Lifestyle Medicine and Stress Management

Kaylan A. Baban, MD, MPH; Darren P. Morton, PhD

doi: 10.12788/jfp.0285

INTRODUCTION

"Stress" is ubiquitous in modern society, and it has been further exacerbated by the COVID-19 pandemic. In the report titled *Stress in America 2020: A National Mental Health Crisis*, issued by the American Psychological Association, it was concluded that the United States is in the midst of a stress-related mental health epidemic that could result in serious long-term health consequences.[1] While there are many catalysts of stress, frequently reported sources in the United States include finances, work, relationships, ill-health, and, more recently, existential concerns about the future of the nation and climate change.[1]

Stress is unequivocally linked to poor health outcomes, as detailed in this article, due to both its physiologic and behavioral effects. Accordingly, the provision of stress management techniques constitutes an integral component of leading lifestyle medicine interventions.[2,3] The American College of Lifestyle Medicine considers stress management to be one of the 6 pillars of lifestyle medicine, alongside healthful eating, physical activity, sleep, social connection, and the avoidance of risky substances.[4] Notably, many of the pillars of lifestyle medicine are also evidence-based approaches for managing stress, demonstrating the interconnectedness of these pillars of health and well-being.

This article examines the reciprocal relationship between stress and health and builds a case for the importance of stress management knowledge for family physicians in the prevention, management, and treatment of chronic diseases. It also explores lifestyle medicine practices for managing stress, with special attention given to mindfulness-based activities, and provides practical strategies for managing stress.

Kaylan A. Baban, MD, MPH[1]

Darren P. Morton, PhD[2]

AUTHOR AFFILIATIONS

[1] George Washington University School of Medicine and Health Sciences, Washington, DC

[2] Lifestyle Medicine and Health Research Centre, Avondale University, Australia

DISCLOSURES

The authors have no conflicts of interest to disclose.

STRESS AND HEALTH

Building on the pioneering studies of Hans Selye,[5] who first coined the term "stress response" to explain the activation of the hypothalamic-pituitary-adrenal axis in response to a "stressor," there is now overwhelming evidence linking chronic stress to poor health outcomes. Numerous and diverse illnesses, including coronary artery disease,[6] heart failure,[7] asthma,[8] rheumatoid arthritis,[9] and psoriasis,[10] to name a few, are known to be directly moderated by stress. Not surprisingly, stress is also intimately related to mental illness—especially anxiety.[11]

Stress can affect physical health outcomes in 2 ways. First, it has direct physiologic consequences consistent with activation of the sympathetic nervous system, including cardiovascular responses, alterations in gut function, and even downregulation of immune function.[11] Indeed, psychoneuroimmunology studies have demonstrated that stress results in significantly slower wound healing.[12] In addition to the physiologic changes that accompany the stress response, stress can adversely affect health behaviors resulting in poorer dietary choices, inactivity, disordered sleep, and substance use.[13-16] As a topical example, nearly half of adults (49%) reported their behavior has been negatively affected by the stress caused by the COVID-19 pandemic,[1] and eating disorder–related hospital admissions have doubled.[17] Once developed, stress can further compound the challenge of behavior change, making the practice of healthy behaviors more difficult. For these reasons, evidence-based stress management should be considered foundational for the management of chronic health conditions.

STRESS MANAGEMENT

It is important to qualify that stress is not necessarily nega-

tive. In their seminal paper in 1908, Yerkes and Dodson[18] described the relationship between arousal/stress and performance as an "inverted U," with low levels of psychological arousal resulting in poor performance, moderate levels of arousal conferring optimal performance outcomes, and high levels of arousal resulting in diminished performance. This relationship infers that some level of arousal/stress, which varies between individuals, is required for optimal functioning. Only high levels of arousal/stress, more appropriately referred to as "distress," are detrimental to function and performance. Further, even high levels of sympathetic activation (associated with the "stress response") may be beneficial in the short term as such levels optimize our ability to "fight or flight." It is prolonged, chronic activation of the stress response that is most deleterious.

Stress management can be achieved in 2 ways: by reducing exposure to a stressor(s) and/or practicing techniques that alleviate stress. As modern living presents an increasing number of stressors and reducing exposure to these can be challenging, there is an increasing emphasis on the practice of stress-relieving techniques.

A variety of lifestyle-based practices can play an important role in ameliorating the stress response, as presented below. However, it is also acknowledged that stressed individuals can find it more challenging to follow through on positive lifestyle choices. Indeed, conditions of stress can often mobilize individuals towards unhealthy and even counterproductive behaviors, as discussed below. Increasing awareness of the benefits of these healthy lifestyle behaviors for managing stress (and related affective conditions such as depression and anxiety) and supporting patients to adopt them can be beneficial.

