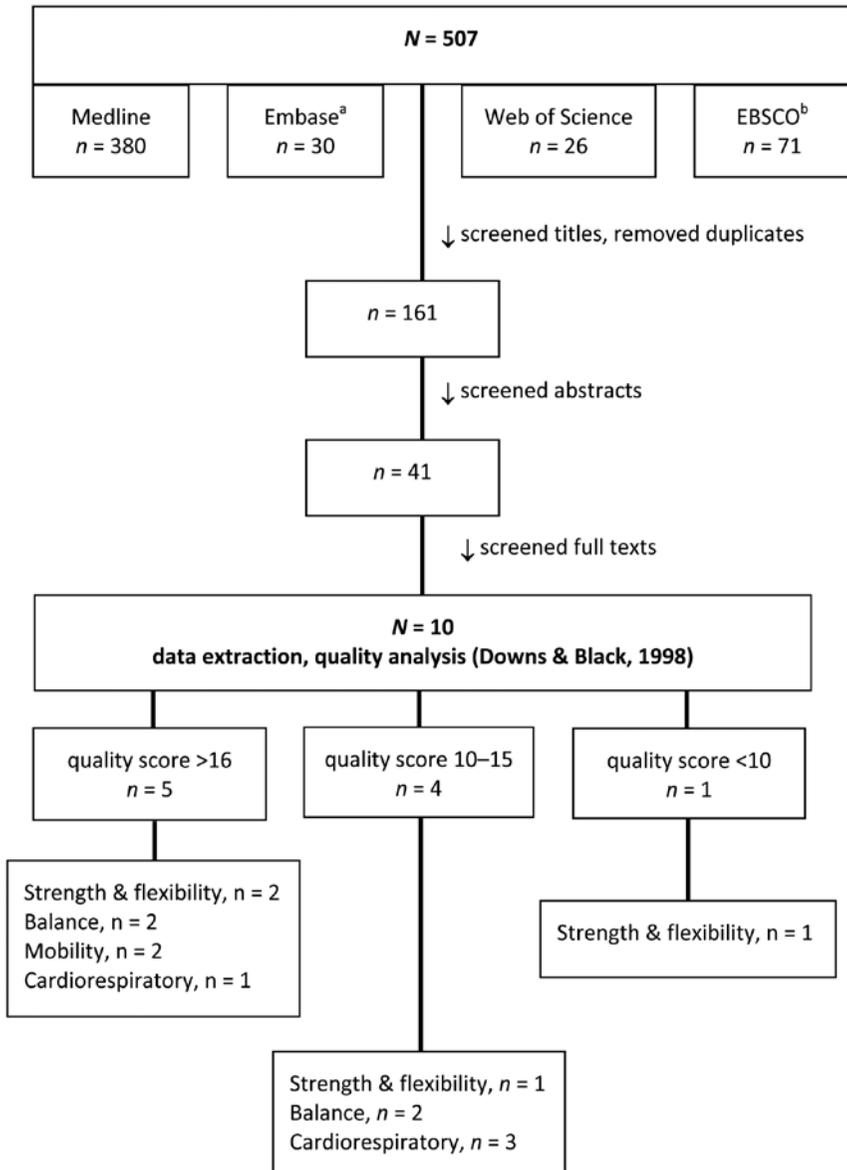


Figure 2 — Literature-search strategy ($N = 10$). ^aVia Ovid. ^bIncluding AgeLine, CINAHL, SPORTDiscus, PsycINFO, and MEDLINE.

