# Harnessing Life's Slings and Arrows: The Science and Opportunities for Mindfulness Meditation During a Global Pandemic and Beyond

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## ABSTRACT

We are at a difficult time in history with societal increases in stress, loneliness, and psychopathology, along with high rates of obesity, sedentary lifestyles, and chronic pain. Mindfulness interventions offer promise to address these societal issues. However, in order to make best use of the opportunities revealed by our current challenges, we must: (1) tackle these issues head-on with inclusive, innovative, and creative experimental designs and interventions, and (2) collectively adhere to rigorous, high quality methods so as to provide an evidence-based integration of mindfulness interventions into mainstream medicine and public health.

We find there are several areas for which important advances are happening, including sampling socially diverse populations, examining mechanisms of action, pain management, and health behaviors. Furthermore, rigorous methods, including measurement, causal inference from control groups, delivery and scalability of mindfulness interventions, and effect modifiers to determine who mindfulness programs work best for are also gaining traction. This special issue on *Mindfulness: Biobehavioral Mechanisms and Health Outcomes* attends to many of these issues, several of which are highlighted in this editorial perspective.

**Key words:** mindfulness, meditation, clinical trial, COVID-19, pandemic.

This special issue of *Psychosomatic Medicine* focuses on the biobehavioral mechanisms and health outcomes associated with mindfulness. The articles in this issue were produced during the unprecedented confluence of societal pressures that are likely to shape the future of biobehavioral and psychosocial interventions for years to come. The COVID-19 global pandemic has amplified and drawn into sharp relief issues that have been developing over decades, that will not disappear as concerns about viral transmission abate. Rates of social isolation, loneliness, and mental illness, for example, spiked over the last year (1–3), but they have been on the rise for the last decade. The first half of 2020 showed a 13% increase in opioid-related mortality (4), erasing recent gains made in reducing opioid misuse and opioid-related deaths; however, prevalence of chronic pain in the U.S. prior to the pandemic was greater than 20%, according CDC estimates (5), and the prevalence of problematic opioid use in those with chronic pain was estimated at an astonishing 36% (6). Though COVID-19 exposed disparities in access to healthcare and the economic fragility of millions of Americans, it was not the underlying cause and these challenges will persist. Similarly, the disproportionate impact of COVID-19 on communities of color in the U.S. collided with entrenched patterns of police violence toward unarmed Black and Brown people to ignite a nationwide reckoning with systemic racism in the U.S that has really just begun. This confluence of pressures has highlighted the urgent need for biologically validated, widely accessible, and culturally appropriate behavioral interventions, that can be deployed at scale, to protect against and mitigate the health- and wellbeing-related sequelae. It has also revealed gaps that behavioral interventions are uniquely suited to address, along with opportunities to make in-roads into domains where these interventions have been largely absent.

The COVID-19 pandemic has had a dramatic impact on our social support networks (2), increasing loneliness (3,7) and perceived social isolation (8). During the early months of the pandemic, prevalence of depressive symptoms increased 3-fold and the need for psychological services, particularly for frontline workers, was very high (1). These statistics are startling, and they are superimposed upon an already vulnerable populace. Prior to the pandemic, 33% of middle-age adults in the U.S reported chronic loneliness (9) and perceived social isolation has more than tripled in the last half century (10). Likewise, the pre-COVID prevalence of depression in the adult US population was 8.5%, which has also grown steadily over the last decade (1). These rates of mental distress are noteworthy on their own, but their importance is compounded when considered in light of their impact on physical health. Increased loneliness, for instance, predicts future development of depression and confers risk of all-cause mortality commensurate with that of well-recognized risk factors, such as smoking and obesity (10,11). A longitudinal study of socially isolated children revealed a 37% increase in risk for poor cardiovascular health at age 26 and a 158% increase in risk for children who experienced social isolation across multiple development periods, even after controlling for health behaviors and stressful life events (12). Similarly, depression is a risk factor

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for most major categories of chronic disease (13). Of particular relevance to our current context, the psychosocial challenges amplified by COVID-19 also influence immune system function in the short term, including immune response to vaccination (14), risk of respiratory viral infection (15), and exacerbations of existing chronic diseases (16–18).

