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Review Article

A systematic review and meta-analysis on the effects of yoga on weight-related outcomes

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ABSTRACT

Introduction. Overweight and obesity are among the most important modifiable risk factors for chronic diseases and premature death. The aim of this review was to systematically assess and analyze the effects of yoga on weight-related outcomes.

Methods. Medline/PubMed, Scopus, and the Cochrane Library were screened through March 2015 for randomized controlled trials on yoga for weight-related outcomes in the general population or overweight/obese individuals. Risk of bias was assessed using the Cochrane risk of bias tool on the following domains: selection bias, performance bias, detection bias, attrition bias, reporting bias, and other bias.

Results. Out of 445 records identified during literature search, 30 trials with a total of 2173 participants were included. No effects on weight, body mass index, body fat percentage or waist circumference were found. In studies with healthy adult participants an effect of yoga compared to usual care was found regarding waist/hip ratio (SMD =- − 1.00; 95% CI =- − 1.44, − 0.55; $p < 0.001$). In studies with overweight/obese participants only, effects relative to usual care were found for body mass index (SMD = −0.99; 95% CI = −1.67, −0.31; $p = 0.004$). Effects however were not robust against selection bias; and publication bias could not be ruled out. No intervention-related adverse events were reported.

Conclusions. Despite methodological drawbacks, yoga can be preliminarily considered a safe and effective intervention to reduce body mass index in overweight or obese individuals.

Contents

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1. Introduction

Overweight and obesity are among the most important modifiable risk factors for chronic diseases and premature death (World Health Organization, 2014). About 69% of the US population are overweight or obese (National Center for Health Statistics, 2015). Worldwide the point prevalence is 39%; with increasing rates especially in low- and middle-income countries (World Health Organization, 2014). Besides inadequate diet, the most important contributing factor to overweight and obesity is a sedentary lifestyle (Cecchini et al., 2010). Thus, regular physical activity is recommended in medical guidelines as the most important treatment option in non-morbid overweight or obesity; as well as a preventive intervention (American College of Cardiology/American Heart Association Task Force on Practice Guidelines — Obesity Expert Panel 2013, 2014; National Health and Medical Research Council, 2013). Given that a considerable number of individuals with weight problems are not adherent to recommended exercise regimens (Castellani et al., 2003), the investigation of alternative forms of exercise for weight-related outcomes seems warranted.

One such alternative form of physical activity that is increasingly used for health purposes is yoga (Feuerstein, 1998; Iyengar, 1966). Yoga is most often associated with physical postures ('Asana'), breath control ('Pranayama'), and meditation ('Dhyana') in North America and Europe (Feuerstein, 1998; De Michelis, 2005); and is gaining increased popularity as a therapeutic method for various health issues. About 14 million adult Americans (6.1% of the population) reported that yoga had been recommended to them by a physician or therapist (Macy, 2008). Indeed, about 80% of American yoga practitioners (more than 16 million people) reported that they had started practice explicitly to improve their health (Birdee et al., 2008; Clarke et al., 2002; Cramer et al., 2015a); and weight control is among the most frequently stated reasons for starting to practice (Park et al., 2014). While there is evidence to suggest that yoga is effective in promoting weight loss and improving body composition (Rioux and Ritenbaugh, 2013), no systematic review and/or meta-analysis on yoga for weight-related outcomes is available to date. Thus, the aim of this review was to systematically assess and analyze the effects of yoga on weight-related outcomes in the general population and in overweight/obese individuals by means of a meta-analysis.

2. Methods

This review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Moher et al., 2009) and recommendations of the Cochrane Collaboration (Higgins and Green, 2008).

2.1. Eligibility criteria

2.1.1. Types of studies

Randomized controlled trials (RCTs) and cluster-randomized trials were eligible. No language restrictions were applied.

2.1.2. Types of participants

Studies on

a) children or adolescents or
b) adults

were included if participants were

i) healthy or from the general population (i.e. not selected based on their health status or weight) or
ii) overweight or obese.

The different subgroups were compared in subgroup analyses (a vs. b; i vs. ii).

Studies were excluded if overweight or obesity were comorbidities of diseases investigated in the trials, for example in studies investigating obese patients with hypertension. However, studies on participants with disease risk factor constellations, which are not a disease in itself, such as metabolic syndrome, were eligible. Studies on pregnant women and patients with eating disorders (anorexia nervosa, bulimia, binge eating) were excluded.

2.1.3. Types of interventions

2.1.3.1. Experimental. Studies were eligible if they included at least one of the following yoga practices based on yoga theory:

i) yoga postures or sequences of yoga postures
ii) breath control, meditation, and/or
iii) lifestyle advice.

No restrictions were made regarding the tradition of the yoga intervention, the length, frequency or duration of the programs. Studies on multimodal interventions including yoga among others were excluded. Studies allowing individual co-interventions were eligible.

2.1.3.2. Control. Studies comparing yoga to

i) usual care
ii) exercise
iii) or other active control interventions

were eligible, but studies with head to head comparisons of different yoga interventions without non-yoga control groups were excluded.

2.1.4. Types of outcome measures

To be eligible for inclusion, studies had to assess at least one primary weight-related outcome:

i) body weight
ii) body mass index
iii) body fat percentage
iv) waist circumference
v) waist-hip ratio.

Secondary outcomes included safety of the intervention, assessed as number of patients with adverse events (AEs).

2.2. Search methods

The search strategy comprised three electronic databases from their inception through March 09, 2015: Medline/PubMed, Scopus, and the Cochrane Central Register of Controlled Trials. The literature search was constructed around search terms for 1 "yoga" and 2 "weight" and adapted for each database as necessary. The complete search strategy for PubMed/Medline is shown in the appendix.

Additionally, reference lists of identified original articles or reviews; and the tables of contents of the International Journal of Yoga Therapy and the Journal of Yoga & Physical Therapy were searched manually; and trials identified as randomized controlled trials in a bibliometric analysis were checked for outcomes (Cramer et al., 2014a). Two reviewers independently screened and selected abstracts; potentially eligible articles were read in full by two reviewers. Disagreements were resolved through discussion with a third reviewer until consensus was reached. If necessary, additional information was obtained from the authors of the primary study.

2.3. Data extraction and management

Two reviewers independently extracted data on patient characteristics (e.g. age, gender, ethnicity), interventions (e.g. yoga type, frequency, and duration), control interventions (e.g. type, frequency, duration), and outcomes (e.g. outcome measures, assessment time points) using an a priori developed data extraction form. Discrepancies were resolved by discussion with a third reviewer until consensus was reached.

2.4. Assessment of risk of bias in individual studies

Two reviewers independently assessed risk of bias using the Cochrane risk of bias tool (Higgins and Green, 2008). This tool assesses risk of bias on seven domains: random sequence generation, allocation concealment, blinding of participants and personnel, blinding of outcome assessment, incomplete outcome data, selective reporting, and other sources of bias. For each domain, risk of bias was assessed as low; unclear; or high risk of bias. Discrepancies were discussed with a third reviewer until consensus was reached.

2.5. Data analysis

2.5.1. Assessment of overall effect size

Separate meta-analyses were conducted for comparisons of yoga to different control interventions. Meta-analyses were conducted using Review Manager 5 software (Version 5.2, The Nordic Cochrane Centre, Copenhagen) by random effects models if at least two studies assessing this specific outcome were available. Standardized mean differences (SMD) with 95% confidence intervals (CI) were calculated as the difference in means between groups divided by the pooled standard deviation using Hedges' correction for small study samples (Higgins and Green, 2008). Where no standard deviations were available, they were calculated from standard errors, confidence intervals or t-values (Higgins and Green, 2008), or attempts were made to obtain the missing data from the trial authors directly.

For all outcomes a negative SMD (i.e. lower scores in the yoga group) were defined to indicate beneficial effects of yoga compared to the control intervention. If necessary, values were inverted (Higgins and Green, 2008). Cohen's categories were used to evaluate the magnitude of the overall effect size with SMD < 0.2: negligible; SMD = 0.2–0.5: small; SMD = 0.5–0.8: medium; and SMD > 0.8: large effect sizes (Cohen, 1988).

2.5.2. Assessment of heterogeneity

Statistical heterogeneity between studies was analyzed using the I^2 statistics; a measure of how much variance between studies can be attributed to differences between studies rather than chance. The magnitude of heterogeneity was categorized as (1) I^2 = 0–24%: low heterogeneity; I^2 = 25–49%: moderate; I^2 = 50–74%: substantial; and I^2 = 75–100%: considerable (Higgins and Green, 2008; Higgins et al., 2003). The Chi^2 test was used to assess whether differences in results are compatible with chance alone. Due to the low power of this test in cases where only a few studies or studies with low sample size are included, a P-value ≤ 0.10 was regarded to indicate significant heterogeneity (Cohen, 1988).

2.5.3. Subgroup and sensitivity analyses

Subgroup analyses were performed for the age of participants (children/adolescents vs. adults) and their weight status (participants: not selected based on their weight vs. overweight/obese participants).

To test the robustness of significant results, sensitivity analyses were conducted for studies with high versus low risk of selection bias (random sequence generation and allocation concealment).

If present in the respective meta-analysis, subgroup and sensitivity analyses were also used to explore possible reasons for statistical heterogeneity.

2.6. Risk of bias across studies

If at least ten studies were included in a meta-analysis, publication bias was assessed by visual inspection of funnel plots generated using Review Manager software (Higgins and Green, 2008; Egger et al., 1997). Roughly symmetrical funnel plots were regarded to indicate low risk of publication bias; and asymmetrical funnel plots were regarded to indicate high risk of publication bias.

3. Results

3.1. Literature search

The literature search retrieved 435 non-duplicate records of which 158 full-texts were assessed for eligibility, and 31 of them were eligible (Bera and Rajapurkar, 1993; Blumenthal et al., 1989; Chen et al., 2008;

Table 1
Excluded studies.

