Mindfulness (2020) 11:507–516
https://doi.org/10.1007/s12671-019-01277-6

ORIGINAL PAPER

The Effect of Meditation on Health: a Metasynthesis of Randomized Controlled Trials

Sabrina Rose[1,2] · Ethan Zell[1] · Jason E. Strickhouser[1,3]

Published online: 10 December 2019

Abstract

Objectives Meta-analyses have identified benefits of meditation for many specific health outcomes, including depression, diabetes, and smoking. However, the meditation literature lacks a comprehensive synthesis of meta-analyses on meditation–health effects. This study used metasynthesis (i.e., second-order meta-analysis) to derive a comprehensive estimate of the effect of meditation on health.

Methods Twenty-eight meta-analyses of randomized controlled trials, which collectively provided 404 meta-analytic effects from over 31,000 participants, met criteria for inclusion. Information on the type of health outcome, meditation, and sample as well as the methodological quality and average intervention length was extracted from each meta-analysis. An unweighted model was used to aggregate data.

Results A medium-sized effect of meditation on health was obtained after aggregating across meta-analyses ($d = 0.50$, 95% *CI* [0.42, 0.58]). The effect of meditation was stronger when examining yoga than mindfulness or focused attention, was similar for mental and physical health, and was stronger in younger samples, higher quality studies, and studies with longer interventions.

Conclusions This metasynthesis provides among the most compelling evidence to date that meditation benefits health. Nonetheless, current estimates of meditation–health effects may be inflated as a result of publication bias, low quality studies, and use of inactive control conditions.

Keywords Meditation · Mindfulness · Health · Well-being · Meta-analysis

Meditation has played an important role in philosophical traditions since its origin over 3,000 years ago (Dahl et al. 2015; Sedlmeier et al. 2012). Meditation is defined as a form of cognitive training that aims to improve attentional and emotional self-regulation (Tang et al. 2015). There are many different types of meditation, each with a specific focus or intention. Meditation that involves fixation on a specific mantra, image, feeling, or idea is known as focused attention; meditation that involves fixation on the present moment is known as mindfulness; and meditation that combines ethical discipline and physical postures, with an emphasis on harmony between the body and mind, is known as yoga (Gong et al. 2015; Lutz et al. 2008). Although ancient in origin, meditation remains a popular activity. Along these lines, yoga is practiced by over 21 million Americans (9.5% of the population) and other forms of meditation are practiced by over 18 million Americans (8% of the population; National Institutes of Health 2017). Further, the benefits of meditation for health are often touted in popular magazines (e.g., Park 2017) and best-selling books (e.g., Kabat-Zinn 2016).

Given its popularity, research on the effect of meditation on health has become a major focus in psychology (Van Dam et al. 2017), neuroscience (Atchley et al. 2016), and medicine (Ludwig and Kabat-Zinn 2008). Emerging research suggests that meditation is beneficial for mental health outcomes including self-esteem, emotion regulation, and psychological well-being (Davis and Hayes 2011; Kok et al. 2013), as well

Electronic supplementary material The online version of this article (https://doi.org/10.1007/s12671-019-01277-6) contains supplementary material, which is available to authorized users.

✉ Ethan Zell
e_zell@uncg.edu

1 Department of Psychology, University of North Carolina at Greensboro, Greensboro, NC, USA

2 Ganesha's Yoga and Wellness, Greensboro, NC, USA

3 Department of Behavioral Sciences and Social Medicine, Florida State University, Tallahassee, FL, USA

as physical health outcomes including heart rate, blood pressure, respiratory rate, and immune function (Black and Slavich 2016; Steinhubl et al. 2015). Hundreds of empirical studies have explored the effect of meditation on specific health outcomes and researchers have increasingly used meta-analysis to estimate the average effect of meditation on these outcomes. Major meta-analyses, for example, have identified beneficial effects of meditation on depression, stress, and anxiety (Abbott et al. 2014), irritable bowel syndrome (Aucoin et al. 2014), sleep quality (Gong et al. 2016), post-traumatic stress disorder (Hilton et al. 2016), smoking cessation (Maglione et al. 2017), and quality of life (Veehof et al. 2016).

A key limitation to many meditation studies is their reliance upon correlational designs, as opposed to experimental designs with randomization and control, which prevents causal conclusions (see Davidson and Kaszniak 2015; Tang et al. 2015; Van Dam et al. 2017). In response to this concern, meditation researchers have increasingly used randomized controlled trials (RCTs). Further, recent meta-analyses have exclusively focused on RCTs to identify beneficial, causal effects of meditation on health outcomes (e.g., Goyal et al. 2014; Spijkerman et al. 2016). In sum, there is now strong meta-analytic support for the argument that meditation positively impacts a variety of specific health outcomes.

Despite this progress, the meditation literature lacks a comprehensive synthesis of meta-analyses on the effect of meditation on health, which is necessary for several reasons. First, scholars and laypersons have long been interested in whether and to what extent meditation generally benefits health, regardless of the particular outcome under consideration (see Dahl et al. 2015; Sedlmeier et al. 2012). Prior meta-analyses have typically focused on one or a few specific health outcomes and are, therefore, unable to address this broader question. Further, knowledge of the overall size and variability of meditation effects across health outcomes would provide useful reference points with which to compare outcome-specific effects, so that effects that are particularly large or small can be identified.

Second, a comprehensive synthesis of meta-analyses is necessary to explore whether the effect of meditation on health is moderated by several theoretical and methodological variables. As we describe below, meditation–health effects may vary as a function of the type of meditation or health outcome category (i.e., mental health, physical health, or health behavior) under consideration. However, because prior meta-analyses typically focused on only one type of meditation or health outcome category, they were unable to evaluate the influence of these moderators. Moreover, aggregation of results across meta-analyses would facilitate comparisons of whether methodological variables, such as the type of meta-analytic model and presence of publication bias, influence meditation–health effects.