Our current context is rife with challenges, but it also presents some compelling opportunities. Many people are experiencing reduced or lost access to healthcare or are looking for ways to improve their mental and physical health on their own. The last two decades of research has established the utility of psychosocial interventions, including mindfulness-based interventions, in ameliorating social and emotional dysfunction and their impacts on physical health (19–23). Building on this solid foundation, we are well-positioned to employ these interventions, and the skills they entrain, to address some of the most pressing concerns that we face. While certainly not a replacement for access to healthcare, mindfulness interventions can be protective, buffering the deleterious effects of chronic stressors, like economic and employment insecurity, on health and building resilience in the face of health disparities.

In order to make best use of the opportunities revealed by the current challenges, it will be important to: (1) tackle these issues head-on with inclusive, innovative, and creative experimental designs and interventions, and (2) collectively adhere to rigorous, high quality methods so as to provide an evidence-based integration of mindfulness interventions into mainstream medicine. This special issue on "Mindfulness: Biobehavioral Mechanisms and Health Outcomes" in *Psychosomatic Medicine* addresses several of these areas, with a focus on the following: (1) The importance of innovative mindfulness research in addressing the current biggest issues in society; (2) the importance of high-quality methodology; and (3) considerations for the future of mindfulness research.

## INNOVATIVE RESEARCH ADDRESSING THE BIGGEST ISSUES OF OUR TIME

### Socially At-Risk Populations

Given the lack of representation for marginalized and historically disenfranchised groups in scientific research, articles in this special issue address these disparities and call out the differential effects that behavioral interventions may have in these populations. For example, Daubenmeir *et al*. report results of a mindfulness-based weight loss intervention and showed an interaction between intervention group, race/ethnicity, and time, where participants of color, compared with white participants, regained more weight in the active control condition, but not in the mindfulness intervention (24). Anderson *et al*. performed an RCT of MBSR vs. social support in women exposed versus unexposed to early life abuse (25). The study showed several differential findings between those exposed to early life abuse vs. not in response to heat pain intensity rating, cortisol, cold pressor tolerance, emotional expression, and impulse control. Furthermore, a study by Amaro and Black, in ethnoculturally diverse women in residential treatment for substance use disorder, showed significant improvements in time delay to first marijuana use in participants receiving the mindfulness program Moment-by-Moment with Women's Recovery (MMWR) (26). These findings show the importance of understanding if, how, and for whom mindfulness programs can help to reverse or mitigate the effects of social determinants of health, such as early life adversity and race.

### Pain

As described above, chronic pain and the opioid misuse that frequently accompanies chronic pain are a significant burden to society. A number of papers addressed this topic in the special issue. For example, Mischkowski *et al*. showed that elevated levels of trait mindfulness were inversely associated with retrospective recollections of pain, but not with immediate experiences of pain, suggesting that mindfulness may influence pain-related cognitive processes (27). Furthermore, the mechanisms of pain modulation may be unique for mindfulness training. For example, Case *et al*. showed that while higher expected pain relief from mindfulness training predicted lower pain intensity, this association was found primarily during opioid receptor blockade (via naloxone infusion) and not during saline infusion. This study found evidence suggesting that non-opioidergic pain modulatory pathways are involved in the pain-relieving effects of mindfulness meditation, such as the PFC-thalamo-cortical pathway (28). Pain has become an increasingly prevalent, debilitating, and costly issue in society and studies such as those described above, and others in this special issue, such as by Davies et al. (29) and Lutz et al (30), identify whether and how mindfulness training can help.