Excluded study (reference)	Reason for exclusion
McIver (2010)	Commentary
Cheung et al. (2012); Corey et al. (2014); LaCroix et al. (2012); Sharma et al. (2013); Singh et al. (2011); Hoogbruin et al. (2012); Lai et al. (2010); Trivedi and Mishra (2014)	Conference abstract
Bock et al. (2010); Bock et al. (2014); Cheema et al. (2011); Cohen et al. (2013); Kandula et al. (2013)	Trial protocol
Neumark-Sztainer et al. (2011); Flaherty (2014); Guarracino et al. (2006)	No clinical trial
Ades et al. (2003); Ankad et al. (2011); Ankad Roopa et al. (2011); Armstrong and Scott Smedley (2003); Bhutkar et al. (2011); Choudhary and Mishra (2013); Hunter et al. (2013); Malhotra et al. (2005); Murthy et al. (2011); Nagarathna and Nagendra (1987); Raj et al. (2011); Ramos-Jimenez et al. (2009); Sarvottam et al. (2013); Satyanarayana et al. (1992); Sivasankaran et al. (2006); Telles et al. (1993); Telles et al. (2010); Thomley et al. (2011); Villien et al. (2005); Yadav et al. (2012); Yadav et al. (2014); Yang and James (2014)	Not controlled
Begum et al. (2012); Cajka et al. (2013); Čajka et al. (2012); Ce et al. (2015); Chatterjee and Mondal (2014); Chaya et al. (2006); Chaya et al. (2008); Dhananjai et al. (2013); Goncalves et al. (2011); Halder et al. (2015); Hegde et al. (2011); Herur et al. (2011); Kim et al. (2014); Krejci (2011); Kubo et al. (2011); Madanmohan et al. (2008); Malhotra et al. (2010); Maninder et al. (2013); Miles et al. (2013); Santhi Sri et al. (2014); Singh et al. (2008); Sukhsohale and Phatak (2012); Tyagi et al. (2014); Narendran et al. (2005a); Narendran et al. (2005b)	Not randomized
Stein et al. (2014); Sprod et al. (2015); Emery and Blumenthal (1990)	Secondary analysis
Bernstein et al. (2014); Chu et al. (2014a); Cramer et al. (2014b); Hartley et al. (2014); Innes and Vincent (2007); Jayasinghe (2004); Liu et al. (2014); Manchanda and Madan (2014); Patel et al. (2012)	Review
Brady (2007)	Not published in a peer-reviewed journal
Ades et al. (2005); Manchanda et al. (2000); Pal et al. (2013); Pal et al. (2011); Raghuram et al. (2014); Cadmus-Bertram et al. (2013); Littman et al. (2012); Carei et al. (2010); McIver et al. (2009); Mitchell et al. (2007); Yurtkuran et al. (2007); Cade et al. (2010); McCaffrey et al. (2005); Murugesan et al. (2000); Rahnama et al. (2011); Cheung et al. (2014); Ebnezar et al. (2012); Sharma et al. (2015); Nidhi et al. (2012); Nidhi et al. (2013a); Nidhi et al. (2013b); Rakhshani et al. (2015); Innes and Selfe (2012); Ikai et al. (2013); Amita et al. (2009); Gordon et al. (2008); Nishanth et al. (2011); Shantakumari et al. (2013); Skoro-Kondza et al. (2009); Visweswaraiah and Telles (2004)	Involved diseased participants
Dandekar (2013); Göring et al. (2013); Jorrakate et al. (2015); Rajajeyakumar et al. (2014); Santaella et al. (2011); Schmidt et al. (1997); Sharma et al. (2014); Blumenthal et al. (1991); Elavsky and McAuley (2007b); Elavsky and McAuley (2007c)	No weight-related outcome
Arciero et al. (2014); Boxer et al. (2010); Bryan and Zipp (2014); DeBar et al. (2012); Kenny et al. (2010); Kim et al. (2008); Park et al. (2010); Ramen et al. (2013); Sabet Sarvestani et al. (2009); Ziv et al. (2013)	No yoga

Chen et al., 2010; Cohen et al., 2008a; DiPietro et al., 1998; Elavsky and McAuley, 2007a; Harbans et al., 2011; Hegde et al., 2013; Kanaya et al., 2014; Kanojia et al., 2013; Lee et al., 2012; Lu and Wang, 2007; Mahajan et al., 1999; Manjunath and Telles, 2012; McDermott et al., 2014; Mooventhan and Khode, 2014; Ray et al., 2001; Sakuma et al., 2012; Seo et al., 2012; Shukla and Gehlot, 2014; Stachenfeld et al., 1998; Telles et al., 2014; Telles et al., 2013; Thiyagarajan et al., 2015; Tracy and Hart, 2013; Van Puymbroeck et al., 2007; Yang et al., 2011; Khatri et al., 2007; Kim et al., 2013; Manchanda et al., 2013), while 127 of those full-texts were excluded (Table 1) (McIver, 2010; Cheung et al., 2012; Corey et al., 2014; LaCroix et al., 2012; Sharma et al., 2013; Singh et al., 2011; Hoogbruin et al., 2012; Lai et al., 2010; Trivedi and Mishra, 2014; Bock et al., 2010; Bock et al., 2014; Cheema et al., 2011; Cohen et al., 2013; Kandula et al., 2013; Neumark-Sztainer et al., 2011; Flaherty, 2014; Guarracino et al., 2006; Ades et al., 2003; Ankad et al., 2011; Ankad Roopa et al., 2011; Armstrong and Scott Smedley, 2003; Bhutkar et al., 2011; Choudhary and Mishra, 2013; Hunter et al., 2013; Malhotra et al., 2005; Murthy et al., 2011; Nagarathna and Nagendra, 1987; Raj et al., 2011; Ramos-Jimenez et al., 2009; Sarvottam et al., 2013; Satyanarayana et al., 1992; Sivasankaran et al., 2006; Telles et al., 1993; Telles et al., 2010; Thomley et al., 2011; Villien et al., 2005; Yadav et al., 2012; Yadav et al., 2014; Yang and James, 2014; Begum et al., 2012; Cajka et al., 2013; Čajka et al., 2012; Ce et al., 2015; Chatterjee and Mondal, 2014; Chaya et al., 2006; Chaya et al., 2008; Dhananjai et al., 2013; Goncalves et al., 2011; Halder et al., 2015; Hegde et al., 2011; Herur et al., 2011; Kim et al., 2014; Krejci, 2011; Kubo et al., 2011; Madanmohan et al., 2008; Malhotra et al., 2010; Maninder et al., 2013; Miles et al., 2013; Santhi Sri et al., 2014; Singh et al., 2008; Sukhsohale and Phatak, 2012; Tyagi et al., 2014; Narendran et al., 2005a; Narendran et al., 2005b; Stein et al., 2014; Sprod et al., 2015; Emery and Blumenthal, 1990; Bar et al., 2014; Chu et al., 2014a; Cramer et al., 2014b; Hartley et al., 2014; Innes and Vincent, 2007; Jayasinghe, 2004; Liu et al., 2014; Manchanda and Madan, 2014; Patel et al., 2012; Brady, 2007; Ades et al., 2005; Manchanda et al., 2000; Pal et al., 2013; Pal et al., 2011; Raghuram et al., 2014; Cadmus-Bertram et al., 2013; Littman et al., 2012; Carei et al., 2010; McIver et al., 2009; Mitchell et al., 2007; Yurtkuran et al., 2007; Cade et al., 2010; McCaffrey et al., 2005; Murugesan et al., 2000; Rahnama et al., 2011; Cheung et al., 2014; Ebnezar et al., 2012; Sharma et al., 2015; Nidhi et al., 2012; Nidhi et al., 2013a; Nidhi et al., 2013b; Rakhshani et al., 2015; Innes and Selfe, 2012; Ikai et al., 2013; Amita et al., 2009; Gordon et al., 2008; Nishanth et al., 2011; Shantakumari et al., 2013; Skoro-Kondza et al., 2009; Visweswaraiah and Telles, 2004; Dandekar, 2013; Göring et al., 2013; Jorrakate et al., 2015; Rajajeyakumar et al., 2014; Santaella et al., 2011; Schmidt et al., 1997; Sharma et al., 2014; Blumenthal et al., 1991; Elavsky and McAuley, 2007b; Elavsky and McAuley, 2007c; Arciero et al., 2014; Boxer et al., 2010; Bryan and Zipp, 2014; DeBar et al., 2012; Kenny et al., 2010; Kim et al., 2008; Park et al., 2010; Ramen et al., 2013; Sabet Sarvestani et al., 2009; Ziv et al., 2013).

Thirty-one full-text articles reporting on 30 RCTs involving a total of 2173 participants were included in the qualitative analysis; and 27 articles on 26 RCTs were meta-analyzed (Fig. 1). All but one article (published in Chinese) (Lu and Wang, 2007) were published in English.

3.2. Study characteristics

Characteristics of the samples, interventions, outcome assessments, and results are shown in Appendix Table 1.

3.2.1. Study and participant characteristics

Of the 30 studies that were included, 15 originated from India (Bera and Rajapurkar, 1993; Harbans et al., 2011; Hegde et al., 2013; Kanojia et al., 2013; Mahajan et al., 1999; Manjunath and Telles, 2012; McDermott et al., 2014; Mooventhan and Khode, 2014; Ray et al., 2001; Shukla and Gehlot, 2014; Telles et al., 2014; Telles et al., 2013; Thiyagarajan et al., 2015; Khatri et al., 2007; Manchanda et al., 2013), 8 from the USA (Blumenthal et al., 1989; Cohen et al., 2008a; Elavsky and McAuley, 2007a; Kanaya et al., 2014; Stachenfeld et al., 1998; Tracy and Hart, 2013; Van Puymbroeck et al., 2007; Yang et al., 2011),

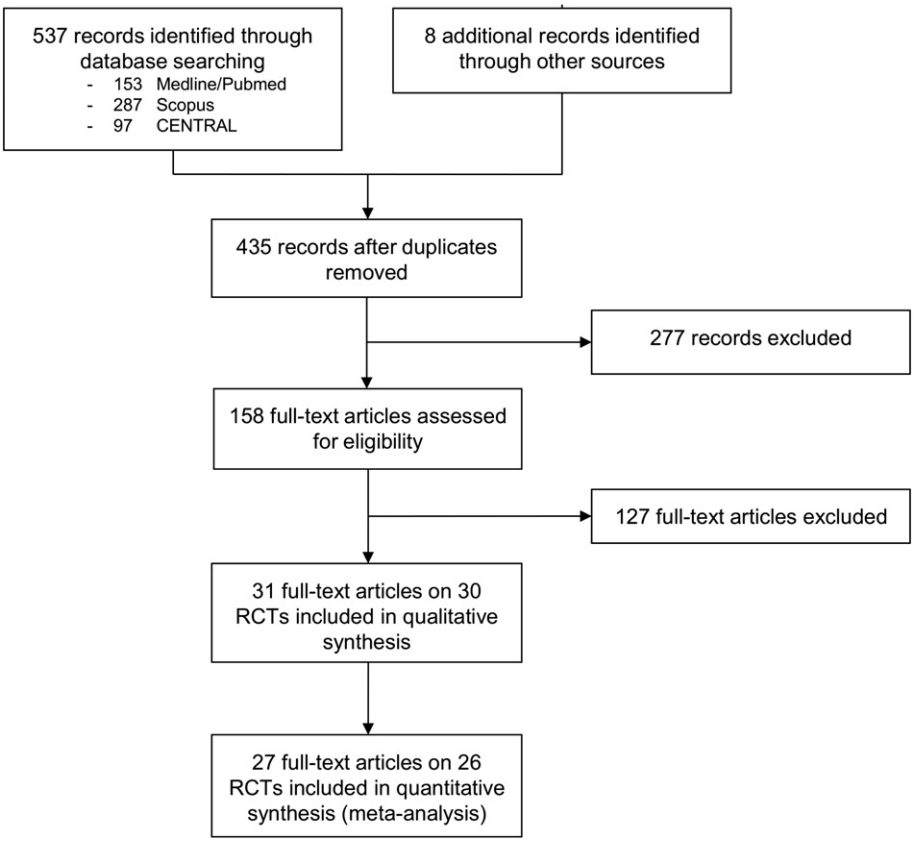

Fig. 1. Flowchart of the results of the literature search.

3 from Korea (Lee et al., 2012; Seo et al., 2012; Kim et al., 2013), 2 from Taiwan (Chen et al., 2008; Chen et al., 2010), and one each from Japan (Sakuma et al., 2012) and China (Lu and Wang, 2007). Ten of the trials explicitly investigated overweight or obese individuals (Cohen et al., 2008a; Harbans et al., 2011; Kanaya et al., 2014; Lee et al., 2012; Seo et al., 2012; Shukla and Gehlot, 2014; Telles et al., 2014; Khatri et al., 2007; Kim et al., 2013; Manchanda et al., 2013); and three trials were conducted on children/adolescents (Bera and Rajapurkar, 1993; Seo et al., 2012; Telles et al., 2013).

The sample size ranged from 17 to 204 with a median of 60. Participant's mean age ranged from 10.4 to 75.4 years with a median of 50.0 years. A median of 48.3% of participants was female.