Third, a comprehensive synthesis is necessary to provide an overview of meta-analyses on meditation–health effects, thereby identifying the strengths and weaknesses of this literature, as well as topics in need of future research. Further, whereas outcome-specific meta-analyses necessarily focus on theoretical and methodological issues that are unique to that outcome, a domain-general meta-analysis would integrate findings across meta-analyses to provide an overview of the meditation–health literature as a whole. By integrating disparate findings that are rarely discussed together in this literature, a synthesis of prior meta-analyses would promote the development of broader theoretical models on the effect of meditation across various health outcome types.

When considering the overall effect of meditation on health, current theory suggests that meditation should be generally beneficial for several reasons (see Hölzel et al. 2011). First, by facilitating an unemotional and detached perspective, meditation may allow people to reappraise negative thoughts, resulting in reduced emotional reactivity and improved emotion regulation. Second, by requiring people to gently and repeatedly bring a wandering mind back toward a desired point of focus (e.g., one's breath or a specific image), meditation may improve attentional regulation, thereby enhancing the ability to direct attention away from negative thoughts that undermine health. Third, by increasing awareness of bodily sensations, meditation may enhance the ability to identify bodily reactions associated with negative affect and trigger compensatory emotion regulation strategies. Thus, meditation may cultivate attentional and emotional regulation strategies that broadly manifest in improved health.

Although generally beneficial, meditation likely has different effects when comparing the three major health outcome categories studied in prior research: mental health, health behaviors, and physical health (see Strickhouser et al. 2017 for a similar categorization scheme). Because physical health effects are determined by many factors and are presumably mediated by changes in mental health and health behavior (e.g., Hodes et al. 2014; Segerstrom and Miller 2004), it was anticipated that the effect of meditation would be larger when examining outcomes that reflect mental health and health behavior than outcomes that reflect physical health. Furthermore, the proposed mechanisms of meditation–health effects (i.e., attentional and emotional self-regulation) are psychological variables that may yield direct effects on mental health and health behavior, that later result in changes in physical health. Consistent with this position, Mindfulness-to-Meaning theory asserts that meditation benefits health via psychological variables such as positive reappraisal of stressful events and other negative stimuli (Garland et al. 2015).

The type of meditation practice may also be an important consideration when understanding meditation–health effects. Three types of meditation are commonly studied in this literature: focused attention, mindfulness, and yoga. Focused attention involves fixing attention on a particular thought, image, idea, or mantra; mindfulness involves focusing on the present moment with nonjudgmental acceptance of thoughts; yoga emphasizes harmony between body and mind through physical postures and ethical discipline. These different types of meditation are often regarded as part of a single family of strategies that seek to improve the regulation of emotion and attention (Lutz et al. 2008). Further, the effect of meditation may be produced by overlapping psychological mechanisms regardless of the type of meditation (Chen et al. 2012). Thus, prior theory suggest that these three major forms of meditation should produce beneficial effects on health and that these effects are likely comparable in size.

Finally, meditation studies vary in methodological quality, which is commonly assessed using standardized checklists (e.g., Boutron et al. 2008; Brozek et al. 2009). Whereas some studies are relatively high quality in that they contain elements such as adequate sample sizes, baseline measures, random assignment to conditions, and blinding of participants and researchers to condition assignment, other studies that neglect these elements are considered relatively low quality. As a result of systematic error in one or more stages of the research process, lower quality studies may result in inflated estimates of meditation–health effects (see A-Tjak et al. 2015; Khoury et al. 2013). Thus, meta-analyses that primarily included higher quality studies should yield more conservative estimates of meditation–health effects than meta-analyses that primarily included lower quality studies.

In sum, because prior meta-analyses have primarily focused on specific health outcomes, the extent to which meditation generally affects health remains unclear. In the current study, data from 28 meta-analyses of randomized controlled trials—which included 404 meta-analytic effects and over 31,000 participants—were aggregated to explore the overall effect of meditation on health and to identify moderators of this effect. Thus, the present analysis is the most comprehensive examination of the causal effect of meditation on health in the literature to date. Specifically, the aims of the current research were to (1) estimate the average size of the effect of meditation on health across prior meta-analyses of RCTs using metasynthesis, (2) examine whether the effect of meditation on health is stronger for some health outcomes and types of meditation than others, and (3) explore whether sample characteristics and methodological factors moderate the effect of meditation on health.

Method

This metasynthesis followed recommended procedures for second-order meta-analysis (Cooper and Koenka 2012; Zell and Krizan 2014). First, an exhaustive literature search was conducted to identify potentially relevant papers. Next, effect sizes and other statistical information were extracted from the meta-analyses. Finally, quantitative aggregation procedures were used to synthesize the obtained meta-analytic effects.

Article Identification

A search of scholarly databases, including PsycInfo, CINAHL, and Medline was conducted on April 23, 2017, to identify meta-analyses on the effect of meditation on health in any age group. Specifically, databases were searched for records that mentioned both meditation and meta-analysis in the title, abstract, or keywords. Meditation search terms included the term "meditation" and also names of specific meditation types (i.e., "mindfulness-based stress reduction," "MBSR," "mindfulness-based cognitive therapy," "MBCT"). Meta-analysis search terms included "meta-ana*," "systematic review," and "quantitative review." After removing duplicates, the search yielded 556 potentially relevant articles. Two additional articles were identified by scanning January through April 2017 issues of the following journals: Clinical Psychology Review, Journal of Psychosomatic Research, Mindfulness, and Psychological Bulletin.