NUTRITION

It is well recognized that psychological stress can alter feeding behaviors by influencing the production of neuropeptides (eg, ghrelin, somatostatin, galanin) and neurotransmitters (eg, norepinephrine, serotonin, dopamine) that in turn affect appetite and result in an increased propensity for consuming high-fat foods.[13,19] Conversely, there is growing interest in the influence of nutrition on affective states, with several studies demonstrating the benefits of nutrition interventions for the management and treatment of depression.[20,21]

One of the confounders of researching the influence of diet on stress is differing views on what constitutes a healthy diet. One study concluded that the ability of diet quality to ameliorate the effects of high stress is small, but their conceptualization of a "high-quality" diet included soft margarines, unsweetened dairy, and oils.[22] While there is some debate regarding specific food items that constitute a healthy diet, there is a consensus that the consumption of whole, plant-rich foods produces positive health outcomes, and this is a position promoted by the American College of Lifestyle Medicine. Certainly, vegetarian diets have been associated with reduced stress.[23]

Plant foods may aid stress management and other psychological conditions through a "psychobiotic" effect, in which the gut microbiota influences brain function through neural and hormonal pathways.[13,24,25] The gut microbiota is especially influenced by diet quality and, while the Western diet is associated with dysbiosis, a high-fiber diet (eg, whole, plant-based foods) promotes a gut microbial profile associated with good physical and mental health.[26] Consequentially, attention to consuming more servings of fruits, vegetables, whole grains, and legumes should be encouraged as a stress-coping strategy.

EXERCISE

Like nutrition, physical activity constitutes a cornerstone of positive physical and mental health.[27,28] However, a systematic review of 168 studies concluded that psychological stress and physical activity are inversely related, indicating that stress impairs an individual's efforts to be physically active.[14] Notwithstanding the challenge that being stressed presents to being physically active, exercise is of tremendous benefit for stress management.

Simply put, the stress response prepares the body for "fight or flight"—both of which are physical pursuits—and the act of physical exertion allows the body and brain to return to homeostasis. From a physiologic perspective, physical activity may aid stress management as it activates the release of beta-endorphins and other neurotransmitters, increases thermogenesis, aids in the regulation of the hypothalamic-pituitary-adrenal axis, and even increases neurogenesis.[27,29] A systematic review concluded that a single bout of exercise (30 minutes at 50% maximal oxygen uptake) could have a significant impact on blood pressure responses to a psychosocial stressor.[30] Similarly, 10 minutes of exercise has been shown to improve levels of vigor and reduce total negative mood.[31] In addition to the physiologic benefits of exercise, it has been proposed that from a psychological viewpoint, exercise may confer a "time out" effect by offering a distraction from daily cares and worries.[32]

To date, most studies have focused on the benefits of low- to moderate-intensity aerobic exercise for the management of mental health conditions, but studies are investigating the benefits of other types of activities such as resistance exercise and high-intensity activities.[29,33] There is emerging evidence that higher-intensity exercise may confer additional mood-enhancing benefits.[29] While more research is required

to understand better the influence of different forms of exercise on mental health, as well as optimal dosages and durations, individuals suffering from stress should be encouraged to aim for the National Physical Activity Guidelines goal of 30 minutes of moderate-intensity activity on most days.[34]

SLEEP

As with both diet and exercise, there is a reciprocal relationship between stress and sleep. Notably, health professionals in numerous countries appear to be especially vulnerable to stress-mediated poor sleep hygiene.[35,36] Indeed, stress is a major contributor to insomnia, and sleep system responses to stress are influenced by genetics, having a family history of insomnia, the female gender, and the type of stress being experienced.[15] Poor sleep can compound stress levels as sleep deprivation results in the human brain being more attuned to negativity.[37] Notwithstanding the effect of stress on sleep quality and quantity, from a stress management viewpoint, attention should be given to prioritizing sleep and pursuing good sleep.

The National Sleep Foundation's guidelines recommend that individuals get 7 to 9 hours of sleep per night—a recommendation that at least one-third of adults fail to meet.[38] Three especially important contributors to poor sleep hygiene are physical inactivity, caffeine usage, and exposure to "night light pollution."[39] These can be addressed by encouraging patients to be more active (especially in the morning), curb or cease the consumption of caffeine (especially later in the day), and avoid bright light (especially screens that emit "blue" light) in the hour before bed.