### Health Behaviors

While the COVID pandemic has been raging, the number one cause of mortality world-wide remains cardiovascular disease (CVD), and people at risk for CVD also have greater risk for SARS-CoV-2-related mortality and complications. We know much about what causes CVD, such as poor diet and lack of physical activity (31). We still have little published research specifying how mindfulness interventions impact physical activity, but this is now changing. In this issue, Don *et al*. showed that mindfulness training out-performed loving-kindness meditation for increasing physical activity, perhaps in part through improving positive emotions during physical activity (32). Loucks *et al*. demonstrated significant reductions in sedentary behavior in those who participated in the Mindfulness-Based College program, compared to an enhanced usual care control (33). Sala *et al*. demonstrated that an audio-recorded Mindfulness-Based Physical Activity program significantly improved accelerometer and self-reported physical activity duration compared to an active control group instructed to exercise while using a heart rate monitor (34). Mindfulness training has the potential to foster mental and physical well-being, and these developments in research focused on physical activity are promising.

## THE IMPORTANCE OF HIGH QUALITY METHODS

While addressing these major issues in innovative ways is important, it is also fundamental to do so using methodological rigor. A solid set of robust scientific methods and guidelines are available for mindfulness intervention development and testing, summarized in Table 1. Below we describe some of the key methods that articles in this special issue exemplify, for which advances are needed.

**TABLE 1.** Models that Support Methodologically Robust Mindfulness Research

| Model | Description |
|---|---|
| NIH Stage Model (35,36) | Emphasizes the entire spectrum of clinical trial stages, including evaluating mechanisms, efficacy and effectiveness, along with implementation and dissemination research in the communities the intervention is designed to serve. |
| Science of Behavior Change (SOBC) (37,38) | Recommends to focus early research to identifying mechanisms of behavior change, and then evaluate whether those changes in the mechanisms cause behavior change. |
| Community-Based Participatory Research (CBPR) (39) | Focuses on active involvement of community members, organizational representatives, and researchers in the entire research process. |
| Multiphasic Optimization Strategy (MOST) (40) | Uses fractional factorial design to identify active and inactive components of interventions, to make them efficient and effective. |
| Mindfulness-Based Program Adaptation Model (41) | Provides recommended steps and knowledge for the team to have in order to determine why, when, and how to adapt mindfulness-based programs to specific populations or contexts. |
| Grading of Recommendations, Assessment, Development and Evaluations (GRADE) (42) | Framework for creating and reporting evidence syntheses. Provides a tool for making clinical practice recommendations, via grading the quality of evidence. |
| Cochrane Risk of Bias Tool (43) | Evaluates risk of bias in clinical trials |
| Standard Protocol Items: Recommendations for Interventional Trials (SPIRIT) and SPIRIT PRO frameworks (44,45) | Recommendations for minimal content for methodological robust clinical trials |
| CONSORT guidelines (46) | Provides consolidated standards of reporting clinical trials, extended to randomized trials of nonpharmacologic treatments. |

## Accurate and Precise Measurement

Key to knowing whether *X* influences *Y* is to measure *X* and *Y* well. When *X* is the amount of home meditation practice, most studies to date have used retrospective reporting or diaries of practice amount. In this special issue, Levi *et al*. (47) measured home mindfulness practice using intensive experience sampling, and in doing so, they found no cumulative or additive effects of total mindfulness meditation practice on outcomes at post-intervention. However, they did find that daily dose of mindfulness meditation home practice significantly predicted same-day levels of state mindfulness, decentering, and emotional valence. This provides more nuanced evidence that the potential value of daily mindfulness practice for wellbeing is apparent, but short-lived, with the potential of a "use it or lose it" scenario, where the beneficial effects don't last into the next day or beyond, at least with novice practitioners after completing a 21-day mindfulness program. The nuance of these effects also highlights the need for objective (behavioral) measures of practice and mindfulness *per se*.