Inclusion and Exclusion Criteria Next, articles were evaluated to determine whether they were eligible for inclusion (see Fig. 1). To be included in the metasynthesis, articles had to provide meta-analytic effect sizes indicating the causal effect of meditation on one or more health-related outcomes. Thus, excluded papers either (a) did not refer to meditation or a type of meditation in the title, abstract, or keywords ($n = 221$), (b) were not meta-analyses ($n = 234$), (c) did not examine health-related outcomes, broadly defined as any outcome related to mental health, health behavior, or physical health ($n = 16$; see the Article Coding section below for more details about health outcome categories), (d) did not consist only of RCTs ($n = 48$), or (e) did not report relevant effect size information, such as Cohen's d, Hedges' g, or an odds ratio ($n = 5$). Taking these exclusions into account, 34 meta-analyses of the effect of meditation on health using RCTs remained.

Sample Overlap Exclusions To promote independence of observation, articles were evaluated to identify meta-analyses that were reliant upon the same or similar samples. A decision rule was used such that meta-analyses were included if most of their samples were unique (i.e., sample overlap was 49% or below; Nater and Zell 2015). This resulted in the exclusion of 6 meta-analyses that used the same samples as later, more comprehensive meta-analyses on the same health outcome (sample overlap ranged from 50 to 100%; see the online supplemental materials), leaving a total of 28 meta-analyses included in the metasynthesis (see the online supplemental materials). Of the included meta-analyses, 18 were independent in that they used samples that did not overlap with any

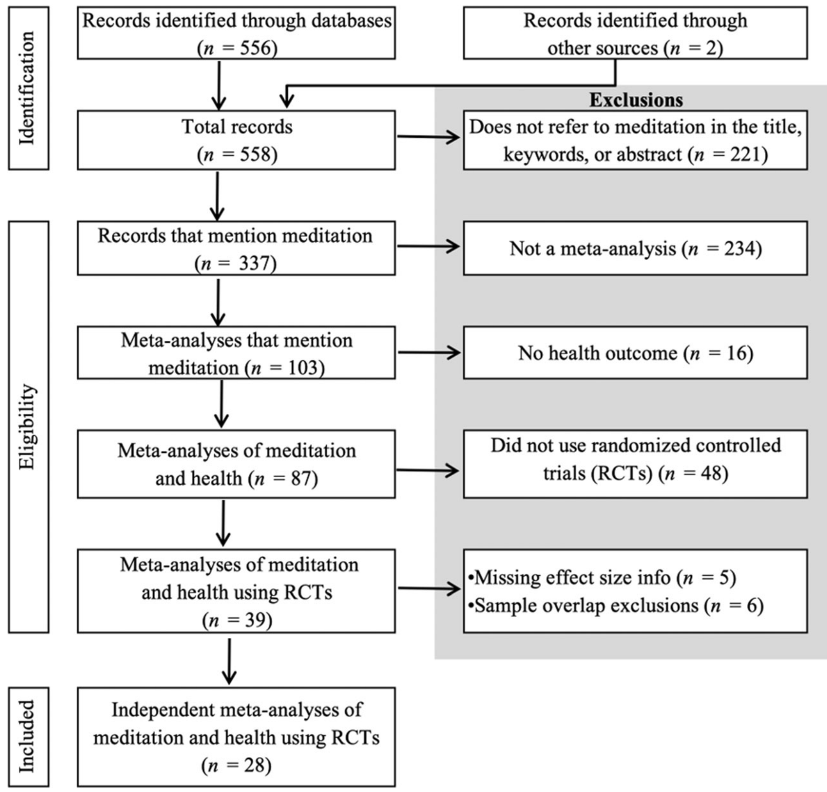

Fig. 1 Flow diagram for the article search

other meta-analyses. The other 10 meta-analyses did contain some overlap, but in all instances the amount of overlap was between 5 and 43% (see the online supplemental materials).

The total number of effect sizes (*k*) across the 28 meta-analyses was 404 and the total number of participants (*N*) was 31,492. Most meta-analyses (*m*) compared the effect of meditation to a variety of different control conditions ($M = 4.41$, $SD = 2.48$, range = [1, 10]) (e.g., treatment as usual, wait-list, progressive muscle relaxation, aerobic exercise, education support group). Two meta-analyses did not report the number or type of control conditions. The control conditions examined in each meta-analysis are reported in the online supplemental materials.

Effect Size Extraction and Conversion

Effect sizes indexing the effect of meditation on health outcomes were extracted from the 28 included meta-analyses. Most meta-analyses reported effect sizes in the form of a standardized mean difference, Cohen's *d* or Hedges' *g*, but 1 reported odds ratios. To facilitate data aggregation, odds ratios were converted to Cohen's *d* (see Borenstein et al. 2009). Effect sizes were coded uniformly such that positive effects indicate that meditation was beneficial for health and negative effects indicate that meditation was detrimental for health. Finally, most meta-analyses provided effects that were weighted by sample size (i.e., used fixed-effect, random-effects, or other approaches). Two papers did not specify the model used for data aggregation.

When meta-analyses reported effect sizes indexing the effect of meditation on multiple health outcomes (26 meta-analyses had multiple outcomes), these effects were averaged before entering them into the final model. This approach ensured that each meta-analysis was given equal weight in the final model.

Coding and Extraction of Moderators

Coding Coding of each meta-analysis was done by 2 raters (i.e., the first and third authors) and disagreements between raters were resolved through discussion (all $\kappa > 0.86$; see the online supplemental materials for correlations among moderators). Along these lines, the type of meditation examined in each meta-analysis was coded as focused attention, mindfulness, yoga, or various.

Further, the type of health outcome examined in each meta-analysis was coded as mental health, health behavior, physical health, or various (see Strickhouser et al. 2017 for a similar coding scheme). Mental health was broadly defined to include any outcome that reflected cognitive, emotional, or social well-being and therefore included outcomes such as anxiety, depression, quality of life, and stress. Health behaviors were defined as any health promoting or deteriorating activities, such as smoking. Finally, physical health was defined as objective measures of the fitness of the body including blood pressure, blood sugar, hemoglobin, and pain, as well as diagnosed health conditions including irritable bowel syndrome and insomnia.

