

Randomized Controlled Trials of Mindfulness and Acceptance-Based Interventions Over the Past Two Decades: A Bibliometric Analysis

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Abstract

Introduction: The past several years have witnessed a significant increase in interest among the public in mindfulness with an unmistakable growth in the scientific literature investigating mindfulness-based therapies. A myriad of therapeutic uses of mindfulness have been studied. Given this burgeoning interest, the authors' objective was to conduct a broad-sweeping bibliometric analysis over the past two decades to describe overarching trends in the publications of randomized controlled trials (RCTs) investigating mindfulness to broadly identify both strengths and gaps in this field and inform a strategic plan for further advancing this research area.

Materials and Methods: The authors retrieved mindfulness-focused RCTs available on PubMed in the past two decades (2000–2019). They synthesized the literature with respect to publication numbers, countries of publication, journal type, areas of research focus, characteristics of study designs, sample size, and trends in remote intervention delivery.

Results: The resulting 1389 publications represent a near exponential growth trend over the past 20 years. Publications from the top three countries (the United States, the United Kingdom, and the Netherlands) with the highest productivity accounted for 60% of total number of publications. The most published modalities include acceptance-based therapy ($n=260$), mindfulness-based stress reduction ($n=238$), mindfulness-based cognitive therapy ($n=174$), and dialectical behavior therapy ($n=82$). Stress, depression, anxiety, pain, cancer, diet/healthy eating, and sleep were the most common major areas of focus. Studies included active (46%) or inactive controls (44%), and increasingly more studies with both types of controls (10%). The top 10 journals that published the most mindfulness RCTs were from behavioral sciences and psychiatry or psychology. There were 187 RCTs utilizing remote delivery, with 146 (87.1%) in the most recent 5 years.

Conclusion: Publications of mindfulness-focused RCTs show a continuous increasing trend. Mindfulness research from non-Western countries and studies published in biomedical journals were less prevalent and potentially represent future opportunities. Trends of studies with both inactive and active controls support an overall advancement in research methodology. There has been a significant expansion of studies of remotely delivered mindfulness interventions. Future research might consider evaluation of a broader range of modalities and further examine optimal delivery formats.

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Introduction

MINDFULNESS IS AN UMBRELLA TERM that characterizes a large number of practices, processes, and characteristics relating to the capacities of attention and awareness.¹ Mindfulness-focused interventions, which aim to foster present moment awareness with an attitude of nonjudgment, openness, and curiosity,² have become increasingly popular in many fields, including health care, education, and business. While mindfulness has its historical footing in Buddhism, early mindfulness-based interventions (MBIs), including mindfulness-based stress reduction (MBSR) and mindfulness-based cognitive therapy (MBCT), helped popularize mindfulness in the West across clinical and nonclinical populations. Interest in the therapeutic use of mindfulness has surged over the past decade. There has been a growth in third wave psychological therapies, including acceptance-based interventions, which also engage the same core processes and share a common goal—to change one’s relationship to internal experiences (i.e., through decentering) to enable a nonjudgmental and nonreactive stance toward these experiences. Existing reviews with a focus on mindfulness often include acceptance-based interventions.^{3–14} Systematic reviews and meta-analyses have shown that MBIs have positive effects on stress,^{15–17} depression and anxiety,^{18–21} insomnia,^{22–24} chronic pain,^{25–30} substance abuse,^{31–33} post-traumatic stress disorder,^{34,35} bipolar disorder,³⁶ psychosis,^{10,37} eating behavior,^{6,38} and body weight.^{12,39} Additional evidence has also shown that MBIs may enhance personal well-being, perceptual sensitivity, processing speed, empathy, concentration, reaction time, motor skills, immune function, and performance outcomes.^{40–45}

Despite the considerable number of mindfulness-related studies published over the past decades, there have been relatively few efforts to systematically describe the broader trends in mindfulness research. In 2016, Valerio⁴⁶ published a bibliometric analysis (based on Web of Science) reviewing the mindfulness literature (from years before 2014) with a focus on trends as it relates to Buddhist contexts. In 2017, Chiesa et al.⁴⁷ published an analysis of systematic reviews on MBIs retrieved in Scopus. Most recently, in 2020, Mann et al.⁴⁸ published a bibliometric analysis on stress and mindfulness, including 103 publications from the Scopus database from 2008 to 2019. While each have been informative, they have targeted specific topics in mindfulness and include relatively small numbers of publications in the analyses. The broader overarching trends in mindfulness research in the biomedical field remain unknown to the academic community.