SOCIAL CONNECTION

Social connection is a well-established determinant of mental and emotional well-being, physical health outcomes, and longevity.[40] Humans appear to be "wired" for social connection, which is why the social isolation and associated loneliness due to COVID-19 lockdowns have been such a concern.[41] In the context of stress management, social support can buffer the negative effects of stress on mental and physical health.[42]

Unlike eating patterns and physical activity levels, which tend to suffer in response to stress, studies indicate that humans are more likely to exhibit prosocial behavior and seek social connection when stressed.[43] This behavioral response has been referred to as the "tend-and-befriend" pattern and is observed in both males and females.[44] According to the Social Baseline Theory, when faced with a stressor, individuals with strong social support perceive less threat, which reduces cognitive and physiologic effort, thereby mitigating the stress response.[45]

The importance of maintaining social ties as a deliberate stress management strategy should not be underestimated. Individuals encountering high levels of stress should be encouraged and enabled to remain connected to friends and family, and, where necessary, to reach out to broaden their social network. Interestingly, even brief social interactions with acquaintances, referred to as "micromoments of connection," can produce positive health benefits.[46]

AVOIDANCE OF RISKY SUBSTANCES

Stress is associated with increased substance (eg, alcohol, drugs, tobacco) usage, dependence, and relapse.[16] In the context of COVID-19, a phenomenon referred to as the Behavioral Immune System (BIS), in which individuals practice certain behaviors to avoid contracting illness, is associated with increased stress and anxiety that leads to increased substance use.[47] Not surprisingly, the use of alcohol, drugs, and tobacco is counterproductive for long-term stress management and can indeed lead to further complications that exacerbate stress. Hence, patients should be advised to avoid these substances—even though doing so may be quite difficult for them.

TIME IN NATURE

While not considered a "pillar" of lifestyle medicine, there is growing evidence for the stress-relieving benefits of time in nature. A meta-analysis of 32 studies concluded that exposure to natural environments leads to less negative affect and greater positive affect.[48]

Time in nature might confer stress-relieving benefits through several mechanisms,[49] but a prominent theory is that modern living makes high demands of our information-processing skills, leading to mental strain. Conversely, natural stimuli, such as landscapes and animals, effortlessly engage our attention, leading to less mental fatigue.[50] As the evidence continues to accumulate regarding a link between time in nature and health (both mental and physical), exposure to nature should be considered a more frontline therapy for stress management.

MIND-BODY PRACTICES

A large body of literature demonstrates the efficacy of a range of practices for managing stress, including biofeedback,[50] prayer,[50] yoga,[51] tai chi,[52] and various forms of meditation.[53,54] Though a concise umbrella term has not been coined to encompass the full scope of these tools, for the purposes of this manuscript we will refer to methods demonstrated to engage the relaxation response and increase parasympathetic activation through nonjudgmental focused attention and/or through intentional movement as "mind-body practices."

Known short-term effects of mind-body practices that activate the relaxation response include slowed heart rate, lowered blood pressure, reduced serum cortisol, improved cognitive function, and lower perceived stress.[51] After several weeks of daily practice, mind-body practices have been shown to result in numerous physiologic changes such as lower peak cortisol levels and fewer cortisol spikes,[55] improved immune function,[56,57] delayed ST-segment depression on stress electrocardiogram of patients with coronary artery disease,[58] improved insulin sensitivity in metabolic syndrome,[59] increased heart rate variability,[60] downregulation of proinflammatory genes and biomarkers,[61] epigenetic modifications,[62,63] and even reversal of telomere shortening.[64,65] The long-term practice of mind-body relaxation techniques (eg, years of daily practice) is associated with appreciable growth of the hippocampus and left prefrontal cortex[65,66] and improved function of the amygdala,[67] which is in turn associated with cognitive and affective benefits.

An evidence-based practice that is increasingly used for stress management is mindfulness. Mindfulness can be defined as a nonjudgmental state of intentionally focused attention to the present and what is happening around or inside an individual at that moment.[68] The advantage of mind-body techniques is that they do not require significant time commitment or training, and hence can be easily practiced in most settings, including brief clinical visits. For example, brief mindful stretching, giving attention to the sensation of one's feet on the ground when walking or sitting, or using one's conversational partner/patient as a focus of mindful attention, can be used under virtually any circumstances. Indeed, any informal activity can be done mindfully—dancing, walking, guitar playing, woodworking, tooth brushing, and even dish washing. With only 1 or 2 minutes to dedicate, more formal mind-body activities, such as box breathing[69] (used in military training and combat), body scans,[70] and brief seated[71] or walking meditations,[72] can be practiced either alone or with a digital guide.