Table 2A Synthesis of Literature-Search Results, High-Quality Studies (Score ≥ 16 ; $n = 5$)

| Study | N | Age, years | Population | Yoga style | Program included | Design | Length, weeks | Outcome measures | Results, ES | Score ^a |
|----------------------|-----|---------------|--------------------------------|-------------|-------------------|--------|---------------|---|---|--------------------|
| Chen, 2008 | 176 | 69 \pm 6.3 | Community activity center | Silver Yoga | Chen et al., 2007 | RCT | 24 | Fitness, body composition, cardiorespiratory strength, flexibility, balance | Systolic BP, 0.40; breath holding, 0.47; LB flexibility and endurance, 0.70; walking speed, 0.54; ROM (shoulders and hip), 0.25; BMI; weight loss; 0.79, 0.73 | 16 |
| Morris, 2009 | 18 | 76.1 (65–86) | Community, 1 fall in 12 months | Hatha | Yes ^b | RCT | 8 | Balance, mobility, fall risk | POMA, 1.61; attention, 1.08; ABC, 0.32; steadiness, 0.66 | 16 |
| Van Puymbroeke, 2007 | 13 | 59 \pm 12.9 | Caregivers | Iyengar | Yes | RCT | 8 | Cognitive function, strength, flexibility, cardiorespiratory, balance | LB strength, 0.51 | 16 |

(continued)

Table 2A (continued)

| Study | N | Age, years | Population | Yoga style | Program included | Design | Length, weeks | Outcome measures | Results, ES | Score ^a |
|-------------------|-----|--------------|------------------------------|------------|------------------|----------|---------------|---|--|--------------------|
| Oken, 2006 | 135 | 72.1 (65–85) | Community | Iyengar | No | RCT | 24 | Balance, mobility, HRQoL, depression, anxiety, flexibility, fatigue | SF-36: vitality/energy and fatigue; physical; pain; social functioning; MFT: activity; OLST, seated forward bend; (total) 0.25 | 19 |
| DiBenedetto, 2005 | 19 | 70.7 ± 6.1 | Community, healthy, nonobese | Iyengar | Yes ^b | Pre-post | 8 | Mobility | Peak hip extension; pelvic tilt; ankle power, 0.83; ankle flexion, 0.48; stride length, 0.55; walking speed, 0.55; 0.80 | 16 |

Note. W = women; RCT = randomized controlled trial; BP = blood pressure; ROM = range of motion; BMI = body-mass index; POMA = Performance Oriented Mobility Assessment; ABC = Activities-specific Balance Confidence Scale; LB = lower body; HRQoL = health-related quality of life; SF = Health Survey; MFI = Multidimensional Fatigue Inventory; OLST = one-legged-standing test; pre-post = single-group, pre-post test measure.

^aOut of 20. Based on modified Downs and Black (1998) checklist. ^bPhotos included in intervention description.

Table 2B Synthesis of Literature-Search Results, Low- (Score 0–10; $n = 1$) and Moderate-Quality (Score 11–15; $n = 4$) Studies

| Study | N | N (W) | Age, years | Population | Yoga Style | Program included | Design | Length, weeks | Outcome measures | Results, ES | Score ^a |
|--------------------|-----|-------|--------------|----------------------------------|-------------|------------------|----------|---------------|---|--|--------------------|
| Blumenthal, 1989 | 101 | 51 | 67 ± 4.9 | Community, no coronary disease | Hatha | No | RCT | 16 | Body composition, cardiovascular, depression, balance, anxiety, psychomotor | Aerobic capacity, 0.10; weight loss, 0.99; diastolic BP, 0.76 | 14 |
| Bowman, 1997 | 26 | 10 | 68 (62–81) | Community, sedentary, healthy | Hatha | No | RT | 6 | Baroreflex | HR, 0.47; VO ₂ , 0.15; parasympathetic sensitivity, 0.18 | 14 |
| Brown, 2008 | 22 | 16 | 82 (69–90) | Residential home | Hatha | Yes | Pre–post | 12 | Balance | BBS, 0.63; OLST, 0.88; ABC, 0.66 | 15 |
| Chen & Tseng, 2008 | 14 | 14 | 68.9 ± 9.1 | Community activity center member | Silver Yoga | Chen et al, 2007 | Pre–post | 4 | Fitness, body composition cardiorespiratory, strength, balance, depression, sleeplessness, flexibility, HRQoL | Body fat (%), 0.16; systolic BP, 0.47; diastolic BP, 0.21; lung capacity, 0.22 (all others <0.1) | 15 |
| Sierpowska, 2006 | 20 | 20 | 63.5 (60–74) | Community | Hatha | No | RT | NA | Body composition, fitness, balance, mobility, flexibility, strength | 30-s chair stand, arm curl, back scratch, BMI; no <i>SD</i> given | 7 |

Note. W = women; RCT = randomized controlled trial; BP = blood pressure; RT = randomized trial; HR = heart rate; VO₂ = oxygen consumption; pre–post = single-group, pre–post test measure; BBS = Berg Balance Scale; OLST = one-legged-standing test; ABC = Activities-specific Balance Confidence Scale; HRQoL = health-related quality of life; ROM = range of motion; NA = not available; BMI = body-mass index.