An examination of publication trends is critical for understanding the quantity, quality, origin, and nature of existing mindfulness-focused studies and identifying avenues of future research. Bibliometrics is a set of methods used to quantitatively analyze academic literature⁴⁹ and is useful in revealing historical development⁵⁰ and quantitative trends of publications.⁵¹ Bibliometric methods have been applied to medical-related topics,^{52–59} including integrative medicine.^{60–62} Findings from bibliometric analyses are used to identify broad-scale strengths and gaps in a research field and to inform a comprehensive strategic plan for advancing

the field. To date, such summary of worldwide trends in mindfulness intervention research publications has not been completed.

MBIs are typically delivered in-person by trained professionals, which limits the accessibility of these interventions in the general population. More recently, the delivery of online mindfulness training tools, using web-based programs, mobile apps, and other technological platforms, has become increasingly popular.^{63,64} Remote delivery of these interventions has the potential to be more cost-effective, accessible, and flexible^{65,66}; however, the trends in the existing research on technology-based remote delivery of MBIs remain unclear.

This study aimed to quantitatively analyze trends in published mindfulness randomized controlled trials (RCTs) over the past two decades. Specifically, the authors sought to examine the following trends in mindfulness research over the past 20 years: (1) quantity of publications, (2) countries with high productivity, (3) journals with a high number of published RCTs and their recent impact factors (IFs), (4) the most commonly used treatment modalities, (5) the most commonly studied medical/psychological conditions, (6) study design characteristics (e.g., intervention and control arms, study duration, and sample size), and (7) quantity of publications focused on remote delivery of mindfulness practice/intervention.

Materials and Methods

Search strategies

PubMed is a free resource that is developed and maintained by the National Center for Biotechnology Information, at the U.S. National Library of Medicine (NLM), located at the National Institutes of Health (NIH). PubMed comprises over 30 million citations for biomedical literature from MEDLINE, life science journals, and online books. Publications on PubMed include the fields of biomedicine and health, covering portions of the life sciences, behavioral sciences, chemical sciences, and bioengineering. PubMed will archive the complete contents of any MEDLINE journal that meet their technical standards, regardless of language.

A professional medical librarian assisted the development of the search strategy. The literature search in MEDLINE (PubMed) was customized to include controlled vocabulary and free text synonyms of mindfulness, including individual modalities (e.g., MBSR, MBCT, and acceptance and commitment therapy [ACT]). Following prior literature, the authors chose to include acceptance-based interventions (third wave therapies) in the review.^{3–14}

The literature search was performed in July 2020; therefore, the authors used Medical Subject Heading (MeSH) terms, title words, and author keywords in PubMed/MEDLINE, with specified publication dates from January 1, 2000 to December 31, 2019 to cover the past two decades. In addition, since the journal *Mindfulness* is not comprehensively indexed in MEDLINE, the authors retrieved and manually searched all available publications from that journal appearing in PubMed (a limited proportion of the total Mindfulness publications) and identified RCTs that met the inclusion criteria. For some analyses, the past

20 years were grouped into 5-year increments to indicate the change in trends. Retrieved results were then further screened to include only RCTs using PubMed filters.

Data analyses

Raw data were retrieved using PubMed's export function, and was processed by a MatLab-based program to extract the following information for each record: year of publication, publication date, title of publication, abstract, authors' names, authors' affiliations, language, journal title, publication type, MeSH terms, authors' keywords, place of publication, and funding information. All results were manually checked by the first author.

