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Effects of yoga on cardiovascular disease risk factors: A systematic review and meta-analysis

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ABSTRACT

Background: The aim of this review was to systematically assess and meta-analyze the effects of yoga on modifiable biological cardiovascular disease risk factors in the general population and in high-risk disease groups.
Methods: MEDLINE/PubMed, Scopus, the Cochrane Library, and IndMED were screened through August 2013 for randomized controlled trials (RCTs) on yoga for predefined cardiovascular risk factors in healthy participants, non-diabetic participants with high risk for cardiovascular disease, or participants with type 2 diabetes mellitus. Risk of bias was assessed using the Cochrane risk of bias tool.
Results: Forty-four RCTs with a total of 3168 participants were included. Risk of bias was high or unclear for most RCTs. Relative to usual care or no intervention, yoga improved systolic (mean difference (MD) = −5.85 mm Hg; 95% confidence interval (CI) = −8.81, −2.89) and diastolic blood pressure (MD = −4.12 mm Hg; 95%CI = −6.55, −1.69), heart rate (MD = −6.59 bpm; 95%CI = −12.89, −0.28), respiratory rate (MD = −0.93 breaths/min; 95%CI = −1.70, −0.15), waist circumference (MD = −1.95 cm; 95%CI = −3.01, −0.89), waist/hip ratio (MD = −0.02; 95%CI = −0.03, −0.00), total cholesterol (MD = −13.09 mg/dl; 95%CI = −19.60, −6.59), HDL (MD = 2.94 mg/dl; 95%CI = 0.57, 5.31), VLDL (MD = −5.70 mg/dl; 95%CI = −7.36, −4.03), triglycerides (MD = −20.97 mg/dl; 95%CI = −28.61, −13.32), HbA1c (MD = −0.45%; 95%CI = −0.87, −0.02), and insulin resistance (MD = −0.19; 95%CI = −0.30, −0.08). Relative to exercise, yoga improved HDL (MD = 3.70 mg/dl; 95%CI = 1.14, 6.26).
Conclusions: This meta-analysis revealed evidence for clinically important effects of yoga on most biological cardiovascular disease risk factors. Despite methodological drawbacks of the included studies, yoga can be considered as an ancillary intervention for the general population and for patients with increased risk of cardiovascular disease.

1. Introduction

Cardiovascular diseases, namely coronary heart disease and stroke, are the most common causes of death worldwide [1,2]. About 30% of all deaths worldwide, an estimated 17.3 million people, died from cardiovascular disease in 2008 [2]. By 2030, it has been estimated that this number will increase to 23.3 million deaths [2]. Over 80% of those deaths take place in low- and middle-income countries. Cardiovascular disease is among the leading causes of morbidity, disability, and work loss worldwide [1,3–5]. Being the major non-communicable disease, cardiovascular disease constitutes a substantial socioeconomic burden in all countries worldwide [1,3]. Although several hundred cardiovascular disease risk factors have been identified, the most important ones include hypertension, hyperlipidemia, hyperglycemia, and abdominal obesity. About 80% of cardiovascular disease is mainly caused by modifiable risk factors [6].

Yoga is rooted in Indian philosophy and has been a part of traditional Indian spiritual practice for millennia [7]. Traditional yoga's ultimate goal has been described as quieting one's mind to achieve the union of mind, body and spirit [7,8]. Regardless of its spiritual origins, yoga has become a popular route to physical and mental well-being [7,8] and has been adapted for use in complementary and alternative medicine in North America and Europe [9]. In the latter setting, yoga is most often associated with physical postures (‘*Asana*’), breath control (‘*Pranayama*’), and meditation (‘*Dhyana*’); and different yoga schools have emerged that put varying focus on physical and mental practices [7,9]. In Western societies, yoga is gaining increased popularity as a therapeutic method. About 14 million adult Americans (6.1% of the population) reported that yoga had been recommended to them by a physician or therapist [10]. Indeed, about half of American yoga

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practitioners (more than 13 million people) reported that they had started practice explicitly to improve their health [11,12]. In the United Kingdom, yoga is even promoted by the National Health Service as a safe and effective approach to improve health in both the general population and diseased patients [13]. Worldwide, it is estimated that yoga is regularly practiced by about 30 million people [14]. However, this number might still underestimate the actual prevalence of yoga practice.

Yoga has been shown to reduce important psychological cardiovascular disease risk factors such as stress [15,16] and depression [17]. Being a combination of exercise, controlled breathing, and relaxation, it is commonly thought to also improve biological cardiovascular disease risk factors [18,19]. The aim of this review was to systematically assess and meta-analyze the effects of yoga on modifiable biological cardiovascular disease risk factors (blood pressure, heart rate, respiratory rate, abdominal obesity, blood lipid levels, insulin resistance, oxidative stress, inflammatory markers, and atherosclerosis) in the general population and in high-risk disease groups (hypertension, metabolic syndrome, and type 2 diabetes).