^aBased on modified Downs and Black (1998) checklist.

Yoga Style

The challenge in reviewing the yoga literature, irrespective of participants' age or sex, is making comparisons across the many different yoga styles and the varied populations that practice yoga. Seven studies provided detailed posture lists, of which two provided photos of each posture performed (DiBenedetto et al., 2005; Morris, 2009). Three studies did not include any details about the administered yoga program (Blumenthal et al., 1989; Bowman et al., 1997; Sierpowska et al., 2006). Three yoga program styles (Iyengar, the Silver Yoga Exercise Program, and general hatha) were used in studies that met the criteria for this review.

Iyengar, a form of hatha yoga, focuses on improving muscle strength and flexibility so that proper body alignment can be achieved (Iyengar, 1979). This is accomplished by holding poses for long durations, and Iyengar provides adaptive assistance with the use of props such as blocks, straps, bolsters, pillows, blankets, and chairs. Props are used to help the participant attain ideal alignment and can be used to accommodate those who are weaker and less flexible. This makes the Iyengar style of yoga more accessible to a wide range of people and abilities (i.e., those who are not physically fit, are ill, older adults). This style of yoga was used in three studies in this review (DiBenedetto et al., 2005; Oken et al., 2006; Van Puymbroeck et al., 2007).

The Silver Yoga Exercise Program was specifically designed for older adults (Chen et al., 2008; Chen & Tseng, 2008; Chen, Tseng, Ting, & Huang, 2007). The postures encompass six types of movements in all joints and limbs: flexion, extension, hyperextension, abduction, adduction, and rotation. The goal of this program is to increase lower and upper body range of motion, promote muscle relaxation, and facilitate abdominal breathing. Four sitting and four standing poses are used as a warm-up to promote safe transition into the program. Gentle stretching postures are performed while standing, kneeling, sitting, and lying down. Finally, the last stage (cooldown) incorporates guided-image meditation to facilitate muscle relaxation (Chen et al., 2007).

Five other general hatha yoga programs were included in this review (Blumenthal et al., 1989; Bowman et al., 1997; Brown et al., 2008; Morris, 2009; Sierpowska et al., 2006; Tables 2A and 2B).

Study Design

Of the 10 studies included in this review, five were randomized controlled trials (Blumenthal et al., 1989; Chen et al., 2008; Morris, 2009; Oken et al., 2006; Van Puymbroeck et al., 2007) and five used a single-group pre-post design (Bowman et al., 1997; Brown et al., 2008; Chen & Tseng, 2008; DiBenedetto et al., 2005; Sierpowska et al., 2006; Tables 2A and 2B). The length of the yoga intervention ranged from 4 (Chen & Tseng, 2008) to 24 weeks (Chen et al., 2008; Oken et al., 2006). Effect sizes (*ES*), calculated as the mean difference between two groups divided by the pooled standard deviation, $\{(M_1 - M_2)/[(s_1 + s_2)/2]\}$, ranged from <0.10 (Chen & Tseng, 2008) to 1.61 (Morris, 2009). Effect sizes were ranked according to Cohen (1992): <0.5 as low, 0.5–0.8 as moderate, and >0.8 as high. The average *ES* in this review was within the moderate range ($M = 0.63 \pm 0.3$; Cohen, 1992).

