Yoga, mindfulness-based stress reduction and stress-related physiological measures: A meta-analysis

Michaela C. Pascoe⁎, David R. Thompsonb,c, Chantal F. Ski

ABSTRACT

Background and objectives: Practices that include yoga asanas and mindfulness-based stress reduction for the management of stress are increasingly popular; however, the neurobiological effects of these practices on stress reactivity are not well understood. Many studies investigating the effects of such practices fail to include an active control group. Given the frequency with which people are selecting such interventions as a form of self-management, it is important to determine their effectiveness. Thus, this review investigates the effects of practices that include yoga asanas, with and without mindfulness-based stress reduction, compared to an active control, on physiological markers of stress.

Materials and methods: A systematic review and meta-analysis of randomised controlled trials published in English compared practices that included yoga asanas, with and without mindfulness-based stress reduction, to an active control, on stress-related physiological measures. The review focused on studies that measured physiological parameters such as blood pressure, heart rate, cortisol and peripheral cytokine expression. MEDLINE, AMED, CINAHL, PsycINFO, SocINDEX, PubMed, and Scopus were searched in May 2016 and updated in December 2016. Randomised controlled trials were included if they assessed at least one of the following outcomes: heart rate, blood pressure, heart rate variability, mean arterial pressure, C-reactive protein, interleukins or cortisol. Risk of bias assessments included sequence generation, allocation concealment, blinding of assessors, incomplete outcome data, selective outcome reporting and other sources of bias. Meta-analysis was undertaken using Comprehensive Meta-Analysis Software Version 3. Sensitivity analyses were performed using ‘one-study-removed’ analysis. Subgroup analysis was conducted for different yoga and control group types, including mindfulness-based stress reduction versus non-mindfulness-based stress reduction based interventions, different populations, length of intervention, and method of data analysis. A random-effects model was used in all analyses.

Results: Forty-two studies were included in the meta-analysis. Interventions that included yoga asanas were associated with reduced evening cortisol, waking cortisol, ambulatory systolic blood pressure, resting heart rate, high frequency heart rate variability, fasting blood glucose, cholesterol and low density lipoprotein, compared to active control. However, the reported interventions were heterogeneous.

Conclusions: Practices that include yoga asanas appear to be associated with improved regulation of the sympathetic nervous system and hypothalamic-pituitary-adrenal system in various populations.

1. Introduction

The daily demands associated with modern life cause arousal and can lead to psychological stress and activation of the stress response, or ‘fight-or-flight’ response (Nesse et al., 2016). The stress response, which can be defined as real or perceived threats to homeostasis or safety/well-being (Herman et al., 2016) is adaptive in situations of imminent threat. Persistent activation of the ‘fight-or-flight’ response can be associated with the onset of psychiatric disorders such as anxiety and depression (Iwata et al., 2013; Ventriglio et al., 2015).

The practice of yoga is aimed at achieving a union of mind, body and spirit and has become popular in recent years as a form of stress management in Western cultures (Penman et al., 2012). Meta-analysis has shown that yoga practice effectively decreases depressive and anxious symptomatology (Cramer et al., 2013). While there is no definitive taxonomy of yoga, as the many forms of the practice have unique
theoretical underpinnings and approaches (Ospina et al., 2007), common elements are shared by many forms, such as controlled breathing, meditative techniques and physical postures (Farmer, 2012; Pfueger, 2011; Travis and Pearson, 2000). Approximately 10% of the population were practising yoga in the United States in 2012 (Clarke et al., 2015). In England, approximately 1.28% of the population were practising it in 2006/08 (Ding and Stamatakis, 2014). Medical practitioners often prescribe yoga to their patients, (Nerurkar et al., 2011) with as many as 77% of surveyed Australian practitioners referring their patients to a yoga therapist (Wardle et al., 2014).

Mindfulness-based stress reduction (MBSR), developed by Kabat-Zinn in the 1970s (Miller et al., 1995), is a group program that uses a combination of mindfulness meditation, body awareness and yoga asanas with the aim of increasing mindfulness (Praissman, 2008). Typically, MBSR is run across eight sessions with at least one session plus a day-long retreat including yoga asanas, as well as home practice that may or may not include further yoga asanas, thus the practice of yoga asanas is part of a wider program in MBSR (Praissman, 2008). MBSR has been promoted to clinicians a safe and effective technique to reduce stress and anxiety in diverse patient populations (Praissman, 2008).