In terms of methodological factors, coding was done to assess the type of meta-analytic model used to aggregate effects including fixed-effect, random-effects, or other approaches, sample type including clinical samples of patients with diagnosed mental or physical health conditions or both clinical and non-clinical samples, sample age category including children and adolescents, adolescents and adults, adults, or older adults, and whether or not unpublished studies were included in the meta-analysis.

Additionally, the methodological quality of included meta-analyses was coded using 5 criteria outlined in previous work: (1) the eligibility criteria for the studies included in the meta-analysis was clearly stated, (2) the search for studies included in the meta-analysis used at least 3 sources, including 1 electronic source, (3) coding of studies was done by at least two independent raters, (4) a strategy was used to assess statistical heterogeneity, and (5) the primary synthesis method was clearly stated (see Higgins et al. 2013). These 5 criteria were coded dichotomously (1 = criteria met, 0 = criteria not met) and summed to create an index of methodological quality (M = 4.64, SD = 0.56, range = [3, 5]).

Extraction When possible, the following data were extracted from the final set of meta-analyses: mean sample age (m = 17, M = 45.56, SD = 9.90, range = [28.70, 60.66]), mean percentage of female participants (m = 16, M = 71.5%, SD = 21.2%, range = [32%, 100%]), and mean length of intervention (m = 18, M = 9.33 weeks, SD = 3.34 weeks, range = [6.66, 20.94]).

Information regarding the quality of studies included in each meta-analysis was also extracted. Of the 28 meta-analyses, 6 did not report any study quality information and 13 broadly discussed study quality but did not categorize individual studies based on their methodological quality. However, 9 meta-analyses categorized individual studies as being high, medium, or low in quality. To explore potential differences in effect size as a function of the average study quality of included meta-analyses, high, medium, and low quality studies were assigned the scores of + 1, 0, and − 1, respectively. Then, an overall study quality score was calculated for each of the 9 meta-analyses by summing the individual study quality scores and dividing them by the total number of studies included in the meta-analysis (M = − 0.10, SD = 0.20, range = [− 0.40, 0.23]). In addition, 3 meta-analyses provided effect sizes both when including and excluding low quality studies and 2 meta-analyses provided separate effect sizes for low, medium, and high quality studies.

Statistical Analysis

An unweighted average of each of the 28 meditation–health effects was used to estimate the population effect (see Zell and Krizan 2014; Zell et al. 2015). Past research found that unweighted averages in meta-analysis tend to perform as well or better in predicting population effects than averages that weight by study sample size or other criteria (see Bonett 2009; Shuster 2010). Nonetheless, exploratory analyses that weighted by sample size (N) or the number of effects (k) included in prior analyses were also conducted to evaluate whether these weighting procedures influenced effect size estimates. Most effects are standardized mean differences (d) and are interpreted as follows: 0.20 = small, 0.50 = medium, 0.80 = large (Cohen 1988; cf. Lipsey 1990). A few effects are correlations (r) and are interpreted as follows: 0.10 = small, 0.30 = medium, 0.50 = large.

Results

Primary Model

There was a robust, medium-sized effect of meditation on health when averaging across the 28 independent meta-analytic effects, d = 0.50, 95% CI [0.42, 0.58], SD = 0.20, range = [0.16, 0.98], which remained after weighting meta-analytic effects by their respective sample size (d = 0.48) or total number of effects (d = 0.49). All of the meta-analytic effects were positive in direction, suggesting that meditation consistently improved health. There was considerable variability, however, in the size of the meta-analytic effects (see Fig. 2). Further, of the 24 meta-analyses that reported heterogeneity tests, 21 (88%) indicated that significantly heterogeneous effects were obtained, which further suggests that the effect of meditation on health is variable across conditions.

Publication Bias

Publication bias was assessed in 11 of the included meta-analyses, of which 6 reported Egger's test for funnel plot

Stem	Leaf
0.1	6
0.2	9 9
0.3	1 2 4 5 5 7 7 7
0.4	4 6 8
0.5	0 2 2 4 6 6 9 9 9
0.6	5
0.7	4
0.8	3
0.9	5 8

Fig. 2 Stem and leaf plot of 28 independent meta-analytic effects (Cohen's d values) indexing the effect of meditation on health outcomes

asymmetry (Egger et al. 1997) and 5 analyzed the symmetry of funnel plots without mentioning Egger's test. Evidence of publication bias, as reflected either by a significant Egger's value ($m = 2$) or by simply describing the funnel plot as asymmetrical ($m = 3$), was identified in 5 of the 11 meta-analyses. The remaining meta-analyses either did not report publication bias tests ($m = 10$) or were unable to adequately test for publication bias due to a small number of studies ($m = 7$).

Moderation Tests

Type of Meditation Although all types of meditation yielded robust effects on health, the effect of yoga ($d = 0.77$) was more pronounced than the effect of focused attention ($d = 0.54$), mindfulness ($d = 0.44$), or various meditation types ($d = 0.40$; see Table 1). Nonetheless, there were far more meta-analyses on mindfulness ($m = 17$) than yoga ($m = 5$), various meditation types ($m = 4$), or focused attention ($m = 2$).

Type of Health Outcome Contrary to predictions, the effect of meditation was similar, but slightly larger when examining physical health ($d = 0.60$) than mental health ($d = 0.53$). The effect of meditation was somewhat smaller when examining health behavior ($d = 0.37$) and various health outcome types ($d = 0.45$). However, these results should be interpreted with caution given that there were far more meta-analyses on mental health ($m = 13$) and various health outcome types ($m = 11$) than physical health ($m = 3$) or health behavior ($m = 1$) (Maglione et al. 2017; smoking cessation). Effects for each health outcome type within each type of meditation are presented in the online supplemental materials.