Study Quality

All studies were assessed for quality using the modified DB checklist. Five studies scored 16 or better on the checklist of a possible total of 20 (Chen et al., 2008; DiBenedetto et al., 2005; Morris, 2009; Oken et al., 2006; Van Puymbroeck et al., 2007). These articles provide methodological details that make the yoga interventions reproducible, as well as offering substantive evidence related to sampling error, measurement outcomes, external and internal validity, bias, confounders, and power limitations on the DB checklist (high quality, ≥ 16). Four studies scored 11–15 points, suggestive of moderate quality on the DB checklist (Blumenthal et al., 1989; Bowman et al., 1997; Brown et al., 2008; Chen & Tseng, 2008), and one study was of poor quality (DB checklist ≤ 10 ; Sierpowska et al., 2006).

Study Outcomes

A wide range of outcomes including body composition, cardiorespiratory function, strength, flexibility, balance, mobility, fall risk, sleep quality, depression, mobility, adherence, anxiety, fatigue, pain, psychomotor, and adherence factors were used by these studies (Tables 2A and 2B). No adverse events were reported in association with yoga or the comparison group in included studies. The lack of common assessment methods used between studies made them difficult to compare. In keeping with the aims of this review, physical fitness (e.g., strength, flexibility, balance, cardiorespiratory, body composition) and function (e.g., mobility) outcomes are discussed in detail. Four studies addressed strength and flexibility (Silver $n = 2$, Iyengar $n = 1$, hatha $n = 1$), three addressed balance ($n = 1$ each Silver, Iyengar, and hatha), two addressed mobility (Iyengar $n = 1$, silver $n = 1$), two addressed cardiorespiratory function (hatha $n = 1$, Silver $n = 1$), and three addressed body composition (Silver $n = 2$, hatha $n = 1$; Tables 2A and 2B).

Physical Fitness and Function Indicators

Strength and Flexibility. Promoting physical fitness in older adults improves successful aging and extends the healthy life span (American College of Sports Medicine et al., 2009). Chen et al. (2008) evaluated a 24-week Silver Yoga Exercise Program and measured physical fitness indicators including strength, flexibility, and shoulder and hip range of motion. Subjects ($N = 176$, mean age = 69 ± 6.3 years), members of a senior's activity center, were randomized to a yoga-plus-meditation group (70 min in length, $n = 64$), yoga-only group (55 min in length, $n = 59$), or wait-list control group ($n = 66$) who continued with their normal daily activities. Both yoga-intervention groups improved lower body flexibility and endurance ($ES = 0.70$) and shoulder and hip range of motion ($ES = 0.25$) compared with wait-list controls (Chen et al., 2008).

In a study by Chen and Tseng (2008), shoulder and hip range of motion improved significantly at the end of a 4-week one-group pre- to posttest Silver Yoga Exercise Program with 16 older women (mean age 68.9 ± 9.1 years). Three yoga classes per week resulted in significant improvements in right ($9.4^\circ \pm 11.6^\circ$) and left ($12.8^\circ \pm 11.7^\circ$) shoulder flexion and right ($9.6^\circ \pm 12.5^\circ$) and left ($11.8^\circ \pm 13.4^\circ$) shoulder abduction compared with pretest scores ($ES < 0.10$). In addition, right hip flexion improved significantly ($17.2^\circ \pm 13.5^\circ$) compared with baseline ($ES < 0.10$; Chen & Tseng, 2008).

Van Puymbroeck et al. (2007) enrolled caregivers ($N = 21$, mean age 59 ± 12.9 years) with an average of 121 months of caregiving experience. Caregivers were randomized to either an Iyengar yoga program ($n = 8$) or a control group ($n = 9$) for 8 weeks to assess physiological fitness and caregiver coping skills. Lower body strength showed significant improvement with the yoga intervention ($ES = 0.51$) compared with the control group (Van Puymbroeck et al., 2007).

Sierpowska et al. (2006) examined functional fitness among active older women (mean age 63.5 years) who were randomized to either a twice-weekly 45-min swimming program ($n = 9$) or twice-weekly 60-min hatha yoga class ($n = 11$). Compared with the swimming group, the yoga group improved on the number of chair stands completed in 30 s ($p < .005$; note that effect size was not included because the authors did not provide standard deviations or the raw data necessary to calculate them), the number of arm curls performed ($p < .05$), and flexibility on the back-scratch test ($p < .05$; Sierpowska et al., 2006). A limitation of this study was that the control exercise (swimming) was not specific to the outcome measures assessed (30-s chair stand); therefore, the control group was at a disadvantage.