It is important to note that mindfulness practices can be challenging for patients with histories of emotional trauma.[73] Although such history is not a contraindication and can, in fact, yield subjective and physiologic benefits,[74] it is recommended the patient be informed of this possibility and encouraged to coordinate with their mental health provider. In the case that a patient finds a particular mind-body practice disagreeable due to exacerbation of emotional trauma, the patient may discontinue and try another mind-body technique. Mindful movements appear to hold a lower risk of this adverse effect than purely cognitive-based practices.[75]

When unhealthful behaviors such as smoking[76] and overeating[77] are to be addressed, mind-body techniques should be considered as adjuncts to usual care. Promoting the nonjudgmental focused attention of mindfulness can bring increased recognition of potential triggers and awareness of poor choices as they are being made, without yielding the self-judgment that can often exacerbate maladaptive coping strategies.[78-80] In turn, this presents the opportunity to intervene intentionally and redirect behavior rather than acting reflexively—an approach to behavior modification sometimes referred to as mindfulness-based cognitive therapy. Mindfulness can also be used both as a substitute for maladaptive coping mechanisms and to build resilience that supports successful behavior modification by better managing the associated stress.

As with any behavior, adherence to mind-body activities is more likely if it is aligned with the patient's interests, needs, and personality. For example, biofeedback activities might resonate with a data-oriented patient, while mindful movements may be better for a patient with attention-deficit/hyperactivity disorder who may find it challenging to sit still. Other mind-body practices may be selected to benefit certain comorbidities. For example, an evening body scan (involving mindful attention to different regions of the body) for a patient experiencing stress-induced insomnia may help reduce or avoid sedative-hypnotics,[81] tai chi may be appropriate for a patient at risk for falls,[82,83] and mindful eating may assist patients with diabetes and a tendency toward unhealthful dietary choices.[81] Conversely, some comorbidities may be a relative contraindication. For example, breath-focused practices should, in general, be avoided in patients for whom breathing is not comfortable, as with patients suffering from chronic obstructive pulmonary disease. Mind-body techniques can also be used to good effect as an adjunctive treatment for conditions such as panic disorder and chronic pain.[86,87] It is often beneficial to acquaint a patient with a variety of mind-body modalities suitable for a range of circumstances (still or moving, alone or in company, seconds or minutes), and to engage in shared decision-making to identify the practices best tailored to the patient's interests and needs.

Notably, mind-body practices have been shown to have demonstrated benefits for healthcare providers—reduced perceived stress, fewer medical errors, improved job satisfaction, and lower burnout[88-90]—as well as for their patients—improved adherence, outcomes, and a greater perception of provider empathy.[90] When used by surgeons, mind-body practices have been shown to improve physical function and mental focus during long or difficult procedures.[91] Given the well-documented epidemic of burnout and stress-related illnesses in the medical profession,[92] the connection between mind-body practices and job satisfaction is particularly rel-

evant, and brief mind-body activities can often be integrated into a provider's busy day (eg, walking a hall, speaking with a patient or colleague, performing surgery, etc).[93] While the optimal frequency and duration of mind-body practices are yet to be determined, appreciable benefits have been observed with consistent practice of approximately 10 minutes daily,[94,95] which puts these benefits within the reach of any interested provider.

MULTIMODAL APPROACHES FOR STRESS MANAGEMENT

This article has explored several evidence-based approaches that can be used to build a versatile stress management "toolkit." While patient preferences and interests are an important consideration when prescribing stress management options, it is also important to recognize that stress may be best managed through a multimodal approach that incorporates a variety of strategies and practices.[96-99] Interventions that have applied a multimodal approach have suggested that a compounding benefit may occur.[98,99] Hence, introducing a variety of stress management options to patients is recommended. ●