PubMed/MEDLINE makes use of a controlled subject vocabulary, MeSH, which are assigned to records by subject specialists who read the associated articles. MeSH terms are arranged hierarchically by subject categories with more specific terms arranged beneath broader terms. Applying the MeSH vocabulary ensures that articles are uniformly and systemically indexed by research topic, regardless of the words used by the authors.⁶⁷ This makes it possible to analyze the major topics in each article and to explore publication trends and changes in focus over time. In addition to MeSH terms, the authors also considered title and authors' keywords to capture the information of interest.

An IF is commonly used to evaluate the relative importance of a journal within its field and to measure the frequency with which the "average article" in a journal has been cited in a particular time period.⁶⁸ To describe the journals' impact, the authors used Journal Citation Reports released IF, which is the most frequently used tool for evaluating journal performance within its field. Journal IF is defined as the year's average number of citations per article published in a specific journal during the preceding 2 years.

For the analyses of study design characteristics, the authors manually checked abstracts or full texts of each published article and extracted data, including intervention group, control group, total number of intervention and control groups, weeks of intervention, total number of subjects, and number of subjects in each group. MBI modality was coded based on the manually extracted data. Interventions

that did not use a single established mindfulness intervention protocol (e.g., MBSR and MBCT) were categorized as "other mindfulness intervention," and included (1) multi-modal combinations of different types of mindfulness protocols/strategies, (2) protocols specifically developed for the study or population, or (3) experimental mindfulness inductions, as the authors were interested in broad characterizations of trends in mindfulness research.

Mindfulness intervention delivery was considered remote if it was delivered through telephone, video, internet-based platforms, or smartphone/mobile applications. Title, authors' key words, MeSH terms, and abstracts (or full text if necessary) were screened to determine whether the intervention was delivered remotely. If a study only involved remote assessment of the outcomes, but had no remote delivery of intervention, it was not included in this part of the analysis.

This bibliometric analysis did not involve a research protocol requiring approval by the relevant Institutional Review Board or ethics committee.

Results

Quantity of mindfulness publications

Results revealed 1389 publications on mindfulness-focused RCTs. Among them, 1374 (98.9%) were published as original full-length journal articles and 15 (1.1%) were published as letters with detailed report of RCT outcomes. One hundred five (7.6%) publications were protocols that only reported RCT rationale and design. In terms of language, 1376 (99.1%) articles were published in English. The number of mindfulness RCT publications (Fig. 1) showed a near exponential increase over the past two decades. The total number of publications in recent decades (2010–2019, $n = 1277$) is more than 10 times that of the previous decade (2000–2009, $n = 112$).

Countries with high productivity

Publications originated from 39 countries (Fig. 2, created with mapchart.net). Over the past two decades, the United States was the leading country with mindfulness RCT publications

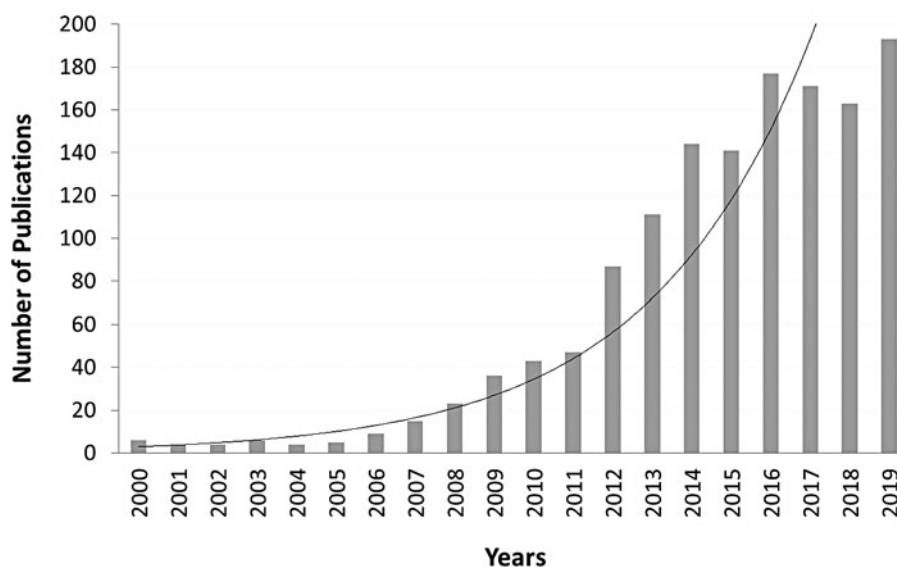


FIG. 1. Trends of mindfulness research in the past two decades.