Balance. Yoga may be an ideal preventive and therapeutic option for balance training and reducing fall risk in older adults. Brown et al. (2008) recruited 22 adults (16 women, mean age = 82 years, range 69–90) from a residential home. Participants completed a 12-week hatha yoga intervention aimed at reducing fall risk. They were assessed using the Berg Balance Scale, one-legged-standing test, and Activities of Balance Confidence Scale. Improvements between baseline and 3 months were seen in the Berg Balance Scale ($ES = 0.63$), one-legged-standing test ($ES = 0.88$), and Activities of Balance Confidence Scale ($ES = 0.66$) despite sex, age, or attendance (Brown et al., 2008). The results of this study suggest that yoga may improve balance measures in older adults. Chen and Tseng (2008) also demonstrated significant improvements in one-legged standing after a Silver Yoga Exercise Program (Chen et al., 2007). Sixteen older women completed a 4-week one-group pilot intervention three times per week. Duration of one-legged standing improved by 9.7 ± 9.4 s from pre- to postintervention ($ES < 0.10$; Chen & Tseng, 2008).

Morris (2009) demonstrated improved balance through the practice of general hatha yoga. However, the purpose was to evaluate the effects of the yoga program on fall risk, with attention given to muscle strength, flexibility, balance, awareness of postural control, mobility, gait, attention and visual-search strategy, confidence, fear of falling, steadiness, and environmental awareness. Women ($N = 26$, mean age 76 ± 6.4 years) participated in twice-weekly 1-hr sessions over 8 weeks. They were randomized to either a hatha yoga group ($n = 8$), balance training ($n = 5$), or a control group (fall-risk-awareness class, $n = 5$). The hatha yoga group demonstrated improved postural control ($ES = 1.61$), steadiness ($ES = 0.66$), attention ($ES = 1.08$), and balance confidence ($ES = 0.32$) compared with baseline values (Morris, 2009). The balance group had similar balance confidence scores ($ES = 0.32$), improved postural control ($ES = 1.30$) and attention ($ES = 0.72$), and reduced fear of falling ($ES = 0.52$) compared with the yoga group. The control reported the strongest improvements in awareness ($ES = 0.44$) but experienced no changes in the other outcome measures (Morris, 2009).

A 6-month randomized controlled trial in healthy older adults compared a weekly Iyengar yoga session ($n = 44$, mean age 72 ± 4.9 years) with an exercise walking group ($n = 47$, mean age 74 ± 5.1 years) and those in a wait-list control

group ($n = 44$, mean age 71 ± 4.4 years; Oken et al., 2006). This study is the largest controlled trial of yoga and older adults to date and assessed a myriad of measures including cognitive function (attention and alertness), fatigue, mood, stress, quality of life, and physical abilities. Significant improvements were seen in balance measures (i.e., timed one-legged standing, seated forward bending) in the yoga group ($ES = 0.25$) compared with both exercise and wait-list control (Oken et al., 2006).

Mobility. DiBenedetto et al. (2005) investigated the use of Iyengar yoga to improve gait and hip flexibility in a single-group pre–post exploratory study. Participants ($N = 19$, mean age 71 ± 6.1 years) attended 90-min Iyengar yoga classes twice weekly for 8 weeks, and indices of gait function were measured (i.e., peak hip extension, average anterior pelvic tilt, stride length). Results illustrated improved peak hip extension from baseline, which was positively correlated with improvements in pelvic tilt ($ES = 0.83$), ankle power ($ES = 0.48$), ankle flexion ($ES = 0.55$), stride length ($ES = 0.55$), and walking speed ($ES = 0.80$; DiBenedetto et al., 2005).

Similar improvements in walking speed were observed for participants who completed the 24-week Silver Yoga Exercise Program described earlier. In that study, time to complete a 6-m-walk test significantly improved compared with wait-list controls ($ES = 0.54$; Chen et al., 2008).