## Causal Inference Derived From Control Groups

There is considerable debate regarding optimal control groups for mindfulness studies (48). Control groups can be designed along the spectrum from inactive to active controls, and from pragmatic to explanatory (i.e., dismantling) studies. While the gold-standard FDA model requires new drug treatments to outperform placebo control in RCTs, many researchers are interested in comparing mindfulness interventions to active controls. Several active control groups are employed in reports in this special issue, such as the neurobiology of addiction psychoeducation control (26) used as a control for the Moment-by-Moment in Women's Recovery intervention for substance use and relapse; the loving-kindness training used as a control for mindfulness training in promoting physical activity (32), and the Health Enhancement Program (HEP) used as a control for the non-specific effects of MBSR on glucocorticoid resistance (49). Active control conditions vary greatly across mindfulness intervention trials. A null effect for a mindfulness program examined in relation to a validated treatment (e.g., cognitive behavioral therapy) leads to a much different interpretation than a null effect examined in relationship to a placebo control condition; the former can be interpreted as a comparative effectiveness trial to determine whether the effects of two clinically viable interventions are similar or different, while the latter can be interpreted as evaluating whether the mindfulness intervention outperforms the placebo-related effects of interventions such as expectancy. Placebo control conditions are not straight-forward to implement in mindfulness studies, and Davies et al in this special issue report on their work developing a sham mindfulness intervention (29). In an effort to promote clarity and transparency in control conditions, Michie *et al*. developed a rigorous and comprehensive Behavior Change Technique (BCT) taxonomy (50). It systematically validates 93 unique BCTs that are active components of behavioral interventions. Use of BCT taxonomies such as this allows scholars to parse the elements of both the mindfulness intervention and the control groups that may influence health outcomes, so that we can better understand which active components of the control conditions, and mindfulness interventions, are driving the observed effects. For example, if an active control condition includes the BCT components "self-monitoring of behavior," "goal setting," and "social support," then if a mindfulness intervention out-performs that active control, we can infer that the effects of the mindfulness intervention are not solely due to the BCT components contained in that active control. This

knowledge improves mechanistic understanding of how mindfulness interventions engender change. Lindsay *et al.* provide one example, where a mindfulness app that trained monitoring present-moment experiences alone vs. monitoring-training coupled with an orientation of acceptance, showed that the acceptance elements were important for reducing loneliness and increasing social interactions (51). Too often the control intervention components are scantly described, and so inferences are unnecessarily foggy. This is important, evidenced in part by the CONSORT statement recommending that all non-pharmacologic studies provide descriptions of "precise details of both the experimental treatment and comparator" and "description of the different components of the interventions" (46). Loucks *et al*. further discuss this challenge in their paper in this special issue (33). Freedland *et al.* and Michie *et al.* have made important contributions to the scholarship around this issue, and Freedland *et al.* emphasize the importance of selecting the control group that best answers the research question (48,52).

### Delivery and Scalability of Mindfulness Interventions

While the first 30 years of mindfulness research focused on evaluating in-person mindfulness programs, because of advances in technology and most recently, the COVID-19 pandemic, many mindfulness programs are now delivered remotely using digital and/or audio technology, either synchronously or asynchronously. For example, the study by Sala *et al*. demonstrated the acceptance, feasibility and early efficacy of an asynchronous audio-delivered mindfulness training program for physical activity (34). Indeed, a recent study of the *Finding Peace in a Frantic World* mindfulness curriculum, in participants randomized to either read the book or take an in-person class, showed health benefits from both delivery modalities, and health the benefits were greater in those provided with the in-person program (53). Identifying non-traditional and efficacious methods of delivery is essential for increasing accessibility of these interventions and improving their integration into communities. In addition, including communities of color and other historically disadvantaged groups in the development, delivery, and dissemination of behavioral interventions is critical to addressing disparities in research representation, and efficacy outcomes in particular, and ultimately may help to combat the profound health inequities that exist today (54).

### Effect Modifiers

A key question at this time is "For whom are mindfulness programs most and least effective?" Studies in this special issue explore this question, examining factors such as race (24), exposure to early life abuse (25), as well as personality, depressive symptoms, and executive function (55). This kind of work will help us understand the boundary conditions for whom mindfulness interventions are most well-suited, along with identifying when, if, and how to adapt mindfulness programs for specific populations and contexts.

While it is important to address innovative questions about key issues of our time using methodologically rigorous study designs and data interpretation methods, there remain many opportunities for the field.