FIG. 2. Productivity of the contributing countries.

($n=616$), followed by the United Kingdom ($n=109$) and the Netherlands ($n=100$). Other countries within the top 10 of total publications included Australia, Canada, Sweden, Germany, China, Spain, and Denmark. Only the top two ranked countries (the United States and the United Kingdom) remained consistent over time. Globally, the total annual publication output increased from 24 in the first 5 years (2000–2004) to 845 in the last 5 years (2015–2019).

Journal analysis

Most journals that published mindfulness RCTs were from the fields of behavioral sciences, psychiatry or psychology, with other journals from multiple fields, including integrative medicine and general medicine. The top 10

journals that published the most mindfulness RCTs were *Behaviour Research and Therapy* (6.3%), *Journal of Consulting and Clinical Psychology* (3.7%), *Trials* (2.4%), *Behavior Therapy* (2.2%), *Mindfulness* (2.0%), *Contemporary Clinical Trials* (1.9%), *BMC Psychiatry* (1.9%), *Journal of Clinical Psychology* (1.8%), *PLoS One* (1.7%), and *Psychotherapy and Psychosomatics* (1.4%) (Table 1).

Analysis on modalities

The most commonly studied modalities included ACT or acceptance-based behavior therapy ($n=260$), MBSR ($n=238$), MBCT ($n=174$), dialectical behavior therapy (DBT, $n=82$), and mindfulness-based movement (Yoga, Tai Chi, *qigong*, $n=68$). Four hundred ninety-seven publications

TABLE 1. JOURNALS THAT PUBLISHED THE MOST MINDFULNESS-FOCUSED RANDOMIZED CONTROLLED TRIALS DURING 2000–2019

Rank	Journal name	Total records	Journal category	2019 IF	5-year IF
1	Behaviour Research and Therapy	88	Psychology, clinical	4.500	5.174
2	Journal of Consulting and Clinical Psychology	51	Psychology, clinical	4.632	5.879
3	Trials	33	Medicine, research and experimental	1.883	2.185
4	Behavior Therapy	30	Psychology, clinical; psychiatry	3.243	4.036
5	Mindfulness ^a	28	Psychology, clinical; psychiatry	3.581	4.559
6	BMC Psychiatry	27	Psychiatry	2.704	3.386
7	Contemporary Clinical Trials	26	Pharmacology and pharmacy; medicine, research and experimental	1.832	2.480
8	Journal of Clinical Psychology	25	Psychology, clinical	2.138	2.824
9	PLoS One	24	Multidisciplinary sciences	2.740	3.226
10	Psychotherapy and Psychosomatics	20	Psychology; psychiatry	14.864	14.050

^aThe actual number of RCTs published in the journal *Mindfulness* is larger; however, *Mindfulness* is not currently indexed for MEDLINE so citations from the journal are limited in PubMed.

IF, impact factor indicated by Journal Citation Reports (JCR), published by Clarivate Analytics; RCTs, randomized controlled trials.