Cardiorespiratory Fitness and Function. The sensitivity of the baroreflex system, which modulates blood pressure, decreases with age. Bowman et al. (1997) examined baroreflex sensitivity and oxygen capacity (VO_2) in 26 older, sedentary, healthy community-dwelling adults (mean age 68 years, range 62–81). Participants were randomized to either a twice-weekly bicycle-based aerobic training program or a hatha yoga class for 6 weeks. Fourteen participants (mean age 66 ± 4) completed the aerobic-training sessions, which were 40 min in length, at 70–80% of maximum heart rate. Twelve participants (mean age 68 ± 5) completed a 90-min hatha yoga program that was specifically designed to avoid repetitive muscle contractions and focus primarily on stretching with minimal physical exertion. The hatha yoga program consisted of a general warm-up, followed by static postures and breathing and concluding with a 20-min relaxation period in supine (*savasana*; Bowman et al., 1997). A significant decrease in resting heart rate ($ES = 0.47$) and a $13\% \pm 11\%$ increase in VO_{2max} ($ES = 0.15$) occurred after the yoga program, compared with no change in resting heart rate ($ES = 0.07$) and a $25\% \pm 16\%$ increase in VO_{2max} ($ES = 0.19$) with aerobic exercise. Baroreflex sensitivity is measured by alpha index (coefficient), which is calculated by the square root of the ratio of R-R interval (from electrocardiogram) spectral powers to systolic blood pressure (Tzeng, Sin, Lucas & Ainslie, 2009). A significant increase in alpha index ($ES = 0.18$) occurred as a result of yoga, with no change in the aerobic-exercise group ($ES = 0.05$; Bowman et al., 1997), whereas reduced baroreflex sensitivity has been linked to poor clinical outcomes (Tzeng et al., 2009).

Blumenthal et al. (1989) examined cardiorespiratory adaptations in 101 men and women (51 women, mean age 67 ± 4.9 years) randomized to 16 weeks of aerobic exercise (bicycling and walking/jogging with arm ergometry, $n = 33$), hatha yoga and flexibility ($n = 34$), or a wait-list control group ($n = 34$). In the yoga group, nonsignificant reductions in aerobic capacity occurred (1–2%, $ES = 0.01$) and anaerobic threshold did not change, compared with significant improvements in the aerobic group (11.6%, $ES = 0.18$, and 13%, $ES = 0.83$, respectively). Subjects

in all 3 groups also showed significant reduction in diastolic blood pressure (2–4 mm Hg, $ES = 0.76$; Blumenthal et al., 1989).

In both a 4-week pilot ($n = 16$, mean age 69 ± 9.1 years; Chen & Tseng, 2008) and a 24-week intervention ($n = 176$, mean age 69 ± 6.3 years; Chen et al., 2008) of Silver Yoga Exercise, as previously described (Chen et al., 2007), resting systolic blood pressure also significantly decreased compared with baseline (19.2 ± 9.5 mm Hg, $ES = 0.47$; Chen & Tseng, 2008) and compared with wait-list control ($ES = 0.40$; Chen et al., 2008) after the yoga intervention. In addition, lung capacity improved ($ES = 0.47$, Chen et al., 2008; $ES = 0.22$, Chen & Tseng, 2008), but not significantly.

Body Composition. The Silver Yoga Exercise Program reported an average body-fat decrease from $28.3\% \pm 6.8\%$ at baseline to $26.7\% \pm 6.9\%$ on completion of the 4-week program ($ES = 0.16$; Chen & Tseng, 2008). In a similar 24-week Silver Yoga Exercise Program, the yoga group with added meditation lost a significant amount of weight ($ES = 0.73$) and showed significant decrease in body-mass index ($ES = 0.79$) compared with the yoga group, which did not (Chen et al., 2008). Finally, 34 subjects (mean age 67.8 ± 5.9) randomly assigned to a 4-month yoga-intervention group revealed statistically significant weight loss (0.6 kg) compared with aerobic (0.4 kg) and wait-list control groups (0.2 kg, $ES = 0.99$; Blumenthal et al., 1989).