REFERENCES

1. American Psychological Association. *Stress in America™ 2020: A National Mental Health Crisis*. Published October 2020. Accessed September 7, 2021. https://www.apa.org/news/press/releases/stress/2020/sia-mental-health-crisis.pdf
2. Ornish D, Brown SE, Scherwitz LW, et al. Can lifestyle changes reverse coronary heart disease? The Lifestyle Heart Trial. *Lancet*. 1990;336(8708):129-133.
3. Morton D, Rankin P, Kent L, Dysinger W. The Complete Health Improvement Program (CHIP): history, evaluation, and outcomes. *Am J Lifestyle Med*. 2014;10(1):64-73.
4. American College of Lifestyle Medicine. What is Lifestyle Medicine? Accessed September 7, 2021. https://www.lifestylemedicine.org/ACLM/About/What_is_Lifestyle_Medicine/ACLM/About/What_is_Lifestyle_Medicine_/Lifestyle_Medicine.aspx?hkey=26f3eb6b-8294-4a63-83de-35d429c3bb88
5. Tan SY, Yip A. Hans Selye (1907-1982): founder of the stress theory. *Singapore Med J*. 2018;59(4):170-171.
6. Gentile C, Starnino L, Dupuis G, D'Antono B. Mindfulness-based stress reduction in older adults at risk for coronary artery disease: a pilot randomized trial. *Clin Gerontol*. 2021:1-15.
7. Gok Metin Z, Ejem D, Dionne-Odom JN, et al. Mind-body interventions for individuals with heart failure: a systematic review of randomized trials. *J Card Fail*. 2018;24(3):186-201.
8. Chen E, Miller GE. Stress and inflammation in exacerbations of asthma. *Brain Behav Immun*. 2007;21(8):993-999.
9. Cutolo M, Straub RH. Stress as a risk factor in the pathogenesis of rheumatoid arthritis. *Neuroimmunomodulation*. 2006;13(5-6):277-282.
10. Gaston L, Lassonde M, Bernier-Buzzanga J, Hodgins S, Crombez J-C. Psoriasis and stress: a prospective study. *J Am Acad Dermatol*. 1987;17(1):82-86.
11. Daviu N, Bruchas MR, Moghaddam B, Sandi C, Beyeler A. Neurobiological links between stress and anxiety. *Neurobiol Stress*. 2019;11:100191.
12. Kiecolt-Glaser JK, Loving TJ, Stowell JR, et al. Hostile marital interactions, proinflammatory cytokine production, and wound healing. *Arch Gen Psychiatry*. 2005;62(12):1377-1384.
13. Bremner JD, Moazzami K, Wittbrodt MT, et al. Diet, stress and mental health. *Nutrients*. 2020;12(8):2428.
14. Stults-Kolehmainen MA, Sinha R. The effects of stress on physical activity and exercise. *Sports Med*. 2014;44(1):81-121.
15. Kalmbach DA, Anderson JR, Drake CL. The impact of stress on sleep: pathogenic sleep reactivity as a vulnerability to insomnia and circadian disorders. *J Sleep Res*. 2018;27(6):e12710
16. Lin S-Y, Fried EI, Eaton NR. The association of life stress with substance use symptoms: a network analysis and replication. *J Abnorm Psychol*. 2020;129(2):204-214.
17. Otto AK, Jary JM, Sturza J, et al. Medical admissions among adolescents with eating disorders during the COVID-19 pandemic. *Pediatrics*. 2021;148(4):e2021052201.
18. Yerkes RM, Dodson JD. The relation of strength of stimulus to rapidity of habit-formation. *J Comp Neurol Psychol*. 1908;18(5):459-482.
19. Weltens N, Zhao D, Van Oudenhove L. Where is the comfort in comfort foods? Mechanisms linking fat signaling, reward, and emotion. *Neurogastroenterol Motil*. 2014;26(3):303-315.
20. Jacka FN, O'Neil A, Opie R, et al. A randomised controlled trial of dietary improvement for adults with major depression (the 'SMILES' trial). *BMC Med*. 2017;15(1):23.
21. Parletta N, Zarnowiecki D, Cho J, et al. A Mediterranean-style dietary intervention supplemented with fish oil improves diet quality and mental health in people with depression: a randomized controlled trial (HELFIMED). *Nutr Neurosci*. 2019;22(7):474-487.
22. Schweren LJS, Larsson H, Vinke PC, et al. Diet quality, stress and common mental health problems: a cohort study of 121,008 adults. *Clin Nutr*. 2021;40(3):901-906.
23. Beezhold BL, Johnston CS, Daigle DR. Vegetarian diets are associated with healthy mood states: a cross-sectional study in Seventh Day Adventist adults. *Nutr J*. 2010;9(1):26.
24. Foster JA, Rinaman L, Cryan JF. Stress & the gut-brain axis: regulation by the microbiome. *Neurobiol Stress*. 2017;7:124-136.
25. Valles-Colomer M, Falony G, Darzi Y, et al. The neuroactive potential of the human gut microbiota in quality of life and depression. *Nat Microbiol*. 2019;4(4):623-632.
26. Makki K, Deehan EC, Walter J, Bäckhed F. The impact of dietary fiber on gut microbiota in host health and disease. *Cell Host Microbe*. 2018;23(6):705-715.
27. Mikkelsen K, Stojanovska L, Polenakovic M, Bosevski M, Apostolopoulos V. Exercise and mental health. *Maturitas*. 2017;106:48-56.