3.2.2. Intervention characteristics

Two studies each used Silver yoga (Chen et al., 2008; Chen et al., 2010) and Hatha Yoga (Ray et al., 2001; Kim et al., 2013), one each used Restorative Yoga (Kanaya et al., 2014) Yogasana,(Sakuma et al., 2012), Bikram (Tracy and Hart, 2013), Vinyasa Yoga (Yang et al., 2011), and yogic lifestyle intervention (Mahajan et al., 1999), and 21 did not report the yoga style used (Appendix Table 1). Twenty-six studies reported using yoga postures while one used only breathing exercises; and the majority of trials also utilized breathing, meditation or relaxation exercises. The duration of yoga programs ranged from 2 to 52 weeks with a median of 12 weeks; participants practiced yoga on 1–7 days per week (median: 3.5) with session of 10–90 (median: 60) minutes length. Intervention adherence was reported by only nine studies (Blumenthal et al., 1989; Chen et al., 2008; Elavsky and McAuley, 2007a; Hegde et al., 2013; Kanaya et al., 2014; McDermott et al., 2014; Manchanda et al., 2013; Cohen et al., 2008b; Yang et al., 2011); participants in those studies attended a mean of 63.0%–95.8% (median: 78.2%) of the prescribed yoga sessions. Regarding control interventions, nineteen studies compared yoga to usual care or no specific treatment, eight studies compared yoga to exercise, three studies compared yoga to lifestyle modification (Mahajan et al., 1999; McDermott et al., 2014; Thiyagarajan et al., 2015); and one trial compared yoga combined with diet to diet alone (Shukla and Gehlot, 2014). One trial compared yoga to herbal medicines (Manjunath and Telles, 2012) and could therefore not be included in the meta-analysis. In addition to a yoga group and a non-yoga exercise control group, one trial included a combination of yoga and exercise as a third study arm (Lu and Wang, 2007). This third group was not included in the meta-analysis. Another trial compared two different yoga interventions with each other and with an untreated control group (Chen et al., 2008). In meta-analysis, the two yoga interventions could be combined into one group. In most exercise studies yoga and exercise interventions were matched for program length, frequency and duration of the sessions.

3.2.3. Outcome measures

All studies assessed outcomes immediately after the end of the intervention. Body weight was assessed in 22 studies, body mass index in 17, body fat percentage in 9, waist circumference in 15 and waist hip ratio in 6 studies. Safety was reported in five trials only.

3.3. Risk of bias in individual studies

Risk of bias in individual studies is shown in Table 2. Eleven studies had reported adequate random sequence generation, but only seven reported allocation concealment; none of the trials reported blinding of patients and personnel; but six studies reported adequate blinding of

Table 2
Risk of Bias assessment.

Reference	Random sequence generation (selection bias)	Allocation concealment (selection bias)	Blinding of participants and personnel (performance bias)	Blinding of outcome assessment (detection bias)	Incomplete outcome data (attrition bias)	Selective reporting (reporting bias)	Other bias
Bera (1993)	unclear	unclear	unclear	unclear	unclear	unclear	low
Blumenthal (1989)	unclear	unclear	unclear	unclear	low	high	low
Chen (2008)	low	high	unclear	unclear	low	high	low
Chen (2010)	unclear	high	unclear	unclear	low	high	high
Cohen (2008)	unclear	high	high	unclear	low	low	high
Elavsky (2007)	low	unclear	unclear	low	low	high	low
Harbans (2011)	unclear	unclear	unclear	unclear	high	low	high
Hegde (2013)	low	unclear	high	high	low	low	low
Kim (2013)	low	low	unclear	low	low	low	low
Kanaya (2014)	unclear	low	unclear	unclear	low	low	low
Kanojia (2013)	unclear	unclear	unclear	unclear	unclear	low	low
Khatri (2007)	unclear	unclear	unclear	unclear	unclear	high	high
Lee (2012)	unclear	unclear	unclear	unclear	low	low	low
Lu (2007)	unclear	unclear	unclear	unclear	unclear	low	low
Mahajan (1999)	unclear	unclear	unclear	unclear	unclear	low	low
Manchanda (2013)	unclear	unclear	high	high	high	low	unclear
Manjunath (2012)	low	low	unclear	unclear	low	High	high
McDermott (2014)	low	low	high	low	low	low	low
Mooventhan (2014)	low	low	unclear	unclear	low	low	low
Ray (2001)	unclear	unclear	unclear	unclear	high	low	low
Sakuma (2012)	low	low	unclear	unclear	high	High	high
Shukla Ravi (2014)	unclear	unclear	unclear	unclear	unclear	unclear	high
Seo (2012)	unclear	unclear	unclear	unclear	high	low	low
Stachenfeld (1998)	unclear	unclear	unclear	unclear	unclear	low	high
Telles (2013)	low	unclear	unclear	low	low	low	high
Telles (2014)	low	unclear	unclear	unclear	high	unclear	high
Thiyagarajan (2015)	low	low	high	high	high	low	high
Tracy (2013)	unclear	unclear	unclear	unclear	high	unclear	high
Van Puymbroeck (2007)	unclear	unclear	high	low	high	low	high
Yang (2011)	unclear	unclear	unclear	low	low	low	low

outcome assessement; fourteen trials had low risk of attrition bias, and eighteen were free of suspected selective reporting.

3.4. Analysis of overall effect

3.4.1. Primary outcomes

Meta-analyses revealed no effects on weight (Fig. 2), BMI, body fat percentage or waist circumference for yoga compared to usual care, exercise or lifestyle modification. For waist hip ratio a significant effect was found for yoga compared to usual care (SMD = −1.00; 95% CI = −1.44 to −0.55; P < 0.0001), see Table 3. One trial compared yoga to an herbal medicine compound but did not include statistical tests for group differences (Harbans et al., 2011).

3.4.2. Subgroup analysis (see Appendix Tables 2–5)

No effects were found for trials including children/adolescents only. Effects were the same in trials for adults only or for participants not selected for weight status only compared to the complete sample.

For studies on overweight or obese participants significant effects were found for body mass index only (SMD = −0.99; 95% CI = −1.67 to −0.31; P = 0.004) for yoga compared to usual care.

3.4.3. Sensitivity analysis

Due to the paucity of eligible trials, no sensitivity analyses could be conducted for studies with low risk of selection bias.

3.4.4. Safety

Only seven studies reported safety-related data, however they stated that no adverse events were reported (Cohen et al., 2008a; Sakuma et al., 2012), no adverse events during the intervention occurred (Telles et al., 2014; Van Puymbroeck et al., 2007), no clinically significant adverse events were reported or observed (Harbans et al., 2011), that no special concerns were found (Chen et al., 2008) or that no participant dropped out because of side effects (Kim et al., 2013).

3.4.5. Risk of bias across studies

Funnel plots were asymmetrical for weight, body mass index, and waist circumference; indicating high risk of publication bias (see Appendix Fig. 1).

4. Discussion

4.1. Summary of evidence

In this systematic review of 30 randomized controlled trials, only little evidence for effects of yoga on weight-related outcomes has been found. Significant changes in body mass index were identified only in studies with overweight/obese participants practicing yoga compared to usual care, while significant effects for waist hip ratio were found for yoga compared to usual care in adults who were not selected based on their weight only. Effects however were not robust against potential methodological bias and publication bias could not be ruled out. Furthermore safety was insufficiently reported.

4.2. Agreements with prior systematic reviews

Only one prior review explicitly investigated the effects of yoga on weight and related parameters. Rioux and Ritenbaugh (2013) conducted a narrative review, and included 17 trials that used yoga as an intervention for weight loss; among them uncontrolled, controlled and randomized controlled trials. Their risk assessment was based on a self-developed instrument. The authors concluded that therapeutic yoga was frequently effective in promotion weight loss or improving body composition in included trials. They also found that increased

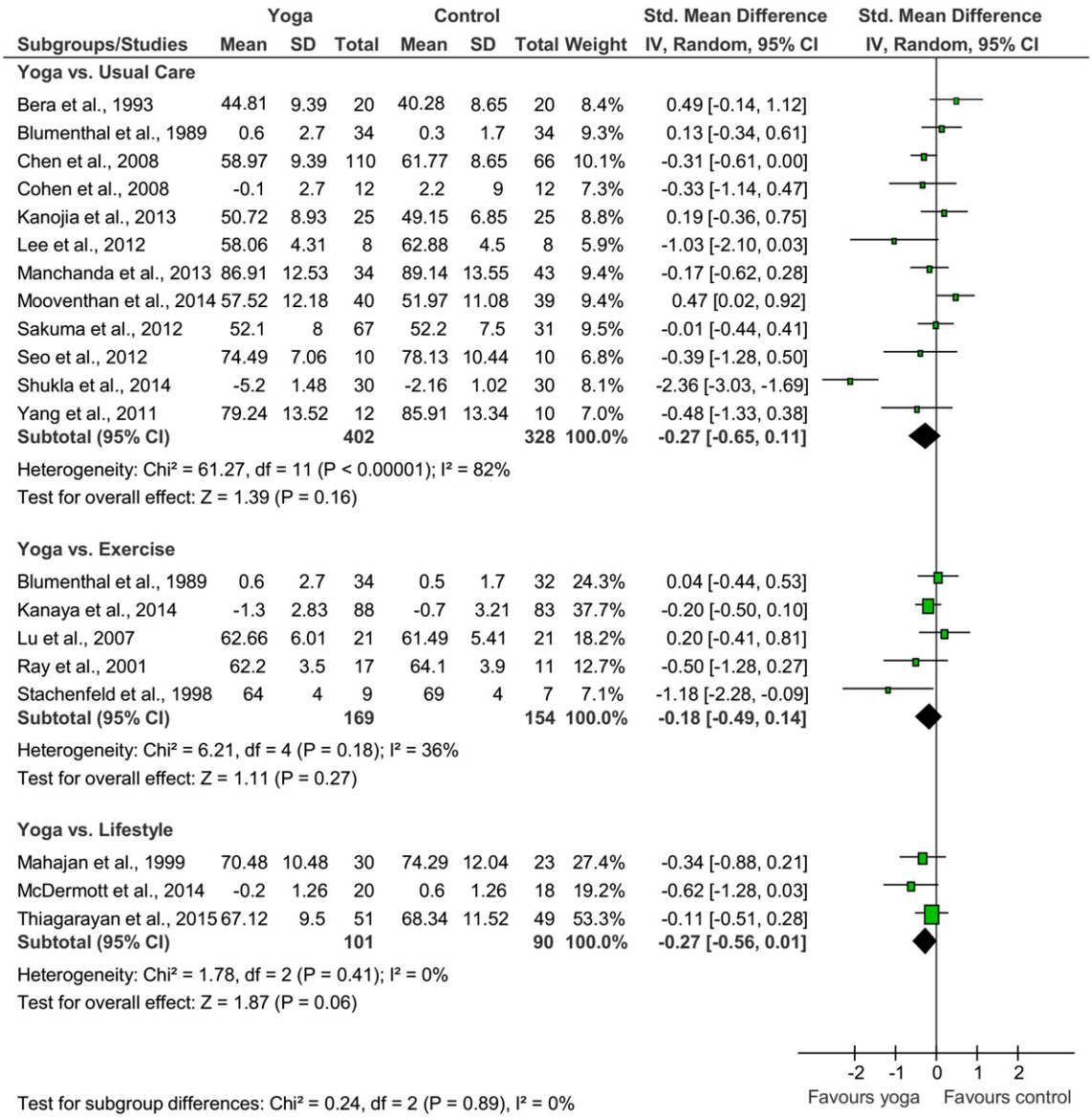

Fig. 2. Forest plot and effect sizes for yoga compared to usual care, exercise and lifestyle modification for the outcome weight.

frequency, longer duration, dietary components, residential components, a multi-component yoga and home practice increased the effectiveness.