Sample Characteristics Meditation effects were comparable when examining meta-analyses that only included clinical samples ($d = 0.50$) versus meta-analyses that included both clinical and non-clinical samples ($d = 0.50$). Most meta-analyses were conducted on adult samples ($d = 0.49$, $m = 25$), but meta-analyses on other samples such as adolescents and adults ($d = 0.56$, $m = 1$), children and adolescents ($d = 0.56$, $m = 1$), and older adults yielded similar results ($d = 0.59$, $m = 1$). In addition, when examining meta-analyses that provided a mean sample age, there was a medium-sized association between sample age and effect size ($r = -0.26$, $m = 17$), such that effect sizes were smaller in older samples. Finally, when examining meta-analyses that provided a mean percentage of participants who were female, there was a small association between gender and effect size ($r = 0.10$, $m = 16$), such that effect sizes were slightly higher in women versus men.

Methodological Factors The effect of meditation was similar when examining meta-analyses that used a fixed-effect model ($d = 0.56$), random-effects model ($d = 0.50$), or another approach for data aggregation ($d = 0.50$). Further, meta-analyses that included both published and unpublished studies ($d = 0.50$) yielded a comparable effect to meta-analyses that included only published studies ($d = 0.50$). In general, the obtained meta-analyses were relatively high in methodological quality and there was only a slight difference in effect size when comparing meta-analyses that received a 4 out of 5 in quality ($d = 0.46$) versus meta-analyses that received a 5 out of 5 ($d = 0.51$). Finally, when examining meta-analyses that

Table 1 Average Cohen's d for the effect of meditation on health by moderator

Moderator	*d*	*SD*	Range	*m*
Type of meditation				
Mindfulness	0.44	0.16	(0.16, 0.83)	17
Focused attention	0.54	0.03	(0.52, 0.56)	2
Yoga	0.77	0.19	(0.59, 0.98)	5
Various	0.40	0.10	(0.29, 0.52)	4
Type of health outcome				
Mental health	0.53	0.16	(0.31, 0.83)	13
Physical health	0.60	0.33	(0.37, 0.98)	3
Health behavior	0.37	–	–	1
Various	0.45	0.21	(0.16, 0.95)	11
Sample type				
Clinical only	0.50	0.23	(0.16, 0.98)	19
Clinical and non-clinical	0.50	0.10	(0.31, 0.59)	9
Sample age				
Adults	0.49	0.21	(0.16, 0.98)	25
Adolescents and adults	0.56	–	–	1
Children and adolescents	0.56	–	–	1
Older adults	0.59	–	–	1
Model type				
Random-effects	0.50	0.18	(0.29, 0.98)	19
Fixed-effect	0.56	0.26	(0.37, 0.74)	2
Other	0.50	0.26	(0.16, 0.95)	7
Publication status				
Published only	0.50	0.21	(0.16, 0.98)	23
Published and unpublished	0.50	0.13	(0.31, 0.65)	5
Meta-analysis quality				
3	0.65	–	–	1
4	0.46	0.13	(0.29, 0.59)	8
5 (highest)	0.51	0.22	(0.16, 0.98)	19
Study quality 1				
High	1.37	1.36	(0.40, 2.33)	2
Medium	0.39	0.31	(0.17, 0.61)	2
Low	0.92	0.13	(0.83, 1.01)	2
Study quality 2				
High, medium, and low	0.33	0.02	(0.31, 0.35)	3
High and medium	0.24	0.05	(0.19, 0.28)	3

d, average effect size; *SD*, standard deviation; *m*, number of meta-analyses provided a mean intervention length, there was a small to medium association between intervention length and effect size ($r = 0.23$, $m = 18$), such that longer interventions yielded larger effects.

Study Quality The potential moderating effect of study quality was assessed in three analyses. First, among 2 meta-analyses that provided separate effect sizes for low, medium, and high quality studies, the effect of meditation was much larger for high quality ($d = 1.37$) and low quality ($d = 0.92$) studies than medium quality studies ($d = 0.39$). Second, among 3 meta-analyses that provided effect sizes both including and excluding low quality studies, the effect of meditation was slightly larger when low quality studies were included ($d = 0.33$) versus excluded ($d = 0.24$). Finally, when examining meta-analyses for which a mean study quality score could be calculated, there was a medium-sized association between study quality and effect size ($r = 0.27$, $m = 9$) such that meta-analyses with relatively high quality studies yielded larger effects than meta-analyses with relatively low quality studies.

Discussion

Research on the benefits of meditation for health has fascinated scholars and laypersons in a variety of disciplines for decades (see Dahl et al. 2015; Sedlmeier et al. 2012). Meta-analyses have identified beneficial effects of meditation on many specific health outcomes, including depression (Lenz et al. 2016), diabetes (Kumar et al. 2016), and smoking (Maglione et al. 2017). However, the meditation literature lacks a comprehensive synthesis of meta-analyses on the effect of meditation on health, which is necessary to appraise the overall size and variability of this effect, to evaluate potential moderators, and to provide an overview of previous meta-analytic findings. In the present research, a metasynthesis of 28 independent meta-analyses of randomized controlled trials (RCTs), that collectively included 404 meta-analytic effects, over 31,000 participants, and a wide variety of health outcomes, was conducted to explore the effect of meditation on health. In addition, analyses tested the potential moderating influence of several variables on meditation–health effects.

Several novel contributions emerged from this metasynthesis. First, there was a robust, medium-sized effect of meditation on health when aggregating across meta-analyses. By aggregating data from a relatively large and highly diverse set of meta-analyses, the current research provides among the most compelling evidence to date that meditation benefits health. Further, by focusing exclusively on meta-analyses of RCTs, the current research suggests that meditation is not merely associated with health but that it causes important health benefits, which addresses a key limitation of prior analyses that incorporated both experimental and correlational studies (see Tang et al. 2015; Van Dam et al. 2017). Although meditation was generally beneficial for health, there was considerable variability in the size of these effects, with some meta-analytic effects being very small and others being very large. Moreover, the majority of included meta-analyses reported heterogeneous results, which further suggests that the effect of meditation on health is variable across conditions.