28. Smith PJ, Merwin RM. The role of exercise in management of mental health disorders: an integrative review. *Annu Rev Med*. 2021;72(1):45-62.
29. Saanijoki T, Tuominen L, Tuulari JJ, et al. Opioid release after high-intensity interval training in healthy human subjects. *Neuropsychopharmacology*. 2018;43(2):246-254.
30. Hamer M, Taylor AH, Steptoe A. The effect of acute aerobic exercise on stress related blood pressure responses: a systematic review and meta-analysis. *Biol Psychol*. 2006;71:183-190.
31. Hansen CJ, Stevens LC, Coast RJ. Exercise duration and mood state: how much is enough to feel better? *Health Psychol*. 2001;20(4):267-275.
32. Breus MJ, O'Connor PJ. Exercise-induced anxiolysis: a test of the "time out" hypothesis in high anxious females. *Med Sci Sports Exerc*. 1998;30(7):1107-1112.
33. Stanton R, Reaburn P, Happell B. Is cardiovascular or resistance exercise better to treat patients with depression? A narrative review. *Issues Ment Health Nurs*. 2013;34(7):531-538.
34. Piercy KL, Troiano RP, Ballard RM, et al. The Physical Activity Guidelines for Americans. *JAMA*. 2018;320(19):2020-2028.
35. Almojali AI, Almalki SA, Alothman AS, Masuadi EM, Alaqeel MK. The prevalence and association of stress with sleep quality among medical students. *J Epidemiol Glob Health*. 2017;7(3):169-174.
36. Deng X, Liu X, Fang R. Evaluation of the correlation between job stress and sleep quality in community nurses. *Medicine (Baltimore)*. 2020;99(4):e18822.
37. Yoo S-S, Gujar N, Hu P, Jolesz FA, Walker MP. The human emotional brain without sleep — a prefrontal amygdala disconnect. *Curr Biol*. 2007;17(20):R877-R878.
38. Hirshkowitz M, Whiton K, Albert SM, et al. National Sleep Foundation's updated sleep duration recommendations: final report. *Sleep Health*. 2015;1(4):233-243.
39. Bedrosian TA, Nelson RJ. Influence of the modern light environment on mood. *Mol Psychiatry*. 2013;18(7):751-757.
40. Holt-Lunstad J. The major health implications of social connection. *Curr Dir Psychol Sci*. 2021;30(3):251-259.
41. Wu B. Social isolation and loneliness among older adults in the context of COVID-19: a global challenge. *Glob Health Res Policy*. 2020;5(1):27.
42. Wiesmaierova S, Petrova D, Arrebola Moreno A, Catena A, Ramírez Hernández JA, Garcia-Retamero R. Social support buffers the negative effects of stress in cardiac patients: a cross-sectional study with acute coronary syndrome patients. *J Behav Med*. 2019;42(3):469-479.
43. von Dawans B, Fischbacher U, Kirschbaum C, Fehr E, Heinrichs M. The social dimension of stress reactivity: acute stress increases prosocial behavior in humans. *Psychol Sci*. 2012;23(6):651-660.
44. von Dawans B, Ditzen B, Trueg A, Fischbacher U, Heinrichs M. Effects of acute stress on social behavior in women. *Psychoneuroendocrinology*. 2019;99:137-144.
45. Coan JA, Sbarra DA. Social Baseline Theory: the social regulation of risk and effort. *Curr Opin Psychol*. 2015;1:87-91.
46. Sandstrom GM, Dunn EW. Social interactions and well-being: the surprising power of weak ties. *Pers Soc Psychol Bull*. 2014;40(7):910-922.
47. McKay D, Asmundson GJG. COVID-19 stress and substance use: current issues and future preparations. *J Anxiety Disord*. 2020;74:102274.
48. McMahan EA, Estes D. The effect of contact with natural environments on positive and negative affect: a meta-analysis. *J Posit Psychol*. 2015;10(6):507-519.
49. Kuo M. How might contact with nature promote human health? Promising mechanisms and a possible central pathway. *Front Psychol*. 2015;6:1093.
50. Pearson DG, Craig T. The great outdoors? Exploring the mental health benefits of natural environments. Opinion. *Front Psychol*. 2014;5:1178.
51. Conversano C, Orrù G, Pozza A, et al. Is mindfulness-based stress reduction effective for people with hypertension? A systematic review and meta-analysis of 30 years of evidence. *Int J Environ Res Public Health*. 2021;18(6):2882.
52. Bergen-Cico D, Possemato K, Pigeon W. Reductions in cortisol associated with primary care brief mindfulness program for veterans with PTSD. *Med Care*. 2014;52(12):S25-S31.
53. Barrett B, Hayney MS, Muller D, et al. Meditation or exercise for preventing acute respiratory infection: a randomized controlled trial. *Ann Fam Med*. 2012;10(4):337-346.
54. Davidson RJ, Kabat-Zinn J, Schumacher J, et al. Alterations in brain and immune function produced by mindfulness meditation. *Psychosom Med*. 2003;65(4):564-570.
55. Gatchel RJ, Licciardone JC. Mindfulness-based stress reduction vs cognitive behavioral therapy for chronic low back pain. *JAMA*. 2016;316(6):663.

