



Review Article

Effects of meditation and mind-body exercise on brain-derived neurotrophic factor: A literature review of human experimental studies

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ABSTRACT

This paper provides a literature review of current studies investigating the effects of meditation and mind-body exercise on peripheral concentrations of brain-derived neurotrophic factor (BDNF), an important mediator of the neuroplasticity of the central nervous system and cognitive function. A literature search was conducted to collect currently published randomized controlled, non-randomized controlled and uncontrolled intervention studies. Fifteen studies were identified; and among these studies, seven were randomized controlled studies, three were non-randomized studies, and five were uncontrolled studies. Current limited evidence tends to support that mindfulness meditation and mind-body exercise (e.g. yoga and tai chi) increase circulating BDNF concentrations in healthy and diseased individuals. It is noteworthy that these findings are based on current studies with a relatively small sample size, or without a randomized controlled design. Further studies are needed to identify a definite effect of meditation or mind-body exercise on BDNF and its role in improving/maintaining brain functions in various populations.

Introduction

Brain-derived neurotrophic factor (BDNF) is an important mediator of the neuroplasticity of the central nervous system, and is involved in promoting and maintaining brain functions.¹ Peripheral BDNF concentrations decline with several conditions and diseases related to changes in the central nervous system, such as aging, mild cognitive decline, depression, Parkinson's disease and Alzheimer's disease.^{2–5} In addition, BDNF appears to be an important biomarker of neuropsychiatric disorders characterized by neurodegenerative changes.⁵

The effects of physical exercise on BDNF have been well summarized by several published reviews.^{6–11} Current evidence supports that physical exercise may alter peripheral BDNF concentrations.^{6–11} In general, acute and chronic aerobic exercise increases peripheral BDNF concentrations, while strength exercise does not change BDNF concentrations.^{6,10} However, recent evidence indicates that both aerobic exercise and resistance exercise seem to increase BDNF concentrations in older adults.^{8,11}

Mindfulness meditation and mind-body exercise (e.g. qigong, yoga, and tai chi) have been reported to benefit brain functions in healthy and diseased individuals.^{12,13} Considering the important role of BDNF in regulating brain functions, a number of recent studies have focused on

the effects of meditation and mind-body exercise on peripheral BDNF concentrations. However, findings from these studies have not been well reviewed. The purpose of this review article is to summarize current evidence on potential effects of meditation and mind-body exercise on BDNF and to provide guidance for future research.

Methods

Electronic searches were conducted using PubMed/Medline, Web of Science, and the Cochrane Library from inception through August 2019. We used the following terms to conduct the searches as follows: “brain-derived neurotrophic factor” OR “BDNF” AND “meditation” OR “mindfulness” OR “qigong” OR “qi gong” OR “yoga” OR “tai chi” OR “tai ji”. Hand searches were also conducted to obtain additional references. Inclusion criteria for the studies were healthy or diseased individuals; meditation, mindfulness, or mind-body exercise protocols; randomized controlled studies, quasi-experimental studies, or uncontrolled studies; written in English; and measurement of peripheral BDNF concentrations. Exclusion criteria were animal studies; no meditation, mindfulness, or mind-body exercise intervention; and acute one-session studies. In the initial search, 115 articles were reviewed from the databases. After

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Table 1

Effects of meditation and mind-body exercise on peripheral BDNF concentrations: Randomized controlled studies.

Study	Participants	Study Design	Effects on BDNF
Ikai et al. 2014 ¹⁴	50 patients with schizophrenia or related psychotic disorders	Control group: daycare rehabilitation Experimental group: daycare rehabilitation, plus Hatha yoga 8 weeks	Compared to the control group, the experimental group: = BDNF
Lee et al., 2014 ¹⁵	25 premenopausal women with chronic low back pain	Control group: no intervention Experimental group: Hatha yoga, 1 h each session, 3 sessions each week 12 weeks	Significant group × time interactions in serum BDNF. Control group: = BDNF Experimental group: †BDNF ($p < 0.01$)
Tolahunase et al. 2018 ¹⁶	58 patients with major depressive disorder	Control group: no intervention Experimental group: yoga and meditation-based lifestyle intervention (YMLI) 12 weeks	Compared to the control group, YMLI: †BDNF ($p < 0.001$)
Dada et al. 2018 ¹⁷	90 patients with primary open-angle glaucoma	Control group: no intervention Experimental group: mindfulness meditation 3 weeks	Compared to the waitlist control group, mindfulness meditation: †BDNF ($p < 0.001$)
Gagrani et al. 2018 ¹⁸	60 patients with primary open-angle glaucoma	Control group: standard medical treatment Experimental group: standard medical treatment plus meditation 6 weeks	Compared to standard medical treatment only, standard medical treatment plus meditation: †BDNF ($p < 0.01$)
Sungkarat et al. 2018 ¹⁹	66 older adults with amnesic mild cognitive impairment	Control group: cognitive education Experimental group: tai chi 6 months	Compared to education control, tai chi: †BDNF ($p < 0.05$)
Nery et al. 2019 ²⁰	99 infertile women	Control group: no intervention Experimental group: mindful-based program (MBP) 8 weeks	Compared to the control group, MBP: = BDNF

= No change or no difference. † Elevated or higher.

removing the duplicates, 35 articles were assessed for eligibility. Among these studies, 15 studies met the inclusion criteria. This is the first review to summarize current evidence regarding the effects of meditation and mind-body exercise on BDNF.