In comparison our current review found only very limited evidence of yoga's efficacy for weight control in overweight/obese patients; however effects were not robust against bias. Subgroup analysis or meta-regression based on intensity, duration and yoga components could not be conducted due to heterogeneity of trials with very little overlap. The present review had also used the Cochrane risk of bias tool and found only a few trials with low risk of selection bias in general.

Another review on the effects of yoga on cardiovascular risk factors found effects of yoga on waist circumference and waist/hip ratio in high-risk groups but did not include other weight-related outcomes (Cramer et al., 2014b). Other reviews reported comparable effects (Chu et al., 2014b; Yang, 2007).

4.3. Strengths and weaknesses

To the best of our knowledge, this is the first systematic review and/or meta-analysis available on yoga for weight management. Strengths of this review include the comprehensive literature search and the inclusion of yoga trials on the general population as well as overweight/obese participants. The primary limitation of this review is the paucity of eligible studies especially for overweight/obese participants, rendering further subgroup analyses impossible. Another major limitation is the insufficient reporting and/or low methodological quality of the included studies, limiting the interpretability of the results. Intervention adherence was reported in less than one third of the included studies; thus the influence of adherence on study outcomes could not be evaluated. The inclusion of studies on metabolic syndrome can be regarded as a limitation because metabolic syndrome — although not defined as a disease — might nevertheless be associated with pronounced symptoms.

4.4. How the intervention might work

While yoga is often considered a form of exercise, beginner-level yoga sessions are not ordinarily considered sufficient for improving cardiovascular fitness (Hagins et al., 2007). More intensive forms of yoga however can contribute to higher energy expenditure (Hagins et al.,

Table 3
Results of the meta-analysis over all studies for body mass index, body fat percentage, waist circumference and waist hip ratio. Legend: BF: body fat; BMI: body mass index; EX: exercise; LSM: lifestyle modification; UC: usual care; WC: waist circumference; WHR: waist hip ratio.

Outcome	Comp	Study	Yoga Mean	Yoga SD	N	Control Mean	Control SD	N	Weight	SMD [95% CI]
BMI	UC	Chen et al. (2008)	24.24	4.96	110	24.48	4.03	66	12.6%	−0.05 [−0.36, 0.25]
		Cohen et al. (2008a)	−0.1	0.9	12	0.8	2.7	12	9.1%	−0.43 [−1.24, 0.38]
		Hedge et al. (2013)	26.8	3.5	14	26.3	4.4	15	9.7%	0.12 [−0.61, 0.85]
		Lee et al. (2012)	24.24	1.43	8	26.01	1.61	8	7.4%	−1.10 [−2.17, −0.03]
		Manchanda et al. (2013)	31.29	3.99	34	33.65	4.9	43	11.7%	−0.52 [−0.97, −0.06]
		Mooventhan and Khode (2014)	22.37	4.279	40	20.82	3.336	39	11.7%	0.40 [−0.05, 0.85]
		Sakuma et al. (2012)	20.7	2.7	67	20.8	2.5	31	11.9%	−0.04 [−0.46, 0.39]
		Seo et al. (2012)	27.56	1.5	10	29.57	2.97	10	8.4%	−0.82 [−1.74, 0.10]
		Shukla and Gehlot (2014)	−1.97	0.7	30	−0.76	0.42	30	10.4%	−2.07 [−2.70, −1.43]
		Van Puymbroeck et al. (2007)	32.07	12.9	6	28.83	8.31	7	7.2%	0.28 [−0.82, 1.38]
		Total			331			261	100.0%	−0.40 [−0.83, 0.04]
		Overall effect	Z = 1.79 (P = 0.07)							
		Heterogeneity	Chi^2 = 49.55, df = 9 (P < 0.00001); I^2 = 82%							
	EX	Lu and Wang (2007)	23.08	1.77	21	23.4	1.31	21	21.1%	−0.20 [−0.81, 0.40]
		Stachenfeld et al. (1998)	27.0	2.7	9	26.8	1.7	7	7.9%	0.08 [−0.91, 1.07]
		Telles et al. (2013)	16.34	1.88	49	16.6	2.78	49	49.4%	−0.11 [−0.50, 0.29]
		Telles et al. (2014)	36.61	6.54	22	33.8	5.76	22	21.6%	0.45 [−0.15, 1.05]
		Total			101			99	100.0%	0.01 [−0.27, 0.29]
		Overall effect	Z = 0.05 (P = 0.96)							
		Heterogeneity	Chi^2 = 2.88, df = 3 (P = 0.41); I^2 = 0%							
BF (%)	UC	Bera and Rajapurkar (1993)	3.71	6.3	20	10.05	8.4	20	17.7%	−0.84 [−1.49, −0.19]
		Chen et al. (2010)	28.7	9.27	31	29.0	9.03	24	18.7%	−0.03 [−0.57, 0.50]
		Lee et al. (2012)	33.83	4.31	8	37.45	2.7	8	14.1%	−0.95 [−2.00, 0.10]
		Seo et al. (2012)	35.66	6.05	10	36.15	6.55	10	15.7%	−0.07 [−0.95, 0.80]
		Shukla and Gehlot (2014)	−3.00	1.06	30	−1.03	1.37	30	18.3%	−1.59 [−2.18, −1.00]
		Tracy and Hart (2013)	27.3	6.3	10	21.0	8.4	11	15.5%	0.81 [−0.09, 1.71]
		Total			109			103	100.0%	−0.47 [−1.15, 0.22]
		Overall effect	Z = 1.33 (P = 0.18)							
		Heterogeneity	Chi^2 = 26.97, df = 5 (P < 0.0001); I^2 = 81%							
	EX	Lu and Wang (2007)	29.0	3.05	21	29.03	2.49	21	61.1%	−0.01 [−0.62, 0.59]
		Ray et al. (2001)	9.5	2.0	17	9.5	2.7	11	38.9%	0.00 [−0.76, 0.76]
		Total			38			32	100.0%	−0.01 [−0.48, 0.47]
		Overall effect	Z = 0.03 (P = 0.98)							
		Heterogeneity	Chi^2 = 0.00, df = 1 (P = 0.98); I^2 = 0%							
WC	UC	Bera and Rajapurkar (1993)	60.29	5.23	20	63.2	7.83	20	14.9%	−0.43 [−1.06, 0.20]
		Cohen et al. (2008a)	−2.7	3.0	12	−2.7	5.0	12	13.5%	0.00 [−0.80, 0.80]
		Hegde et al., 2013	89.4	9.1	14	90.0	13.7	15	14.1%	−0.05 [−0.78, 0.68]
		Kim et al. (2013)	90.0	5.2	17	90.52	9.1	20	14.8%	−0.07 [−0.71, 0.58]
		Lee et al. (2012)	85.13	1.36	8	86.44	1.95	8	11.7%	−0.74 [−1.76, 0.29]
		Manchanda et al. (2013)	95.12	5.12	34	98.0	7.3	43	16.2%	−0.44 [−0.90, 0.01]
		Shukla and Gehlot (2014)	−3.53	1.5	30	−0.96	0.49	30	14.7%	−2.27 [−2.93, −1.61]
		Total			135			148	100.0%	−0.57 [−1.17, 0.02]
		Overall effect	Z = 1.90 (P = 0.06)							
		Heterogeneity	Chi^2 = 32.54, df = 6 (P < 0.0001); I^2 = 82%							
	EX	Kanaya et al. (2014)	−1.7	4.25	88	−0.8	5.04	83	43.1%	−0.19 [−0.49, 0.11]
		Lu and Wang (2007)	82.05	0.09	21	81.02	3.72	21	22.8%	0.38 [−0.23, 1.00]
		Stachenfeld et al. (1998)	90.7	4.5	9	94.7	4.6	7	10.4%	−0.83 [−1.87, 0.21]
		Telles et al. (2014)	109.83	13.28	22	108.18	14.41	22	23.7%	0.12 [−0.47, 0.71]
		Total			140			133	100.0%	−0.05 [−0.42, 0.32]
		Overall effect	Z = 0.29 (P = 0.77)							
		Heterogeneity	Chi^2 = 5.18, df = 3 (P = 0.16); I^2 = 42%							
	LSM	McDermott et al. (2014)	−4.2	4.71	20	0.7	4.71	18	42.4%	−1.02 [−1.70, −0.34]
		Thiyagarajan et al. (2015)	82.96	6.26	51	85.06	8.0	49	57.6%	−0.29 [−0.69, 0.10]
		Total			71			67	100.0%	−0.60 [−1.30, 0.11]
		Overall effect	Z = 1.67 (P = 0.10)							
		Heterogeneity	Chi^2 = 3.28, df = 1 (P = 0.07); I^2 = 70%							
WHR	UC	Hegde et al. (2013)	0.88	0.04	15	0.93	0.08	14	34.1%	−0.78 [−1.54, −0.02]
		Shukla and Gehlot (2014)	−0.02	0.01	30	−0.01	0.01	30	65.9%	−1.11 [−1.66, −0.57]
		Total			45			44	100.0%	−1.00 [−1.44, −0.55]
		Overall effect	Z = 4.41 (P < 0.0001)							
		Heterogeneity	Chi^2 = 0.49, df = 1 (P = 0.48); I^2 = 0%							
	EX	Lu and Wang (2007)	0.69	0.03	21	0.79	0.02	21	32.6%	−3.85 [−4.90, −2.79]
		Stachenfeld et al. (1998)	0.92	0.03	9	0.93	0.04	7	32.9%	−0.27 [−1.27, 0.72]
		Telles et al. (2014)	0.91	0.05	22	0.93	0.08	22	34.5%	−0.29 [−0.89, 0.30]
		Total			52			50	100.0%	−1.45 [−3.56, 0.66]
		Overall effect	Z = 1.34 (P = 0.18)							
		Heterogeneity	Chi^2 = 35.44, df = 2 (P < 0.00001); I^2 = 94%							

2007; Mody, 2011; Ray et al., 2011); and can thus contribute to weight loss and maintenance (Kristal et al., 2005). Moreover, yoga can ameliorate back and joint pain (Cramer et al., 2013a; Cramer et al., 2013b; Haaz and Bartlett, 2011; Bussing et al., 2012), and increase levels of other, non-yoga physical activity (Bryan et al., 2012). Beyond exercise, yoga can also encompass yogic dietary advice; as well as relaxation,

meditation, breath control and positive thinking. Thus, yoga has been shown to effectively decrease chronic depression (Cramer et al., 2013c) and stress (Chong et al., 2011); which might in turn reduce emotional overeating and resulting overweight (Dallman et al., 2003). This way, yoga interventions target both, physical and emotional maintaining factors of obesity.

4.5. Implications for further research

Given that the main drawback of this review was the insufficient reporting of trial methodology, authors of future research should improve the reporting of yoga trials and follow commonly accepted reporting guidelines (e.g. CONSORT) (Schulz et al., 2010). Further trials should ensure rigorous methodology such as a-priori sample size calculations to prevent the trial from being underpowered. They should further ensure adequate randomization, allocation concealment, intention-to-treat analysis, and blinding of at least outcome assessors (Schulz et al., 2010).

Only seven trials in this review explicitly investigated overweight/obese samples, and two of them could not be included in the meta-analysis due to their unique control groups. The remaining trials — when combined — only included 60 patients in the meta-analytic comparison of yoga and usual care. More trials on yoga for overweight or obese people therefore are warranted. Since overweight and obesity might also be associated with eating disorders, trials on for example binge eating are urgently needed, as such participants may require special consideration.