56. Paul-Labrador M, Polk D, Dwyer JH, et al. Effects of a randomized controlled trial of transcendental meditation on components of the metabolic syndrome in subjects with coronary heart disease. *Arch Intern Med*. 2006;166(11):1218-1224.
57. Brown L, Rando AA, Eichel K, et al. The effects of mindfulness and meditation on vagally mediated heart rate variability: a meta-analysis. *Psychosom Med*. 2021;83(6):631-640.
58. Heckenberg RA, Eddy P, Kent S, Wright BJ. Do workplace-based mindfulness meditation programs improve physiological indices of stress? A systematic review and meta-analysis. *J Psychosom Res*. 2018;114:62-71.
59. Kuo B, Bhasin M, Jacquart J, et al. Genomic and clinical effects associated with a relaxation response mind-body intervention in patients with irritable bowel syndrome and inflammatory bowel disease. *PloS One*. 2015;10(4):e0123861.
60. Black DS, Christodoulou G, Cole S. Mindfulness meditation and gene expression: a hypothesis-generating framework. *Curr Opin Psychol*. 2019;28:302-306.
61. Dada T, Mittal D, Mohanty K. Mindfulness meditation reduces intraocular pressure, lowers stress biomarkers and modulates gene expression in glaucoma: a randomized controlled trial. *J Glaucoma*. 2018;27(12):1061-1067.
62. Schutte NS, Malouff JM, Keng S-L. Meditation and telomere length: a meta-analysis. *Psychol Health*. 2020;35(8):901-915.
63. Ahola K, Sirén I, Kivimäki M, et al. Work-related exhaustion and telomere length: a population-based study. *PloS One*. 2012;7(7):e40186.
64. Kaliman P. Epigenetics and meditation. *Curr Opin Psychol*. 2019;28:76-80.
65. Jacobs TL, Epel ES, Lin J, et al. Intensive meditation training, immune cell telomerase activity, and psychological mediators. *Psychoneuroendocrinology*. 2011;36(5):664-681.
66. Yang C-C, Barrós-Loscertales A, Li M, et al. Alterations in brain structure and amplitude of low-frequency after 8 weeks of mindfulness meditation training in meditation-naïve subjects. *Sci Rep*. 2019;9(1):10977.
67. Luders E, Toga AW, Lepore N, Gaser C. The underlying anatomical correlates of long-term meditation: larger hippocampal and frontal volumes of gray matter. *Neuroimage*. 2009;45(3):672-678.
68. Crane RS, Brewer J, Feldman C, et al. What defines mindfulness-based programs? The warp and the weft. *Psychol Med*. 2017;47(6):990-999.
69. Gotter A. Box breathing. Updated June 17, 2020. Accessed September 8, 2021. https://www.healthline.com/health/box-breathing
70. 1 minute guided body scan meditation for beginners. Accessed September 8, 2021. https://www.youtube.com/watch?v=E07n7Dtk4iA
71. Brach T. Brief meditation: arriving in mindful presence. Accessed September 8, 2021. https://www.tarabrach.com/brief-meditation-1-minute
72. Brach T. Walking meditation instructions. Accessed September 8, 2021. https://insighttimer.com/tarabrach/guided-meditations/walking-meditation-instructions
73. Britton WB. Can mindfulness be too much of a good thing? The value of a middle way. *Curr Opin Psychol*. 2019;28:159-165.
74. Tubbs JD, Savage JE, Adkins AE, Amstadter AB, Dick DM. Mindfulness moderates the relation between trauma and anxiety symptoms in college students. *J Am Coll Health*. 2019;67(3):235-245.
75. Justice L, Brems C. Bridging body and mind: case series of a 10-week trauma-informed yoga protocol for veterans. *Int J Yoga Therap*. 2019;29(1):65-79.
76. Brewer JA, Mallik S, Babuscio TA, et al. Mindfulness training for smoking cessation: results from a randomized controlled trial. *Drug Alcohol Depend*. 2011;119(1):72-80.
77. Katterman SN, Kleinman BM, Hood MM, Nackers LM, Corsica JA. Mindfulness meditation as an intervention for binge eating, emotional eating, and weight loss: a systematic review. *Eat Behav*. 2014;15(2):197-204.
78. Garland EL, Howard MO. Mindfulness-based treatment of addiction: current state of the field and envisioning the next wave of research. *Addict Sci Clin Pract*. 2018;13(1):14.