## THE FUTURE OF MINDFULNESS RESEARCH

We began this article by calling attention to the global challenges during the preparation of this special issue: a global pandemic, increasing rates of social isolation, racism and social injustice, and increasing mental and physical health burdens. The emerging science described in this special issue suggests that mindfulness training is well-poised to foster resilience among individuals and communities dealing with these challenges. Indeed, initial studies show that mindfulness interventions have the potential to protect against viral transmission (56), can increase positive health behaviors (32–34), reduce loneliness (33,51) and positively impact stress-related health and disease risks (57–60). But we are still in the early days of establishing a rigorous evidence-based mindfulness intervention science, and there remain many gaps in our knowledge, and in our ability to translate our science into practice.

The future of mindfulness intervention science hinges on our ability to address these important questions using the most rigorous scientific methods. This special issue and editorial paper push on leading questions around the benefits of mindfulness interventions for at-risk populations, and around those populations who are most likely to benefit (or not) from these interventions.

Theories and initial data suggest that populations with higher stress burdens are the most likely to experience health benefits from mindfulness interventions (57,61) although more research is still needed. It is still unknown whether mindfulness interventions can have enduring effects on addressing inter-group biases and social/racial injustice (57,62,63). We still need a better understanding of the biobehavioral mechanisms of mindfulness interventions, as well as studies rigorously measuring and evaluating clinical disease endpoints. While we currently have some initial mindfulness intervention effects on biobehavioral mechanisms and clinical outcomes, the field is now poised to conduct large, well-controlled RCTs of mindfulness interventions, and it is time we focus our efforts and collaborate on multi-site trials that target key mechanisms and disease endpoints. One of the principal challenges (and opportunities) facing mindfulness intervention science is in our ability to shift to more scalable interventions– our current standard bearers are the in-person group-based MBSR programs (49,64,65), and variants. But this intervention can be more difficult to scale than asynchronous digital mindfulness programs, thereby limiting access for hard-to-reach populations. Increasingly, there have been more efforts to use remote or online delivery approaches (e.g., (66)) which is key not only for building a more scalable science, but also for testing and evaluating the safety and efficacy of these programs, since millions of people are now using mindfulness apps and online delivery platforms. The global pandemic and quarantine guidelines have pushed many mindfulness training programs into an online delivery format, and our science still lags on what impacts different delivery modalities have on access, outcomes, and risks.

The success and impact of mindfulness intervention science depends on our ability to study diverse populations. Like many of the scientific literatures on behavioral interventions, the emerging mindfulness intervention literature oversamples white, middle-aged, educated women from just a couple of industrialized countries (57). The global pandemic has revealed that marginalized communities are often the first and most profoundly impacted by major stressful events. Thus, it is of paramount importance that mindfulness interventions and the research evaluating them are culturally relevant, inclusive, and accessible. Several articles in this special issue highlight the benefits of studying mindfulness interventions in more diverse populations and settings, asking

important questions about how these interventions can be culturally tailored to the contexts in which they are delivered. Ultimately, the broad adoption of mindfulness interventions will depend on whether we can make public health impacts across diverse populations.

The future of mindfulness intervention research depends on our ability to make the leap from preliminary efficacy trials, to multi-site trials testing efficacy, to effectiveness trials of sustainable mindfulness interventions in communities. Dimidjian and Segal (35) provided an excellent review about the gaps in our knowledge base of mindfulness interventions, and ways we can address these gaps. But broadly, some of their recommendations remind us of the importance of generating a plan for implementation science. Using implementation science principles, can we build effective and sustainable mindfulness interventions that are embedded in communities (e.g., workplaces, health care centers, institutions of higher education, religious and spiritual settings, community centers), helping the people who need them the most? In the near term, we can build pragmatic trials that address the impacts of mindfulness interventions for broader groups of people, while also designing the next generation of effectiveness trials. This work can be done in community settings and in patient care clinics, offering mindfulness interventions to foster resilience and health in the midst of our existing challenges and those that arise in the future.

## CONCLUSIONS

Amidst a period of great unrest and suffering, the emerging science on mindfulness interventions reminds us of the benefits of being present, curious, open, and non-judgmental in order to support skillful action. We expect that this special issue on *Mindfulness: Biobehavioral Mechanisms and Health Outcomes* provides steps forward in high quality research that the readership can interpret, communicate, and apply to our communities in need.

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