Narrative Review of Yoga Intervention Clinical Trials Including Weight-related Outcomes

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ABSTRACT

Context • Medical authorities have identified obesity as a causal factor in the development of diabetes, hypertension, and cardiovascular disease (CVD), and more broadly, of metabolic syndrome/insulin resistance syndrome. To provide solutions that can modify this risk factor, researchers need to identify methods of effective risk reduction and primary prevention of obesity. Research on the effectiveness of yoga as a treatment for obesity is limited, and studies vary in overall quality and methodological rigor.

Objective • This narrative review assessed the quantity and quality of clinical trials of yoga as an intervention for weight loss or as a means of risk reduction or treatment for obesity and diseases in which obesity is a causal factor. This review summarized the studies' research designs and evaluated the efficacy of yoga for weight loss via the current evidence base.

Design • The research team evaluated published studies to determine the appropriateness of research designs, comparability of programs' intervention elements, and standardization of outcome measures. The research team's literature search used the key terms *yoga and obesity* or *yoga and weight loss* in three primary medical-literature databases (PubMed, PsychINFO, and Web of Science). The study excluded clinical trials with no quantitative obesity-related measure. Extracted data included each study's (1) design; (2) setting and population; (3) nature, duration, and frequency of interventions; (4) comparison groups; (5) recruitment strategies; (6) outcome measures; (7) data analysis and presentation; and (8) results and conclusions. The research team developed an overall evaluation parameter to compare disparate trials.

Outcome Measures • The research team reviewed each study to determine its key features, each worth a specified number of points, with a maximum total of 20 points. The features included a study's (1) duration, (2) frequency of yoga practice, (3) intensity of (length of) each practice, (4) number of yogic elements, (5) inclusion of dietary modification, (6) inclusion of a residential component, (7) the number of weight-related outcome measures, and (8) a discussion of the details of the yogic elements.

Results • Overall, therapeutic yoga programs are frequently effective in promoting weight loss and/or improvements in body composition. The effectiveness of yoga for weight loss is related to the following key features: (1) an increased frequency of practice; (2) a longer intervention duration (3) a yogic dietary component; (4) a residential component; (5) the comprehensive inclusion of yogic components; (5) and a home-practice component.

Conclusions • Yoga appears to be an appropriate and potentially successful intervention for weight maintenance, prevention of obesity, and risk reduction for diseases in which obesity plays a significant causal role. (*Altern Ther Health Med.* 2013;19(3):##-##.)

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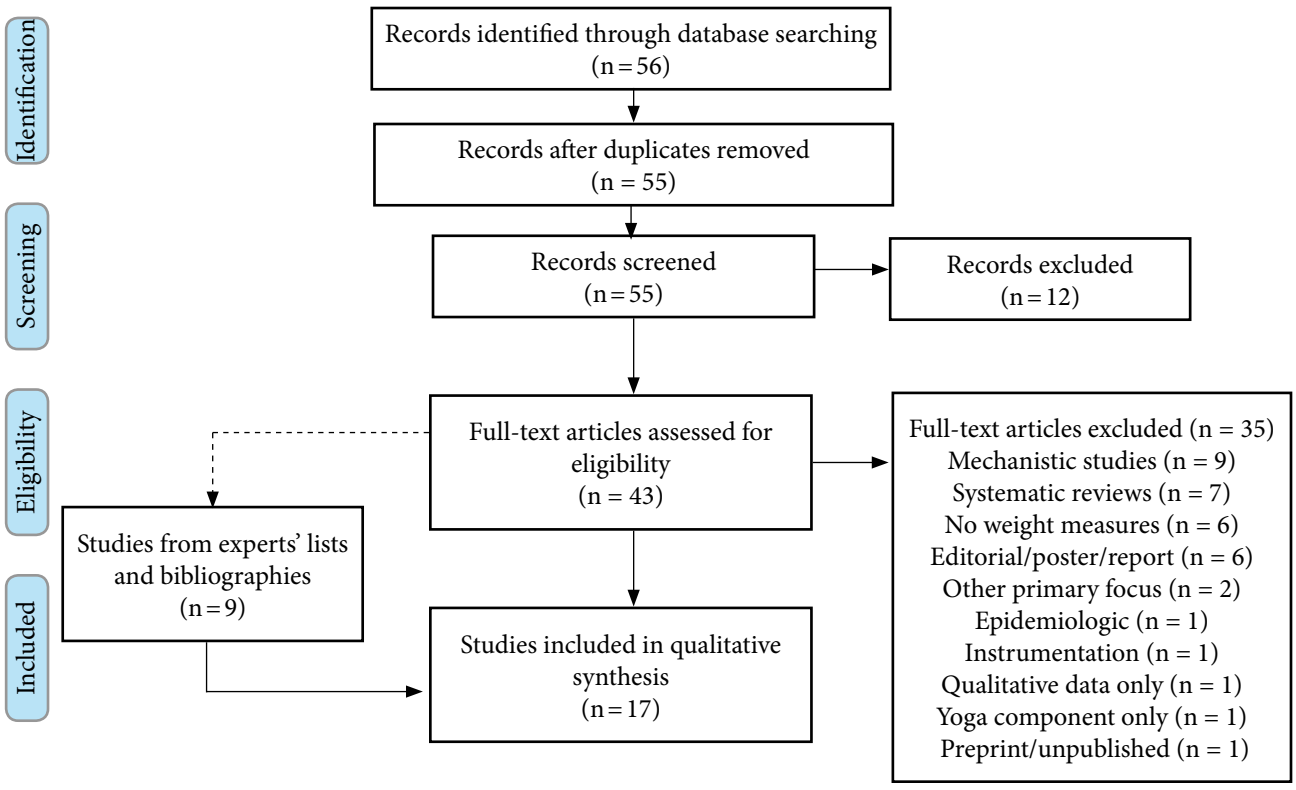
Medical authorities have identified obesity as a causal factor in the development of diabetes, hypertension, and cardiovascular disease (CVD), and more broadly, of metabolic syndrome/insulin resistance syndrome.[1-5] In addition, in recent years, authorities have identified obesity as a significant risk factor for the development of certain cancers.[6] All of these conditions play a role in premature morbidity, often leading to unemployment, lost earnings, lowered quality of life, and mortality.[5] As a chronic condition that interferes with daily function and overall well-being, obesity is also often linked with other psycho-social comorbidities. Obesity is connected to high health care costs

Figure 1. PRISMA 2009 Flow Diagram: Yoga and Weight Loss Narrative Review



and frequent visits to conventional care providers.[7-8] Conventional care paradigms for obesity treatment, however, typically have a limited duration of success.