In spite of the popularity of practices that include yoga asanas in the management of stress, research in this area is in its infancy and the neurobiological effects of such practices are still not well elucidated. Given the frequency with which people are choosing to engage in yoga asanas and MBSR for stress management, it is important to validate and understand the neurobiological effects of these practices. Some researchers have hypothesised that practices including yoga may decrease stress reactivity and thus result in overall improved health and well-being (Riley and Park, 2015). We have shown previously in a systematic review that yoga asanas appear to modulate the regulation of the sympathetic nervous system (SNS) and hypothalamic-pituitary-adrenal (HPA) system in people experiencing depressive symptomatology, indicated by decreases in blood pressure (BP), heart rate (HR), cortisol or cytokine levels (Pascoe and Bauer, 2015). While this previous review provided preliminary evidence of the beneficial effects of yoga asanas on stress activity, to date no meta-analysis has been conducted. Furthermore, our previous review was limited to a particular population and highlighted that many studies fail to include an active control (AC), a limitation in this developing field. Therefore, we aim to conduct a meta-analysis investigating the effects of yoga asanas, including MBSR, on stress reactivity, in randomised controlled trials (RCTs) that include an AC group, in all populations. We discuss the relevance of these findings in the context of stress-related depression.

2. Methods

This study was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Moher et al., 2010). A prospective protocol for the systematic review was not previously published.

2.1. Criteria

Eligible studies were RCTs published in English from any time. Eligible studies included any intervention with yoga asanas (the physical postures practiced in yoga), including MBSR, compared to an AC group. There was no restriction on participant eligibility and thus studies of all populations were included. All RCTs with a yoga asanas intervention and AC control were included if they assessed at least one of the following outcomes: measures related to autonomic parameters (heart rate [HR], blood pressure, heart rate variability [HRV], mean arterial pressure [MAP]), inflammation (C-reactive protein [CRP] Interleukin 6 [IL-6], Interleukin 8 [IL-8]) or HPA axis activation (including cortisol). Studies with lipid outcomes were also eligible for inclusion as high cholesterol is associated with the accumulation of cholesterol in macrophages and other immune cells, which promotes inflammation (Tall and Yvan-Charvet, 2015), and individuals with chronic inflammatory diseases have shown a changed lipid profile (Feingold and Grunfeld, 2000). Fasting blood glucose (FBG) was also included as inflammation contributes the development of insulin resistance (Henriksen et al., 2011; Kalupahana et al., 2012; Olefsky and Glass, 2010).

In order to meet the requirements of meta-analysis, eligible studies were required to report outcomes as means with standard error (SE), standard deviation (SD) or confidence intervals (CI). We intended to include only peer reviewed RCTs and thus dissertations were excluded. Conference abstracts and technical reports were also excluded as these were not likely to include the detailed information required for assessment of bias or meta-analysis inclusion.

2.2. Search strategy

The following electronic databases were searched: MEDLINE, AMED, CINAHL, PsycINFO, SocINDEX, PubMed, and Scopus. Searches were undertaken in May 2016 and last updated on December 15, 2016. Exact search strategies are listed in the Appendix A. Authors of eligible studies were contacted to request unpublished data.

2.3. Study selection

Sourced studies were imported into Covidence Online Software (https://www.covidence.org). Two independent reviewers screened studies for relevance based on titles/abstracts and later full texts (MCP, MH) with disagreements resolved through discussion or by consulting a third reviewer (CFS).

2.4. Data extraction

Data were extracted using Covidence Online Software (https://www.covidence.org) and a predefined form that included study design, country undertaken, aims, ethical information, studied outcomes, sample size, participant characteristics and intervention characteristics. Mean (M), standard deviation (SD) and sample size (n) were extracted. The data were extracted by two independent reviewers (MCP, MH).

2.5. Risk of bias in individual studies and grades of recommendation, assessment, development and evaluation

The methodological quality of the included studies was assessed independently by two reviewers (MCP, MH) using the Cochrane Risk of Bias Tool (The Cochrane Collaboration, 2011) on Covidence Online Software (https://www.covidence.org) and included assessments of sequence generation, allocation concealment, blinding of assessors, incomplete outcome data, selective outcome reporting and other sources of bias. To best capture the current state and quality of research in this field, studies were not included or excluded based on quality assessment, and thus all eligible articles were included. Grades of Recommendation, Assessment, Development and Evaluation (GRADE) were assessed using the GRADE working group recommendations as published in the Cochrane Handbook. We considered five factors when assessing the quality of evidence: 1) risk of bias; 2) heterogeneity; 3) population, intervention, comparison, outcomes (PICO) and applicability; 4) precision; and 5) publication bias (The Cochrane Collaboration, 2011).

2.6. Summary measures

For the meta-analysis we report the raw difference in means when the outcome is reported on the same meaningful scale in all studies. The SMD was used in place of raw difference in means when studies used different outcome measures, unable to be converted to a common form, and thus the different scales used are not comparable in raw...