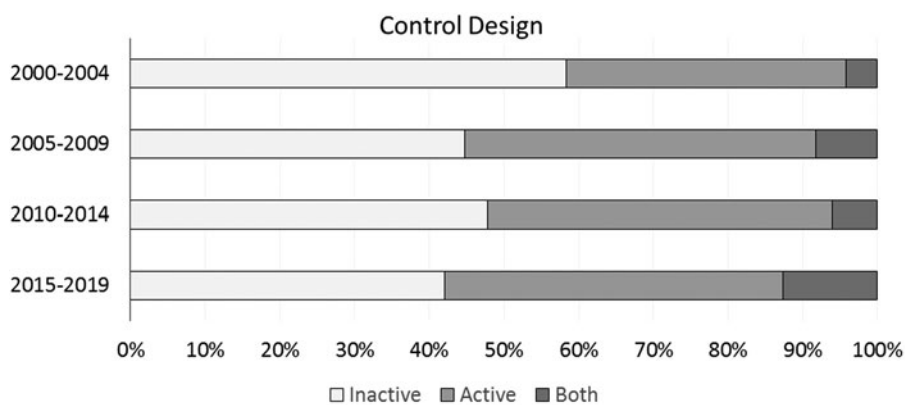


FIG. 3. Control design for the comparison groups.

included an intervention categorized as an “other mindfulness intervention.” Newer or customized modalities included mindfulness-based relapse prevention ($n=14$), mindfulness-oriented recovery enhancement ($n=12$), mindfulness-based cancer recovery ($n=9$), mindfulness-based eating awareness training ($n=8$), mindful awareness in body-oriented therapy ($n=5$), mindfulness training for smokers ($n=4$), mindfulness-based addiction treatment ($n=3$), and mindful self-compassion ($n=3$). Among the included RCTs, the most common duration of intervention was 6–12 weeks ($n=900$).

Study design and sample size

Among the retrieved data, 598 publications used inactive controls (e.g., usual care, wait list, and no intervention), 617 publications were with active controls (e.g., cognitive behavioral therapy, health enhancement program [HEP], relaxation intervention, and attention training), 131 publications involved both active and inactive controls (Fig. 3), and 43 publications had insufficient information to identify their comparison designs. Over the studied years, the percentage of active controls remained relatively stable (37.5%, 47.1%, 46.1%, 45.3% in each 5-year period). The percentage of inactive controls has decreased (58.3% in the first 5 years to 42.0% in the last 5 years), while the percentage of studies with both inactive and active controls has increased (4.2% in the first 5 years to 12.6% in the last 5 years). Most of the RCTs had two arms ($n=1113$) or three arms ($n=246$). A small number of RCTs had four or more arms ($n=31$), including nine RCTs with a factorial design in the past 10

years. In terms of the sample size, although small- to medium-sized studies were dominant, relatively larger sized studies were also available, with 146 published studies (plus 20 protocols) including over 200 study participants (Fig. 4).

Main research focus of mindfulness application on medical conditions

Table 2 shows the top 10 medical conditions that appeared in retrieved articles. The most commonly studied areas include stress, depression, anxiety, pain, cancer, substance-related disorders, diet/eating, sleep, obesity or weight control, and personality disorder. Other conditions included but were not limited to fatigue, post-traumatic stress disorder, diabetes, addiction, smoking cessation, and pregnancy.

Remote delivery of mindfulness practice/intervention

Among the retrieved records, 187 publications were identified as involving remote delivery of mindfulness practice/intervention (Fig. 5a). Among them, 146 articles (78.1%) were published in the past 5 years (Fig. 5b), indicating a significantly increasing trend of remote delivery of mindfulness over the past two decades.

Discussion

This study quantitatively reviewed the publication trends of mindfulness-focused RCTs over the past two decades (2000–2019). The 1389 publications retrieved from PubMed