To provide solutions that can modify this risk factor, researchers need to identify effective methods of risk reduction and primary prevention for obesity. Patients often turn to holistic medical disciplines, looking for alternative weight loss strategies, yet limited data are available on CAM modalities, such as yoga, as a primary or adjunctive treatment for obesity.[6-7] The use of yoga as a treatment for obesity may have significant public health implications, given that obesity has been identified as an epidemic in both adults and children in the US population.[8] As an economical, noninvasive practice, with potentially synergistic effects, yoga may provide an intervention with few adverse events; no identified, negative side effects; multiple coordinated benefits of lifestyle change; and high rates of documented adherence and home practice. Therefore, yoga may be a core primary or adjunctive clinical therapy for obesity and risk-reduction or prevention of associated diseases.[1-5]

Research on the effectiveness of yoga as a treatment for obesity is limited, and studies vary in overall quality and methodological rigor. Sample sizes are often small, and studies may not be randomized, blinded, or controlled. The orientation, intensity, comprehensiveness, and duration of yoga therapy for obesity also vary widely across reported studies, making direct comparisons difficult. Researchers have published enough studies, however, to permit a review of the literature in an effort to summarize the state of research regarding the effectiveness of yoga as a treatment, method of risk reduction, or prevention strategy for obesity. This review attempts to discern some of the primary characteristics of interventions that may promote therapeutic efficacy and beneficial results for participants. It also addresses methodological concerns, potential standardization of primary outcome measures, and an analysis of overall findings that point to a need to further refine research designs to increase the generalizability of future studies. Discussion of these issues permits the comparison of many studies and allows the research team to summarize results across them. It also provides a rationale for the future inclusion of psycho-social measures to enhance the medical community's understanding of the overall benefits of yoga therapy for obesity.

METHODS

Search Strategy

The research team performed a literature search using the search terms *yoga and obesity* or *yoga and weight loss* in the following databases: PubMed, PsycINFO, and Web of Science. The team eliminated duplicates, opinion pieces, and some research bearing an inappropriate focus. The team located additional relevant articles in the related-articles sections of the aforementioned databases and in the reference sections of articles under review as well as through a systematic review of articles on yoga interventions for obesity-associated conditions that included studies reporting weight-related outcome measures (Figure 1). Overall, 43 articles merited further review.

Nine articles were mechanistic in orientation, examining cardiorespiratory and metabolic changes associated with acute yoga practice in healthy populations.[9-17] Often participants in these studies were experienced yoga practitioners who served to represent an ideal of yogic practice rather than yoga as a clinical intervention for an at-risk or diseased population. The research team found it complex to reconcile outcomes of mechanistic studies of yoga with outcomes of studies evaluating the effectiveness of yoga as a method of risk-reduction or an intervention for disease treatment. Seven articles were systematic reviews,[1-5,18-19] and six articles did not include a quantitative, weight-related measure at all or did not include a measure in a form comparable to any other study, making them outside the parameters of this review.[20-25] Six of the remaining citations were not full-length articles but rather conference posters, editorials, or brief reports providing only minimal information.[26-31] Two studies had an alternate focus such as binge eating or anorexia,[32-33] one was an epidemiologic study,[34] one focused on instrument development and validation,[35] one included only qualitative data,[36] and one represented a intervention for obesity using conventional medicine, with a minimal yoga element aimed at stress reduction.[37] Finally, one article with weight-related measures was in prepublication, electronic form, but since the researchers had not finalized the data reporting, the research team also removed this article from the review.[38] After exclusion of 35 articles from the 43 assessed for eligibility, eight articles remained. During the review, the research team found nine more articles to include in the qualitative synthesis; thus, this narrative review includes 17 articles. Many of the studies included in this review had a primary focus on disease biomarkers. Systematic reviews of evidence on the use of yoga for diabetes,[1] cardiac health,[2-3,5] and metabolic syndrome[4-5] have summarized those results, suggesting generally beneficial effects on outcomes associated with those diagnoses. The most common, additional outcome measures were blood pressure, glucose/insulin, lipid parameters, exercise capacity, flexibility, strength, balance, quality of life, program satisfaction, and self-esteem and anxiety measures.

Data Summary

Due to the diverse designs, sizes, and implementations of the studies reviewed in this article, the research team included data tables to summarize comparable features that it could use to evaluate the rigor and quality of a study's elements and contextual features that may have impacted feasibility and outcomes. This review included only randomized, controlled trials and uncontrolled pre-post designs with weight measures.

Study Designs. Table 1 presents data on each study, including (1) sample size; (2) country of origin; (3) recruitment strategy—conventional, opportunistic, self, clinic; (4) number and type of yogic components included; (5) a brief description of the study's population in terms of demographics and health status; and (6) a notation of the type of control used.

Table 1 also includes a more detailed discussion of each intervention's design, noting (1) key features; (2) unique components; (3) lineage or style of yoga, if provided; (4) training of instructors; (5) the frequency and duration of each session; and (6) the overall program for and structure of each session, if provided. The table also notes the presence of a residential component or a dietary component as part of the overall intervention. The research team considered these features of program design and implementation to be the most relevant to a comparative evaluation, and the table indicates the diversity in sample populations, program design, implementation, objectives, and the comprehensiveness and frequency of yogic practice.

Anthropometric Outcome Measures. Table 2 summarizes all anthropometric outcome measures related to weight loss. A considerable variety existed in terms of the conventions that investigators used to report weight loss outcomes. A simple pre-post weight for both intervention and control groups was the most common outcome measure, occurring in 12 of 17 studies.[39-51] Eight studies included an outcome measure for body mass index (BMI).[39,41-42,47-48,51-53] Four studies included an outcome for percent body fat[40,43,47,54]; four included a measure of fat mass,[43,47,54-55] and three included lean mass.[43,47,55] Three studies included outcome measures for waist and hip circumferences,[39,54-55] and two included measures of the waist to hip ratio.[53,55] Only one study directly compared individual weight-change scores between groups,[39] while four studies provided data specifically on pre-post, individual change scores related to weight measures.[40-41,44,54] Most studies provided only simple baseline and postintervention group means for weight-related measures (also for the control group, if one existed). Five studies provided data on the relative percentage of change.[40,43,44,48,55] One study included no information on *P* values for outcome data.[48] Eight outcome measures—weight, BMI, body fat percentage; fat and lean mass; waist circumference, hip circumference, and waist to hip ratio—may comprise a minimum standard for data collection for studies on yogic interventions for weight loss.

Table 2 also indicates the health status of the population under study in terms of any current diagnoses or risk profiles. Seven of 17 studies had healthy population samples,[40,43,47-50,54] while the remaining 10 studies enrolled participants with risk profiles for or diagnoses of obesity,[39,42,55] CVD,[44,46,51] hypertension,[45,52] and diabetes,[42,52-53] sometimes with multiple risk factors or diagnoses. Studies conducted in the United States and India were about equally divided between healthy populations and those with a diagnosed risk or diseases. Indian and Thai studies were more likely, however, to use yogic intervention for disease treatment, doing so in seven of 11 studies, including studies for hypertension, diabetes, CVD, and obesity.[44-46,51-53,55] The only study centered on treatment in the United States examined yoga for obesity.[42] Sixteen of the 17 studies calculated the statistical significance of their results (usually at $P < .05$), with one providing no information on statistical significance.[48] However, research-