Second, moderation tests provide tentative evidence suggesting that the effect of meditation varies as a function of the type of meditation and health outcome under consideration. Along these lines, yoga yielded stronger effects than focused attention or mindfulness, but all types of meditation yielded robust positive effects. Additionally, the effect of meditation was surprisingly similar for mental and physical health outcomes, which deviates from the hypothesis that effects on mental health should be larger since they may exert downstream effects on physical health (Hodes et al. 2014; Segerstrom and Miller 2004). Nonetheless, only 3 meta-analyses exclusively focused on physical health. Further, only 1 meta-analysis was obtained for health behavior, which prevents broad conclusions.

Third, moderation tests in the present research suggest that meditation–health effects were largely resistant to several methodological variables, such as the inclusion of non-clinical samples, type of statistical model used to aggregate effects, inclusion of unpublished data, and methodological quality of the included meta-analyses. However, moderation tests also suggest that the effect of meditation may be somewhat larger when examining younger versus older samples, women versus men, and studies that used longer versus shorter interventions. Thus, aspects of the sample and meditation intervention itself may influence the size of meditation–health effects.

Limitations and Future Research

Although the present research suggests that meditation may be generally beneficial for health, such conclusions should be tempered by the possibility of publication bias in the meditation literature. Of the 11 included meta-analyses that conducted publication bias tests, 5 obtained evidence of publication bias. Thus, it remains possible that meta-analytic estimates of meditation–health effects are inflated due to selective publication of positive results. Further, the majority of the included meta-analyses did not report publication bias tests. It is advised that future meta-analyses include publication bias tests so that the potential contaminating influence of publication bias can be better understood in this literature.

Another limitation of the present research was that it was unable to discern whether the effect of meditation in RCTs is altered by the nature of the control condition. Whereas some studies used an active control condition such as relaxation, stress management, or health enhancement, others used a non-active (i.e., wait-list) control condition. Active controls are highly desirable because they allow for a comparison of whether meditation is beneficial above and beyond other established interventions (Davidson and Kaszniak 2015; Tang et al. 2015). However, included meta-analyses did not provide separate effects for meditation studies that used active control conditions versus those that used inactive control conditions. Future meta-analyses should specifically explore the degree to which meditation is beneficial above and beyond other treatments.

Moreover, the present research did not yield conclusive information regarding the influence of low quality studies on estimates of meditation effects (see A-Tjak et al. 2015; Khoury et al. 2013). One analysis found that effect sizes were slightly larger when meta-analyses included low quality studies, but a second analysis found larger effects in high quality studies than low quality studies, and a third analysis found that the average quality of studies included in a meta-analysis was positively correlated with meta-analytic effect size. Nonetheless, several meta-analyses did not provide sufficient information to evaluate the potential influence of study quality on effect size estimates. Thus, future research is needed to evaluate whether and to what extent meditation–health effects are reduced after accounting potential inflation by low quality studies.

Finally, the present research identified types of meditation that have so far received less attention. Specifically, there are relatively few meta-analyses on the health effects of focused attention or yoga, in contrast to the much larger number investigating mindfulness meditation. The present research also found that key details are sometimes missing from published meta-analyses on meditation effects. Future meta-analyses should be sure to report the nature of the included control conditions, statistical model used to aggregate data, methodological quality of the included studies, heterogeneity tests, publication bias tests, and other essential details.

In sum, the present research synthesized an enormous body of data, originally collected by scholars from several disciplines and specialty areas, to evaluate the effect of meditation on health. Results suggest that meditation yields robust, beneficial effects on health regardless of the particular type of meditation or health outcome under consideration. However, additional study is needed to assess the degree to which publication bias and low quality studies have inflated estimates of meditation effects. Future study is also needed to evaluate how the effect of meditation compares with other established treatments. By synthesizing the current state of the literature, the present investigation will inform future studies and meta-analyses examining the effect of meditation on health. The benefits of meditation for health remain tantalizing and should occupy researchers for decades to come.

Authors' Contributions SR designed and executed the metasynthesis, analyzed data, and wrote the paper. EZ assisted with the metasynthesis, data analysis, and writing of the paper. JES collaborated on the metasynthesis, data analysis, and writing of the paper.

Compliance with Ethical Standards

Conflict of Interest Sabrina Rose has been teaching yoga since the summer of 2018. Ethan Zell and Jason Strickhouser declare that they have no conflict of interest.

Informed Consent This article does not contain any studies with human participants or animals performed by any of the authors.

Ethics Statement This article does not contain any studies with human participants or animals performed by any of the authors.

References

Abbott, R. A., Whear, R., Rodgers, L. R., Bethel, A., Coon, J. T., Kuyken, W., et al. (2014). Effectiveness of mindfulness-based stress reduction and mindfulness based cognitive therapy in vascular disease: a systematic review and meta-analysis of randomized controlled trials. *Journal of Psychosomatic Research, 76*(5), 341–351. https://doi.org/10.1016/j.jpsychores.2014.02.012.

Atchley, R., Klee, D., Memmott, T., Goodrich, E., Wahbeh, H., & Oken, B. (2016). Event-related potential correlates of mindfulness meditation competence. *Neuroscience, 320*, 83–92. https://doi.org/10.1016/j.neuroscience.2016.01.051.

A-Tjak, J. G. L., Davis, M. L., Morina, N., Powers, M. B., Smits, J. A. J., & Emmelkamp, P. M. G. (2015). A meta-analysis of the efficacy of acceptance and commitment therapy for clinically relevant mental and physical health problems. *Psychotherapy and Psychosomatics, 84*, 30–36. https://doi.org/10.1159/000365764.