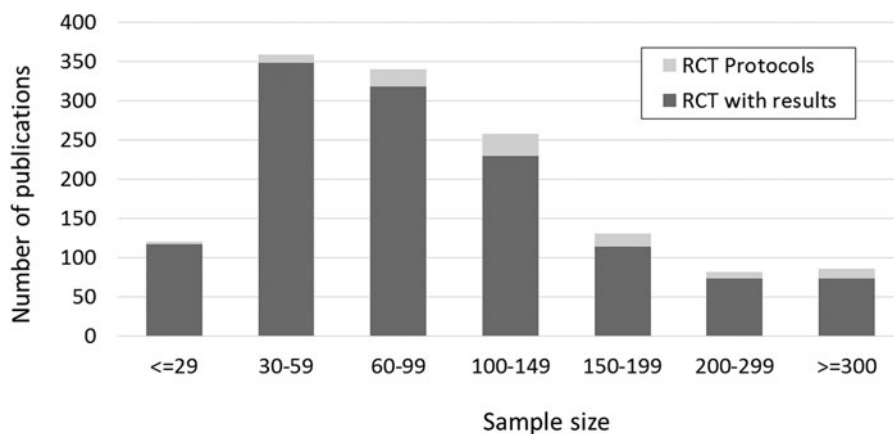


FIG. 4. Sample size of the included mindfulness-focused RCTs. RCTs, randomized controlled trials.

TABLE 2. OVERALL RANKING OF RESEARCH FOCUS ON MEDICAL CONDITIONS IN THE PAST 20 YEARS

Rank	Medical conditions	Records of publications	Percentage of total
1	Stress/burnout	508	36.57
2	Depression/depressive disorder	356	25.63
3	Anxiety	299	21.53
4	Pain	168	12.10
5	Cancer/neoplasm	125	9.00
6	Substance-related disorders	108	7.78
7	Sleep	72	5.18
8	Diet/eating	72	5.18
9	Obesity/weight control	55	3.96
10	Personality disorder	54	3.89

demonstrated a near exponential growth over the past two decades. In the past several years, numbers suggest that mindfulness publications may be leveling off (177 in 2016, 171 in 2017, 163 in 2018, and 193 in 2019), having reached a stable level that may remain consistent over the next several years. However, given that 2019 saw the greatest number of publications, continued growth in 2020 is still possible.

Countries with the highest productivity were mostly Western countries (e.g., the top countries, the United States, the United Kingdom, the Netherlands, Australia, Canada, Sweden, and Germany). The most commonly published modalities of mindfulness, which were all developed in Western countries, included acceptance-based therapy, MBSR, MBCT, and DBT. Globally, although the number of contributing countries has increased, this number is still relatively small and the distribution of the countries is scattered. Many non-English journals may not be included in the PubMed database, and it is possible that many RCTs were published in their local native non-English journals. Unfortunately, non-English publications are, in general, less accessible to authors, much less cited in the literature, and are thus less likely to be known to the global scientific community at large.⁶⁹ These findings suggest that MBIs, which were developed in Western countries and studied by predominately Western researchers, may not generalize to populations in non-Western countries. Indeed, some research has found that Western-derived interventions for psychological problems can conflict with norms of non-Western populations.⁷⁰⁻⁷² It is possible that there are many other forms of mindfulness practice or localized MBIs from non-Western countries that were not captured in the search (i.e., non-English journals not included in PubMed).