Table 1. Study Designs

Authors/ Year	Design	Sample Size	Study Population	Experimental Intervention	Duration	Control
Littman et al, 2011 **Conventional* *UNITED STATES*	Randomized controlled trial **A, P, Me,**	63	• Breast cancer survivors, without prior yoga experience • 21 to 75 y • Majority: white, college educated, married, with income above 60K • Knowledge of yoga moderately low, mean of 2.2 on a 5-point scale	• Facility and home-based viniyoga (physical stretches, poses, breath control, and meditation) • Instructors with 10+ y experience teaching yoga to chronically ill and cancer patients and survivors • Class manual to standardize delivery; DVD for home practice • Sequences designed for intervention • No dietary advice • E-mail, telephone counseling, motivational interviews to encourage class attendance, and home practice	6 mo, 3 d/wk, 75 min/class	Wait-list control (31); stratified randomization by age, cancer stage, and BMI
Thomley et al, 2011 **Opportunistic* *UNITED STATES*	Uncontrolled pre-post study **A, P, Me, SS, Ph**	50	• Self-selected employees • 24 to 76 y • 74% female • No previous training in yoga	• Power vinyasa flow = poses and breathing techniques to build strength, tone muscles, and increase flexibility • Philosophy and benefits of mindfulness, breath, and meditation • Small- and large-group sharing, journal writing, mindful eating, personal reflection, community support • Weekly e-mails, journal questions, nutrition goals, meditation focus, and yoga sequence • Duration of practice increased weekly	6 wk, 6 d/wk, 60-80 min/session, 5:10 AM	None
Yang et al, 2011 **Conventional* *UNITED STATES*	Randomized controlled trial **A, P, R**	23	• 19 white/4 nonwhite; 17.4 % minority • At high risk for type 2 diabetes • 91% female • Mean age = 51.7 y • Mean y of completed education = 18 • Mean BMI = 29.79 • Nonexercisers • Family Hx of type 2 diabetes	• Fitness-based vinyasa yoga program, sun salutations, and poses, combined with breathing • One-h class began with 5-7 min warm up, 10 min relaxation • Classes by certified yoga instructor/PhD nurse • Audio CD for home practice	3 mo, 2 d/wk, 60 min/session	Health-education materials every 2 wk
Telles et al, 2010 **Self-recruited* INDIA	Uncontrolled pre-post **A, P, D, K, R**	47	• Obese • 17-68 y old • 16 males, 31 females • Middle income • No prior yoga experience	• **Residential** yoga program • Emphasis on breathing techniques and yoga postures • **Low-fat, high-fiber vegetarian diet,** no restricted portions	6 d, 5 h/d, 2 - 2.5 h/session	None
Benavides, Caballero, 2009 **Conventional* UNITED STATES	Uncontrolled pre-post **A, P, Me**	20	• Children, ages 8-15 • Mostly Hispanic • At risk for type 2 diabetes • 71% overweight or obese	• Modified ashtanga yoga sequence with pranayama and meditation	3 mo, 3 d/wk, 75 min/class	None
Sivasankaran et al, 2006 **Clinic recruitment* INDIA	Uncontrolled pre-post **A, P, Me, R**	33	• 61% male, 39% female • Mean age 55 • 30% with and 70% without coronary artery disease • No current yoga practice	• Seminar on yoga and heart disease prior to enrollment • Yoga and meditation: each class consisting of 15 min meditation; 15 min breathing techniques; 20 min deep relaxation (shavasana); 40 min asana	6 wk, 3 d/wk, 90 min/class	None

Table 1 (cont). Study Designs

Authors/ Year	Design	Sample Size	Study Population	Experimental Intervention	Duration	Control
McCaffrey et al, 2005 **Clinic Recruitment* THAILAND	Randomized controlled trial **A, P, R, Ph, SS**	61 (7 dropped)	• 35 women, 19 men • Average age: 56 y • Diagnosis of hypertension/ not currently on hypertensive medication	• Pranayama and asana, yogic principles and stress reduction techniques • Group support and health information • Yoga training cassettes and classes led by trained teacher	8 wk, 3 d/wk, 63 min/class	Outpatient care, general hypertension education; no yoga or stress reduction
Tran et al, 2001 **Conventional* UNITED STATES	Uncontrolled pre-post study **A, P, R**	10	• Healthy untrained volunteers • 9 females, 1 male • 18-27 y • No regular physical activity, including yoga, for previous 6 mo • Exclusion: myocardial infarction or unstable angina w/in 6 mo	• Each session: 10 min breath-control, 15 min dynamic warm-up exercises, 50 min of asana, 10 min of supine relaxation	8 wk, 2-4 d/wk, 85 min/class, 7:30-9:00 AM	None
Manchanda et al, 2000 **Clinic recruitment* INDIA	Randomized controlled trial **A, D, P, R, Me, SS, Ph**	42	• Men with angiographically proven coronary artery disease, with chronic stable angina • Mean age: 51.0 y	• 4-d **residential** yoga program • Various yogic lifestyle techniques • Home practice • Control of risk factors, exercises for tone and flexibility, asana, relaxation exercise, meditation, reflection and contemplation • **Dietary modification,** low-fat, low cholesterol, high carbohydrate, high fiber diet • Aerobic exercise and stress management • Every 2 wk visited yoga center for follow-up • Patients and spouses reported compliance	4 d residential program with 1 y of home practice of 90 min/d	(n = 21) Conventional methods-risk factor control and Heart Association's Step-1 diet
Murugesan, 2000 **Conventional* INDIA	Randomized controlled trial **A, P, R, Ma, Me**	33	• Hypertension diagnosis • Aged 35-65 y • Body weight 53 to 81 kgs	• One-h sessions of yoga asana, with meditation and Om mantra	11 wk, 6 d/wk, 2 times/d AM & PM, 60 min/session	1) drug treatment (n = 11); 2) therapeutic advice, no yoga or drugs (n = 11)
Mahajan et al, 1999 **Clinic recruitment* INDIA	Randomized controlled trial **A, P, D, Me, R**	93	• Male subjects • Aged 56-59 y • Two Groups: (1) Angina patients (yoga = 22, c = 18); (2) normal subjects with >/ = 2 risk factors for coronary artery disease (yoga = 30, c = 23)	• **Residential** yoga training, followed by home practice • No drug therapy • No calorie restriction • Home practice requested—30 min asana/30 min meditation • Visits to yoga center every 2 wk for evaluation, compliance, and technique	4 d residential course, followed by home practice 1 h/d for 14 wk, 60 min/d	Control (n = 41) Conventional care, control of risk factors Lifestyle advice - both groups
Raju et al, 1997 **Opportunistic* INDIA	Uncontrolled pre-post study **A, P**	6 (9 started, 3 dropped)	• Healthy adult female volunteers • Mean age = 25.6 y	• **Residential** yoga program, 8 techniques: 4 breath-based, 4 posture-based	4 wk, 2 times/d, 90 min/session	None