Aucoin, M., Lalonde-Parsi, M. J., & Cooley, K. (2014). Mindfulness-based therapies in the treatment of functional gastrointestinal disorders: a meta-analysis. *Evidence-based Complementary and Alternative Medicine, 2014*, 1–11. https://doi.org/10.1155/2014/140724.

Black, D. S., & Slavich, G. M. (2016). Mindfulness meditation and the immune system: a systematic review of randomized controlled trials. *Annals of the New York Academy of Sciences, 1373*, 13–24. https://doi.org/10.1111/nyas.12998.

Bonett, D. G. (2009). Meta-analytic interval estimation for standardized and unstandardized mean differences. *Psychological Methods, 14*, 225–238. https://doi.org/10.1037/a0016619.

Borenstein, M., Hedges, L. V., Higgins, J. P. T., & Rothstein, H. R. (2009). Converting among effect sizes. In M. Borenstein, L. V. Hedges, J. P. T. Higgins, & H. R. Rothstein (Eds.), *Introduction to meta-analysis* (pp. 45–49). Chichester: Wiley. https://doi.org/10.1002/9780470743386.ch7.

Boutron, I., Moher, D., Altman, D. G., Schulz, K. F., & Ravaud, P. (2008). Extending the CONSORT statement to randomized trials of nonpharmacologic treatment: explanation and elaboration. *Annals of Internal Medicine, 148*, 295–309. https://doi.org/10.7326/0003-4819-148-4-200802190-00008.

Brozek, J. L., Akl, E. A., Alonso-Coello, P., Lang, D., Jaeschke, R., Williams, J. W., et al. (2009). Grading quality of evidence and strength of recommendations in clinical practice guidelines. *Allergy, 64*(5), 669–677. https://doi.org/10.1111/j.1398-9995.2009.01973.x.

Chen, K. W., Berger, C. C., Manheimer, E., Forde, D., Magidson, J., Dachman, L., & Lejuez, C. W. (2012). Meditative therapies for reducing anxiety: a systematic review and meta-analysis of randomized controlled trials. *Depression and Anxiety, 29*(7), 545–562. https://doi.org/10.1002/da.21964.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Hillsdale: Lawrence Erlbaum Associates.

Cooper, H., & Koenka, A. C. (2012). The overview of reviews: unique challenges and opportunities when research syntheses are the principal elements of new integrative scholarship. *American Psychologist, 67*(6), 446–462. https://doi.org/10.1037/a0027119.

Dahl, C. J., Lutz, A., & Davidson, R. J. (2015). Reconstructing and deconstructing the self: cognitive mechanisms in meditation practice. *Trends in Cognitive Sciences, 19*, 515–523. https://doi.org/10.1016/j.tics.2015.07.001.

Davidson, R. J., & Kaszniak, A. W. (2015). Conceptual and methodological issues in research on mindfulness and meditation. *American Psychologist, 70*(7), 581–592. https://doi.org/10.1037/a0039512.

Davis, D. M., & Hayes, J. A. (2011). What are the benefits of mindfulness? A practice review of psychotherapy related research. *Psychotherapy, 48*, 198–208. https://doi.org/10.1037/a0022062.

Egger, M., Smith, G. D., Schneider, M., & Minder, C. (1997). Bias in meta-analysis detected by a simple, graphical test. *BMJ, 315*(7109), 629–634. https://doi.org/10.1136/bmj.315.7109.629.

Garland, E. L., Farb, N. A., Goldin, P. R., & Fredrickson, B. L. (2015). Mindfulness broadens awareness and builds eudaimonic meaning: a process model of mindful positive emotion regulation. *Psychological Inquiry, 26*(4), 293–314. https://doi.org/10.1080/1047840X.2015.1064294.

Gong, H., Ni, C., Shen, X., Wu, T., & Jiang, C. (2015). Yoga for prenatal depression: a systematic review and meta-analysis. *BMC Psychiatry, 15*, 1–8. https://doi.org/10.1186/s12888-015-0393-1.

Gong, H., Ni, C., Liu, Y., Zhang, Y., Su, W., Lian, Y., & Jiang, C. (2016). Mindfulness meditation for insomnia: a meta-analysis of randomized controlled trials. *Journal of Psychosomatic Research, 89*, 1–6. https://doi.org/10.1016/j.jpsychores.2016.07.016.

Goyal, M., Singh, S., Sibinga, E. S., Gould, N. F., Rowland-Seymour, A., Sharma, R., & Haythornthwaite, J. A. (2014). Meditation programs for psychological stress and well-being: a systematic review and meta-analysis. *JAMA Internal Medicine, 174*(3), 357–368. https://doi.org/10.1001/jamainternmed.2013.13018.

Higgins, J. P., Lane, P. W., Anagnostelis, B., Anzures-Cabrera, J., Baker, N. F., Cappelleri, J., & Whitehead, A. (2013). A tool to assess the quality of a meta-analysis. *Research Synthesis Methods, 4*(4), 351–366. https://doi.org/10.1002/jrsm.1092.

Hilton, L., Maher, A. R., Colaiaco, B., Apaydin, E., Sorbero, M. E., Booth, M., & Hempel, S. (2016). Meditation for posttraumatic stress: systematic review and meta-analysis. *Psychological Trauma: Theory, Research, Practice, and Policy, 9*(4), 453–460. https://doi.org/10.1037/tra0000180.

Hodes, G. E., Pfau, M. L., Leboeuf, M., Golden, S. A., Christoffel, D. J., Bregman, D., & Russo, S. J. (2014). Individual differences in the peripheral immune system promote resilience versus susceptibility to social stress. *Proceedings of the National Academy of Sciences, 111*(45), 16136–16141. https://doi.org/10.1073/pnas.1415191111.

Hölzel, B. K., Lazar, S. W., Gard, T., Schuman-Olivier, Z., Vago, D. R., & Ott, U. (2011). How does mindfulness meditation work? Proposing mechanisms of action from a conceptual and neural perspective. *Perspectives on Psychological Science, 6*(6), 537–559. https://doi.org/10.1177/1745691611419671.