Results

Current randomized controlled studies regarding the effects of meditation and mind-body exercise on peripheral BDNF concentrations are summarized in Table 1.^{14–20} To date, 7 randomized controlled studies have been conducted in various populations, including patients with schizophrenia, women with chronic low back pain, older adults with mild cognitive impairment, individuals with major depressive disorder, individuals with primary open-angle glaucoma, and infertile women. The interventions included mindfulness meditation, yoga and tai chi. The term ranged from 3 weeks to 6 months. Overall, the majority of the studies^{15–19} reported that mindfulness meditation or mind-body exercise increased or tended to increase peripheral BDNF concentrations in

Table 2

Effects of meditation and mind-body exercise on peripheral BDNF concentrations: Quasi-experimental studies and uncontrolled studies.

Study	Participants	Study Design	Effects on BDNF
Naveen et al. 2013 ²¹	54–65 patients with depressive disorders	Non-randomized comparison study. Drugs only: antidepressant drug treatment Yoga only: classical and contemporary yoga Drugs plus yoga: combined antidepressant drug treatment and yoga therapy as shown above 3 months	Compared to drugs only, yoga only and drugs plus yoga: †BDNF ($p < 0.05$)
Naveen et al. 2016 ²²			
Halappa et al. 2018 ²³			
Pal et al. 2014 ²⁴	60 healthy active males of three age groups (20–29, 30–39, and 40–49 years, n = 20 each)	Uncontrolled study: yogasana, pranayama and meditation 3 months	All three age groups: †BDNF ($p < 0.01$ to $p < 0.001$)
Turakitwanakan et al. 2015 ²⁵	30 healthy second-year medical students	Uncontrolled study: mindfulness meditation (breathing and attention training) 4 days	= BDNF
Cahn et al., 2017 ²⁶	38 apparently healthy individuals	Uncontrolled study: yoga and meditation 3 months	†BDNF ($p < 0.05$)
Tolahunase et al. 2017 ²⁷	96 apparently healthy individuals	Uncontrolled: yoga and meditation based lifestyle intervention 3 months	†BDNF ($p < 0.05$)
Oka et al., 2018 ²⁸	50 patients with chronic fatigue syndrome	Uncontrolled study: yoga 2 months	= BDNF

= No change or no difference. † Elevated or higher.

various populations.

Current quasi-experimental studies and uncontrolled studies regarding the effects of meditation and mind-body exercise on peripheral BDNF concentrations are summarized in Table 2. To date, there are 3 non-randomized controlled studies (belong to the same parent study)^{21–23} and 5 uncontrolled studies^{24–28} reported in the literature. The subjects were apparently healthy adults, patients with major depressive disorder, and patients with chronic fatigue syndrome. The interventions were mainly yoga and/or meditation lasting 4 days to 3 months. Current non-randomized controlled studies^{21–23} and some uncontrolled studies^{24,26,27} reported significantly increased peripheral BDNF concentrations. Two uncontrolled studies^{25,28} did not report a significant change; however, it is noteworthy that the intervention term was very short (4 days) in one of the studies.²⁵

Discussion and conclusion

To date, several randomized controlled studies have reported the

effects of meditation and/or mind-body exercise on peripheral BDNF concentrations in diseased individuals. Limited findings indicate meditation and mind-body exercise (e.g. yoga and tai chi) tend to increase BDNF concentrations in women with chronic low back pain, older adults with mild cognitive impairment, individuals with major depressive disorder, and individuals with primary open-angle glaucoma. Similar findings have been shown by non-randomized controlled studies and uncontrolled studies. It is noteworthy that current randomized controlled studies have reported a relatively small sample size, or a relatively short intervention term. More studies are needed in the future to confirm these findings and to investigate if BDNF mediates the effects of meditation and mind-body exercise on cognition and other brain functions.

Current randomized controlled studies, non-randomized controlled studies and uncontrolled studies tend to support a positive effect of meditation and mind-body exercise on BDNF concentrations. However, the limited evidence is not sufficient to identify a potential difference between mindfulness meditation and mind-body exercise in their effects on BDNF. It is important to note that exercise itself has shown to increase BDNF concentrations, thus, effect observed from mind-body exercise such as yoga and tai chi may be due to its physical demand rather than the mindfulness of the program. Therefore, it is necessary for future well-designed mind-body exercise studies to consider the influence of physical exercise alone on BDNF and clarify if mind-body exercise has an additional effect in altering peripheral BDNF concentrations in healthy and diseased individuals.

Conflict of interest

The authors declare no conflicts of interest.

Submission statement

This manuscript has not been published and is not under consideration for publication elsewhere.

Authors' contributions

TJY generated the idea, conducted literature search and drafted the paper. E.F.O., conducted literature search and revised the paper.

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