Table 1 (cont). Study Designs

Authors/ Year	Design	Sample Size	Study Population	Experimental Intervention	Duration	Control
Schmidt et al, 1997 **Self-recruit* SWEDEN	Randomized controlled trial (residential) **A, P, Me, D, SS, Pr, K**	106	• Healthy • 58 men, 48 women • Aged 18 to 64 y (mean = 29.6 y) • Self-selected • 50% vegetarians • 1/3 smokers	• **Residential** yoga and meditation program • **Low fat, lacto-vegetarian diet** • Service work • No outside social contact • No alcohol, coffee, black tea, or sweets Month 1: Traditional yoga, breathing, relaxation, meditation Month 2: 33 d of silence, kriya yoga, tantric meditation, physical and mental techniques, 4 h/d Month 3: kriya yoga, physical techniques, meditations	3 mo, 4+ h/d, multiple cohorts, January to April, from 1987 to 1991	Control = people living normal lives in Hanover matched for age, gender and initial risk factors
Jain, Talukdar, 1995 **Clinic recruitment* INDIA	Uncontrolled pre-post study **A, Me, K, P, D**	30	• Male • Hospitalized • Noninsulin dependent, outpatient diabetics	• **Residential** program • Visceral cleansing procedures (shat kriya), postures, breathwork, meditation • **Isocaloric vegetarian diet**	40 d, 2 times/d, 60 min/session	None
Bera, Rajapurkar, 1993 **Opportunistic* INDIA	Randomized controlled trial **A, P, K, B, Mu**	40	• Male students • 12-15 y • No cardiovascular respiratory disorders or exposure to yoga	• Yoga postures, breathwork (pranayama), energy locks (bandhas), hand gestures (mudras), sodhana kriyas (cleansing techniques)	1 y, 3 times/wk, 45 min/d, 5:00-5:45 PM	Sedentary control with same diet as yoga group
Telles et al, 1993 **Opportunistic* INDIA	Uncontrolled pre-post study **A, P, Me, Ph, SS, K, MA**	40	• Male physical education teachers • 25 to 48 y • Actively engaged in diverse physical activity for 9 y	• **Residential** yoga training camp. Asana, pranayama, meditation, devotional sessions, theory/philosophy of yoga • Yogic approach to eyesight, voice culture, physical stamina and creativity, emotional culture, IQ, spiritual and personal development • Cleansing practices 2 times/wk • Ocular exercises: 20 min/d • Silent Om chant 15 min/d • Alternating stimulation/relaxation meditation, 60 min/d • Two 60-min lectures/d • 90 min asana, 60 min breath work	3 mo, 4-5 h/d	None
Satyanarayana, 1992 **Opportunistic* INDIA	Uncontrolledpre-post study **P, R, K, D**	8 (20 started, 12 dropped)	• Healthy male volunteers • Mean age = 25.9 y • Mean weight = 57.2 kg	• *Santi kriya* practice 50 min/d. *Santi kriya* is said to merge the individual self with the universal self. *Santi kriya* combines yogic breathing, relaxation, and awareness/concentration practices in standing and *shavasana* postures • **Light vegetarian diet** advised	30 d, 7 d/wk, 50 min/d	None

Program Elements Key: A = *asanas* (postures), P = *pranayama* (breathwork), D = diet, R = relaxation, Me = meditation, Ph = philosophy, Ma = *mantra* (chanting), K = *kriya* (cleansing practices), SS = social support, Pr = *pratyahara* (sensory withdrawal), B= *bandha* (energy locks), mu = *mudras* (hand gestures)

Recruitment Strategies:

- Conventional: Community outreach for intervention and research study
- Self-recruit: Paid a fee to participate in intervention; outcome data collected as part of program
- Clinic recruitment: Recruited from ongoing out-patient clinical population
- Opportunistic: Volunteers from ongoing, on-site programs (schools, training programs)

Table 2. Anthropometric Outcome Measures

Study	Parameter	Baseline for Intervention Mean (SD)	Postintervention Mean (SD)	Baseline, Control Mean (SD)	Postintervention Control Mean (SD)	Pre-post Difference	Relative Change %	*P* value
Littman et al, 2011 **DT-Ob RR-Ow** (6 mo) UNITED STATES	Weight (kg): BMI (kg/m^2) : Waist Circum. (cm): Hip Circum. (cm) :	80.4 (12.0) 29.3 (3.7) 94.4 (7.2) 113.0 (9.1)	81.1 (13.6) 29.5 (4.1) 93.1 (8.5) 113.0 (10.1)	81.3 (13.6) 29.5 (4.3) 91.1 (8.9) 112.7 (8.4)	81.3 (14.3) 29.5 (4.7) 92.7 (10.5) 113.9 (10.3)	6-mo Δ btwn grps +0.8 (-0.9, +2.5) +0.2 (-0.4, +0.8) -3.1 (-5.7, -0.4) -1.2 (-3.4, +1.0)		.34 .41 .12 .27
Thomley et al, 2011 **H** (6 wk) UNITED STATES	Weight (lbs): Body Fat%:	165.68 (39.42) 31.24 (9.14)	160.85 (37.22) 29.29 (8.94)			-4.84 (5.24) -1.94 (2.68)	-2.76 (2.70) -6.15 (9.97)	<.001 <.001
Yang et al, 2011 **RR-D** (3 mo) UNITED STATES	Weight (lbs):	175.5 (30.0)	174.7 (29.8)	188.4 (28.8)	189.4 (29.4)	-0.79 (I) +1.02 (C)		.166
Telles, et al, 2010 **DT-Ob** (6 d residential) INDIA	BMI: Fat Mass (kg): Lean Mass (kg): Water (L): Waist Circumference (cm): Hip Circumference (cm): Waist/Hip Ratio:	35.97 (5.72) 37.22 (9.21) 59.76 (13.45) 43.74 (9.84) 44.16 (5.07) 48.67 (5.28) 0.91 (0.09)	35.40 (6.09) 37.84 (9.94) 57.11 (13.55) 41.81 (9.91) 42.44 (6.31) 46.98 (5.42) 0.91 (0.10)				BMI: 1.6%	<.01 NS <.001 <.001 <.01 <.01 NS
Benavides, Caballero, 2009 **RR-Ow/ RR-D** (12 wk) UNITED STATES	Weight (kg): BMI (kg/m^2):	61.2 (20.2) 26.4 (6.6)	59.2 (19.2) 25.6 (6.2)					.01 .01
Sivasankaran et al, 2006 **DT-CVD/RR-CVD** (6 wk) INDIA	BMI:	29 (5)	28 (5)					<.01
McCaffrey et al, 2005 **DT-Hy** (8 wk) THAILAND	BMI:	25.74 (2.87)	25.50 (2.71)	25.32 (3.19)	25.37 (3.31)			<.05
Tran et al, 2001 **H** (8 wk) UNITED STATES	Weight (kg): Body Fat (%): Fat Mass (kg) : Fat-free Mass (kg):	62.5 ± 2.0 28.5 ± 2.3 18.0 ± 1.8 44.6 ± 1.7	62.8 ± 1.9 28.3 ± 2.3 18.0 ± 1.8 44.7 ± 1.5				1 ± 1 0 ± 2 0 ± 2 1 ± 1	NS NS NS NS
Manchanda et al, 2000 **DT-CVD** (4 d residential, 1 y home practice) INDIA	Weight (kg):	72 (12)	66 (8)	73 (10)	72 (9.7)	Yoga: -5.6 (7.2) Control: -0.4 (3.4)	Yoga: -6.8 (8.2) Control: 0 (5)	.0019 .005 yoga change vs control change *P* = .005