Future trials must also improve reporting of safety. Even though a systematic review of randomized controlled trials found no evidence for serious yoga-associated adverse events or an accumulation of adverse events compared to usual care or exercise (Cramer et al., 2015b), evidence was limited because only one third of the trials actually reported safety and most of them insufficiently. Yoga has also been occasionally associated with serious adverse events (Cramer et al., 2013d). Especially overweight and obese patients may be required to present a certain physical fitness; and certain poses might be associated with an increased risk of injuries. This should be an additional focus of further trials.

4.6. Implications for clinical practice

Based on the results of this meta-analysis, no recommendation can be made for or against yoga to influence weight-related outcomes in children and adolescents. Despite the methodological drawbacks of the included trials, yoga can however be preliminarily considered a safe and effective intervention to reduce body mass index in overweight or obese but otherwise healthy adults. It has been shown that while women and younger individuals are less adherent to physical activity interventions targeting overweight and obesity (Bautista-Castano et al., 2004), those individuals are however more likely to practice yoga (Birdee et al., 2008; Cramer et al., 2013e). Thus, yoga can be specifically considered as an alternative to other forms of physical activity for overweight/obese individuals who are not adherent to recommended physical activity regimens.

Conflict of interests

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Appendix A. Complete search strategy for PubMed/Medline

(*Yoga*[*MeSH Terms*] *OR Yoga**[*Title/Abstract*] *OR Yogic*[*Title/Abstract*] *OR Asana**[*Title/Abstract*] *OR Pranayama*[*Title/Abstract*]) *AND* (*Body Weights and Measures*[*MeSH Terms*] *OR Body Weight*[*MeSH Terms*] *OR Body Composition*[*MeSH Terms*] *OR Weight**[*Title/Abstract*] *OR Body Mass Index*[*Title/Abstract*] *OR BMI*[*Title/Abstract*] *OR Body Fat*[*Title/Abstract*] *OR fat mass*[*Title/Abstract*] *OR Body Composition*[*Title/Abstract*] *OR Adiposity*[*Title/Abstract*] *OR Obes**[*Title/Abstract*] *OR Overweight*[*Title/Abstract*] *OR Waist Circumference*[*Title/Abstract*] *OR Waist-Hip Ratio**[*Title/Abstract*]) *AND* (*Randomized Controlled Trial* [*Publication Type*] *OR controlled clinical trial*[*Publication Type*] *OR randomized*[*Title/Abstract*] *OR placebo*[*Title/Abstract*] *OR randomly*[*Title/Abstract*] *OR trial*[*Title/Abstract*] *OR groups*[*Title/Abstract*]) *NOT* (*Animals*[*MeSH Terms*] *NOT humans*[*MeSH Terms*]).

Appendix Table 1
Characteristics of the included studies. Legend: NA: not assessed, NR: not reported, f: female; m: male.

Reference	Origin	Overweight as inclusion criterion	Sample	Intervention	Control group	Outcome assessment time point	Outcome measures:
			Sample size; mean age; gender; ethnicity	Intervention; program length; frequency; duration Components of yoga intervention	Intervention; program length; frequency; duration		1. Weight 2. Body mass index 3. Body fat percentage 4. Fat mass (absolute) 5. Waist circumference 6. Waist hip ratio 7. Safety
Bera and Rajapurkar (1993)	India	No	Sample size: n = 40 (n = 20 each) Mean age: 12–15 years Gender: 100%m Ethnicity: NR	Yoga 1 year 3×/week 45 min each	No treatment	1 year	1. Weight 2. NA 3. Body fat percentage 4. Fat mass

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Appendix Table 1 (*continued*)

Reference	Origin	Overweight as inclusion criterion	Sample	Intervention	Control group	Outcome assessment time point	Outcome measures:
							5. NA 6. NA 7. NA
				Asana Pranayama Meditation			
Blumenthal et al. (1989)	USA	No	Sample size: n = 101 (Yoga n = 34; exercise n = 33, no treatment n = 34) Mean age: Yoga 67.8 ± 5.9 years; exercise 66.5 ± 4.3 years; no treatment 66.8 ± 4.3 years Gender: 49.5%f Ethnicity: 96.0% Caucasians	Yoga 16 weeks 2×/week 60 min each NR	1) Aerobic exercise 16 weeks 3×/week 60 min. each 2) No treatment	16 weeks	1. Weight 2. NA 3. NA 4. NA 5. NA 6. NA 7. NA
Chen et al. (2008)	Taiwan	No	Sample size: n = 204 (Yoga n = 64, short yoga n = 59, no treatment n = 66) Mean age: 69.0 ± 6.3 years Gender: 72.7%f Ethnicity: NR	Silver yoga 24 weeks 3×/week 70 min each Asana Meditation Relaxation	1) Short yoga intervention (group combined with interventional group for meta-analysis) 24 weeks 3×/week 55 min. Each Asana Relaxation 2) No treatment	24 weeks	1. Weight 2. Body mass index 3. NA 4. NA 5. NA 6. NA 7. NA
Chen et al. (2010)	Taiwan	No	Sample size: n = 69 (Yoga n = 38, control n = 31) Mean age: 75.4 ± 6.7 years Gender: 52.7%f Ethnicity: NR	Silver Yoga 24 weeks 3×/week 70 min each Asana Meditation Relaxation	No treatment	24 weeks	1. NA 2. NA 3. Body fat percentage 4. NA 5. NA 6. NA 7. Special concerns
Cohen et al., 2008a	USA	Yes	Sample size: n = 26 (Yoga n = 14; control n = 12) Mean age: Yoga 52 ± 9 years; control 52 ± 8 years Gender: 100%m Ethnicity: 45% Caucasians	Yoga 10 weeks 3 h introductory course 2×/week (weeks 1–5) 1×/week (weeks 6–10) 90 min each Asanas Pranayama Relaxation	No intervention	10 weeks	1. Weight 2. Body mass index 3. NA 4. NA 5. Waist circumference 6. NA 7. Adverse events
Elavsky and McAuley (2007a) (multiple publications)	USA	No	Sample size: n = 164 (Yoga n = 62; exercise n = 63; usual care n = 39) Mean age: Yoga 50.0 ± 3.7 years; exercise 50.5 ± 3.4; usual care 48.6 ± 3.5 Gender: 100%f Ethnicity: 82.6% Caucasians; 12.6% Blacks	Yoga 16 weeks 2×/week 90 min each Asanas Mediation	1) Exercise 16 weeks 2×/week 90 min each 2) Usual care	16 weeks	1. NA 2. NA 3. Body fat percentage (NR) 4. NA 5. NA 6. NA 7. NA
Harbans et al. (2011)	India	Yes	Sample size: n = 63 (Yoga n = 34; control n = 29) Age range: 20–70 years Gender: NR Ethnicity: NR	Yoga 8 weeks 2×/day 45 min each	Herbal medicine Lashunadi compound	8 weeks	1. Weight 2. Body mass index 3. NA 4. NA 5. Waist circumference 6. Waist hip ratio 7. Significant adverse events
Hegde et al. (2013)	India	No	Sample size: n = 29 (Yoga n = 14, control n = 15) Mean age: Yoga 46.5 ± 13.0 years; control 44.7 ± 9.6 years Gender: 48.3%f Ethnicity: NR	Yoga 12 weeks 5×/week 75–90 min each Asanas Pranayama Relaxation	No intervention	12 weeks	1. NA 2. Body mass index 3. NA 4. NA 5. Waist circumference 6. Waist hip ratio 7. NA
Kanaya et al. (2014)	USA	Yes	Sample size: n = 180 (Yoga n =	Restorative Yoga	Stretching	12 months	1. Weight

Appendix Table 1 (*continued*)

Reference	Origin	Overweight as inclusion criterion	Sample	Intervention	Control group	Outcome assessment time point	Outcome measures:
			91, control n = 89) Mean age: Yoga 55 ± 7 years; control 54 ± 7 years Gender: 65.3%f Ethnicity: 62.2% Caucasians	48 weeks 2×/week (weeks 1–12) 1×/week (weeks 13–24) 1×/month (weeks 24, weeks 48) Asanas	48 weeks 2×/week (weeks 1–12) 1×/week (weeks 13–24) 1×/month (weeks 24 weeks-48)		2. Body mass index 3. Body fat percentage 4. NA 5. Waist circumference 6. NA 7. NA
Kanojia et al. (2013)	India	No	Sample size: n = 50 (n = 25 each) Mean age: Yoga 18.6 ± 1.1 years; control 18.1 ± 0.8 years Gender: 100%f Ethnicity: NR	Yoga 3 months 6×/week 35–40 min. Each Asanas Pranayama Meditation Relaxation	No intervention	3 months	1. Weight 2. NA 3. NA 4. NA 5. NA 6. NA 7. NA
Khatri et al., 2007	India	No	Sample size: n = 101 (Yoga n = 55; control n = 46) Mean age: Yoga 54.1 ± 8.8 years; control 54.0 ± 11.2 years Gender: NR Ethnicity: NR	Yoga 3 months	Usual care	3 months	1. NA 2. Body mass index 3. NA 4. NA 5. Waist circumference 6. NA 7. NA
Kim et al. (2013)	South Korea	Yes	Sample size: n = 41 (Yoga n = 20; control n = 21) Mean age: Yoga 48.2 ± 7.2 years; control 50.3 ± 8.3 years Gender: 100%f Ethnicity: NR	Hatha Yoga 12 weeks 3×/week 60 min each Asanas Pranayama Relaxation	Usual care	12 weeks	1. NA 2. NA 3. NA 4. NA 5. Waist circumference 6. NA 7. Drop outs due to side effects
Lee et al. (2012)	Korea	Yes	Sample size: n = 16 (Yoga n = 8, control n = 8) Mean age: Yoga 54.8 ± 2.8 years; control 54.3 ± 2.9 years Gender: 100%f Ethnicity: NR	Yoga 16 weeks 3×/week 60 min each Asanas Pranayama Relaxation	No intervention	16 weeks	1. Weight 2. Body mass index 3. Body fat percentage 4. NA 5. Waist circumference 6. NA 7. NA
Lu and Wang (2007)	China	No	Sample size: n = 63 (n = 21 each) Mean Age: NR Gender: 100%f Ethnicity: NR	Yoga Asanas Relaxation	1) Aerobic exercise 2) Aerobic + yoga (group not included in meta-analysis)	10 weeks	1. Weight 2. Body mass index 3. NA 4. NA 5. Waist circumference 6. Waist hip ratio 7. NA
Mahajan et al. (1999)	India	No	Sample size: n = 53 (n = 30 Yoga, n = 23 control) Age range 56–90 years Gender: 100%m Ethnicity: NR	Yogic lifestyle intervention 4 day initial residential yoga camp +14 weeks home practice (60 min daily) Asanas Pranayama Meditation Relaxation +Vegetarian diet	Lifestyle advice Diet control and moderate exercise	14 weeks	1. Weight 2. NA 3. NA 4. NA 5. NA 6. NA 7. NA
Manchanda et al. (2013)	India	Yes	Sample size: n = 100 (n = 50 each) Mean age: Yoga 62.4 ± 12.5 years; control 56.7 ± 12.8 years Gender: 49.0%f	Yoga 1 week yoga instruction +12 months home practice (60 min	Usual care	12 months	1. Weight 2. Body mass index 3. NA 4. NA

(*continued on next page*)

Appendix Table 1 (*continued*)