Kabat-Zinn, J. (2016). *Mindfulness for beginners: reclaiming the present moment-and your life*. Louisville: Sounds True.

Khoury, B., Lecomte, T., Fortin, G., Masse, M., Therien, P., Bouchard, V., et al. (2013). Mindfulness-based therapy: a comprehensive meta-analysis. *Clinical Psychology Review, 33*, 763–771. https://doi.org/10.1016/j.cpr.2013.05.005.

Kok, B. E., Waugh, C. E., & Fredrickson, B. L. (2013). Meditation and health: the search for mechanisms of action. *Social and Personality Psychology Compass, 7*(1), 27–39. https://doi.org/10.1111/spc3.12006.

Kumar, V., Jagannathan, A., Philip, M., Thulasi, A., Angadi, P., & Raghuram, N. (2016). Role of yoga for patients with type II diabetes mellitus: a systematic review and meta-analysis. *Complementary Therapies in Medicine, 25*, 104–112. https://doi.org/10.1016/j.ctim.2016.02.001.

Lenz, A. S., Hall, J., & Smith, L. B. (2016). Meta-analysis of group mindfulness-based cognitive therapy for decreasing symptoms of acute depression. *Journal for Specialists in Group Work, 41*(1), 44–70. https://doi.org/10.1080/01933922.2015.1111488.

Lipsey, M. W. (1990). *Design sensitivity: Statistical power for experimental research*. Newbury Park: Sage.

Ludwig, D. S., & Kabat-Zinn, J. (2008). Mindfulness in medicine. *JAMA., 300*(11), 1350–1352. https://doi.org/10.1001/jama.300.11.1350.

Lutz, A., Slagter, H. A., Dunne, J. D., & Davidson, R. J. (2008). Attention regulation and monitoring in meditation. *Trends in Cognitive Sciences, 12*(4), 163–169. https://doi.org/10.1016/j.tics.2008.01.005.

Maglione, M. A., Maher, A. R., Ewing, B., Colaiaco, B., Newberry, S., Kandrack, R., & Hempel, S. (2017). Efficacy of mindfulness meditation for smoking cessation: a systematic review and meta-analysis. *Addictive Behaviors, 69*, 27–34. https://doi.org/10.1016/j.addbeh.2017.01.022.

Nater, C., & Zell, E. (2015). Accuracy of social perception: an integration and review of meta-analyses. *Social and Personality Psychology Compass, 9*(9), 481–494. https://doi.org/10.1111/spc3.12194.

National Institutes of Health. (2017). *Use of complementary health approaches in the U.S.* Retrieved from https://nccih.nih.gov/research/statistics/NHIS/2012/mind-body/meditation

Park, A. (2017). *Meditation may help against heart disease, says American Heart Association*. Retrieved from http://time.com/4959725/meditation-heart-disease-stress/

Sedlmeier, P., Eberth, J., Schwarz, M., Zimmermann, D., Haarig, F., Jaeger, S., & Kunze, S. (2012). The psychological effects of meditation: a meta-analysis. *Psychological Bulletin, 138*(6), 1139–1171. https://doi.org/10.1037/a0028168.

Segerstrom, S. C., & Miller, G. E. (2004). Psychological stress and the human immune system: a meta-analytic study of 30 years of inquiry. *Psychological Bulletin, 130*, 601–630. https://doi.org/10.1037/0033-2909.130.4.601.

Shuster, J. J. (2010). Empirical vs. natural weighting in random effects meta-analysis. *Statistics in Medicine, 29*, 1259–1265. https://doi.org/10.1002/sim.3607.

Spijkerman, M., Pots, W., & Bohlmeijer, E. (2016). Effectiveness of online mindfulness-based interventions in improving mental health: a review and meta-analysis of randomized controlled trials. *Clinical Psychology Review, 45*, 102–114. https://doi.org/10.1016/j.cpr.2016.03.009.

Steinhubl, S. R., Wineinger, N. E., Patel, S., Boeldt, D. L., Mackellar, G., Porter, V., & Topol, E. J. (2015). Cardiovascular and nervous system changes during meditation. *Frontiers in Human Neuroscience, 9*, 1–10. https://doi.org/10.3389/fnhum.2015.00145.

Strickhouser, J. E., Zell, E., & Krizan, Z. (2017). Does personality predict health and well-being? A metasynthesis. *Health Psychology, 36*(8), 797–810. https://doi.org/10.1037/hea0000475.

Tang, Y., Hölzel, B. K., & Posner, M. I. (2015). The neuroscience of mindfulness meditation. *Nature Reviews Neuroscience, 16*(4), 213–225. https://doi.org/10.1038/nrn3954.

Van Dam, N. T., van Vugt, M. K., Vago, D. R., Schmalzl, L., Saron, C. D., Olendzki, A., et al. (2017). Mind the hype: a critical evaluation and prescriptive agenda for research on mindfulness and meditation.

Perspective on Psychological Science, 13(1), 36–61. https://doi.org/10.1177/1745691617709589.
Veehof, M. M., Trompetter, H. R., Bohlmeijer, E. T., & Schreurs, K. G. (2016). Acceptance- and mindfulness-based interventions for the treatment of chronic pain: a meta-analytic review. *Cognitive Behavior Therapy, 45*(1), 5–31. https://doi.org/10.1080/16506073.2015.1098724.
Zell, E., & Krizan, Z. (2014). Do people have insight into their abilities? A metasynthesis. *Perspectives on Psychological Science, 9*(2), 111–125. https://doi.org/10.1177/1745691613518075.
Zell, E., Krizan, Z., & Teeter, S. R. (2015). Evaluating gender similarities and differences using metasynthesis. *American Psychologist, 70*(1), 10–20. https://doi.org/10.1037/a0038208.