Study	Parameter	Baseline for Intervention Mean (SD)	Postintervention Mean (SD)	Baseline, Control Mean (SD)	Postintervention Control Mean (SD)	Pre-post Difference	Relative Change %	*P* value
Murugesan et al, 2000 **DT-Hy** (3 arms) (11 wk) INDIA	Weight (kg):	54.75 (10.23)	47.32 (09.50)	057.58 (12.20) (drug therapy) 047.49 (10.56) (no treatment)	053.29 (10.26) (drug therapy) 049.25 (11.25) (no treatment)			<.01 <.01 NS
Mahajan et al, 1999 **DT-CVD/RR-CVD** (4 d residential/14 wk home practice) INDIA	Weight (kg):	**CRF:** 74.26 (11.61) **Angina:** 68.51 (7.56)	70.48 (10.48) 65.52 (7.06)	74.94 (12.53) 67.15 (10.39)	74.29 (12.04) 66.68 (10.07)	* Weight measures also taken at 4 and 10 wk, showing gradual reduction		<.05 <.05
Raju et al, 1997 **H** (4 wk residential) INDIA	Weight (kg): BMI (kg/m^2): Lean Mass (kg): Body Fat (%): Fat Mass (kg):	53.0 (5.97) 21.3 (1.53) 45.95 (2.35) 15.38 (2.35) 7.04 (1.04)	53.0 (4.41) 21.1 (1.60) 46.34 (3.60) 12.57 (3.76) 6.66 (1.68)					NS NS <.05 <.05 <.05
Schmidt et al, 1997 **H** (3 mo residential) SWEDEN	Weight (kg): BMI (kg/m^2): Caloric Intake (n = 17)	 2264	-5.71 average -1.88 average 1841			-423	BMI 25+ (n = 12) lost 2x weight, -12 kg vs -4.9 kg; BMI: -3.94 vs -1.61.	?
Jain, Talukdar, 1995 **DT-D** (40 d residential) INDIA	BMI (kg/m^2): Waist/Hip Ratio:	22.5 (2.14) 0.870 (.056)	21.9 (2.40) 0.853 (.059)					NS <.01
Bera, Rajapurkar, 1993 **H** (1 y residential) INDIA	Body Fat %: Body density (gm/cc): Fat Mass (kg): Ideal Body Weight (kg): Waist Circumference (cm): Umbilical Circumference: Hip Circumference (cm): Thigh Fat-Fold (mm): Tricep Fat Fold (mm): Suprailiac Fat Fold (mm): Umbilical Fat Fold (mm): Subscapular Fat Fold (mm): Calf Fat Fold (mm):		Change, yoga: 03.7103 1.0938 1.5986 44.8090 60.29 65.24 80.45 12.36 7.32 8.39 7.05 6.14 10.50		Change, control: 10.0522 1.0757 4.0175 40.2823 63.20 71.92 86.21 22.50 12.56 13.24 11.23 9.50 13.21	Difference in changes -6.3419 .0182 -2.4189 4.5267 -2.91 -6.68 -5.75 -10.14 -5.24 -4.85 -4.18 -3.36 -2.71		<.01 <.01 <.01 <.01 <.01 <.01 <.01 <.01 <.01 <.01 <.01 <.01 <.01
Telles et al, 1993 **H** (3 mo residential) INDIA	Weight (kg):	59.50 (1.24)	58.60 (1.05)					<.05
Satyanarayana, 1992 **H** (30 d) INDIA	Weight (kg):	57.2 (5.6)	52.0 (5.6)			Weight also taken on days 10 and 20; shows gradual reduction		.001

Type of study population:

- **DT**: Disease treatment (Ob-obesity, Hy-hypertension, D-diabetes, CVD-cardiovascular disease)
- **RR**: Risk reduction (Ow-overweight, D-diabetes, CVD-cardiovascular disease)
- **H**: Healthy

CRF: Cardiac Risk Factor

? = Information not provided in article

NS = not statistically significant

Table 3. Evaluation of Studies' Quality

Study	Duration/Sample (n)	Frequency	Total Intensity Practice = Asan* +	# of Elements	Diet Component	Outcome Measures	Yogic Element Details	Result
Littman (DT-Ob/ RR-Ow) US	6 mo (63) +2	3d/wk +1	75 min +1	3 +1	N 0	+3	+1	**(9/20)
Thomley (H) US	6 wk (50) 0	6d/wk +2	60-80 min +1	5 +1	N 0	+2	0	*(6/20)
Yang (RR-D) US	3 mo (23) +1	2d/wk 0	60 min +1	3 +1	N 0	+1	0	*(4/20)
Telles (DT-Ob) India	6 d residential (47) +1	Daily +2	2 x/d, 2.5 h +3	5 +1	Y +1	+3	+1	**(12/20)
Benavidez, Caballero (RR-Ow/RR-D) US	12 wk (20) +1	3d/wk +1	75 min +1	3 +1	N 0	+2	0	*(6/20)
Sivasankaran (DT-CVD/RR-CVD) India	6 wk (33) 0	3d/wk +1	90 min +2	4 +1	N 0	+1	+2	**(7/20)
McCaffrey (DT-Hy) Thailand	8 wk (61) 0	3d/wk +1	60 min +1	4 +1	N 0	+1	+1	*(5/20)
Tran (H) US	8 wk (10) 0	2-4d/wk +1	85 min +1	3 +1	N 0	+3	+3	**(9/20)
Manchanda (DT-CVD) India	4 d residential/ 1 y home practice (42) +3	HP = unknown 0	Residential = ? HP = 90 min +2	8 +2	Y +1	+1	+2	**(11/20)
Murugesan (DT-Hy) India	11 wk (33) 0	6d/wk +2	2 x/day, 60 min +3	5 +1	N 0	+1	+1	**(8/20)
Mahajan (DT-CVD/RR-CVD) India	4 d residential/14 wk home practice (93) +2	Residential = daily HP = 7d/wk +2	Residential = ? HP = 1 h +1	5 +1	Y = residential HP = N +1	+1	+2	**(10/20)
Raju (H) India	4 wk residential (6) +1	7d/wk +2	2 x/day, 90 min +3	2 0	N 0	+4	+2	**(12/20)
Schmidt (H) Sweden	3 mo residential (106) +2	7d/wk +2	4 hrs/d, >1 session +3	7 +2	Y +1	+2	+0	**(12/20)
Jain (DT-D) India	40 d residential (30) +1	7d/wk +2	2x/d, 60 min +2	5 +1	Y +1	+2	+3	**(12/20)
Bera (H) India	1 y residential (40) +3	3d/wk +1	45-min session 0	5 +1	N 0	+3	+0	**(8/20)
Telles (H) India	3 mo (40) +1	7d/wk +2	4-5 h, >1 session +3	3 +1	N 0	+1	+2	**(10/20)
Satyanarayana (H) India	30 d (8) 0	7d/wk +2	50-min session 0	3 +1	Y +1	+1	+2	**(7/20)

*(1-4 points, 1-6) = Significant issues in study design, intervention, or outcome measures
**(5-8 points, 7-12) = Adequate study design, intervention elements, and/or outcome measures
**(9-12 points, 13-20) = Significant strengths in study design, intervention elements, and/or outcome measures
Population Type:

- **DT**: Disease Treatment (Ob-obesity, Hy-hypertension, D-diabetes, CVD-cardiovascular disease)
- **RR**: Risk Reduction (Ow-overweight, D-diabetes, CVD-cardiovascular disease)
- **H**: Healthy

Study Evaluation Key	Duration/ Residential	Frequency	Intensity (per session)	Comprehensiveness # of Elements, of 12	Dietary Component	Outcome Measures Included	Yogic Elements
Points Given (20-point scale)	>3 mo = 0 3-6 mo = +1 >6 mo = +2 Residential = +1	<3d/wk = 0 3-5d/wk = +1 6-7d/wk = +2	<60 min = 0 60-89 min = +1 >/ = 90 min = +2 2 sessions/d = +1	<3 elements = 0 3-5 elements = +1 6-8 elements = +2 9-12 elements = +3	No = 0 Yes = +1	Weight = +1 BMI = +1 Body fat % = +1 Fat mass/lean mass = +1 Hip/waist circ OR ratio = +1	None = 0 Asana OR pranayama = +1 Asana AND pranayama = +2 A, P, and other elements = +3

ers usually performed these analyses to assess the significance of longitudinal changes *within* groups rather than comparing change scores *between* groups, which would have been called for by their designs.