Reference	Origin	Overweight as inclusion criterion	Sample	Intervention	Control group	Outcome assessment time point	Outcome measures:
			Ethnicity: NR	daily) Asanas Pranayama Meditation Relaxation Lifestyle			5. Waist circumference 6. NA 7. NA
Manjunath and Telles (2012)	India	No	Sample size: n = 69 (n = 23 each) Mean age: Yoga 70.1 ± 8.3 years; control 1) 72.1 ± 9.0 years; control 2) 72.3 ± 7.4 years Gender: NR Ethnicity: NR	Yoga 24 weeks 6×/week 60 min each Asanas Pranayama Meditation Relaxation	1) Ayurvedic herbal preparation 24 weeks 2×/day 2) No intervention	6 months	1. NA 2. Body mass index (NR) 3. NA 4. NA 5. NA 6. NA 7. NA
McDermott et al. (2014)	India	No	Sample size: n = 41 (Yoga n = 21, control n = 20) Mean age: Yoga 47.0 ± 9.7 years, control 47.2 ± 9.1 years Gender: 61.0%f Ethnicity: NR	Yoga 8 weeks 3-6×/week 75 min each Asanas Pranayama Relaxation Meditation	Lifestyle advice and home-based walking 8 weeks 3-6×/week 30 min each	8 weeks	1. Weight 2. Body mass index 3. NA 4. NA 5. Waist circumference 6. NA 7. NA
Mooventhan and Khode (2014)	India	No	Sample size: n = 82 (n = 41 each) Mean age: Yoga 19.8 ± 1.7 years, control 19.7 ± 2.0 years Gender: 78.0%f Ethnicity: NR	Yoga 2 weeks 6 days/week 10 min/day Pranayama	No intervention	2 weeks	1. Weight 2. Body Mass Index 3. NA 4. NA 5. NA 6. NA 7. NR
Ray et al. (2001)	India	No	Sample size: n = 40 (n = 20 each) Mean age: Yoga 21.9 ± 1.5 years; control 22.7 ± 2.0 years Gender: 100%m Ethnicity: NR	Hatha Yoga 6 months 6×/week 60 min each Asana Pranayama Relaxation Meditation	Exercise 6 months 6×/week 60 min each	6 months	1. Weight 2. NA 3. Body fat percentage 4. Fat mass (absolute) 5. NA 6. NA 7. NA
Sakuma et al. (2012)	Japan	No	Sample size: n = 123 (Yoga n = 83, control n = 40) Mean age: Yoga 32.6 ± 11.5 years; control 35.8 ± 13.0 years Gender: 100%f Ethnicity: NR	Yogasanas 2 weeks 7×/week 15 min each Asanas Pranayama	No intervention	4 weeks	1. Weight 2. Body mass index 3. NA 4. NA 5. NA 6. NA 7. Adverse events
Seo et al. (2012)	Korea	Yes	Sample size: n = 20 (n = 10 each) Mean age: Yoga 14.7 ± 0.5 years; control: 14.6 ± 1.0 years Gender: 100%m Ethnicity: NR	Yoga 8 weeks 3×/week 60 min each Asanas Relaxation	No treatment	8 weeks	1. Weight 2. Body mass index 3. Body fat percentage 4. Fat mass (absolute) 5. NA 6. NA 7. NA
Shukla and Gehlot (2014)	India	Yes	Sample size: n = 60 (n = 30each) Age: 25–55 years Gender: 55.0%f Ethnicity: NR	Yoga 90 days Kapalabhati 50×/day; Paschimottanasana 20×/day Asana Pranayama +Diet	Diet 90 days 1600 Kcal/day	90 days	1. Weight 2. Body Mass Index 3. Body fat percentage 4. Fat mass (absolute, body fat, visceral fat) 5. Waist circumference 6. Waist hip ratio 7. NA
Stachenfeld et al.	USA	No	Sample size: n = 17 (Yoga n = 8,	Yoga	Aerobic exercise	12 weeks	1. Weight

Appendix Table 1 (*continued*)

Reference	Origin	Overweight as inclusion criterion	Sample	Intervention	Control group	Outcome assessment time point	Outcome measures:
(1998); DiPietro et al. (1998)			control n = 9) Mean age: Yoga 71 ± 2 years; control 73 ± 3 years Gender: 100%f Ethnicity: NR	12 weeks 3–4×/week 60 min each Asanas	12 weeks 3-4×/week 40–50 min each Treadmill or trampoline walking		2. Body mass index 3. NA 4. NA 5. NA 6. NA 7. NA
Telles et al. (2013)	India	No	Sample size: n = 98 (Yoga n = 49, control n = 49) Mean age: Yoga 10.4 ± 1.2 years; control 10.5 ± 1.3 years Gender: 38.8% Ethnicity: NR	Yoga 3 months 5×/week 45 min each Asanas Pranayama Relaxation	Physical exercise 3 months 5×/week 45 min each	3 months	1. Weight (NR) 2. Body mass index 3. NA 4. Fat mass (NR) 5. Waist circumference 6. Waist hip ratio 7. NA
Telles et al. (2014)	India	Yes	Sample size: n = 68 (Yoga n = 34, control n = 34) Age: Yoga 36.0 ± 10.3 years, control 36.8 ± 12.1 years Gender: 51.5% Ethnicity: NR	Yoga 15 days 2×/day 45 min each Asanas, Pranayama, Relaxation	Walking 15 days 2×/day 45 min each	15 days	1. NA 2. Body mass index 3. NA 4. Fat mass 5. Waist circumference 6. Waist hip ratio 7. Adverse events
Telles et al. (2014)	India	No	Sample size: n = 192 (n = 96 each) Mean age: Yoga 44.1 ± 9.4 years; control 42.5 ± 9.0 years Gender: 38.0%f Ethnicity: NR	Yoga 12 weeks 3×/week 45 min. Each Asanas Pranayama Relaxation +LSM (see control)	Lifestyle modification 12 weeks Diet Physical activity Maintaining/Reducing weight	12 weeks	1. Weight 2. Body mass index 3. NA 4. NA 5. Waist circumference 6. NA 7. NA
Tracy and Hart, 2013	USA	No	Sample size: n = 21 (Yoga n = 21, control n = 11) Mean age: 29.0 ± 6.1 years; control 25.1 ± 5.0 years Gender: 52.4% Ethnicity: NR	Bikram Yoga 8 weeks 3×/week 90 min each. Asanas	No intervention	8 weeks	1. Weight (NR) 2. NA 3. Body fat percentage 4. Fat mass (absolute) (NR) 5. NA 6. NA 7. NA
Van Puymbroeck et al. (2007)	USA	No	Sample size: n = 17 (Yoga n = 8, control n = 9) Mean age: Yoga 55.17 ± 15.0 years; control 62.7 ± 10.8 years Gender: 69.2% Ethnicity: 92.3% Caucasian	Yoga 8 weeks 2×/week 75 min each Asanas Pranayama	Usual care	8 weeks	1. NA 2. Body mass index 3. NA 4. NA 5. NA 6. NA 7. Adverse events during yoga sessions
Yang et al. (2011)	USA	No	Sample size: n = 25 (Yoga n = 13, control n = 12) Mean age: 51.7 ± 4.9 years Gender: 91.3%f Ethnicity: 76.0% Caucasians	Vinyasa Yoga 12 weeks 2×/week 60 min each Asanas, Pranayama, Relaxation	General health education (written information)	12 weeks	1. Weight 2. NA 3. NA 4. NA 5. NA 6. NA 7. NA

Appendix Table 2
Results of the meta-analysis for studies with overweight/obese participants only.

Outcome	Comp	Study	Yoga Mean	Yoga SD	N	Control Mean	Control SD	N	Weight	SMD [95% CI]
Weight	UC	Cohen et al. (2008a)	−0.1	2.7	12	2.2	9.0	12	19.8%	−0.33 [−1.14, 0.47]
		Lee et al. (2012)	58.06	4.31	8	62.88	4.5	8	17.8%	−1.03 [−2.10, 0.03]
		Manchanda et al. (2013)	86.91	12.53	34	89.14	13.55	43	22.3%	−0.17 [−0.62, 0.28]
		Seo et al. (2012)	74.49	7.06	10	78.13	10.44	10	19.2%	−0.39 [−1.28, 0.50]
		Shukla and Gehlot (2014)	−5.2	1.48	30	−2.16	1.02	30	20.9%	−2.36 [−3.03, −1.69]
		Total			94			103	100.0%	−0.86 [−1.76, 0.05]
		Overall effect	Z = 1.86 (P = 0.06)							
		Heterogeneity	Chi^2 = 30.61, df = 4 (P < 0.00001); I^2 = 87%							
BMI	UC	Cohen et al., (2008a)	−0.1	0.9	12	0.8	2.7	12	19.6%	−0.43 [−1.24, 0.38]
		Lee et al. (2012)	24.24	1.43	8	26.01	1.61	8	16.2%	−1.10 [−2.17, −0.03]
		Manchanda et al. (2013)	31.29	3.99	34	33.65	4.9	43	24.2%	−0.52 [−0.97, −0.06]
		Seo et al. (2012)	27.56	1.5	10	29.57	2.97	10	18.1%	−0.82 [−1.74, 0.10]
		Shukla and Gehlot (2014)	−1.97	0.7	30	−0.76	0.42	30	22.0%	−2.07 [−2.70, −1.43]
		Total			94			103	100.0%	−0.99 [−1.67, −0.31]
		Overall effect	Z = 2.86 (P = 0.004)							
		Heterogeneity	Chi^2 = 17.10, df = 4 (P = 0.002); I^2 = 77%							
BF (%)	UC	Lee et al. (2012)	33.83	4.31	8	37.45	2.7	8	29.1%	−0.95 [−2.00, 0.10]
		Seo et al. (2012)	35.66	6.05	10	36.15	6.55	10	32.5%	−0.07 [−0.95, 0.80]
		Shukla and Gehlot (2014)	−3.00	1.055	30	−1.03	1.37	30	38.4%	−1.59 [−2.18, −1.00]
		Total			48			48	100.0%	−0.91 [−1.86, 0.04]
		Overall effect	Z = 1.87 (P = 0.06)							
		Heterogeneity	Chi^2 = 8.02, df = 2 (P = 0.02); I^2 = 75%							
WC	UC	Cohen et al. (2008a)	−2.7	3.0	12	−2.7	5.0	12	19.4%	0.00 [−0.80, 0.80]
		Kim et al. 2013	90.0	5.2	17	90.52	9.1	20	20.7%	−0.07 [−0.71, 0.58]
		Lee et al. (2012)	85.13	1.36	8	86.44	1.95	8	17.4%	−0.74 [−1.76, 0.29]
		Manchanda et al. (2013)	95.12	5.12	34	98.0	7.3	43	22.1%	−0.44 [−0.90, 0.01]
		Shukla and Gehlot (2014)	−3.53	1.5	30	−0.96	0.49	30	20.6%	−2.27 [−2.93, −1.61]
		Total			101			113	100.0%	−0.71 [−1.53, 0.12]
		Overall effect	Z = 1.68 (P = 0.09)							
		Heterogeneity	Chi^2 = 29.77, df = 4 (P < 0.00001); I^2 = 87%							
	EX	Kanaya et al. (2014)	−1.7	4.25	88	−0.8	5.04	83	79.5%	−0.19 [−0.49, 0.11]
		Telles et al. (2014)	109.83	13.28	22	108.18	14.41	22	20.5%	0.12 [−0.47, 0.71]
		Total			110			105	100.0%	−0.13 [−0.40, 0.14]
		Overall effect	Test for overall effect: Z = 0.95 (P = 0.34)							
		Heterogeneity	Chi^2 = 0.84, df = 1 (P = 0.36); I^2 = 0%							

Appendix Table 3
Results of the meta-analysis for studies with healthy participants/general population only. Legend: BF: body fat; BMI: body mass index; EX: exercise; LSM: lifestyle modification; UC: usual care; WC: waist circumference; WHR: waist hip Ratio.