79. O'Reilly GA, Cook L, Spruijt-Metz D, Black DS. Mindfulness-based interventions for obesity-related eating behaviours: a literature review. *Obes Rev*. 2014;15(6):453-461.
80. Salmoirago-Blotcher E, Carey MP. Can mindfulness training improve medication adherence? Integrative review of the current evidence and proposed conceptual model. *Explore (NY)*. 2018;14(1):59-65.
81. Wang X, Li P, Pan C, Dai L, Wu Y, Deng Y. The effect of mind-body therapies on insomnia: a systematic review and meta-analysis. *Evid Based Complement Alternat Med*. 2019;2019:9359807.
82. Li F, Harmer P, Fitzgerald K, et al. Effectiveness of a therapeutic tai ji quan intervention vs a multimodal exercise intervention to prevent falls among older adults at high risk of falling: a randomized clinical trial. *JAMA Intern Med*. 2018;178(10):1301-1310.
83. Lomas-Vega R, Obrero-Gaitán E, Molina-Ortega FJ, Del-Pino-Casado R. Tai chi for risk of falls. A meta-analysis. *J Am Geriatr Soc*. 2017;65(9):2037-2043.
84. Miller CK. Mindful eating with diabetes. *Diabetes Spectr*. 2017;30(2):89-94.
85. Miller CK, Kristeller JL, Headings A, Nagaraja H. Comparison of a mindful eating intervention to a diabetes self-management intervention among adults with type 2 diabetes: a randomized controlled trial. *Health Educ Behavior*. 2014;41(2):145-154.
86. Goldberg SB, Tucker RP, Greene PA, et al. Mindfulness-based interventions for psychiatric disorders: a systematic review and meta-analysis. *Clin Psychol Rev*. 2018;59:52-60.
87. Saeed SA, Cunningham K, Bloch RM. Depression and anxiety disorders: benefits of exercise, yoga, and meditation. *Am Fam Physician*. 2019;99(10):620-627.
88. Daigle S, Talbot F, French DJ. Mindfulness-based stress reduction training yields improvements in well-being and rates of perceived nursing errors among hospital nurses. *J Adv Nurs*. 2018;74(10):2427-2430.
89. Saban M, Dagan E, Drach-Zahavy A. The relationship between mindfulness, triage accuracy, and patient satisfaction in the emergency department: a moderation-mediation model. *J Emerg Nurs*. 2019;45(6):644-660.
90. Xie C, Li X, Zeng Y, Hu X. Mindfulness, emotional intelligence and occupational burnout in intensive care nurses: a mediating effect model. *J Nurs Manag*. 2021;29(3):535-542.
91. Cheung EO, Barsuk JH, Mitra D, et al. Preliminary efficacy of a brief mindfulness intervention for procedural stress in medical intern simulated performance: a randomized controlled pilot trial. *J Altern Complement Med*. 2020;26(4):282-290.
92. Jackson-Koku G, Grime P. Emotion regulation and burnout in doctors: a systematic review. *Occup Med (Lond)*. 2019;69(1):9-21.
93. Brooks SK, Dunn R, Amlôt R, Rubin GJ, Greenberg N. Protecting the psychological wellbeing of staff exposed to disaster or emergency at work: a qualitative study. *BMC Psychol*. 2019;7(1):78.
94. Ribeiro L, Atchley RM, Oken BS. Adherence to practice of mindfulness in novice meditators: practices chosen, amount of time practiced, and long-term effects following a mindfulness-based intervention. *Mindfulness (NY)*. 2018;9(2):401-411.
95. Strohmaier S, Jones FW, Cane JE. Effects of length of mindfulness practice on mindfulness, depression, anxiety, and stress: a randomized controlled experiment. *Mindfulness*. 2021;12(1):198-214.
96. Przybylko G, Morton DP, Renfrew ME. Addressing the COVID-19 mental health crisis: a perspective on using interdisciplinary universal interventions. *Front Psychol*. 2021;12:644337.
97. Morton DP. Combining lifestyle medicine and positive psychology to improve mental health and emotional well-being. *Am J Lifestyle Med*. 2018;12(5):370-374.
98. Morton DP, Hinze J, Craig B, et al. A multimodal intervention for improving the mental health and emotional well-being of college students. *Am J Lifestyle Med*. 2017;14(2):216-224.
99. Przybylko G, Morton D, Kent L, et al. The effectiveness of an online interdisciplinary intervention for mental health promotion: a randomized controlled trial. *BMC Psychol*. 2021;9(1):77.