Evaluation of Study Quality. Table 3 is a rubric developed to evaluate a study's quality in the face of the great disparity in terms of the depth of information provided for each study, its design, and its key features. Its summarized details include (1) country of origin; (2) condition or risk being treated, if any; (3) sample size; (4) duration of intervention; (5) frequency of the intervention; (6) the intensity of each practice session; (7) the comprehensiveness of the included yogic elements; and (8) the presence of a dietary component.

The research team reviewed each study to determine its key features. After reviewing the data, the team identified key features of each study's design that enhanced either the effectiveness of the intervention or the impact of the research outcomes. The team attributed points on a scale to these key features, each worth a specified number of points, for a maximum total of 20 points. The features included a study's (1) duration, (2) frequency of yogic practice, (3) number of yogic elements, (4) intensity of (length of) each practice, (5) inclusion of a dietary component, (6) inclusion of a residential component, (7) the number of weight-related outcome measures, and (8) a discussion of the details of the yogic elements.

Interventions lasting 3 to 6 months received 1 point because they were appropriate for establishing lifestyle change, and studies of 6 months or more received 2 points because they established some measure of sustainability of change. The research team gave 1 point to interventions with a practice frequency of three to five times per week because they were adequate for achieving a threshold of change in daily routine and body habits, while it considered interventions with practice six or more times per week to have established a daily habit of yoga practice, giving them 2 points. Interventions with practice sessions of 60 to 89 minutes, which allowed time for at least 60 minutes of asana, 5 to 10 minutes of meditation, and 10 minutes of deep relaxation, appeared to be adequate for enhancing aerobic capacity, strength, flexibility, and cardiovascular endurance, and they received 1 point. The research team considered practice sessions of 90 minutes or more per day to further enhance these effects, because they seemed to contribute to greater weight loss and changes in body composition, and therefore, they received 2 points. The research team considered incorporation of three to five yogic elements to be the minimum for an effective program (1 point), with positive outcomes seeming to increase at the threshold of five to eight elements (2 points) and comprehensive modifications in lifestyle at 9-12 yogic elements, a threshold that no study achieved. Only one yogic intervention conducted in the United States had five or more elements,[40] as did one in Sweden[48] and six in India.[40,44-46,53-54] Interventions with dietary or residential components indicated more beneficial results in terms of weight loss (1 point each). [44,46-50,53,55] Studies incorporating more comprehensive weight-related measures were more comparable and provided more thorough measures of change (1 point per measure).[39,43,47,54-55]

The research team evaluated each study based on a point and star system. Researchers represented the number of points attributed to each study as one, two, or three stars, with 1 to 6 points equal to one star, [40-42,52] 7 to 12 points equal to two stars, [39,43-51,53-55] and 13+ points equal to three stars. One star indicated a study in which the research team identified significant issues in the study's design, intervention, or outcome measures. One star also might indicate that the reporting of results obscured the outcomes of the intervention or that the study's reporting provided insufficient information on key features of the study's design or intervention. Two stars indicated that the study's design, intervention elements, and outcome measures appeared to be adequate overall. These studies may have included design issues, such as the absence of a control group or a small sample size, or the researchers may have indicated preliminary issues with the intervention's design that may have affected its outcomes but were not deemed critical. Three stars would indicate significant strengths in the study's design, intervention elements, and/or outcome measures. No studies reviewed in this article met the criteria to amass three stars, but this finding is consistent with the state of the field of yoga research, which is a developing discipline without standardized study designs, interventions, or agreed-upon outcome measures. However, several studies came close to the 13-point threshold, receiving 12 points overall and the most positive evaluation.[47-48,53,55]

The following traits characterize studies with higher scores: (1) a trend toward a larger effect size; (2) an intervention with more numerous yogic components; (3) innovative research-design elements; (4) a discussion of yogic technique or potential mechanistic explanations for outcomes; and (5) the inclusion of unique features that enhance a study's impact or the potential effectiveness of the intervention. Four studies in India[44,47,53,55] and one in Sweden[48] at a yoga treatment center were the most highly rated studies in this review. It is understandable that Indian researchers would provide more clinically relevant details about a study's interventions, designs, and outcomes, given that they are able to contextualize yogic practice via the scientific precepts of traditional Indian medical systems, like ayurveda. Conversely, in the United States, where researchers still primarily view yoga as an exercise modality, research has yet to explicitly include traditional scientific principles of yoga or ayurvedic medicine to enhance appropriateness and causal modeling when designing studies, interventions, or outcome measures for clinical trials of yoga for weight loss.

This remainder of this article discusses the implications of Table 3 for evaluating yogic weight-loss interventions or for designing future studies in more detail below.

KEY CHARACTERISTICS OF REVIEWED STUDIES

Study Designs, Control Groups, and Settings

Studies conducted in the United States were more likely to use conventional, community-wide recruitment strategies, while those in India were more likely to recruit opportunistically through current clinical populations or through schools or training programs. Studies conducted in the United States and Sweden had sample sizes between 10 and 106 people, while those conducted in India and Thailand were similar, with sample sizes ranging between nine and 93.

Researchers conducted two randomized, controlled trials (RCTs) in the United States: one with wait-list control[39] and one with a health-education control.[41] In a wait-list controlled study, researchers assign a comparable number of participants to a waiting list, and its members receive the intervention after the study's completion. A wait-list control group serves the purpose of providing an untreated comparison group for the active treatment group while at the same time allowing the wait-listed participants the opportunity to obtain the intervention at a later date. In a health-education control study, a number of participants comparable to those receiving the intervention are assigned to one or more educational sessions providing information about prevention, risk-reduction, or self-care of the condition being studied, often in conjunction with usual care. The goal is to match the time and attention of the intervention group. Researchers in Sweden conducted one additional RCT using untreated community members as the control group and matching them to the intervention group for demographics and risk-factor profiles.[48] Researchers conducted three additional pre-post, uncontrolled trials in the United States.[40, 42-43] Studies in India and Thailand included five RCTs, with the controls as follows: (1) a group receiving conventional care comprising risk-factor control and advice on preventive diet,[44,46,52] (2) a group receiving drug therapy and health advice,[45] and (3) a sedentary population on the same diet.[54] Researchers in India also conducted six pre-post, uncontrolled trials.[47,49-51,53,55]

Interventions' Settings, Durations, and Frequencies

The research team identified and coded 12 possible elements of a yogic intervention, and Table 1 presents a key for these codes. The authors have labeled yogic elements for research purposes, with the label representing a general category that indicates the predominant feature of the practice. It may be useful in the future to standardize labeling conventions for components of yogic interventions to encourage comparability of reporting across diverse settings. Programs implemented and designed in the United States or Sweden contained a mean of four yogic elements with a median of 3, while programs designed and implemented in India or Thailand contained a mean of 4.9 elements with a median of 5.