2. Materials

The review was planned and conducted in accordance with PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines [20] and the recommendations of the Cochrane Collaboration [21].

2.1. Eligibility criteria

2.1.1. Types of studies

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

2.1.2. Types of participants

Studies including the following participants were eligible: 1) healthy participants; 2) non-diabetic participants with high risk for cardiovascular disease (including participants with hypertension, prehypertension, metabolic syndrome, obesity, dyslipidemia, or impaired insulin resistance); and 3) participants with type 2 diabetes mellitus. Differences between the 3 types of participants were investigated in subgroup analyses.

2.1.3. Types of interventions

Studies that compared yoga with no treatment, usual care, or any active treatment were eligible. Studies were excluded if yoga was not the main intervention but a part of a multimodal intervention. Since in North America and Europe, physical exercise is perceived as a main component of yoga [7,9], studies examining meditation or yogic lifestyle without physical component were also excluded. No further restrictions were made regarding yoga tradition, length, frequency, or duration of the program. Co-interventions were allowed. Head-to-head comparisons of different types of yoga without a non-yoga control group were excluded.

2.1.4. Types of outcome measures

For inclusion, RCTs had to assess at least 1 of the following primary outcomes: 1) blood pressure (systolic, diastolic); 2) heart rate; 3) respiratory rate; 4) abdominal obesity (assessed as e.g. waist circumference, waist–hip ratio, index of central obesity); 5) blood lipid levels (e.g. levels of cholesterol, LDL, HDL, VLDL, triglycerides); 6) insulin resistance (assessed as e.g. fasting blood insulin levels, fasting blood glucose, HbA1c, adiponectin levels, glucose tolerance test, or the Homeostatic Model Assessment [HOMA-IR]); 7) oxidative stress (assessed as e.g. blood levels of glutathione, superoxide dismutase, or catalase); 8) inflammatory markers (such as high-sensitivity C-reactive protein, interleukin-6 or homocysteine); and 9) atherosclerosis (assessed as e.g. intima-media thickness). Safety (assessed as adverse events and severe adverse events) was defined as secondary outcome.

2.2. Search methods

Four electronic databases were searched from their inception through August 08, 2013: Medline/PubMed, Scopus, the Cochrane Library, and IndMED. The literature search was constructed around search terms for “yoga” and search terms for “cardiovascular disease risk factors” and adapted for each database as necessary. The complete search strategy for PubMed/Medline is shown in Additional file 1.

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.

Two review authors independently screened abstracts identified during literature search and read potentially eligible articles in full to determine whether they met the eligibility criteria (HC and RL). Disagreements were discussed with a third review author until consensus was reached.

2.3. Data extraction and management

Pairs of 2 authors (HC and HH, RL and NS) independently extracted data on design (e.g. origin, setting), participants (e.g. condition, age, gender, race), interventions (e.g. yoga type, components, duration), control interventions (e.g. type, duration), outcomes (e.g. outcome measures, assessment time points), and results using an a priori developed data extraction form. Discrepancies were discussed with a third review author until consensus was reached.

2.4. Risk of bias in individual studies

Pairs of 2 authors (HC and HH, RL and NS) independently assessed risk of bias using the Cochrane risk of bias tool [21]. This tool assesses risk of bias on the following domains: selection bias, performance bias, detection bias, attrition bias, reporting bias, and other bias.

Selection bias includes the criteria ‘random sequence generation’ and ‘allocation concealment’. Adequate random sequence generation should produce comparable random groups; and adequate allocation concealment means that the intervention allocations could not have been foreseen before or during enrolment. Performance bias describes blinding of participants and personnel. Adequate blinding means that neither participants nor personnel (therapists or other healthcare providers) had knowledge of which intervention a participant received. While blinding of participants and personnel might be difficult or even impossible in yoga trials, inadequate blinding still remains a possible risk of bias. Detection bias describes adequate blinding of outcome assessors from knowledge of which intervention a participant received. Attrition bias due to incomplete outcome data includes inadequate exclusion of participants from the study or analysis; and/or drop-out rates beyond 20% in the short-term if not addressed by intention-to-treat analysis. Reporting bias due to selective reporting means that not all predefined outcomes were reported; and other bias includes all sources of potential bias not covered by any other criterion [21].

For each criterion, risk of bias was assessed as 1) low risk of bias (adequate fulfillment of the respective criterion), 2) unclear (insufficient information to judge about fulfillment or non-fulfillment of the respective criterion), and 3) high risk of bias (inadequate fulfillment or non-fulfillment of the respective criterion) [21]. Discrepancies were rechecked with a third reviewer and consensus achieved by discussion.

2.5. Data analysis

2.5.1. Assessment of overall effect size

Effects of yoga compared to different control interventions were analyzed separately. Meta-analyses were conducted using Review Manager 5 software (Version 5.1, The Nordic Cochrane Centre, Copenhagen) using a random effects model if at least 2 studies assessing this specific outcome were available.