Outcome	Comp.	Study	Yoga Mean	Yoga SD	N	Control Mean	Control SD	N	Weight	SMD [95% CI]
Weight	UC	Bera and Rajapurkar (1993)	44.81	9.39	20	40.28	8.65	20	11.0%	0.49 [−0.14, 1.12]
		Blumenthal et al. (1989)	0.6	2.7	34	0.3	1.7	34	15.1%	0.13 [−0.34, 0.61]
		Chen et al. (2008)	58.97	9.39	110	61.77	8.65	66	21.1%	−0.31 [−0.61, 0.00]
		Kanojia et al. (2013)	50.72	8.93	25	49.15	6.85	25	12.8%	0.19 [−0.36, 0.75]
		Mooventhan and Khode (2014)	57.52	12.18	40	51.97	11.08	39	16.0%	0.47 [0.02, 0.92]
		Sakuma et al. (2012)	52.1	8.0	67	52.2	7.5	31	16.7%	−0.01 [−0.44, 0.41]
		Yang et al. (2011)	79.24	13.52	12	85.91	13.34	10	7.3%	−0.48 [−1.33, 0.38]
		Total			308			225	100.0%	0.07 [−0.19, 0.34]
		Overall effect	Z = 0.54 (P = 0.59)							
		Heterogeneity	Chi^2 = 12.30, df = 6 (P = 0.06); I^2 = 51%							
	EX	Blumenthal et al. (1989)	0.6	2.7	34	0.5	1.7	33	34.3%	0.04 [−0.44, 0.53]
		Lu and Wang (2007)	62.66	6.01	21	61.49	5.41	21	28.7%	0.20 [−0.41, 0.81]
		Ray et al. (2001)	62.2	3.5	17	64.1	3.9	11	22.6%	−0.50 [−1.28, 0.27]
		Stachenfeld et al. (1998)	64.0	4.0	9	69.0	4.0	7	14.5%	−1.18 [−2.28, −0.09]
		Total			81			71	100.0%	−0.21 [−0.71, 0.28]
		Overall effect	Z = 0.85 (P = 0.40)							
		Heterogeneity	Chi^2 = 6.08, df = 3 (P = 0.11); I^2 = 51%							
	LSM	Mahajan et al. (1999)	70.48	10.48	30	74.29	12.04	23	27.4%	−0.34 [−0.88, 0.21]
		McDermott et al. (2014)	−0.2	1.26	20	0.6	1.26	18	19.2%	−0.62 [−1.28, 0.03]
		Thiyagarajan et al. (2015)	67.12	9.5	51	68.34	11.52	49	53.3%	−0.11 [−0.51, 0.28]
		Total			101			90	100.0%	−0.27 [−0.56, 0.01]
		Overall effect	Z = 1.87 (P = 0.06)							
		Heterogeneity	Chi^2 = 1.78, df = 2 (P = 0.41); I^2 = 0%							
BMI	UC	Chen et al. (2008)	24.24	4.96	110	24.48	4.03	66	44.7%	−0.05 [−0.36, 0.25]
		Hegde et al. (2013)	26.8	3.5	14	26.3	4.4	15	9.7%	0.12 [−0.61, 0.85]
		Mooventhan and Khode (2014)	22.37	4.28	40	20.82	3.34	39	15.3%	0.40 [−0.05, 0.85]
		Sakuma et al. (2012)	20.7	2.7	67	20.8	2.5	31	16.8%	−0.04 [−0.46, 0.39]
		Van Puymbroeck et al. (2007)	32.07	12.9	6	28.83	8.31	7	2.5%	0.28 [−0.82, 1.38]
		Total			237			158	100.0%	0.07 [−0.13, 0.28]
		Overall effect	Z = 0.69 (P = 0.49)							

Appendix Table 3 (*continued*)

Outcome	Comp.	Study	Yoga Mean	Yoga SD	N	Control Mean	Control SD	N	Weight	SMD [95% CI]
		Heterogeneity	$Chi^2 = 3.12$, df = 4 (P = 0.54); $I^2 = 0\%$							
	EX	Lu and Wang (2007)	23.08	1.77	21	23.4	1.31	21	26.9%	−0.20 [−0.81, 0.40]
		Stachenfeld et al. (1998)	27.0	2.7	9	26.8	1.7	7	10.1%	0.08 [−0.91, 1.07]
		Telles et al. (2013)	16.34	1.88	49	16.6	2.78	49	63.0%	−0.11 [−0.50, 0.29]
		Total			79			77	100.0%	−0.11 [−0.43, 0.20]
		Overall effect	Z = 0.71 (P = 0.48)							
		Heterogeneity	$Chi^2 = 0.23$, df = 2 (P = 0.89); $I^2 = 0\%$							
BF (%)	UC	Bera and Rajapurkar (1993)	3.71	6.3	20	10.05	8.4	20	34.3%	−0.84 [−1.49, −0.19]
		Chen et al. (2010)	28.7	9.27	31	29.0	9.03	24	36.9%	−0.03 [−0.57, 0.50]
		Tracy and Hart (2013)	27.3	6.3	10	21.0	8.4	11	28.8%	0.81 [−0.09, 1.71]
		Total			61			55	100.0%	−0.07 [−0.89, 0.76]
		Overall effect	Z = 0.16 (P = 0.87)							
		Heterogeneity	$Chi^2 = 8.86$, df = 2 (P = 0.01); $I^2 = 77\%$							
	EX	Lu and Wang (2007)	29.0	3.05	21	29.03	2.49	21	61.1%	−0.01 [−0.62, 0.59]
		Ray et al. (2001)	9.5	2.0	17	9.5	2.7	11	38.9%	0.00 [−0.76, 0.76]
		Total			38			32	100.0%	−0.01 [−0.48, 0.47]
		Overall effect	Z = 0.03 (P = 0.98)							
		Heterogeneity	$Chi^2 = 0.00$, df = 1 (P = 0.98); $I^2 = 0\%$							
WC	UC	Bera and Rajapurkar (1993)	60.29	5.23	20	63.2	7.83	20	57.4%	−0.43 [−1.06, 0.20]
		Hegde et al. (2013)	89.4	9.1	14	90.0	13.7	15	42.6%	−0.05 [−0.78, 0.68]
		Total			34			35	100.0%	−0.27 [−0.74, 0.21]
		Overall effect	Z = 1.10 (P = 0.27)							
		Heterogeneity	$Chi^2 = 0.60$, df = 1 (P = 0.44); $I^2 = 0\%$							
	EX	Lu and Wang (2007)	82.05	0.09	21	81.02	3.72	21	56.3%	0.38 [−0.23, 1.00]
		Stachenfeld et al. (1998)	90.7	4.5	9	94.7	4.6	7	43.7%	−0.83 [−1.87, 0.21]
		Total			30			28	100.0%	−0.15 [−1.33, 1.03]
		Overall effect	Z = 0.25 (P = 0.81)							
		Heterogeneity	$Chi^2 = 3.90$, df = 1 (P = 0.05); $I^2 = 74\%$							
	LSM	McDermott et al. (2014)	−4.2	4.71	20	0.7	4.71	18	42.4%	−1.02 [−1.70, −0.34]
		Thiyagarajan et al. (2015)	82.96	6.26	51	85.06	8.0	49	57.6%	−0.29 [−0.69, 0.10]
		Total			71			67	100.0%	−0.60 [−1.30, 0.11]
		Overall effect	Z = 1.67 (P = 0.10)							
		Heterogeneity	$Chi^2 = 3.28$, df = 1 (P = 0.07); $I^2 = 70\%$							
WHR	UC	Hegde et al. (2013)	0.88	0.04	15	0.93	0.08	14	34.1%	−0.78 [−1.54, −0.02]
		Shukla and Gehlot (2014)	−0.02	0.01	30	−0.01	0.01	30	65.9%	−1.11 [−1.66, −0.57]
		Total			45			44	100.0%	−1.00 [−1.44, −0.55]
		Overall effect	Z = 4.41 (P < 0.0001)							
		Heterogeneity	$Chi^2 = 0.49$, df = 1 (P = 0.48); $I^2 = 0\%$							
	EX	Lu and Wang (2007)	0.69	0.03	21	0.79	0.02	21	32.6%	−3.85 [−4.90, −2.79]
		Stachenfeld et al. (1998)	0.92	0.03	9	0.93	0.04	7	32.9%	−0.27 [−1.27, 0.72]
		Telles et al. (2014)	0.91	0.05	22	0.93	0.08	22	34.5%	−0.29 [−0.89, 0.30]
		Total			52			50	100.0%	−1.45 [−3.56, 0.66]
		Overall effect	Z = 1.34 (P = 0.18)							
		Heterogeneity	$Chi^2 = 35.44$, df = 2 (P < 0.00001); $I^2 = 94\%$							

Appendix Table 4
Results of the meta-analysis for studies with children/adolescent participants only. Legend: BF: body fat; UC: usual care.

Outcome	Comp	Study	Yoga Mean	Yoga SD	N	Control Mean	Control SD	N	Weight	SMD [95% CI]
Weight	UC	Bera and Rajapurkar (1993)	44.81	9.39	20	40.28	8.65	20	56.5%	0.49 [−0.14, 1.12]
		Seo et al. (2012)	74.49	7.06	10	78.13	10.44	10	43.5%	−0.39 [−1.28, 0.50]
		Total			30			30	100.0%	0.11 [−0.75, 0.97]
		Overall effect	Z = 0.25 (P = 0.81)							
		Heterogeneity	$Chi^2 = 2.53$, df = 1 (P = 0.11); $I^2 = 60\%$							
BF (%)	UC	Bera and Rajapurkar (1993)	3.71	6.3	20	10.05	8.4	20	57.8%	−0.84 [−1.49, −0.19]
		Seo et al. (2012)	35.66	6.05	10	36.15	6.55	10	42.2%	−0.07 [−0.95, 0.80]
		Total			30			30	100.0%	−0.52 [−1.25, 0.22]
		Overall effect	Z = 1.37 (P = 0.17)							
		Heterogeneity	$Chi^2 = 1.88$, df = 1 (P = 0.17); $I^2 = 47\%$							

Appendix Table 5
Results of the meta-analysis for studies with adult participants only. Legend: BF: body fat; BMI: body mass index; EX: exercise; LSM: lifestyle modification; UC: usual care; WC: waist circumference; WHR: waist hip Ratio.