Five out of 11 studies conducted in India or Thailand were residential or included a residential phase of the intervention,[44,49,51,53,55] and five studies conducted in India or Sweden included dietary modification.[44,48,50,53,55] One study in Sweden was residential and included a dietary component,[51] and no studies conducted in the United States included either a residential or a dietary component in the intervention's design.

Studies conducted in the United States lasted a range of 6 weeks to 6 months, with practice sessions two[41] to six[40] times per week, but most commonly, three times per week.[39,42-43] In the Swedish study, yoga was practiced daily.[48] The duration of the yoga interventions conducted in India was anywhere from 6 days to 1 year. In six of the studies conducted in India, participants practiced yoga daily[44,46,47,49-50,53]; in two others, participants practiced six times per week[45,55]; and in an additional two, plus the Thai study, participants practiced yoga three times per a week.[51-52,54] The greater frequency of yoga practice in the Indian studies reflects the understanding of yogic practice as a lifestyle change rather than an exercise routine or an adjunctive therapy.

All studies conducted in the United States had yogic practice sessions ranging from 60 to 85 minutes,[39-43] while the Swedish yogic interventions incorporated 4 hours of yoga practice a day as part of a residential program.[48] Four of 11 studies conducted in India or Thailand employed yogic sessions between 45 to 60 minutes,[46,50,52,54], while two of the remaining studies had 90-minute sessions of yogic practice,[44,51] and five of the yogic interventions implemented in India had more than one practice session per day of between 1 to 2.5 hours.[45,47,49,53,55]

Indian study designs indicate attention to the role of greater frequency and duration of yoga practice and the importance of social support as key features in establishing new routines and sustaining lifestyle changes. Review of the studies indicates that a residential component in a yogic intervention with a weight loss focus may have significant impact on the results achieved, even if its duration is brief. Two programs that included only a 4-day residential component, followed by 14 weeks to 1 year of home practice, achieved beneficial results in terms of adherence to lifestyle changes inculcated in the residential phase of the intervention.[44,46] In contrast, interventions using facility-based classes occurring two times per week or fewer, with a home practice component, did not appear to instill a proportionally similar commitment to lifestyle change or to result in high rates of class attendance or adherence to home practice.[41,43]

Characterization and Comprehensiveness of Yoga Interventions

The 12 possible yogic components that an intervention's design could have incorporated were (1) postures (*asana*), (2) breathing techniques (*pranayama*), (3) diet, (4) meditation (*dhyana*), (5) relaxation (*shavasana*), (6) chanting (*mantra*), (7) cleansing practices (*kriya*), (8) sensory withdrawal (*pratyahara*), (9) hand gestures (*mudras)*, (10) energy locks (*bandha*), (11) social support (*sangha*), and (12) yogic philosophy. For the evaluated studies, all 17 interventions included breathing techniques, and all but one included pos-

tures[50] as part of the intervention (Table 1). Ten of the 17 interventions included meditation practice[39-40,42,44-46,48-49,51,53] and nine included relaxation.[41,43,44-46,50-52,55] Five of the 17 interventions included a yogic dietary component[44,48,50,53,55]; six interventions included cleansing practices[48-50,53-55]; and five studies included a social-support component.[40,44,48-49,52]

Four studies conducted in the United States and one conducted in India identified the type of yogic practice by style or lineage for each intervention. Table 1 shows these identifications, when they were available.[39-42,50] The types of yogic practice included both traditional and modern versions with different foci, such as *ashtanga* (power yoga), *viniyoga* (adapted to the individual), *vinyasa yoga* (breath-synchronized movement), or *santi kriya* (merging the individual self with the universal), but more often than not, the studies did not label the yogic approach. The majority of studies (12: 10 from India, one from the United States, and one from Sweden) did not identify the style of yogic practice,[43-49,51-55] but this lack is not necessarily a deficit. Often the studies that did not note a style of yoga instead provided more information on the particular combination of postures, breathing techniques, meditation, relaxation, or identifiable dietary practices used to achieve a therapeutic effect. For clinical purposes, this information is more valuable than a simple labeling of a yogic style that does not necessarily specify the particular therapeutic methods used. In addition, detailed information regarding asana, pranayama, and other yogic elements can provide a greater context for discussion of causal mechanisms related to beneficial outcomes.

Although all studies provided a brief description of the yogic intervention in descriptive terms, 12 studies provided additional details on the particular postures, breathing techniques, methods of meditation, and relaxation approaches that the interventions used.[39,43-47,49-53,55] In general, studies conducted in India were more likely to include detailed discussions of incorporated components and techniques, as well as discussions of potential mechanistic explanations for the impact of the yoga intervention on the study's population. Both of these features could be key elements for improving the quality and comparability of studies being conducted in the United States.

Only one recent US-based study included information on whether, or how, the researchers standardized the delivery of the yoga intervention. This study used a manualized protocol developed specifically for the intervention to train yoga instructors.[39] Two recent studies discussed the training and credentials of the yoga instructors.[39,41] These design conventions in US-based studies invite replication by subsequent investigators to provide additional depth to study design and implementation. Indications exist that these factors influence the successful delivery of the intervention, and such information is useful for enhancing the design of future studies. Researchers could address many of these issues by including a yoga expert on the panel of authors to address the relevance and significance of an intervention's features in terms of the therapeutic delivery of yoga as a healing modality.

Outcome Measures

While this review focuses on anthropometric outcome measures, many of the studies had additional biologic measures related to the associated comorbidities. Four out of five studies conducted in the United States measured the psychosocial impact of the yogic intervention,[39-42] which enhanced their capacity to discuss the overall benefits or positive side effects of yogic lifestyle interventions beyond the clinical measures. Psychosocial measures focused on (1) quality of life[39-40];(2) physical, social, and spiritual well-being[40]; (3) self-efficacy and program satisfaction[41]; and (4) self-esteem, anxiety, and depression inventories.[42] One study conducted in Thailand implemented a stress-assessment questionnaire.[52] It may be useful for Indian researchers to consider routinely including psychosocial measures on the impact of yogic interventions, particularly for studies that include a residential or social-support component as part of the intervention. This practice would also contribute to enhancing the international standardization of yogic research in populations where obesity plays a role as a causal factor in current or future disease. A few studies included feasibility measures (attendance/adherence) or measures of the program's implementation (time to recruit or preintervention knowledge of yoga) that could provide useful information to ensure accessibility of yogic interventions for diverse populations.[39-42] Researchers could use this same data to create incentives or social-support structures for sustaining the lifestyle changes catalyzed by yogic interventions.