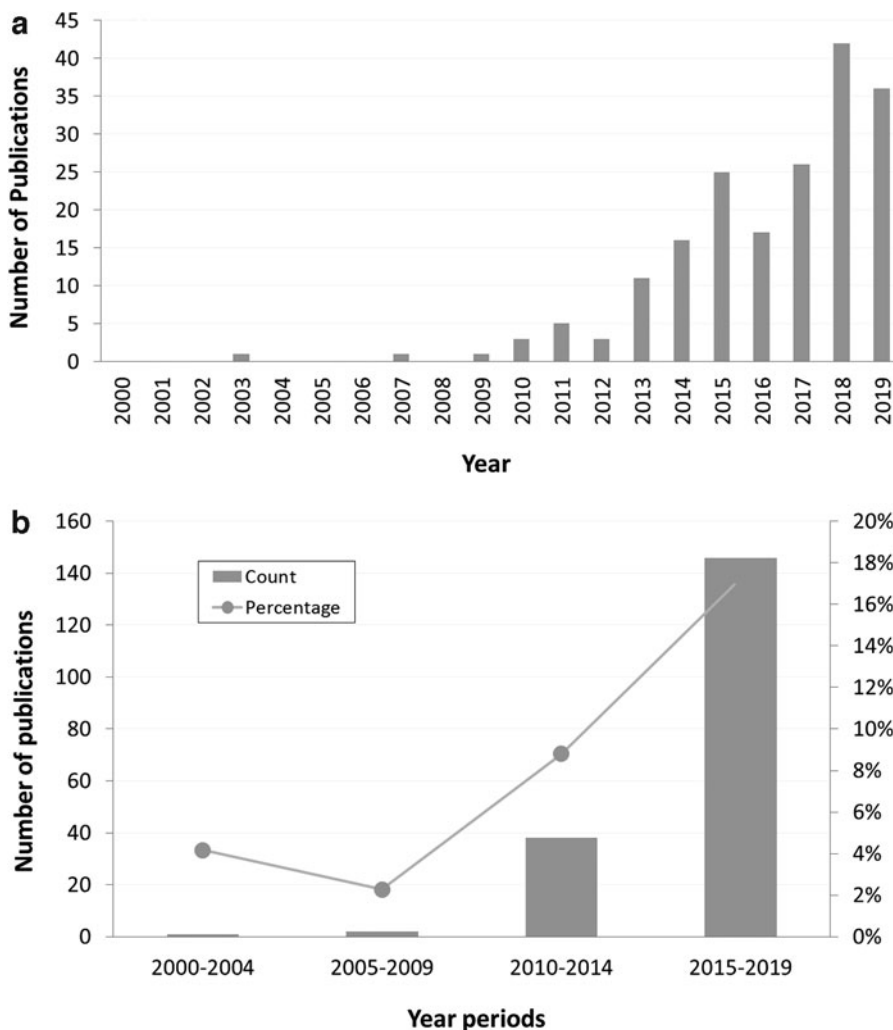


FIG. 5. Remote delivery of mindfulness practice/intervention. (a) Annual records of publications involving remote delivery of mindfulness. (b) Numbers of publications involving remote delivery of mindfulness in each 5-year period.

Although the authors found some research from other areas of the world (e.g., China, India, Iran, Korea, South Korea, Malaysia, Brazil, Chile, and Singapore), further growth of mindfulness research from non-Western countries is needed for broader reach to the global academic community.

This analysis found that stress, depression, anxiety, and pain have been the most commonly studied conditions in mindfulness RCTs. This finding is not surprising given that early MBIs (i.e., MBSR and MBCT) were explicitly developed for pain, stress management, and depression relapse^{73,74} and several proposed mechanisms of mindfulness (e.g., self-regulation and attention regulation⁷⁵) may be directly applicable to these issues. Substantial evidence from RCTs indicated that properly designed and delivered mindfulness meditation can perform comparably to established treatments for specific domains of psychopathology, including depression, anxiety, and chronic pain.⁷⁶ Meanwhile, most journals that published mindfulness RCTs were from the fields of behavioral sciences and psychiatry or psychology. Much fewer studies focused on medical conditions and a relatively smaller proportion of studies were published in biomedical journals, representing a potential avenue for future research. Indeed, the burgeoning literature on mindfulness for various medical conditions and for promoting behavior change has been promising.⁷⁷ For example, mindfulness interventions target co-occurring psycho-emotional symptoms that are common across chronic medical conditions, can lead to worsening physical health outcomes,⁷⁸ and engage processes key to positive healthy behavior change (e.g., self-efficacy for exercise⁷⁹). Researchers should consider publishing research in this area explicitly in biomedical journals for broader dissemination of findings.