Discussion

In this review, 10 studies of high ($n = 5$), moderate ($n = 4$), and low quality ($n = 1$) met our inclusion criteria. The literature search was limited to studies published in English, and this bias may have influenced the outcome of the review. The results of these investigations suggest that there were modest improvements in gait (Chen et al., 2008; DiBenedetto et al., 2005), balance (Brown et al., 2008; Chen & Tseng, 2008; Morris, 2009; Oken et al., 2006), upper and lower body flexibility (Chen & Tseng, 2008; DiBenedetto et al., 2005; Van Puymbroeck et al., 2007), lower body strength (Chen et al., 2008; Van Puymbroeck et al., 2007), and body weight (Blumenthal et al., 1989; Chen et al., 2008) in older adults. These reported improvements might be associated with holding the posture in a static or isometric manner in a position in which the muscle is stretched.

The intensity of yoga in younger adults (age 18–40 years) is deemed too low to enhance cardiovascular fitness according to current guidelines ($p < .05$) but may be beneficial for muscle fitness and flexibility (Clay et al., 2005). Similarly, Hagins et al. (2007) and DiCarlo et al. (1995) determined that the metabolic cost of yoga was significantly lower than ACSM recommendations for moderate physical activity. However, the combination of flexibility, strength, and motor-control demands may qualify yoga as a complementary exercise to improve overall fitness (DiCarlo et al., 1995).

Because of yoga's growing popularity as an alternative exercise, this critical review examined whether yoga benefits physical fitness and improves physical function in older adults. Appropriate physical activity can help remedy age-associated loss of independence and positively influence functional abilities (Paterson et al., 2007). Yoga has a beneficial effect of maintaining body flexibility and strength, which are important for preventing falls and subsequent loss of independence (Chen et al., 2008; Chen & Tseng, 2008, DiBenedetto et al., 2005). The beneficial

effects of yoga on lower leg (Chen et al., 2008; Van Puymbroeck et al., 2007) and ankle (DiBenedetto et al., 2005) strength and balance measures (Brown et al., 2008; Morris, 2009; Oken et al., 2006) suggest improved mobility and lowered risk for falls. Future studies examining the effects of yoga on physical function, specifically those that maintain or improve functional independence, in older adults are justified.

The evidence to support yoga as a means to improve cardiorespiratory fitness was weak; however, yoga does improve vagal tone as a result of relaxation and breathing techniques (Bowman et al., 1997), which likely improves cardiorespiratory response. Controlled breathing induces optimized abdominal motions during breathing and reduces breathing rate. This implies that higher amplitude and reduced breathing frequency per cycle are associated with yoga training (Barros et al., 2003).

Exercise has a beneficial effect on body composition. Similarly, yoga may result in weight loss (Blumenthal et al., 1989; Chen et al., 2008), improved body-mass index (Chen et al., 2008), and decreased percent body fat (Chen & Tseng, 2008). However, the mechanism is yet unknown, and further investigation into the magnitude of change in relation to participants' initial anthropometric values is needed.

These studies used a variety of yoga styles, so it is difficult to make comparisons between them. In addition, future studies need to be adequately powered with a focus on physiological benefit before clinical significance can be demonstrated. The preliminary research presented here is promising. However, to make conclusive statements regarding the fitness benefits of yoga would be premature. A recent review of comparative yoga studies shows promise from a health perspective for yoga as an alternative exercise, but there is a lack of evidence from a fitness perspective (Ross & Thomas, 2010). Future investigations are needed to determine the appropriate "dose" of yoga (i.e., duration of yoga class, length of intervention, intensity) and should report the specific style of yoga, detailed posture lists and images, and program durations in an attempt to standardize interventions and allow for confident comparisons.

General Recommendations

The recommendation from this review is that the quality and quantity of future yoga-intervention research needs to be improved before formal exercise dose recommendations can be made. The current yoga literature has limitations related to methodology, at the levels of both designing and defining the yoga program, and the studies are often underpowered. Despite insufficient power to detect clinical significance and design limitations, the practice of yoga has some merit for improving fitness and functional performance in older adults. However, more investigation into the physiological influence of yoga on older adults needs to be undertaken before conclusions regarding fitness benefits can be claimed.