DISCUSSION

Results for Anthropometric Measures

Experts on therapeutic yoga have clearly defined yogic interventions as having a focus on lifestyle modification rather than a narrower behavioral-change approach as may be the case with other exercise-based interventions. It is important to acknowledge that a focus on anthropometric outcomes for the reviewed studies provides a narrow definition of efficacy, particularly since some of the studies focused on other clinical endpoints or scenarios for disease treatment. Anthropometric outcomes are a useful starting point, however, for a discussion of yogic interventions for weight loss. Table 2 shows all of the reported anthropometric outcome measures, and this article discusses them above. One study with a dietary component provided an analysis of the caloric and nutrient composition of the yogic diet.[48] With regard to body composition, of the 17 studies, three reported no significant change, one provided no measures of significance, and 13 reported significant improvements in one or more of its aspects. Of the 13 reporting significant changes, the results showed beneficial changes in body composition even when weight or BMI changes were minimal.

To achieve beneficial results, it is apparent that yogic practice must be sustained and consistent, much like any change related to diet, exercise, or other behavioral or cognitive therapy. None of the studies reviewed in this article collected follow-up data from participants to determine if they

had maintained the yogic lifestyle changes that the intervention established. Thus, it is difficult to determine the sustainability or durability of the effect of yogic lifestyle changes on obesity or related diseases and risk profiles. It would be useful to collect follow-up data in future studies.

Commentary on Variations in Interventions

The variety of conditions being addressed may account somewhat for the varied duration, intensity, and frequency of yogic practice in each intervention. It is a convention of mainstream biomedical research to provide a rationale for a treatment program and its intended mechanism of efficacy, and yoga research would do well to follow this model. Studies should clearly connect such rationales with the characteristics of the sample population and the stated goal of prevention, risk reduction, or disease treatment. None of the studies that this article reviewed provided any rationales as to why the researchers chose a certain style of yoga or a particular practice schedule to address the specific condition(s) that the sample population exhibited. Five of the reviewed studies—three Indian, one Swedish, and one US-based—included potential mechanistic explanations for the therapeutic benefits of yoga in terms of the health profiles of the sample populations.[41,48,50-51,53] These discussions are extremely useful in comparing studies and determining the appropriateness of the research design and outcome measures for specific interventions. The issue of dosage in yoga interventions for health conditions is relevant, as yoga is traditionally a tailored rather than standardized healing modality, as is consistent with therapeutic frameworks in traditional Indian systems of medicine, such as ayurveda. Ayurvedic practitioners tailor yoga therapy programs to address degrees of severity and chronicity and accompanying risk factors as well as comorbid conditions and the overall health of participants. The studies reviewed in this article provide little discussion of yoga tailoring or design of interventions according to these considerations. When studies do provide mechanistic explanations, they permit reviewers to evaluate yoga therapy according to its own scientific precepts, thereby providing model validity and relevant principles for objective analysis.

Evaluation of Yogic Interventions and Quality of Results Related to Weight Loss

Due to limited funding for yoga research, small sample sizes and short durations of interventions are the norm, particularly in the United States where mainstream clinical environments have not integrated yoga as they have in India. Limited resources may have informed some studies' designs or intervention programs. Nevertheless, this review aims to discuss strong design features of yogic interventions for weight loss. Table 3 summarizes the findings of this narrative review in terms of the most significant design features of yogic interventions for weight loss: (1) the duration of the program; (2) the frequency of practice; (3) intensity of practice (length of each session); (4) the comprehensiveness of the yogic elements included (on a 12-point scale, based on elements described above); (5) the inclusion of a yogic dietary component; (6) the number of weight-related outcome measures; and (7) specific detailed information on yogic techniques included in the intervention. The research team reviewed all studies in detail and evaluated each in terms of research design, the key features of the yogic intervention and the chosen outcome measures. These items were then contextualized by characteristics of the sample population and the therapeutic intent in terms of prevention, risk reduction, or disease treatment.

Relevance for Future Research

It appears from the reviewed studies that the minimum requirements for an effective yogic intervention with a weight-loss focus may be the following: (1) intervention sessions of approximately 75 to 90 minutes in length, incorporating 60 minutes of sustained asana practice, 5 to 15 minutes of breathing techniques (*pranayama*) and 10 minutes of deep relaxation (*shavasana*); (2) a minimum frequency of yoga practice of three times per week; and (3) an intervention duration of not less than 3 months. Duration of interventions would vary according to whether the focus is on prevention, risk reduction, or disease treatment, with the severity and chronicity of conditions increasing the length of the intervention. According to the data reviewed, a brief, initial, residential component (2 to 4 days) would likely enhance effectiveness by providing a structure for the establishment and maintenance of a home yoga practice as the foundation of sustained lifestyle change. Evidence gleaned from these studies suggests that incorporation of a residential phase of the intervention, even if only for a weekend, would increase the likelihood of achieving desired outcomes. This enhancement may be due to the synergistic effect of participants experiencing the combination of all yogic components simultaneously and of being removed from their typical daily habits.

Researchers need to undertake further studies of yoga for weight loss and prevention of obesity-related conditions. Researchers must identify a set of primary, standardized, anthropometric outcome measures to increase comparability across studies and the generalizability of a study's findings across populations and settings. The eight weight-related outcome measures that this review submits for consideration are as follows: (1) weight, (2) BMI, (3) body fat percentage, (4) fat mass, (5) lean mass, (6) waist circumference, (7) hip circumference, and (8) waist to hip ratio. The reviewed studies suggest that an asana practice of 60 minutes or more—combined with breathing techniques and relaxation—three times or more per week for 3 months contributes to weight loss.[40-42,44-46,48,50] Studies show a decrease in BMI,[42,47-48,51-53,55] fat mass,[47,54] body fat percentage,[40,47,54] and waist and/or hip circumference or ratio.[39,53-55] Studies also indicate an increase in lean mass[47,54] and improvements in strength,[43,49,55] flexibility, and steadiness.[40,43,49,55] Some studies indicate that yoga improves cardiovascular and aerobic capacity[43,47,54] while

enhancing quality of life,[39-40] instilling a sense of self-efficacy and self-esteem,[41-42] providing satisfaction,[39,41] and reducing stress and anxiety.[42,50,52] The mainstream obesity literature notes all of these factors as key elements in supporting lifestyle changes that lead to weight loss and weight maintenance and attendant improvements in health status, psychosocial function, and quality of life.[7-8]

CONCLUSIONS

In summarizing the features of those programs that demonstrated a higher degree of efficacy in terms of weight-related outcome measures, the research team drew some general overall conclusions: (1) programs with a yogic dietary component appear to be more successful; (2) programs with a residential component appear to be more successful; (3) a higher frequency of practice throughout the intervention appears to influence outcomes more than the intensity (length of a session) of practice; (4) practice sessions including 60 minutes of sustained asana practice appear to be adequate in achieving a beneficial result when combined with *pranayama* and meditation as the three core components of an intervention; (5) programs integrating a higher number of yogic elements into the intervention appear to demonstrate greater success; and (6) yogic interventions for weight loss appear to be equally appropriate and potentially successful for prevention of obesity or weight maintenance, for risk reduction for diseases in which obesity plays a significant causal role, or for treatment of patients with diseases in which being overweight and obese are causative factors. The authors have drawn these conclusions from the data presented in Table 2, which demonstrates gradual, moderate reductions in weight and BMI across the majority of interventions, in conjunction with an analysis of the programmatic features of the interventions. These conclusions are analytically distinct from a somewhat separate analysis of the quality of the studies' designs themselves and the comprehensiveness of the outcome measures presented.

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