Outcome	Comp.	Study	Yoga Mean	Yoga SD	N	Control Mean	Control SD	N	Weight	SMD [95% CI]
Weight	UC	Blumenthal et al. (1989)	0.6	2.7	34	0.3	1.7	34	10.9%	0.13 [−0.34, 0.61]
		Chen et al. (2008)	58.97	9.39	110	61.77	8.65	66	11.9%	−0.31 [−0.61, 0.00]
		Cohen et al. (2008a)	−0.1	2.7	12	2.2	9.0	12	8.6%	−0.33 [−1.14, 0.47]
		Kanojia et al. (2013)	50.72	8.93	25	49.15	6.85	25	10.4%	0.19 [−0.36, 0.75]

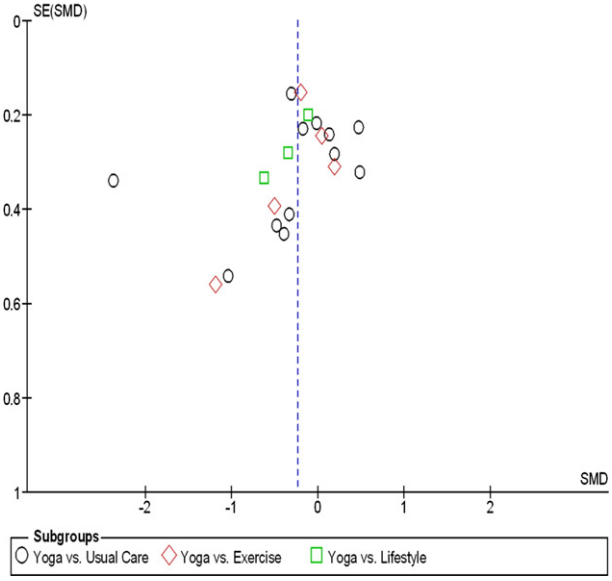
(*continued on next page*)

Appendix Table 5 (*continued*)

Outcome	Comp.	Study	Yoga Mean	Yoga SD	N	Control Mean	Control SD	N	Weight	SMD [95% CI]
		Lee et al. (2012)	58.06	4.31	8	62.88	4.5	8	7.0%	−1.03 [−2.10, 0.03]
		Manchanda et al. (2013)	86.91	12.53	34	89.14	13.55	43	11.0%	−0.17 [−0.62, 0.28]
		Mooventhan and Khode (2014)	57.52	12.18	40	51.97	11.08	39	11.1%	0.47 [0.02, 0.92]
		Sakuma et al. (2012)	52.1	8.0	67	52.2	7.5	31	11.2%	−0.01 [−0.44, 0.41]
		Shukla and Gehlot (2014)	−5.2	1.48	30	−2.16	1.02	30	9.6%	−2.36 [−3.03, −1.69]
		Yang et al. (2011)	79.24	13.52	12	85.91	13.34	10	8.3%	−0.48 [−1.33, 0.38]
		Total			372			298	100.0%	−0.34 [−0.76, 0.08]
		Overall effect	Z = 1.57 (P = 0.12)							
		Heterogeneity	Chi^2 = 56.67, df = 9 (P < 0.00001); I^2 = 84%							
	EX	Blumenthal et al. (1989)	0.6	2.7	34	0.5	1.7	33	24.4%	0.04 [−0.44, 0.53]
		Kanaya et al. (2014)	−1.3	2.83	88	−0.7	3.21	83	37.6%	−0.20 [−0.50, 0.10]
		Lu and Wang (2007)	62.66	6.01	21	61.49	5.41	21	18.2%	0.20 [−0.41, 0.81]
		Ray et al. (2001)	62.2	3.5	17	64.1	3.9	11	12.7%	−0.50 [−1.28, 0.27]
		Stachenfeld et al. (1998)	64.0	4.0	9	69.0	4.0	7	7.1%	−1.18 [−2.28, −0.09]
		Total			169			154	100.0%	−0.18 [−0.49, 0.14]
		Overall effect	Z = 1.11 (P = 0.27)							
		Heterogeneity	Chi^2 = 6.21, df = 4 (P = 0.18); I^2 = 36%							
	LSM	Mahajan et al. (1999)	70.48	10.48	30	74.29	12.04	23	27.4%	−0.34 [−0.88, 0.21]
		McDermott et al. (2014)	−0.2	1.26	20	0.6	1.26	18	19.2%	−0.62 [−1.28, 0.03]
		Thiyagarajan et al. (2015)	67.12	9.5	51	68.34	11.52	49	53.3%	−0.11 [−0.51, 0.28]
		Total			101			90	100.0%	−0.27 [−0.56, 0.01]
		Overall effect	Z = 1.87 (P = 0.06)							
		Heterogeneity	Chi^2 = 1.78, df = 2 (P = 0.41); I^2 = 0%							
BMI	UC	Chen et al. (2008)	24.24	4.96	110	24.48	4.03	66	13.7%	−0.05 [−0.36, 0.25]
		Cohen et al. (2008a)	−0.1	0.9	12	0.8	2.7	12	9.4%	−0.43 [−1.24, 0.38]
		Hegde et al. (2013)	24.24	4.96	110	24.48	4.03	66	13.7%	−0.05 [−0.36, 0.25]
		Lee et al. (2012)	24.24	1.43	8	26.01	1.61	8	7.4%	−1.10 [−2.17, −0.03]
		Manchanda et al. (2013)	31.29	3.99	34	33.65	4.9	43	12.5%	−0.52 [−0.97, −0.06]
		Mooventhan and Khode (2014)	22.37	4.28	40	20.82	3.34	39	12.6%	0.40 [−0.05, 0.85]
		Sakuma et al. (2012)	20.7	2.7	67	20.8	2.5	31	12.7%	−0.04 [−0.46, 0.39]
		Shukla and Gehlot (2014)	−1.97	0.7	30	−0.76	0.42	30	10.9%	−2.07 [−2.70, −1.43]
		Van Puymbroeck et al. (2007)	32.07	12.9	6	28.83	8.31	7	7.2%	0.28 [−0.82, 1.38]
		Total			417			302	100.0%	−0.36 [−0.77, 0.05]
		Overall effect	Z = 1.71 (P = 0.09)							
		Heterogeneity	Chi^2 = 48.23, df = 8 (P < 0.00001); I^2 = 83%							
	EX	Lu and Wang (2007)	23.08	1.77	21	23.4	1.31	21	41.1%	−0.20 [−0.81, 0.40]
		Stachenfeld et al. (1998)	27.0	2.7	9	26.8	1.7	7	16.9%	0.08 [−0.91, 1.07]
		Telles et al. (2014)	36.61	6.54	22	33.8	5.76	22	42.0%	0.45 [−0.15, 1.05]
		Total			52			50	100.0%	0.12 [−0.30, 0.54]
		Overall effect	Z = 0.56 (P = 0.58)							
		Heterogeneity	Chi^2 = 2.24, df = 2 (P = 0.33); I^2 = 11%							
BF (%)	UC	Chen et al. (2010)	28.7	9.27	31	29.0	9.03	24	27.0%	−0.03 [−0.57, 0.50]
		Lee et al. (2012)	33.83	4.31	8	37.45	2.7	8	22.5%	−0.95 [−2.00, 0.10]
		Shukla and Gehlot (2014)	−3.0	1.06	30	−1.03	1.37	30	26.6%	−1.59 [−2.18, −1.00]
		Tracy and Hart (2013)	27.3	6.3	10	21.0	8.4	11	23.9%	0.81 [−0.09, 1.71]
		Total			79			73	100.0%	−0.45 [−1.50, 0.59]
		Overall effect	Z = 0.85 (P = 0.40)							
		Heterogeneity	Chi^2 = 25.09, df = 3 (P < 0.0001); I^2 = 88%							
	EX	Lu and Wang (2007)	29.0	3.05	21	29.03	2.49	21	61.1%	−0.01 [−0.62, 0.59]
		Ray et al. (2001)	9.5	2.0	17	9.5	2.7	11	38.9%	0.00 [−0.76, 0.76]
		Total			38			32	100.0%	−0.01 [−0.48, 0.47]
		Overall effect	Z = 0.03 (P = 0.98)							
		Heterogeneity	Chi^2 = 0.00, df = 1 (P = 0.98); I^2 = 0%							
WC	UC	Cohen et al. (2008a)	−2.7	3.0	12	−2.7	5.0	12	16.1%	0.00 [−0.80, 0.80]
		Hegde et al. (2013)	89.4	9.1	14	90.0	13.7	15	16.6%	−0.05 [−0.78, 0.68]
		Kim et al. (2013)	90.0	5.2	17	90.52	9.1	20	17.3%	−0.07 [−0.71, 0.58]
		Lee et al. (2012)	85.13	1.36	8	86.44	1.95	8	14.2%	−0.74 [−1.76, 0.29]
		Manchanda et al. (2013)	95.12	5.12	34	98.0	7.3	43	18.6%	−0.44 [−0.90, 0.01]
		Shukla and Gehlot (2014)	−3.53	1.5	30	−0.96	0.49	30	17.2%	−2.27 [−2.93, −1.61]
		Total			115			128	100.0%	−0.60 [−1.31, 0.11]
		Overall effect	Z = 1.65 (P = 0.10)							
		Heterogeneity	Chi^2 = 32.30, df = 5 (P < 0.00001); I^2 = 85%							
	EX	Kanaya et al. (2014)	−1.7	4.25	88	−0.8	5.04	83	43.1%	−0.19 [−0.49, 0.11]
		Lu and Wang (2007)	82.05	0.09	21	81.02	3.72	21	22.8%	0.38 [−0.23, 1.00]
		Stachenfeld et al. (1998)	90.7	4.5	9	94.7	4.6	7	10.4%	−0.83 [−1.87, 0.21]
		Telles et al. (2014)	109.83	13.28	22	108.18	14.41	22	23.7%	0.12 [−0.47, 0.71]
		Total			140			133	100.0%	−0.05 [−0.42, 0.32]
		Overall effect	Z = 0.29 (P = 0.77)							
		Heterogeneity	Chi^2 = 5.18, df = 3 (P = 0.16); I^2 = 42%							
	LSM	McDermott et al. (2014)	−4.2	4.71	20	0.7	4.71	18	42.4%	−1.02 [−1.70, −0.34]
		Thiyagarajan et al. (2015)	82.96	6.26	51	85.06	8.0	49	57.6%	−0.29 [−0.69, 0.10]
		Total			71			67	100.0%	−0.60 [−1.30, 0.11]
		Overall effect	Z = 1.67 (P = 0.10)							
		Heterogeneity	Chi^2 = 3.28, df = 1 (P = 0.07); I^2 = 70%							
WHR	UC	Hegde et al. (2013)	0.88	0.04	15	0.93	0.08	14	34.1%	−0.78 [−1.54, −0.02]

Appendix Table 5 (*continued*)

Outcome	Comp.	Study	Yoga Mean	Yoga SD	N	Control Mean	Control SD	N	Weight	SMD [95% CI]
		Shukla and Gehlot (2014)	−0.02	0.01	30	−0.01	0.01	30	65.9%	−1.11 [−1.66, −0.57]
		Total			45			44	100.0%	−1.00 [−1.44, −0.55]
		Overall effect	$Z = 4.41$ ($P < 0.0001$)							
		Heterogeneity	$Chi^2 = 0.49$, $df = 1$ ($P = 0.48$); $I^2 = 0\%$							
	EX	Lu and Wang (2007)	0.69	0.03	21	0.79	0.02	21	32.6%	−3.85 [−4.90, −2.79]
		Stachenfeld et al. (1998)	0.92	0.03	9	0.93	0.04	7	32.9%	−0.27 [−1.27, 0.72]
		Telles et al. (2014)	0.91	0.05	22	0.93	0.08	22	34.5%	−0.29 [−0.89, 0.30]
		Total			52			50	100.0%	−1.45 [−3.56, 0.66]
		Overall effect	$Z = 1.34$ ($P = 0.18$)							
		Heterogeneity	$Chi^2 = 35.44$, $df = 2$ ($P < 0.00001$); $I^2 = 94\%$							



Appendix Fig. 1. Funnel plot for yoga compared to usual care, exercise and lifestyle modification for the outcome weight.

Appendix B. Supplementary data

Supplementary data to this article can be found online at http://dx.doi.org/10.1016/j.ypmed.2016.03.013.

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