Yoga encompasses mind and body, so participants' initial health conditions and beliefs should be noted. Documentation of previous exercise experience (yoga and nonyoga) should also be included, in addition to specific adherence monitoring (Luskin et al., 2000). Despite yoga's wide popularity, there are limited numbers of randomized, controlled yoga studies using objective quantitative outcome measures, and those studies often have small numbers of subjects (Oken et al., 2006). Yoga-intervention studies need to focus on larger participant samples, use validated and reliable assessment instruments, specify inclusion and exclusion criteria, and use

sound methodology to prove that the intervention is having an effect on the appropriate outcome measures. This would improve the usability of the study results and promote growth in this area (Chen et al., 2007).

This review suggests that yoga has moderate effects on physical fitness and function; however, future research in determining how this might compare with traditionally prescribed exercise programs is recommended. Although some studies did compare yoga with other exercise interventions (swimming, Sierpowska et al., 2006; balance training, Morris, 2009; walking, Oken et al., 2006; and bicycling, Bowman et al., 1997), the outcome measures did not necessarily reflect the specificity of the exercise performed. Nevertheless, the fitness benefits of yoga in addition to other training (i.e., brisk walking, resistance training) merit further investigation in older adults.

Literature in this area needs to clearly describe outcome measures with a focus on optimal duration and intensity (exercise dose) to maximize effectiveness of yoga interventions. These recommendations will foster the development of a more transparent connection between a specific intervention and the benefits that result, inevitably with the inclusion of follow-up data. It should also be recognized that the focus of a yoga program might not necessarily be fitness. Yoga is practiced for a variety of reasons (i.e., stress, spirituality, sleep), but exploring the benefits of yoga in these areas is beyond the scope of this review.

Yoga programs for older adults traditionally use static physical postures and stretching to improve muscle strength and flexibility, reduce body weight, and improve overall physical health (Chen et al., 2007). Programs that are too complicated to learn or perform are likely to discourage older learners, lower their self-esteem, diminish interest, and decrease participation (Chen et al., 2007). Yoga will be made more palatable to older individuals through clearly described yoga interventions and readily available guidance during the interventions (Van Puymbroeck et al., 2007). Furthermore, diverse abilities and populations need to be studied (active and inactive older adults, community and residential dwellers) and long-term implications determined, and goals directed at chronic-disease and frailty prevention should also be addressed (Chen et al., 2007; Luskin et al., 2000). Although yoga interventions show beneficial trends for the general aging population, one must consider the impact on other aging subpopulations, namely, those with chronic diseases (e.g., chronic obstructive pulmonary disease) and neurological disorders. For example, despite the widespread advocacy of using yoga for neurological disorders (multiple sclerosis, Alzheimer's, Parkinson's), there is a dearth of randomized controlled evidence in this area (Wahbeh, Elsas, & Oken, 2008). In addition, yoga's focus on slower and deeper breathing (breath control) and fitness makes it a potential therapy for patients with cardiac obstructive pulmonary disease (Donesky-Cuenco, Nguyen, Paul, & Carrieri-Kohlman, 2009). More investigation is needed to assess the benefits of yoga in maintaining independence in older clinical populations and those with neurological disorders.

Conclusion

An estimated 2.9 million Americans age 55 years and older practice yoga. More high-quality research needs to be conducted to elucidate the degree to which fitness benefits might be engendered in older adults through regular yoga participation.

Exercise interventions aimed at older adults need to consider individual abilities and needs and their impact on physical function in this population. The scientific evidence supporting yoga for improved fitness in older adults shows promise, albeit there are methodological issues related to the current available literature. Nevertheless, there are meaningful trends toward improvement in gait, balance, strength, flexibility, and anthropometric measures as a result of practicing yoga. Therefore, future yoga interventions that follow sound methodological practice may provide evidence to prescribe yoga as an alternative exercise for older adults.

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