Among the retrieved publications with sufficient information, a similar number of studies included active and inactive controls. Studies with both active and inactive controls accounted for less than 1/10th of all RCTs. Two-armed RCTs were dominant, suggesting that researchers are comparing mindfulness interventions to either active or inactive controls or conducting comparative effectiveness studies (i.e., comparing mindfulness interventions to other established interventions). The percentage of publications with inactive controls decreased over the past two decades, whereas the percentage of publications with both inactive and active controls increased. Among the reviewed studies, the most commonly used comparison groups included wait-list controls, treatment as usual or no treatment, HEP, psychoeducation/health education, attention control, cognitive behavioral therapy, support group, and relaxation. Meanwhile, there were only nine RCTs with factorial designs. Given the state of the science and efforts to better understand active components and optimize interventions (e.g., utilizing the MOST framework⁸⁰), the authors might expect to see more factorial clinical trials in the future. Although small- to medium-sized studies were dominant, it is noteworthy that more than 1/10th of the studies (146 completed RCTs and 20 RCT protocols, about 12% of total publications) included relatively larger sample sizes of over 200 study participants. Although this bibliometric analysis cannot comment directly on potential bias in the retrieved studies, with small samples being a common limitation, these findings might suggest that the proportion of ade-

quately powered studies in mindfulness research may be increasing. The authors also note that the intensity and duration of participants' formal practice varied considerably across studies.⁸¹ Implications of such heterogeneity should be further considered.

The authors' findings also point to growing interest in disseminating mindfulness practices through technology-based approaches. The authors found that the greatest growth of mindfulness RCT research involving remote delivery occurred in the past 5 years, although the total percentage of these publications (13.46%) remains relatively small. MBIs are typically delivered in-person, which limits the accessibility of these interventions in the general population. Moreover, there are still relatively few well-trained mindfulness practitioners. Technology-based approaches can improve accessibility to health care and decrease the burden associated with scheduling and travel, costs, long wait lists, or a lack of trained providers. There is a growing literature supporting the remote delivery of mindfulness, but evidence of their effectiveness has been mixed.⁸² Because most of these studies used inactive controls (e.g., waiting list controls), it is difficult to draw conclusions on the efficacy of remotely delivered mindfulness interventions and whether these interventions are similarly efficacious as in-person mindfulness treatment. It should be noted that the authors' search only covered publications until the end of 2019. Given the coronavirus disease 2019 pandemic and global quarantine starting in early 2020, this sector of research might be expected to balloon in the coming years.

To the authors' knowledge, this study is the first bibliometric analysis of mindfulness-focused RCTs. In contrast to conventional bibliometric approaches, the authors manually screened and extracted data (e.g., study design, comparison groups, sample size, and duration of intervention) to provide a more comprehensive review of the state of mindfulness research. However, the authors acknowledge the limitations of this study. First, some journals are not currently indexed for MEDLINE, so citations from those journals are not added to PubMed unless the study was supported by NIH funding or available as free full text in PubMed Central. For example, the journal *Mindfulness* is not indexed for MEDLINE and only 206 publications (28 RCTs) were searchable in PubMed. Given that the total number of publications from the journal *Mindfulness* on Web of Science during the same time period was 1433, the authors estimate that they have captured only 15% of total RCTs. Meanwhile, such phenomenon is universal in database-dependent bibliometric analyses. While there are other databases available for bibliometric studies (e.g., Web of Science, Scopus, Embase, PsychNet, and CINAHL), PubMed was chosen due to overall inclusivity, timely updates, and the authors' primary interest in a more biomedical focus. Second, the authors did not include explicit search terms related to movement-based mind-body interventions, such as Tai Chi and Yoga; however, if these interventions were described as mindfulness focused, they were included in the data. Therefore, separate bibliometric analyses for these movement-based interventions may be warranted. Consistent with most bibliometric analyses, given that many non-English journals are not included in the PubMed database, it is possible that the authors' search missed several non-English studies, limiting the generalizability of the findings.

Conclusion

Publications of mindfulness RCTs demonstrated a near exponential growth over the past 20 years, with most of that growth occurring over the past 10 years. However, there are still several gaps in mindfulness research and avenues for future study. More studies from non-Western countries are needed, along with studies examining mindfulness for medical conditions and published in biomedical journals. Recent trends indicate growing interest in the remote delivery of mindfulness; however, the relatively small number of published studies suggest that this line of research is still in its infancy.

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Author Disclosure Statement

No competing financial interests exist.

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